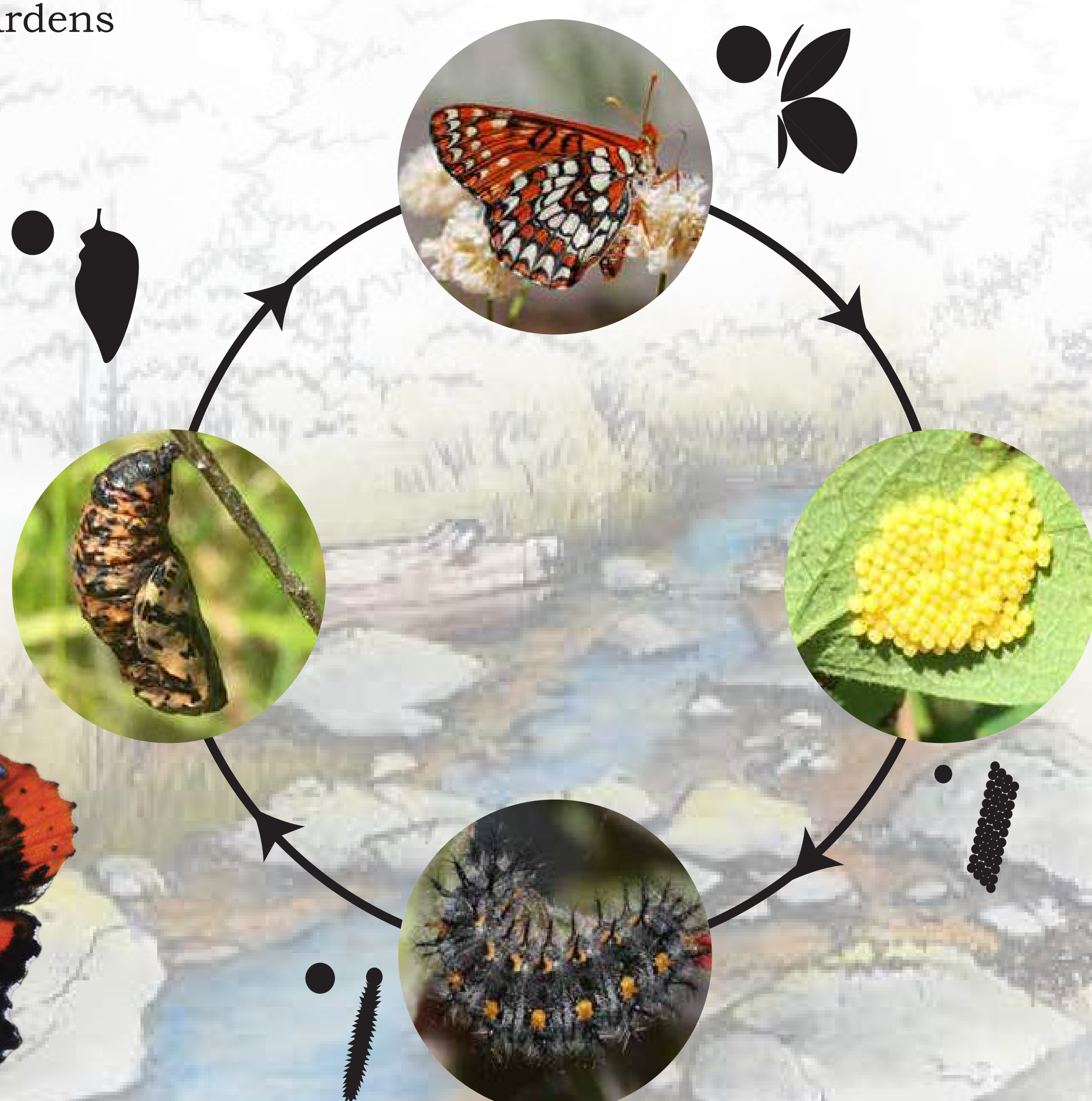
And Then There Were Butterflies

Using Butterfly Life Histories to Design for Urban Butterfly Habitat Gardens

Chad Hawthorne



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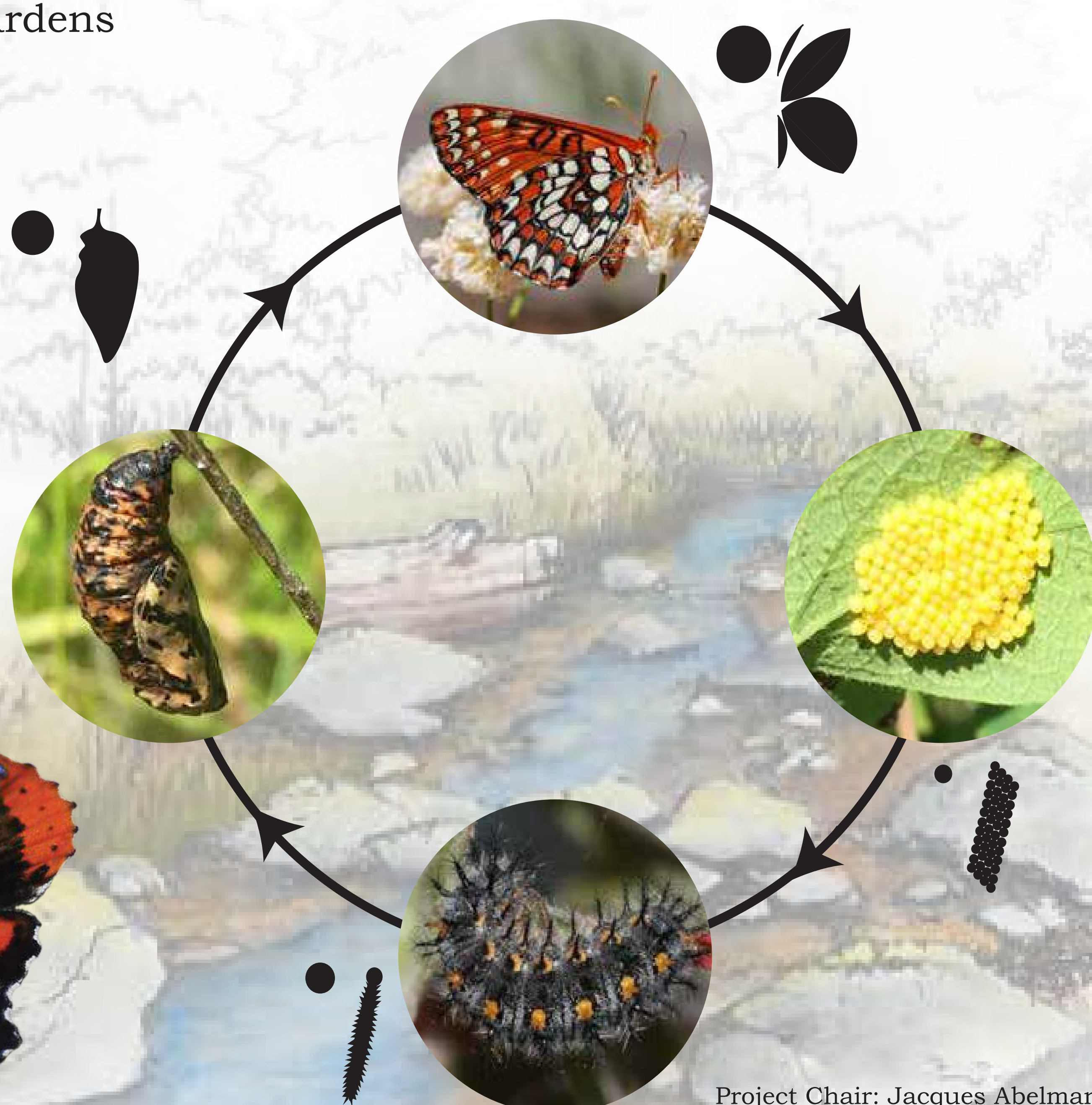

Project Chair: Jacques Abelman

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Chad Hawthorne

Approval

Submitted in partial fulfillment for the Master of Landscape Architecture
Department of Landscape Architecture, University of Oregon

Jacques Abelman, Master's Project Chair

Master's Project Chair Approval

Date ____________________ Signature ____

Acknowledgments

Faculty

Jacques Abelman- Master's Project Chair
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Abstract

Butterfly populations face many challenges, none so great as the loss of habitat do to urbanization. The practice of clearing native vegetation and replacing it with an exotic plant palette forces many urban butterflies further and further from human development. This habitat loss can be mitigated by strategically planning and designing urban butterfly gardens. The question then arises, how can these butterfly gardens be designed to best insure butterfly survival. Through this master's project I introduce a methodological process framework for the designing of urban butterfly habitat gardens. This process centers on design strategies based on butterfly life histories of the butterfly life cycle, butterfly needs, and butterfly behaviors. Employing the design strategy of research through designing, this master's project demonstrates how designers can employ this framework to ensure the survival of urban butterflies. To accomplish this goal, I have first produced a guidebook that walks the reader through this step by step process of using butterfly life histories to design butterfly gardens. I then demonstrate how to use the design process by employing the methodological framework on a site within the city of Eugene, Oregon. I assert, that through a detailed examination of butterfly life histories, design elements can be generated to better meet the survival needs of urban butterflies.

Note:
All images and photographs are produced by the author unless otherwise noted.

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1 Introduction

1.1 Project Scope and Motivations

Problem statement

Urbanization of natural areas is increasing. This urbanization and cultivation of land for both human inhabitation and agricultural practices often removes native vegetation. The practice of clearing native vegetation and replacing it with concrete and exotic plant palettes has had substantial negative impacts on butterfly biodiversity within built environments (Meehan 2012).

Factors such as the intensity of urbanization and species resilience to urbanization contribute to the degree to which a butterfly species will be affected. Although a handful of butterfly species have demonstrated the ability to coexist or even benefit from urbanization, the loss of habitat and the fragmentation of existing habitats has greatly diminished many healthy butterfly populations, resulting in diminished diversity. Urban sprawl, the primary cause of habitat loss, and fragmentation are now recognized as the primary causes of species extinctions (Clark 2007).

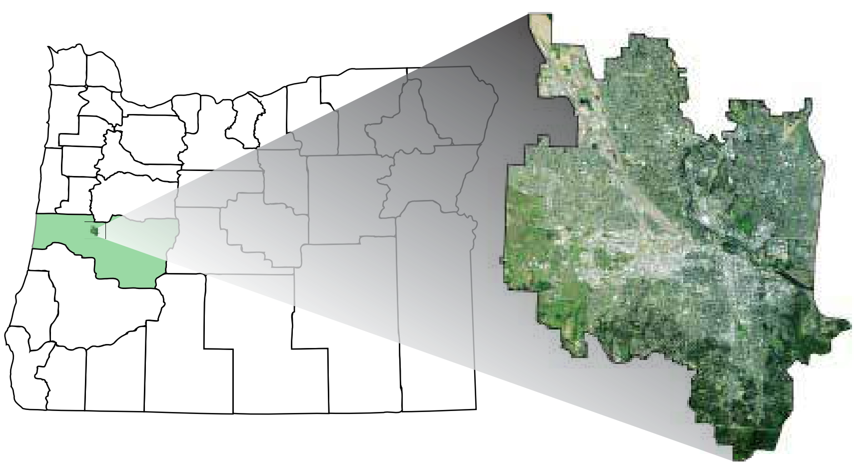


Figure 1.1 The urban growth boundary surrounding the city of Eugene, Oregon

Within the state of Oregon, metropolitan areas have devised a means of controlling sprawl; the urban growth boundary (Fig. 1.1). In Eugene, the UGB limits population growth outside of city limits, sparing farm and more natural landscapes from overdevelopment. This system reduces stress on rural and native landscapes but turns the intensity of development inward. Butterfly populations which reside within city boundaries are subject to a high degree of habitat loss, displacement or localized extinction.

As designers and landscape architects, finding solutions to complex issues such as mitigating habitat loss for urban butterfly populations requires us to look for new methods to improve the design process beyond that the traditional methods in butterfly gardening. The complexity of butterfly life histories; their life cycle, needs and behaviors must be systematically explored to arrive at design solutions.

A key concern, is the method on how design professionals proceed in the design process of butterfly habitat gardening. Admittedly, there is a lot of written material about butterfly gardening; books, pamphlets and websites abound, all providing excellent information on the basic needs of butterflies. However, most written work focuses on basic ideas on butterfly gardening, often targeting home owners as the main consumers of butterfly gardening material.

Through researching this subject, it became clear that there was little information published on how design professionals employ butterfly life history information to arrive at design solutions, and even less frequent was a published process for carrying out design.

Through this master's project, I introduce a methodological framework which examines the butterfly life histories and employs the use of both spatial and temporal analysis to improve the design process of creating urban butterfly habitat gardens. The resulting document will be a systematic process that designers and landscape architects can use for the designing of butterfly habitat gardens. It is my hope to gain a greater understanding of the process of design and produce a transferable document which can be utilized to mitigate habitat loss and provide a functional home for urban butterfly populations.

Motivation

Why butterfly gardens? Butterflies have captured the imagination of humankind throughout the ages. Historically, many cultures saw the butterfly as representations of resurrection of a passed one's soul. As a totem, they represent change and transformation, the finding of joy and a lightness of being. They are the inspiration of art, books, music and poetry (Fig.1.2). Their imagery is iconic, represented in literally every aspect of human life from advertising to symbology.

Butterflies are more than living pieces of art. From an ecological standpoint, butterflies have genuine merit. Butterflies are important indicators of biodiversity and environmental health (Karunarathna 2012). Butterflies react quickly to changes to their environment (Clark 2007), and the disappearance of them warrants concern. Changes in environment can be obvious, such as the conversion of a native vegetation to an urban landscape. The loss of habitat resources can have immediate negative impacts on butterfly population health (Clark 2007). However, butterfly populations are also being studied on larger environmental phenomena such as climate change.

Because butterflies have been scientifically studied and collected by enthusiasts for centuries, data obtained and recorded from early expeditions can serve as useful baseline data for current environmental conditions. Given these factors, butterflies may be among the most useful indicators of habitat health.

Because many organisms such as birds, mammals and other insects rely on butterflies as a source of food, their disappearance has a domino effect on ecological food webs (Fig. 1.3). Many bird species who rely on butterfly and moth larvae as a primary source to feed their young, will delay their breeding season if caterpillars are scarce (Fig. 1.4).

Butterflies also serve as secondary pollinators to many flowering native and garden plants (Shackleton 2016). As adults, much of their time is spent visiting flowers. Although many butterfly species tend to visit a multitude of flower species, some butterfly species tend to favor a select range of flower species at a given time, thus, pollination increases due to fidelity.

Figure 1.2 Art, Acrylic Painting Chad Hawthorne

Figure 1.3 Insect Predators feed on all stages of butterfly life cycle.

Introduction

Butterfly gardens can occur at any scale and be placed in a variety of site locations. Arguably the best means for mitigating butterfly population decline is the protection and management of existing natural areas where butterflies are still prevalent. Within the built environment, butterfly habitat gardens need careful site analysis and design strategy if intended butterfly population stabilization is to occur.

Figure 1.4 Insect-eating birds rely on butterflies for food. Photo: Chad Hawthorne

For this master's project, I investigate the use of elementary schools as an appropriate site selection for the design process of butterfly habitat gardening.

Elementary schools are in an advantageous position to engage children on urban ecology, forming lasting philosophical ideas towards their environment lead to environmental stewardship (Blair 2009).

Children who grow up in urban environments may be unaware of the diversity of butterflies that exist. With each generation, a child's lack of access to natural spaces can result in a shifting baseline of what is now seen as normal. As urban density increases and access to wild spaces decreases, the gap between the built environment and the natural environment widens, creating a disconnect with nature in children. Frequent and positive exposure to wild spaces can foster and enhance ecoliteracy in children creating the capacity to understand ecosystems, building the skills towards environmental stewardship (Rigolon 2012). It is this stewardship that can have lasting positive effects on the survival of urban butterflies (fig. 1.6).

Schools can form a network of butterfly gardens and share information effectively. Schools also retain a longevity that may not present with private landowners within urban city boundaries. Elementary schools within Eugene have little to no dedicated space for butterfly habitat. Most of the open spaces of school grounds are occupied by vast fields of turf grass or asphalt surfaces for play (Fig. 1.5). This expanse of land can be converted to butterfly habitat benefiting both butterflies and children.

Urban butterfly habitat gardens can have a positive effect on butterfly populations by creating much needed habitat within the built environment. This project aims to discover, through the process of designing a scholastic butterfly garden, creative strategies that can generate new knowledge to the field of landscape architecture. This guidebook will provide a step by step design template that will ensure the survival of these beautiful insects for generations to come.

Figure 1.5 Elementary school yard in Eugene, showing habitat garden potential.

Scope

Given that urban butterfly habitat gardens can and do facilitate the survival of butterfly populations within the built environment, the question remains: to what degree does design play in the success of these gardens. The scope of the project is to create a step by step design process that explores, defines, and identifies the needs of urban butterflies, with the intent to create solutions and applications for the designing of a butterfly habitat garden within the city of Eugene, Oregon.

To form the base for the methodological framework of designing for a butterfly habitat garden, literature review, observation are used. The butterfly life histories of the butterfly life cycle, the butterfly needs, and the butterfly behaviors form the center of my master's project design process. The needs of butterflies; food, shelter, water and sun, are classified for the butterfly species that occur within the Eugene area. Broken down into individual spatial and temporal components are the butterfly behaviors. Butterfly behaviors are direct components of butterfly needs. These spatial and temporal components can be manipulated to form design elements and strategies (Fig. 1.6).

The design process created for this master's project breaks each spatial component of each need and behavior into individual design elements in a systematic manner allowing the designer to follow a prescriptive format. The advantage here is that the designer needs not to become an expert in butterflies to employ this design process application. This process will be discussed in detail within chapter two; The Methods chapter. Because butterfly life cycle, needs and behaviors are basically the same for many butterfly species across scale and place, this design process can be implemented at a multitude of geographical locations and at any scale. The only deviation that the designer needs to take into consideration are the specific butterfly and plant species, and specific regional geographic variances.

1.2 Purpose and Significance

Human created green spaces within cities are now recognized as a vital and important component of conservation efforts promoting urban biodiversity (Hunter 2012). Although habitat degradation has had a significant impact on butterfly

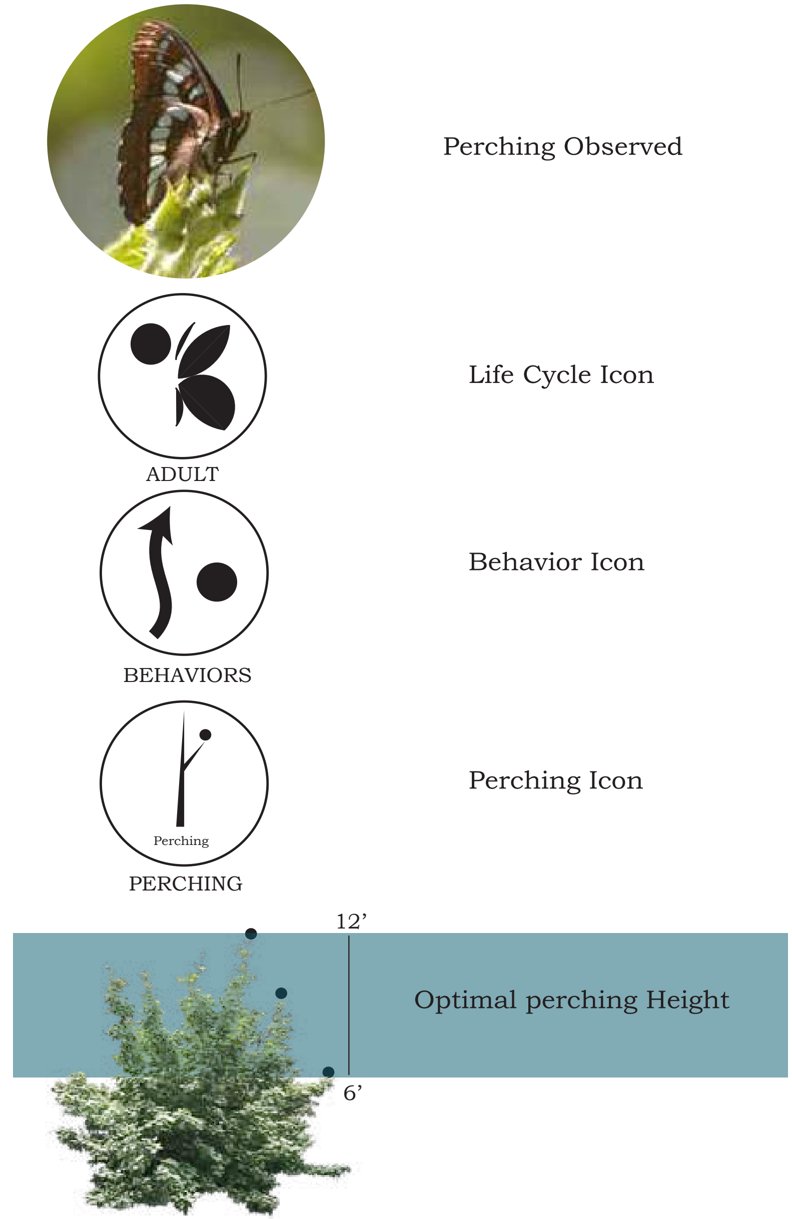


Figure 1.6 How the design element flow process works.

populations, evidence that even small natural green spaces can foster very rich butterfly diversity within highly urbanized landscapes. Thus, looking for mitigating design solutions to improve urban ecology through butterfly gardening warrants much exploration.

The creation of a step by step process for the designing of butterfly habitat gardens can be a vital tool for the designer to better understand the needs of butterflies to create meaningful and ecologically functional butterfly habitat gardens.

1.3 Current knowledge and gaps in knowledge

Most butterfly books, pamphlets and websites that teach you the basics of butterfly gardening will tell you that there is no minimum or maximum size that a butterfly garden needs to be to be successful. Butterfly gardens can range in scale from the size of a window box up to the expanse of an acre (Mauro 2007).

Although it is difficult to justify any actual size requirement to the overall success of a butterfly garden, research does in fact demonstrate that a larger scale garden is more effective in the provision and overall success of sustaining butterfly populations. This was concluded in 1995 where Vickery examined more than 1000 gardens in the UK, determining that larger gardens attracted more butterflies than did smaller gardens (Mauro 2007)

Studies show that there is a close relationship between butterfly diversity within a garden in respects to the diversity of the surrounding landscape. The more diverse the surrounding habitats, the more diverse the butterfly species that visit the garden. (Mauro 2007) Mauro also demonstrated that gardens that were situated within rural areas were more likely to have greater butterfly diversity than suburban and urban gardens where plant palettes were diminished. Gardens that provided 20 varieties or more of blooming plants attracted a greater number of butterflies than did smaller gardens with fewer than 10 varieties of blooming plants. The planting of hostplants further increases butterfly gardening success by providing a food source for the developing caterpillars (Tekulsky 1985).

I see butterfly gardening as a form of habitat gardening for mitigating habitat loss. For this project, the principles of butterfly gardening and the principles of habitat gardening are examined to compliment the use of butterfly life histories as a design strategy.

Arguably one of the more comprehensive guides to butterfly gardening, is “The Art of Butterfly Gardening”, written in 1985 by author, photographer, and essayist Mathew Tekulsky. In his work, Mr. Tekulsky systematically gives a history of butterflies and butterfly gardening, addressing their biology, their needs, and basic butterfly gardening principles. This book forms a very easy to follow set of informational guidelines from life cycle to basic butterfly needs.

Douglas Tallamy produced “Bringing Nature Home”, a home-owner’s guidebook for habitat gardening. In his book, Tallamy stresses the use of natives within the urban context over exotics to drive diversity. Both works are exemplary in laying out the needs and principles of creating habitat for their respective inhabitants. Neither book claims to be a design guide or a how to guide. They do however provide a basic theme of how to approach their respective subjects. My master’s project uses the blending of these two philosophical threads of gardening to form a holistic approach, looking deeply into habitat and life history processes.

Through research and analysis of existing professional butterfly garden design work, a gap in knowledge has been identified. There is a lack of documentation that synthesizes the specific life histories of butterflies with an emphasis on design solutions. And where Tallamy and Tekulsky step back from the creation of design process, I aim to center my project on this aspect, thus in some manner closing a gap.

Designers and landscape architects have produced works for creating and restoring habitat. Illustrative modeling backed by research and scientific data are combined with impressive rendering, filling both aesthetic and functional need. However, the lack of documenting the process or producing a step by step analysis on the arrival of such design solutions is often omitted from publication. What does the process of the designing of a butterfly garden look like? How does one take the concepts of creating a habitat garden for butterflies to the generative stages? What information does the design profession use to arrive at solutions for habitat butterfly gardening?

Published work from design professionals on the creation of butterfly gardens is a very limited pool. Much of the published work for butterfly gardens is created by homeowners, students, arboretums or nature centers. Little to no documentation of the process, outside of some very basic fundamental information, is provided to the reader.

My project focuses on the butterfly life histories and shows what these life histories look like within a design process (Fig. 1.7). How we generate knowledge and show the process of design, is arguably more important than the showing of finished work and illustrative imagery. Creating a step by step design process for butterfly habitat gardening that can contribute to the conversation of addressing this gap of knowledge lies at the core of this master's project.

1.4 Methodology

Arguably, the field of landscape architecture is a design-oriented field, with design becoming an accepted form of research (Lenzholzer 2013). This masters project uses two components of design as a research strategy; research for design with the lower-case r and Research through design(ing) with an upper-case R. With research using the lowercase r, the researcher examines information that has been previously carried out. The lower case r strategy is the 'what's known component' of research.

In research for design, this project examines and classifies butterfly life history data, categorizes habitats into typologies, classifies host plant information, and nectar source information which sustain butterfly life needs. Through literature review, classification and observation, a methodological framework is created to form a base set of information needed to carry out a design process.

The creative process of design(ing) constitutes the big R component, where new knowledge is generated through the research process (Deming & Swaffield 2011). In Research through designing, the butterfly life history components of

Figure 1.7 Behaviors, needs and life cycle yielding potential spatial elements.

life cycle, needs and behaviors necessary for survival are broken down into individual pieces and then converted into “design elements”. These design elements are arranged both spatially and temporally to form design scenarios. It is the intent of this master’s project to create a methodological framework by generating design solutions which yield new knowledge to the approach to butterfly habitat gardening.

“The argument for design as research builds from the observation that design necessarily involves empirical research to understand the context of a project and to develop a design program.” (Deming & Swaffield 2011) Through a series of “reflexive and reflective” activities, the creation of new ideas and concepts are generated, and it is this that gives design as research it credentials (Deming & Swaffield 2011).

It is argued “that design has all the attributes of research”, a method/strategy of investigation which looks to find out rather than reporting on what has already been found (Deming & Swaffield 2011). However, this methodology that I see fit to explore for this master’s project, albeit reliant on creativity and emotive components, is founded upon known structural components that allow for a transition or steps taken to arrive at a projective design process.

1.5 Goals

<u>Goals explained</u>

Goal 1: Achieved through examining existing knowledge derived from written work, literature review, classification and direct observation. This form of research falls under the category of research for design and relies upon examination of what is known and the classification of knowledge. This form of research uses the (lowercase r) research; r. Through this first phase of the use of research for design, information is collected and gained to build a framework of published work, proven methods and documented study (Table 1.1).

A subset to data collection is direct observation. Direct observation contributed a large amount of data to this project through photo documentation of the local butterflies, hostplants, nectar sources, and habitats both natural, urban, and site analysis.

Goal 2: To generate new knowledge, the second phase of this research process is the use of an (uppercase R) research method; R. This research strategy is known as research through designing. With research through designing, the newly generated information is seen in both process design work and finished design work. This generated imagery helps inform the designer with the intent of communicating these ideas and generated images to inform the viewer. Within this project, conceptual models, sketching, drawing, painting

Question	Can a framework derived from butterfly life histories improve the process of designing butterfly habitat gardens?
Goal 1	Goal 1: To classify and describe the life cycle, needs, and behaviors of butterflies in both a general sense and on a local level and relate these to their habitats.
Goal 2	Goal 2: To examine and create spatially generated design strategies based on the butterfly life history of the classified life cycle, needs and behaviors of local butterflies..
Synthesis	To synthesize goals 1 and 2 to create methodological framework for a step by step process that design professionals can follow and use to generate a butterfly habitat garden design that culminates in a guide book.

Table 1.1 Goals

and writing illustrate the components of information gleaned from the research for design strategy to refine and reconstruct ideas and concepts to form new design models, both conceptual and actual.

Goal 3: The generation of images and concepts derived and formed through the design process of goals 1 and 2 are synthesized to produce a methodological design process for the designing of butterfly habitat gardens. This design process provides a step by step framework which materializes into a procedural document for the reader, on how to design these gardens by using butterfly life histories of the butterfly life cycle, butterfly needs and butterfly behaviors in both spatial and temporal analytical methods. Within this master's project a guidebook for the designing of butterfly habitat gardens is produced. This guidebook is designed to be a transferable document that can be implemented across scale and place for design professionals for the building of butterfly habitat gardens (Table 1.1).

By using the research strategy of research through designing, new knowledge from the generation of new design elements and concepts should demonstrate a more comprehensive butterfly habitat design process.

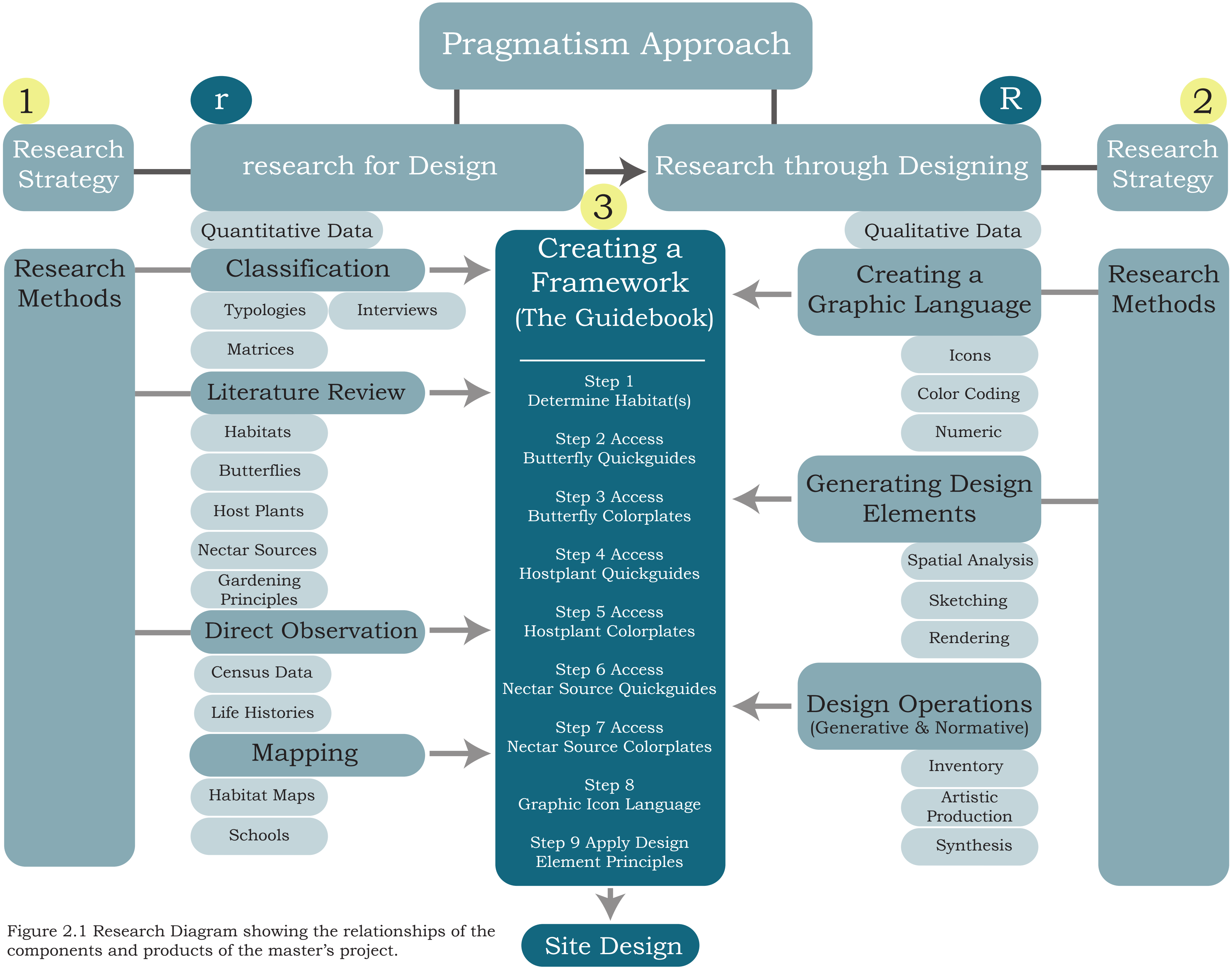


Figure 2.1 Research Diagram showing the relationships of the components and products of the master's project.

2 Methods

2.1 A Methods Overview

Designing is the core activity of landscape architecture. As such, this project employs the methods and strategy of research through designing as its primary course of research. Because design as a research strategy is fairly new and confusion amongst academia exists on the degree to which design constitutes research, there is a need to define the role of design and designing to help bring into focus on how I approach this research project.

Design as a noun is seen as the outcome of a design process in which shape and form are given and produced. Research carried out examining the “noun” of design can be seen in studying designs after they have been created or implemented (van den Brink 2017). Whereas “drawing, mapping, visualizing, representing, and giving shape are unique activities that constitute the act of designing”, the verb (Lenzholzer 2013). Here, “designing is studied during the design process” (van den Brink 2017).

Eight Criteria for Design to be used as Research

1. Truth Value	Do procedures do what they say they do?
2. Applicability	Is knowledge created transferable?
3. Consistency	Is knowledge created reliable or dependable?
4. Transparency	Is knowledge free of hidden bias?
5. Significance	Is knowledge relevant to landscape architecture?
6. Efficiency	Is research of quality without wasting resources?
7. Organization	Is this process well structured?
8. Originality	Does knowledge provide a new value, idea or theory?

Table 2.1 The 8 criteria that design needs to address when used as research. Adapted from Deming & Swaffield.

Many academics are now recognizing that both design as noun and as verb are vital forms of research strategy/ methodology if design(ing) adheres to accepted criteria which constitute research. Deming & Swaffield have suggested eight criteria that design needs to address when used as a research strategy (Table 2.1).

	Inductive	Reflexive	Deductive
Objectivist	Descriptive	Modeling/ Correlation	Experimentation
Constructionist	Classification	Interpretation	Evaluation/ Diagnosis
Subjectivist	Engaged Action	Projective Design	Logical Systems

Table 2.2 The 9 strategies of inquiry. Adapted from Deming & Swaffield

Deming & Swaffield further describe the nine strategies of inquiry. The research strategy research through designing utilizes multiple methods and strategies of inquiry. Of these descriptive nine descriptive strategies, my research will utilize four (Table 2.2).

Research for Design and Research Through designing

Research for design involves the collection and examination of produced evidence-based knowledge to support the design process. The goal of using research for design as a strategy is that it contributes to the quality and reliability of the design product. This knowledge is then used by the designer to substantiate a design process and the artifacts produced (Lenzholzer 2013). Research outcomes inform the design process, creating knowledge through the generation of data (van den Brink 2017).

Through this research project I employ the strategy of research for design by using the methods of literature review to gain an understanding of what is known, direct observation to gain a first-hand knowledge what exists within the environment, and expert interviews to affirm both observation and literature review (See Figure 2.1). A more detailed description of the use of research for design is demonstrated later within this chapter.

Research through designing is the activity of designing with the intent to generate new knowledge. Through this strategy, the idea of creating, be it through drawing, sketching, modeling or rendering are paramount to new ways of thinking. Much of my project focuses on spatial relationships of butterflies to their environment and the configurations that lead to successful butterfly habitat garden design strategy. The shifts between what triggers thinking and what triggers making is at the core of the design process of research through designing (Lenzholzer 2013). The active form of designing, the verb, forms a research strategy in which the following criteria are met; "a clear research question, a theoretical framework, and appropriate methods" (van den Brink 2017).

Research through design is further broken down into four distinct strategies as suggested by Creswell in 2009. The first, (post)positivist view follows a traditional scientific strategy of the testing of a hypothesis rigorously. The second, the constructivist, is a more human centered strategy which aims to make sense of context through interpretations. The third, the advocacy/participatory strategy which focuses on social context mostly has direct involvement of the researcher as an involved component. The fourth, the pragmatic, involves the use of the three previously described strategies and uses a blending when and where needed to support claims. Because my strategy involves a blending of methods, a framework is vital to show when and where various methods are employed (Deming & Swaffield 2013).

The pragmatic research through designing approach

The pragmatic approach to research through designing utilizes many ideologies to form a contextual framework of "what works" to arrive at decisions, using both objective and subjective claims (See Table 2.1). "Single strategies often generate partial knowledge", therefore multiple methods or strategies can be combined to arrive at more complete findings (Lenzholzer 2013). Because the pragmatic approach concerns itself with design procedures within a geographical context, I utilize aspects of this approach to substantiate my framework.

(Post)Positivism approach

I used the (post)positivism claim of direct observation where the objective design methodology of observation can contribute new knowledge. Here I was able to observe how butterflies interact with local environments within Eugene beyond what literature could contribute. Some aspects of observation helped confirm published writings, while other observations help refine or even refute literature claims. The various aspects of observation that I undertook strengthened the core of my butterfly habitat design methods through the aspect of truthing claims previously observed from other individuals.

I use (post)positivist claim when conducting literature review for the building of data to support my claims rather than to refute current literature. Some literature review was conducted early to help form contextual concepts. Other literature review was needed later in the project to deepen understanding and assert claims that I attempted to bring into focus. Pragmatic claims draw on many ideas and values both the objective and subjective and methods can range from surveys to personal involvement to reflexive methods (my own thoughts) to creative generation.

Methods: Research Through Designing "Pragmatic Approach"

Overview of RTD in the different knowledge claims and related parameters in landscape architecture.

	(Post)positivism	Constructivism	Advocacy/participatory	Pragmatism
Kind of new design knowledge	Predictive 'Objective' Deductive/generalizable Quantitative Verified theory/design guidelines Patterns, prototypes	Suggestive 'Individual', meaning Contextual Qualitative New artifacts/projects Making tacit knowledge explicit/procedural	Transformative Collaborative Contextual Agendas for action Qualitative (and sometimes quantitative) Procedural/theoretical	Combination of design knowledge of (post)positivist, constructivist and advocacy/participatory knowledge claims depends on specific needs per research project
Issues that research questions address	Physical/functional Psychological	Social Interpretations and meanings New forms and artifacts Esthetics	Adaptation Social Emancipatory Appreciative Political Real-world Economical	Combinations of issues e.g. physical and social, psychological and esthetics, search for meanings and political
RTD methods	Design hypothesis testing Design experiments tested with surveys, simulations or measurements Strict protocol	'Creative' reflection in action Personal involvement Question driven design process Thick description Intense designer involvement/immersion Systematic 'reflexive journal' Triangulation	Qualitative/quantitative Collaborative/interactive Recursive design and participant feedback loops Emergent Normative Sequential/concurrent	Depends on research questions – mixed methods: e.g. design hypothesis testing with surveys and participatory methods; creative form generation, testing with simulations
Research evaluation criteria and methods	'Objective' Validity Reliability Generalizability	Originality Dependability Transparency Credibility Effect on perception and feelings of users Shift in values	Shift in values Ownership of knowledge Participant commitment to change	Directly depends on research question and research methods chosen
	Quantitative/numerical Statistical analysis Empirical science test methods	Mainly qualitative Precedent comparison Design competitions	Mainly qualitative On-going researcher commitment Monitoring of emancipation	

Table 2.3 Pragmatic Approach to Research Through Designing. Lenzholzer 2013.

Within the research through designing strategy, there are multiple methods applied within the pragmatic approach. This chart identifies in yellow, the methods and questions addressed by research through designing. There is a clear pattern of a multi-use format that my project uses in the assimilation of researching for the designing of a butterfly garden design process.

Constructivist approach

The new knowledge generated through the forming of new procedures within the construction of a framework for the building of butterfly habitat gardens fall within a constructivism approach. I use this claim for the generation of creative action techniques. Here, drawing, crafting, even doodling is valuable if they can generate knowledge. Within the constructivist claim I place a high value in the use of classification where typologies of habitats are generated. The creation of matrices helps structure data into easy to use constructs.

The reflexive moments of this project tend to be tied into my analog and digital media illustrations where I assert a high degree of creative license to demonstrate both the need to be creative and clear in the production of design elements based on butterfly life histories. I would further stress this blending of techniques culminates into what Deming & Swaffield refer to as a subjectivist claim which ultimately lends itself to a design process.

Because the pragmatic strategy examines different studies which parallel a problem, the sequence of the use of each method needs to be clearly stated and placed within a framework (Deming & Swaffield 2013). Milburn & Brown provide an excellent research and design framework which can be borrowed from and placed within a design-based research project. Lenzholzer also provides a very helpful framework in building a pragmatic claim. I found both frameworks helpful in the building of a contextual framework for my own research project.

The methods of my research are divided into three main phases of design. The first phase utilizes the strategy of research for design, where a base is established for many of the research claims, this constitutes the what I need to know phase (Fig 2.2). New knowledge is generated through structuring the information learned into a unique reference format termed quickguides and colorplates. The second phase is situated within the research strategy of research through designing, where new knowledge centers on the generation of a graphic language. The third phase is the synthesis of the two, resulting in a framework in which a guidebook is produced to help designers navigate through the process for

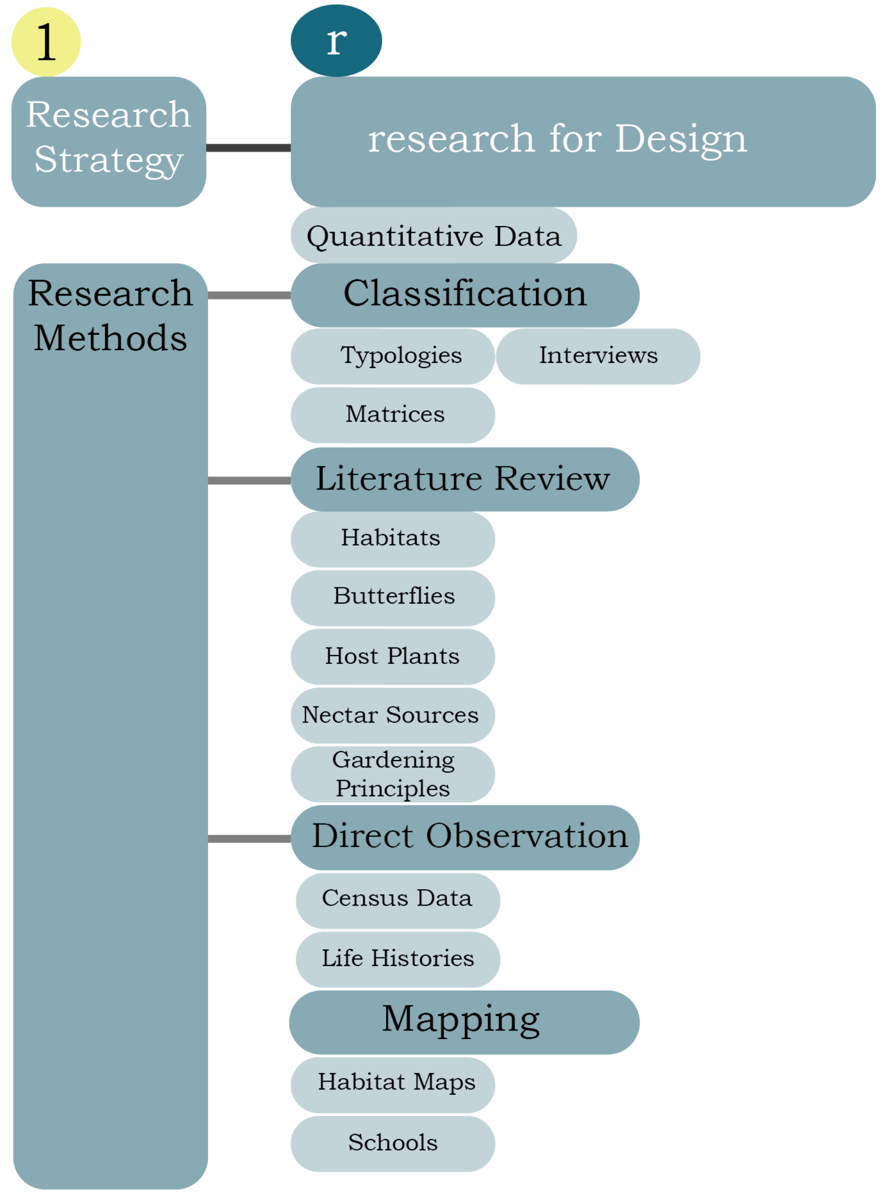


Figure 2.2 Phase 1. Research for Design Framework

the designing butterfly habitat gardens.

Research for Design

Research for design, as stated previously looks at existing components and examines the "what is known" phase of design. This is important to form a base, look at what has been done, and then decide what needs doing from that point on. A step by step process for creating a framework for butterfly habitat garden design uses the component of research for design to identify and classify; habitats, butterfly species, host plants, nectar sources, as well as design principles in both butterfly gardening and habitat gardening. Thus, it is useful to design a step by step process to inform the designer from what is known to what needs to be known.

Because this master's project uses the pragmatic approach to analyze and synthesize data and create new constructs, the need to move from one method and strategy when and where necessary creates a complex matrix. To simplify this process for the reader I devise and introduce a step by step process based on how I would strategize the designing of a butterfly garden from start to finish. Rather than describe each method and strategy used as separate headings, the step by step process helps to define the process pattern sequence but also calls out the methods used during that sequence. Within each step, the method or research strategy is revealed and explained how and where the application occurred.

Figure 2.3 Color code system denoting the six native vegetation communities found within the Eugene area.

2.2 The Habitats

The first step in inquiry to butterfly habitat garden design is to gain an understanding of the habitat(s) that once existed on the site as well as determine the current condition of the site. Here, the use of classification and specifically the formation of habitat typologies is used.

Classification

Classification as a research strategy produces new knowledge by structuring data into an organizational system, using properties, patterns or themes and is one of the most fundamental research activities (Deming & Swaffield 2011). I assert that the manner in which I use classification is more representative of a method than strategy, thus I chose to deviate from Deming and Swaffield's definition. Regardless, classification is utilized and woven throughout this master's project when and where needed to form a cohesive construct to form typologies and matrices to help organize thoughts and patterns.

Typologies

This master's project utilized the strategy of classification when constructing a typological model of the six habitat communities occurring within the Southern Willamette Valley. Gathering information of what is known about each of the six habitat communities largely falls under research for design. However, the reconstructing these habitats into a visual typological model uses the research

Habitat: Traditional Vegetation

Typology	Canopy Layer	Shrub Layer	Ground Layer
Upland Dry Prairie	0-5% Very Sparse Tree Cover	Low and Patchy Vegetation	95-100% Cover Dominated by Grasses and Forbs
	Oregon White Oak Black Hawthorn Ponderosa Pine (see colorplates for complete lists)	Blue Elderberry Pacific Serviceberry Red-flowering Currant (see colorplates for complete lists)	Roemer's Fescue Lemmon's Needlegrass Kincaid's Lupine (see colorplates for complete lists)

Figure 2.4 Example of the Habitat Typology format

through designing construct. It becomes quite clear that the pragmatic approach to designing is a necessary component to building landscape design paradigms.

For the habitat typology pages, each of the six native habitat communities of upland forest, riparian forest, wet prairie, upland prairie, oak savanna, and oak woodland were given a unique color code. This color code allows the reader a quick recognition reference throughout the document when habitats are referenced and shown (Fig. 2.3).

For habitat classification, I referenced locally published works by professionals and academics whose expertise on the various local ecoregions and habitat communities reside within the Willamette Valley and the Eugene area specifically. The format provided for reestablishing native vegetation types within the Willamette Valley "Restoring Rare Native Habitats in the Willamette Valley" authored by Bruce Campbell, and the structure of the ecoregion dynamics of the "Willamette River Basin Planning Atlas" by professor David Hulse at the University of Oregon provided a detailed

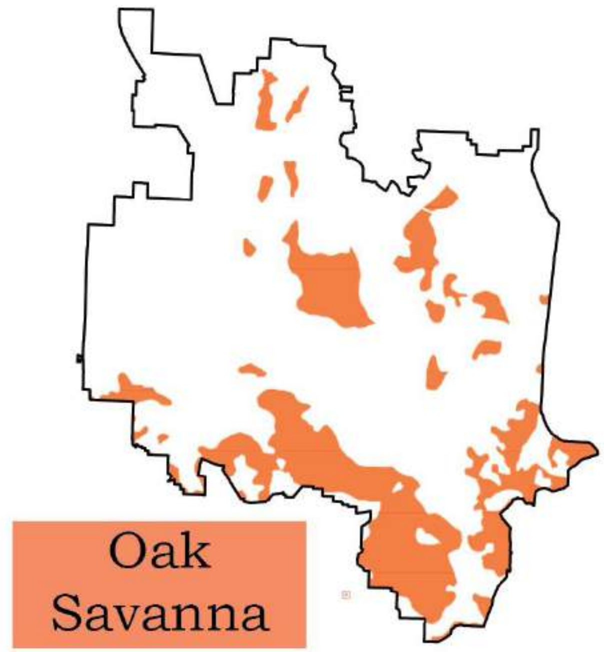


Figure 2.5 Habitat mapping through GIS

framework to local environmental ecoregion dynamics and helped define the six the native habitat communities for the structure of this master's project (Fig 2.4). The native habitat communities are described in greater detail in chapter three; "The Guidebook".

Mapping.

Defining, locating and mapping specific native habitat communities is vital to determining what native vegetation historically occurred within the Eugene area. Also vital is the determination of which, if any, remnant habitats remain within Eugene.

To determine native habitat distribution, GIS files were obtained from Dr. Chris Enright of the University of Oregon, Department of Landscape Architecture. Through ArcGIS the delineation of the study area (City of Eugene) was attained by downloading a shapefile of the UGB (Urban Growth Boundary). This UGB helped define the areas within the city limits to concentrate queries on native vegetation patches. Once the UGB was determined, bringing in additional shapefiles into ArcGIS of the traditional vegetation communities of Upland forest, Riparian forest, Mixed prairie, Oak savanna, and Oak Woodland helped create a visual construct of where these native habitat communities occurred and to what extent (Fig. 2.5). For consistency, each habitat shapefile was assigned the same color codes given to the habitat typology matrix pages.

Because most native habitat communities have been fragmented or have disappeared completely within the UGB and resemble little to their original distributional patterns, it was necessary to establish the location of remaining remnant habitat patches. This was accomplished by bringing in additional shape files of open spaces and parks within the UGB. This is key to determining if possible butterfly populations could still be functioning within these sites.

Native habitat distribution maps and parks and opens space maps were generated through ArcGIS and assigned their unique color codes. The building of habitat maps and typologies help inform what habitats are most suited for specific sites. Bringing in open space and park GIS shapefiles were important for showing spatial proximity patterns to potential school sites as well. These maps also helped me locate green spaces for the observation phase; ground truthing habitat viability.

Observation

Finding intact traditional plant communities within the Eugene area is unlikely. Most plant communities within the Eugene and surrounding areas have been highly modified by human practices of urbanization and agricultural activity. Invasion by exotic plant species have established themselves within the plant matrix of many of these urban wild spaces. It is highly recommended to walk and document the current condition of potential habitat at this point. Documentation of remaining traditional plant communities and the extent of encroaching exotics can be determined. A census of butterfly species that are using the site is vital to determining if these species can be pulled into your designed garden spaces. This ground truthing is a vital step to the observational research component of this project and was accomplished through the establishment of observational study sites (Fig. 2.7).

Figure 2.6 Literature review of butterfly life histories

2.3 Determining Butterfly Species

The next step in the process is researching the butterfly. This portion of the project is by far the focus and makes up the majority of the work generated for this master's project. Methods and strategies for identifying the components of butterfly life histories is the next step after habitats have been identified.

Literature Review

Literature review of peer reviewed articles, scientific journals, published books, and web pages on both local species and butterflies in general were solicited to answer the questions of butterfly life histories. The butterfly life histories of primary research were the butterfly life cycle, needs and behaviors. Also researched was butterfly anatomy and defense strategies, but these were treated with less vigor, as design is centered around the first three criteria.

The importance to address butterfly life histories for butterflies in general helped form a baseline on how butterflies interact with their environment. However, the acquisition of knowledge on local species is paramount to understand specifics to how these butterflies interact within their local environments (Fig. 2.6).

Investigating local species

I was fortunate to find access to several locally written field guides written specifically on the butterflies of Lane County, as well as a regional text describing life histories of Cascadian butterflies. In addition to locally written published work, specific information on population densities of butterflies of the Eugene area was gleaned from the NABA (North American Butterfly Association) Eugene/Springfield chapter. Here, local species lists, butterfly census data, and host and nectar interactions were attained. The significance of data derived from the NABA cannot be overstated as detailed records of butterfly distribution, dating back nearly 20 years, are publicly available on their web pages. Compiling a species list of butterflies specific to Eugene was largely determined by census data provided from annual butterfly counts orchestrated by the NABA.

Once I had a working list of butterflies occurring within Eugene I could begin compiling life history data their life cycle, needs and behaviors.

Determining butterfly life cycle information comprised of understanding their habitats to which they most commonly occurred, hostplants they used to rear their young, seasonal occurrence, and the time to which they spend in each of their four phases of their life cycle; egg, caterpillar, chrysalis, and adult.

Also needed was determining butterfly needs; food, water, sunlight, and shelter. Because these needs tend to be more universal, regional or even general, writings on butterfly needs were extracted from a multitude of sources. The need for food was broken down into adult (nectar) and juvenile (host plants) specifically. Shelter was broken into three main categories of shelter from wind, rain, and heat.

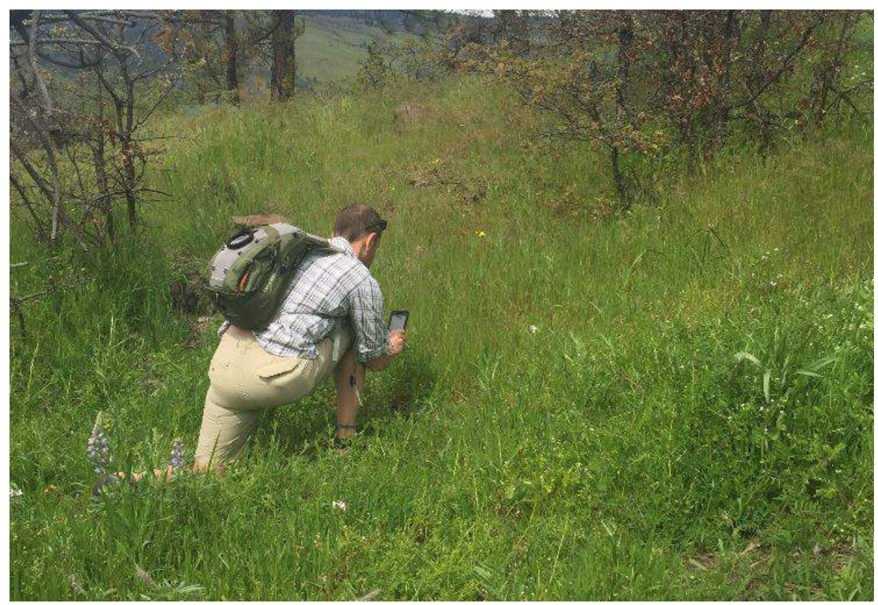
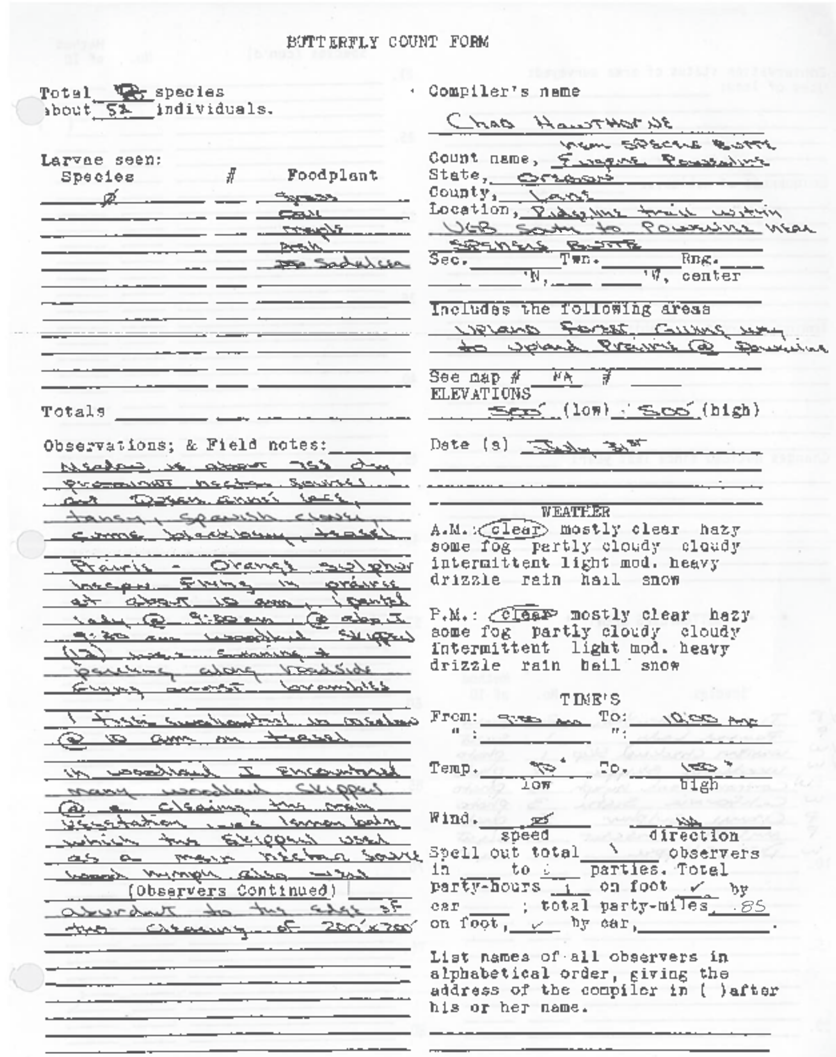


Figure 2.7 In-field observation of how butterflies interact with their environment

Methods: Study Site (South Hills of Eugene)

Because observation played such a large part in my research, I constructed three butterfly census survey sites within the city of Eugene. I conducted a weekly butterfly monitored transect census counts. The sites represented the landscapes found within Eugene. I recored my findings on a butterfly count form (see Figure 2.9)

Figure 2.8 Transect site the South Hills of Eugene surveying local butterflies.



BUTTERFLY COUNT FORM

Total ____ species
about 52 individuals.

Larvae seen:
Species | # | Foodplant

Totals

Observations; & Field notes:

(Observers Continued)

Compiler's name

Count name,
State,
County,
Location,

Sec. ____ Twn. ____ Rng. ____
____ 'N, ____ 'W, center

Includes the following areas

See map # ____ # ____
ELEVATIONS
____ (low) ____ (high)

Date (s)

WEATHER

A.M.: clear mostly clear hazy
some fog partly cloudy cloudy
intermittent light mod. heavy
drizzle rain hail snow

P.M.: clear mostly clear hazy
some fog partly cloudy cloudy
intermittent light mod. heavy
drizzle rain hail snow

TIME'S

From: ____ To: ____
" : ____ ": ____

Temp. ____ To. ____
low high

Wind. ____ ____
speed direction

Spell out total ____ observers in ____ to ____ parties. Total party-hours ____ on foot ____ by car ____; total party-miles .85 on foot, ____ by car, ____.

List names of all observers in alphabetical order, giving the address of the compiler in ( )after his or her name.

Figure 2.9 Survey census form used for bi-weekly butterfly counts.

I established three permanent census transect study sites within the city of Eugene. Each site was walked along a transect route and butterfly census data was collected by employing the UK butterfly monitoring scheme system. Each route was walked at or nearly at the same time of the day (between 9am and 3pm) at an interval of every two weeks between the months of April through October.

Butterfly behaviors of hibernating, puddling, patrolling, basking, nectaring, perching, and hilltopping were researched both on a general level and on a very species-specific level, since each species exhibits unique tendencies. Butterfly life histories were compiled onto a spreadsheet and cross referenced against published field guides.

Measurement & Mapping

Each year the NABA Eugene/Springfield chapter collects detailed census data across multiple sites across multiple native habitat typologies within Eugene. The censuses are conducted using a transect method adopted from the United Kingdom Butterfly Monitoring Scheme (UKBMS). The aim is to track and catalog butterfly occurrence, population density and distribution. Census data has been collected and posted on the NABA web page since 2001. I was able to extract this data and place it into an excel spreadsheet. Through data compilation and graphing, I was able to gain considerable insight to the occurrence of local butterfly populations within the habitats within and surrounding the city of Eugene.

Selecting Study Sites for Observation

Because observation played a large part in my research, I conducted a similar transect count survey method. Between April 9 and October 5th, 2017, I conducted my butterfly counts. Data collection consisted of photo documentation, field observation notes, and census transect techniques recommended by the NABA. I established three permanent census transect routes within Eugene. The routes were traveled at the same speed (a normal walk), at the same time of day (between 9am and 3pm) at an interval of every two weeks from mid-April to mid-October. This transect method of butterfly census data collection can yield some very revealing data in determining butterfly abundance (Pollard 1993).

The first study site consisted of a transect that followed a single trail, (the Ridgeline Trail) that traversed through a forest habitat and opened into an upland prairie habitat along a power-line in the south hills of Eugene (Fig. 2.8). The second transect route was a line walked through a prairie habitat along an ecotone of an ash forest/mixed prairie in Eugene's Willow Creek Preserve. The final transect site was a south hills residential neighborhood which consisted of landscaped single family residential homes. Butterfly counts were tallied into an excel program and compared to that of the NABA census data.

Each butterfly transect study site was monitored for adult butterfly occurrence based on the United Kingdom Butterfly Monitoring Scheme (UKBMS). This method employs a person to walk at a moderate normal pace between the hours of 9am and 3pm for roughly 45 minutes to an hour. The person monitors a spatial area at a distance of roughly fifteen feet on both sides of the transect line. Each butterfly seen within this zone is counted and tallied on a sheet, noting

Figure 2.10 Camera used in the field to capture data

species. Transects are counted in a single-direction as not to recount the same butterflies twice.

Observation: Butterfly life history photo documentation

Observation of butterfly life history was a major priority to understand the behavior of butterflies within the Eugene study sites. Differing from transect survey methods, field observation butterfly of life cycle of courtship, mating, pupation, and oviposition was documented. Butterfly behavior of puddling, perching, patrolling, hilltopping, basking, nectaring, and the seeking of shelter was documented and recorded. This direct observation was a valuable tool in comparing and confirming written text on these behaviors.

Tools used in the field comprised of my Nikon D-50SLR with a 300 macro-zoom lens, which allowed me to monitor and capture images of butterflies in undisturbed behavior. I also found that my Iphone6 also worked well for quick images and a butterfly net for proved useful for positive identification of species in field (Fig. 2.10). In all, over 540 images of butterflies in various life cycle stages were documented during the butterfly season of 2017.

Direct observation is a key to the design process of butterfly habitat gardening. Visiting butterflies in their natural habitat and observing how they interact with their environment can produce volumes of valuable information. Getting out in the field often gives the designer a much more complete view of seasonal butterfly behavior and activity (Tekulsky 1985). The need to describe and reproduce this data into both written text and imagery serves as a baseline for depicting the requirements of butterflies within their environment.

Common versus rare butterflies:

Literature for butterfly gardeners to target common species versus rare species is based on the success of attracting those species to the garden. Rare species may have many limiting factors; distance of travel, habitat selectivity, feeding specialist, or naturally low population numbers. All of which contribute to the difficulty of gardening for rare butterfly species. Thus, most experts agree that for reasons of successfully attracting and keeping butterflies within a designed garden space, the garden should target attracting commonly occurring butterfly species.

Of the species found within the Eugene area, not all occur commonly, nor are all reasonable candidates for butterfly habitat gardens. Selecting suitable species to design a habitat garden for must be done in a logical and systematic way.

Because determining the common versus rare status of a local butterfly is a process that is universally used, I utilized the method of determining rare versus common status based on the published work (Table 2.4).

The building of the Butterfly Color Plates

The product of observation, photo documentation, literature review, study site data compilation, and census data resulted in the building of the butterfly color plates (Fig. 2.11). The color plates are an illustrated description of each butterfly species which occurs within the Eugene area, common or not.

Target Group (green) | Non-Target Group (grey)

Superabundant	500 individuals in a given place per day or 2000 individuals on seasonal census counts
Abundant	20 or more individuals in a given place per day or 500 individuals on seasonal census counts
Common	5-20 individuals in a given place per day or 100 individuals on seasonal census counts
Fairly common	1-4 individuals in a given place per day or 10 individuals on seasonal census counts
Uncommon	1-4 individuals seen per season but not daily
Occasionally common	5-20 individuals in one season
Locally common	0 individuals in most locations, but in specific locations 5-20 individuals per day
Rare	Individuals rarely seen at any location, Less than 5 individuals per season
Irruptive	Species are absent from most locations but abundant under favorable conditions

Table 2.4 Adapted from “Butterflies of New Jersey” determining abundance

Methods

Observation

The information was compiled into a series of color plates complete with photo likeness of the adult butterfly and the following information was provided; species name and accepted common name, seasonal caterpillar activity, adult butterfly flight period time, description of the species, habitats to which they most likely occur, their level of abundance (common vs rare), conservation status, adult behavior, larval behavior, host plants used, design considerations, and design level; easy to difficult (which are my assertions).

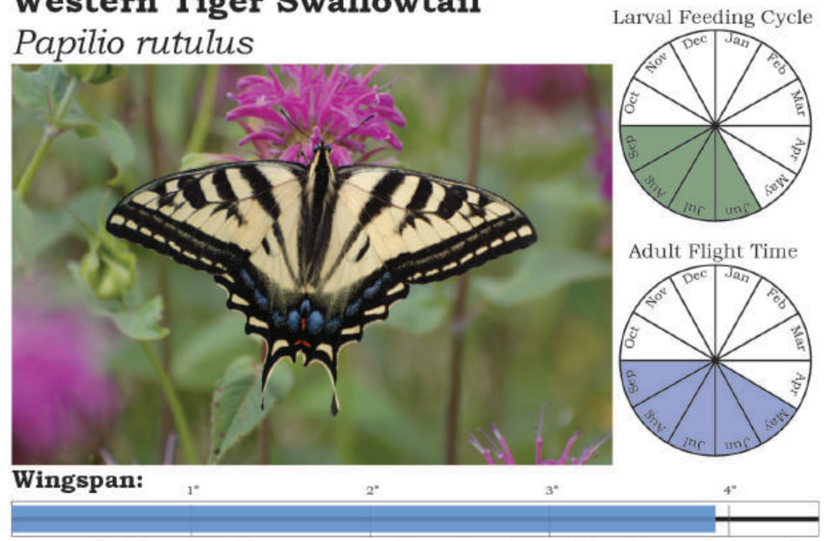
Literature Review

Literature review of peer reviewed work, field guides, how to books, and web pages played a large part in the collection of information about the life cycle, needs, and behaviors of butterflies in both a general sense and on a specified local level. Because the guidebook focuses on the butterflies of Eugene, local field guides prove very helpful for this process versus butterfly guide books that provide information on butterflies on a more national geographic scale.

The building of the Butterfly to Habitat Quickguide

The Quickguides are a schematic that I devised for building a targeted butterfly checklist based on the proposed habitat garden design. This chart allows the designer to quickly build a target butterfly species list based on the specific habitat garden design. The quickguide is an X and Y chart matrix where the habitats are represented as color tabs (matching the habitat colors from the habitat typology charts) along the X axis. The butterfly species form the Y axis. If a butterfly species is found within a specific habitat then the box is filled within the matrix of that specific habitat's color codes. This system allows the reader to form a very fast visual list of butterfly species found within these habitats (Fig. 2.12).

Western Tiger Swallowtail
Papilio rutulus



Description: Both upper and underside of both males and females are a conspicuous bright yellow with bold black stripes, making the butterfly very visible from great distances.
Habitat: Forests clearings, riparian corridors, woodlands, savanna, mixed prairie, and urban gardens.
Abundance: Common. One of the most abundant and visible butterflies within the Eugene area.
Broods: One.
Conservation Status: Secure
Adult behavior: Males patrol every habitat from forest clearings to urban neighborhoods, slowly gliding through established flight-ways. Some perching occurs on taller vegetation. Especially fond of hilltopping, males circle and battle each other in a tireless aerial display. Males puddle.
Larval behavior: Caterpillars, are solitary and use eyespot patterns for defense to ward off predators. Caterpillar wanders off of hostplant to pupate on vegetation near the ground. Chrysalis overwinters.
Host Plants: Maples, ash, willows, cottonwoods, alder, apple, and birch.
Design Considerations: The host plants can serve as windbreaks, backdrops, and shade. Plant mid summer flowering plants.

Figure 2.11 Colorplate example for a local butterfly species

Although developed early in the design system, the quickguide formula is the culmination of the pragmatic approach which uses a variance of methods to create an rich schematic. This new method of building a butterfly palette through a quick and easy reference system should demonstrate an efficient design process. A more comprehensive description on how to apply the quickguides and color plates is discussed in greater detail in chapter three.

2.4 Investigating the Host Plants

Host plants are the sole food source for the caterpillar stage of the butterfly life cycle. Research shows that native vegetation has co-evolved with local butterfly species and these plants are more adapted to local growing seasons. For this reason, I focused almost entirely on the use of native plants for the component for host plants, as these

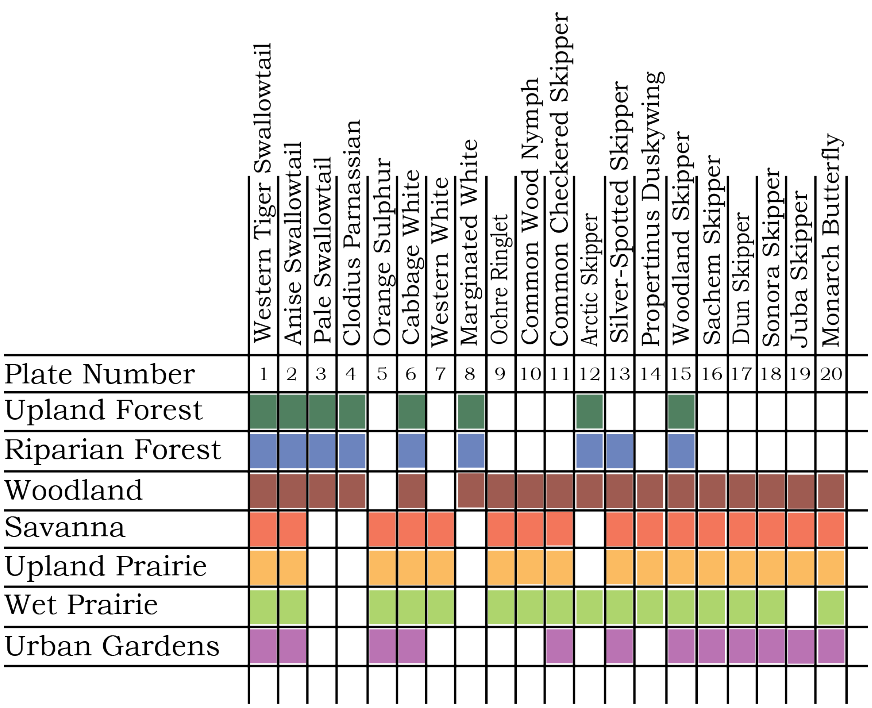


Figure 2.12 An example of the quickguide format

relationships with local butterfly species foster a greater ecological benefit. However, in very urbanized areas, the use of exotic host plants may be a useful if not a necessary component to sustaining urban butterflies.

<u>Literature Review</u>

Determining host plant species was largely compiled through literature. Local butterfly field guides and regional field guides were used to create a list of indigenous host plants to be used as a planting palette for the habitat gardens. Host plant lists were obtained through the NABA website, and regional butterfly field guide host plant documentation. Each plant was categorized as a tree, shrub, annual, perennial forb, or grass. Each plant was then further described as deciduous or evergreen and their cultural needs of water usage, sunlight requirements, their height and spread, habitats that they are associated with and the butterfly species that use them were addressed. A subjective and suggested design use based on best design value is provided from my assertions. Each host plant is illustrated with a photo of the mature plant with a closeup image of the particular part of the plant used by the butterfly. All host plants are compiled into a quickguide and an illustrative series of color plates and presented in much the same format as the butterfly color plates (Fig. 2.13).

<u>Observation</u>

Each of the 72 butterfly host plants shown in this document were sought in the field in their respective habitats and photographed in the Spring, Summer, and Fall of 2017 both as an entire plant and for their various distinguishing characteristics. Tools used in the field comprised of my Nikon D-50SLR with 50mm lens. I was able to locate nearly all usable hostplants within the Eugene area. In cases where I failed to locate appropriate and documented butterfly host plants, I relied on images from published web pages to complete this guidebook. In cases where I needed to borrow imagery for other sources, I provided a photo credit.

Building the Host Plant to Habitat Quickguides

The same methods for building the host plant to habitat quickguides were used with the building of the butterfly to habitat quickguides. Once the host plants are selected based on habitat community, the reader needs to access the host plant colorplates to cross reference the butterfly species which use the plant species for their juvenile stage of the life cycle. A more detailed description of how to use the host plant to habitat quickguides and color plates is described in chapter three.

Building the Host Plant Color Plates

Over 730 images were taken and cataloged for the various host plants occurring within the Eugene area. Color plates are formatted much the same way that the color plates are with the butterfly color plates.

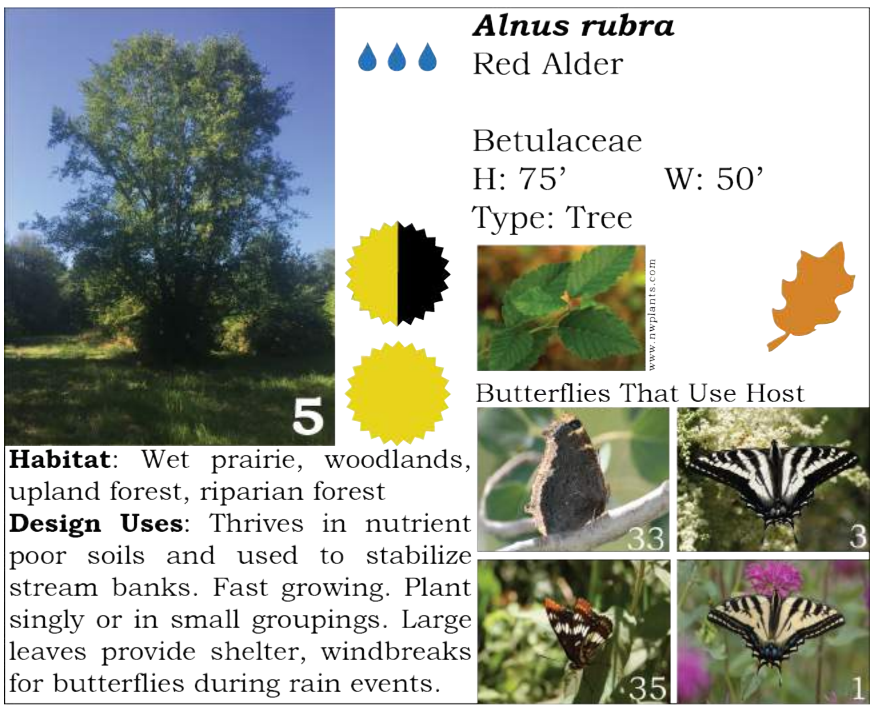


Figure 2.13 An example of the Host Plant Color Plate

2.5 Selecting Nectar Sources

Literature Review

Determining native nectar sources was accomplished through literature review by recommended and documented butterfly species to specific flower use from local and regional field guides and organizational websites.

Native Nectar Source Data

Determining which species of flowering plants were to be placed on the list was a combination of objective and subjective thinking. There are no guidelines to how lists of favored nectaring plants are compiled, so I devised a method of researching local butterfly recommended nectaring plants. Each time a flowering plant was cited on an organization's list as good for a butterfly nectar source, I gave the plant a check mark, as the list of sources grew, plants that showed repeated occurrence as recommended nectar sources were given the according check marks. The number of local resources researched totaled six. Plants that appeared on all six separate sourced lists were given a rating of six out of six and were listed as a top nectar source. Each plant was given the same consideration and given the same check mark tally.

1. NABA
2. Salix & Associates
3. Heritage Seedling and Liners
4. Life Histories of Cascadia Butterflies (book)
5. Oregon State University
6. Self-observation in-field documentation

An arbitrary number of suggested nectaring plants was arrived to be at the number 50. Some plant lists stop at 20, some continue up to the top 100 recommended nectaring plants. I chose 50, as I felt it was enough of a list to be inclusive but not so much as to be overwhelming. Out of the top fifty nectaring plants, 44 occur as color plates. This choice was made due to the lower half of the list consisted of plants that only occurred once out of the six sources and thus could be considered omissible from garden design despite being documented as a valid nectar source. However, experimentation is always recommended. Plants that occur on one list may not work for certain gardens. Use lists as a baseline but experiment and stick with what works.

Exotic Nectar Source Data

Because it is recognized that certain exotic flowering plants play a key role in providing high quality of nectar and that many of these flowering plants have shown to extend the nectaring season for adult butterflies, that the use of exotic flowers is warranted. Accordingly, I present a list of the top 50 exotic flowering plants favored by butterflies. This list was again compiled by the same methods used to compile native nectaring plants. This list used eight sources, both local and non-local plant lists. These plants however, do not appear as color plates, and the reader needs to further research web pages or gardening books for specific uses and cultural needs of those individual plants. This plant list was compiled from the following sources:

1. Butterfly Conservation Top 100 nectar sources
2. Nectar sources appendix: Mathew Tekulsky's book The Butterfly Garden
3. NABA Southwest Oregon Top Butterfly Nectar Flowers Checklist
4. Oregon State University Butterfly Garden Nectar Source Checklist
5. Xerces Society Butterfly Gardening Appendix A, Nectar Plants for North American Butterflies
6. Missouri Botanical Garden Plant Finder web page
7. Sunset Western Garden Book, Butterfly Attracting Flowering Plants Checklist
8. Self-observation and documentation

Observation

Observation played a key part in determining butterfly nectar fidelity within urban settings. There is good reason to conduct ground truthing surveys when it comes to nectar source usage. An example: Many books recommend the Shasta Daisy and Black-Eyed Susan as top nectaring plants, however, within my study area of the urban neighborhood, Shasta Daisy and Black-Eyed Susan were rarely used as nectar sources and fell favor to English Lavender and Echinacea in the summer and Goldenrod and asters in the fall. By far the most utilized annual flowering plant was the zinnia. Gardens which had mass plantings of butterfly weed, lavender, asters, echinacea, tall verbena and mints were used almost exclusively over gardens which presented large patches of colorful Black-Eyed Susan's, Shasta Daisy, cosmos, daylily, and coreopsis.

Building the Nectar Source to Habitat Quickguides

The same methods for building the nectar source to habitat quickguides were used with the building of the butterfly to habitat and host plant to habitat quickguides.

Achillea millefolium
Yarrow
Asteraceae
H: 1-3'   W: 1-2'
Type: Perennial

3

Culture: Aggressive and spreading. Plant with both short & tall grasses, goldenrod, and asters.

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forests and riparian corridors and cultivated beds
Notes: Foliage has a pleasant aroma
Growing Conditions: Grows well in all soils from wet to dry soils in open meadows and fields.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Figure 2.14 An example of a nectar source colorplate

Once the nectar sources are selected based on habitat community, the reader needs to access the nectar source color plates to select a palette of flowering plants for the garden. A more detailed description of how to use the nectar source to habitat quickguides and color plates is described in chapter three.

Building the Native Nectar Source Color Plates

Over 1000 images of nectar sources both exotic and native were photographed and cataloged between April 2017 and March 2018. Photo documentation was key for the building of the nectar color plates. Color plates were formatted much the same as the host plant color plates with the omission of butterfly images, as butterflies as far less exclusive to flower choices than they are to host plant interactions (Fig. 2.14). Color plates are explained in greater detail in chapter three.

2.6 Site Selection 4J Elementary Schools

Because this master's project involves the designing of butterfly habitats upon elementary schools grounds within an urban context, the selection process of determining which schools to select is the next step.

Admittedly, a butterfly garden can be designed upon a myriad of potential sites. However, choosing elementary schools as potential habitat gardens was based on the following determining factors;

I chose the 4J elementary school system because this system met most if not all criteria for school butterfly habitat garden potential. I wanted a garden that can engage the age demographic of grades K through 5th, as these ages show the greatest degree of empathy for the development of stewardship for wild places. The criteria were set based on the Niche Blog which compares private vs public school systems and lists the advantages and disadvantages to both systems.

1. Potential for the greatest network area
2. Demographic of student ages (K-5th grades)
3. Greatest variety of student body diversity
4. Greatest distribution of school districts across multiple habitat types
5. Greatest needs of school ground improvement
6. Greatest potential government funding potential for habitat garden programs

Once I determined that a 4J elementary school was an appropriate site for the potential for butterfly habitat gardens I set about conducting site visits. During the weeks of July 24, the and August 18th 2017, I visited all twenty 4J elementary schools, evaluating each school and performing a series of site analyses. All school grounds were photo documented and evaluated. In all, 980 images were taken, capturing each school's characteristics. The main criteria were assessed for each school grounds.

1. School with a surplus of open turf grass space that did not have a direct and obvious set of programming applied to it (ball fields. Running track, etc.).
2. School with an active vegetable garden program.
3. School that is within a quarter-mile of a natural area. This natural area needed to be different than a park, as parks can be devoid of native vegetation.
4. Existing native vegetation remaining on school grounds.
5. Located near a year round fresh water source.

After evaluating each school, I chose the Willagillespie Elementary School in north central Eugene. The school had an excellent working vegetable garden program, but more importantly the school grounds comprised of 4.4 acres of habitat garden potential. The school also resides no more than 900 feet from an intact oak savanna city park, Gillespie Butte.

Once a school site was chosen, I conducted a more in depth site analysis. A plant survey revealed that the property has an existing semi-mature mixed oak woodland of over an acre on the eastern side of the property and the north border of the property has a year round source of water that drains through and off the property.

GIS mapping of school distribution

Bringing in the shapefile of the schools of Eugene into ArcGIS allowed me to see all schools from preschool to high school which occur within the UGB of Eugene (Fig. 2.15). Generating a simple map of the twenty 4J elementary schools of Eugene, allowed for a simplified spatial analysis of the distribution of schools and how a network of working butterfly habitat gardens might look.

Once the exact school site was determined, I attained several images from Google Earth and imported these images into AutoCAD to generate a series of site design maps. Through these site map images, I set to divide the property into thematic use zones of buildings, play spaces, parking and drop off zones, sports and activity fields and current open spaces. The current open spaces were further evaluated for potential butterfly habitat garden spaces. I determined that the greatest potential spaces for butterfly habitat gardening resided to the periphery. I then divided these spaces into distinct habitat typologies and generated a habitat zone map, assigning each zone the appropriate habitat typology color code. Although the school resided on historically mixed

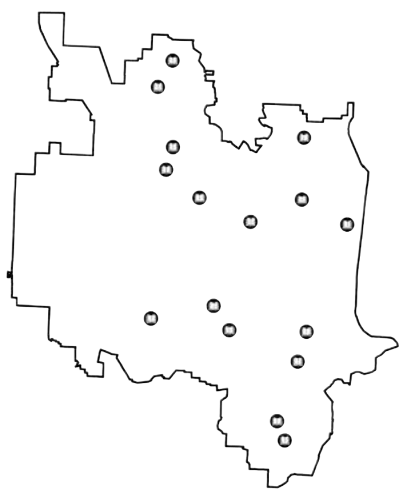


Figure 2.15 Location of 4J elementary schools of Eugene

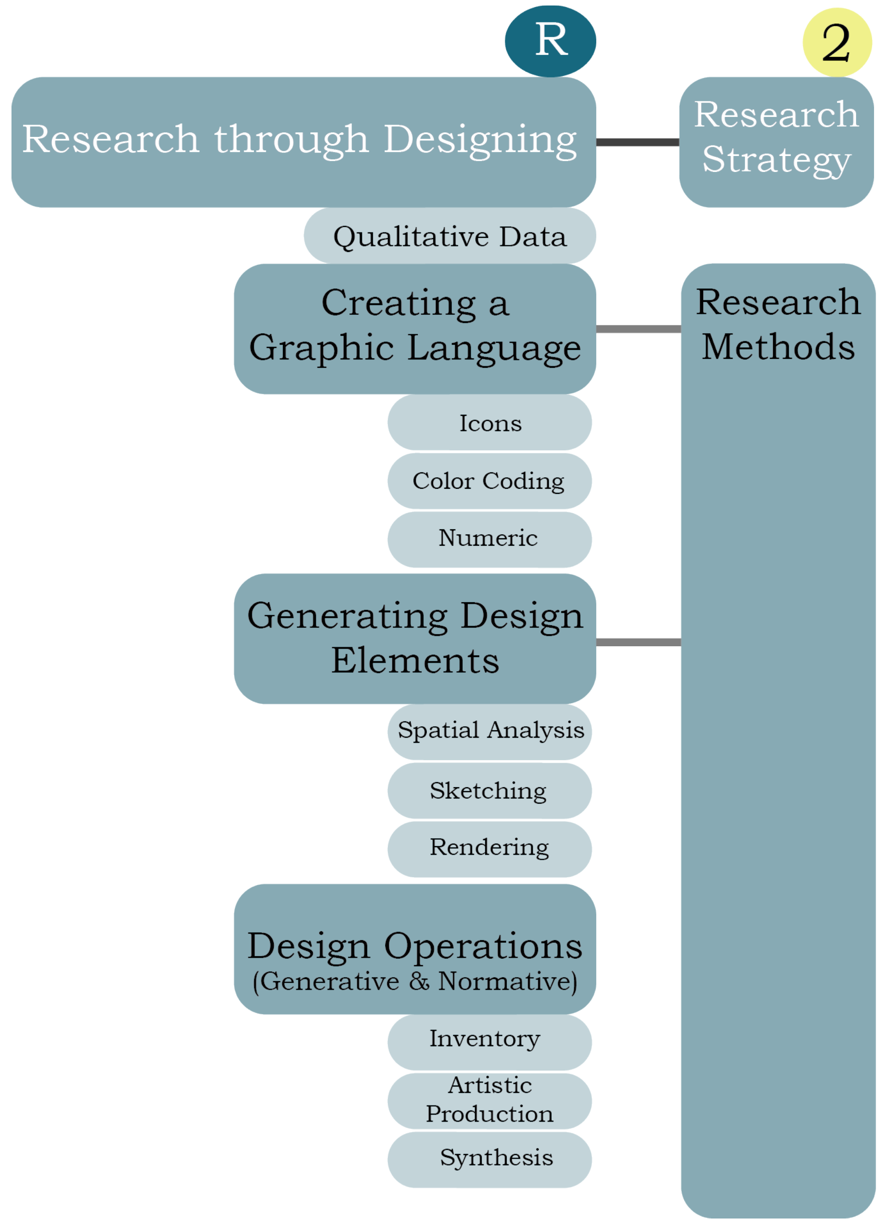


Figure 2.16 Research through Designing framework

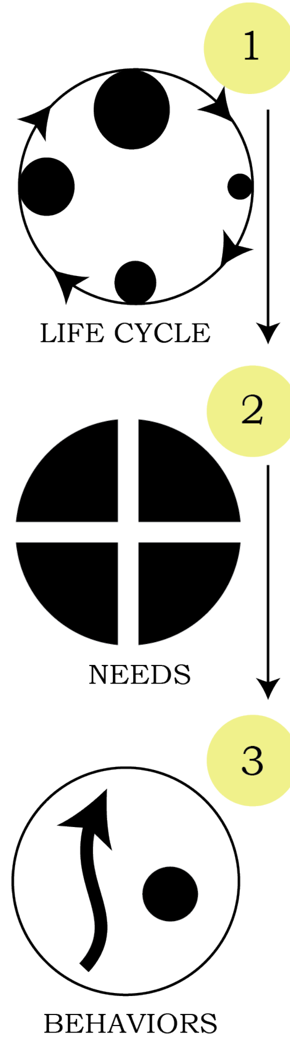
prairie habitat, the existing woodland and close proximity to the Gillespie Butte savanna allowed me to determine that there were four potential butterfly habitat garden themes; wet prairie, upland prairie, oak savanna, and oak woodland.

Research Through designing

I see design as a communicative tool, strongly influenced by and asserting an art-based component. It is recognized how artistic knowing can complement scientific analysis (McNiff 2013). Knowing which areas of research may not need an art-based component to convey information compared to which areas of design research most benefit from an art-based component is a key process through the pragmatic approach to designing. The generation of new ideas through the action of designing (verb) applies with the research strategy, research through designing.

Working closely with the foundational steps accomplished in the first half of this project (building the palette) with the research for design and the research through designing components are blended into the language of graphic representation. The research through designing section aims at the generation of new knowledge (Fig. 2.16).

The primary generative information during the research through designing phase of this master’s project focuses around the butterfly life histories of life cycle, butterfly needs, and butterfly behaviors. Each life history component is broken down into individual parts and examined as a single construct, then rebuilt back into the design model to show both spatial and temporal relationships that butterflies share with their environment. Understanding these components and the best strategies to employ them within a design context helps the reader understand how each element should/could be used to maximize the benefits for the survival of butterfly species within the context of the garden space.



The life cycle is the first level of Hierarchy within the graphic language of the icons. Each of the four stages of butterfly life cycle of; egg, caterpillar, chrysalis and adult have specific characteristics which give rise to certain needs.

The first level need icon shows the needs of food, water, shelter, and sunlight effect each of the life cycle in a different way. Design considerations for specific needs to take into consideration each stage. Needs at each stage lend themselves to specific behaviors.

The first level of the behaviors icon hierarchy are the; puddling, perching, patrolling, basking, hiding, nectaring, hibernating, roosting, feeding and hilltopping icons, all demonstrate specific spatial properties.

Figure 2.17 First level icons to building a graphic language

Although I see the first half of my methods; literature review and direct observation as research for design components, admittedly there are numerous contributions of new knowledge that were derived from this process, namely in the construction a butterfly and plant palette. Thus research for design and research through designing components were used when and where needed to form this research strategy.

I address the second half of the project through a generative process of creating a visual base of communication. The first step, the building of a graphic language.

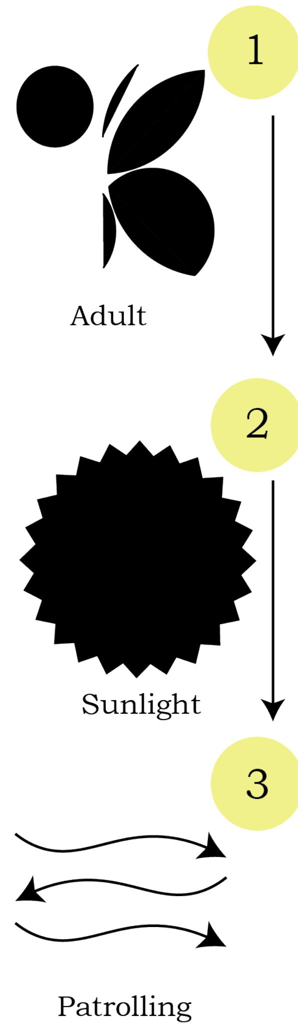
2.7 Building a Graphic Language

Through Icons

My approach to the research through designing component is to create a graphic language that the reader can follow seamlessly through the document. This is achieved first by the formation of iconology. Icons represent a lot of information in a very simple visual construct. These icons are introduced in chapter three, the guidebook, to introduce the reader to the language that will be used to communicate design intentions throughout the remaining pages of this master's project (Fig. 2.17).

Simplicity and efficiency are the driving forces for the use of icons. The icons function as a navigation tool. Each icon represents a specific stage in the butterfly life cycle, a specific need, and a specific behavior. Thus the icons serve as an indicator of the both design intent and as a wayfinding tool. The use of icons in this design construct help convey a lot of complex information without overloading the viewer.

The icons form a hierarchy. The icon hierarchy begins with the four stages of the butterfly life cycle. Each stage of the butterfly life cycle gives rise to certain needs that each life cycle stage requires for survival. The next level of hierarchy are the butterfly behaviors. The butterfly behaviors are a direct result from the butterfly needs. Thus, the icon hierarchy reads as; life cycle, needs, and behaviors. Establishing a hierarchal format helps the reader know what level of design each move within the document is intending to address (Fig. 2.18). Because color is used to convey other aspects of design through the document, the choice of using all black for icons eliminates confusion and increases icon recognition.



A second level life cycle icon shows more specific information. Here, the adult stage of the butterfly lifecycle is represented by the winged adult.

A second level needs icon of sun represents the need for bright sunlight and warmth necessary for butterfly activity to remain at a high functioning capacity.

The second level icon represented here shows the behavior that males butterflies engage in called patrolling where males search for females to mate with. The arrows in behavior icons represent motion.

Figure 2.18 Second level icons add to specificity

The life cycle of a butterfly is divided into four distinct phases; the egg, the caterpillar, the chrysalis, the adult. During each distinct phase of the butterfly life cycle the butterfly has certain needs to meet their survival requirements. These needs are food, water, sunlight and shelter, with the adult butterfly given the additional need for reproduction. Reproduction is classified as a need because of the behaviors that rise from it. These needs give rise to behaviors to which the butterfly

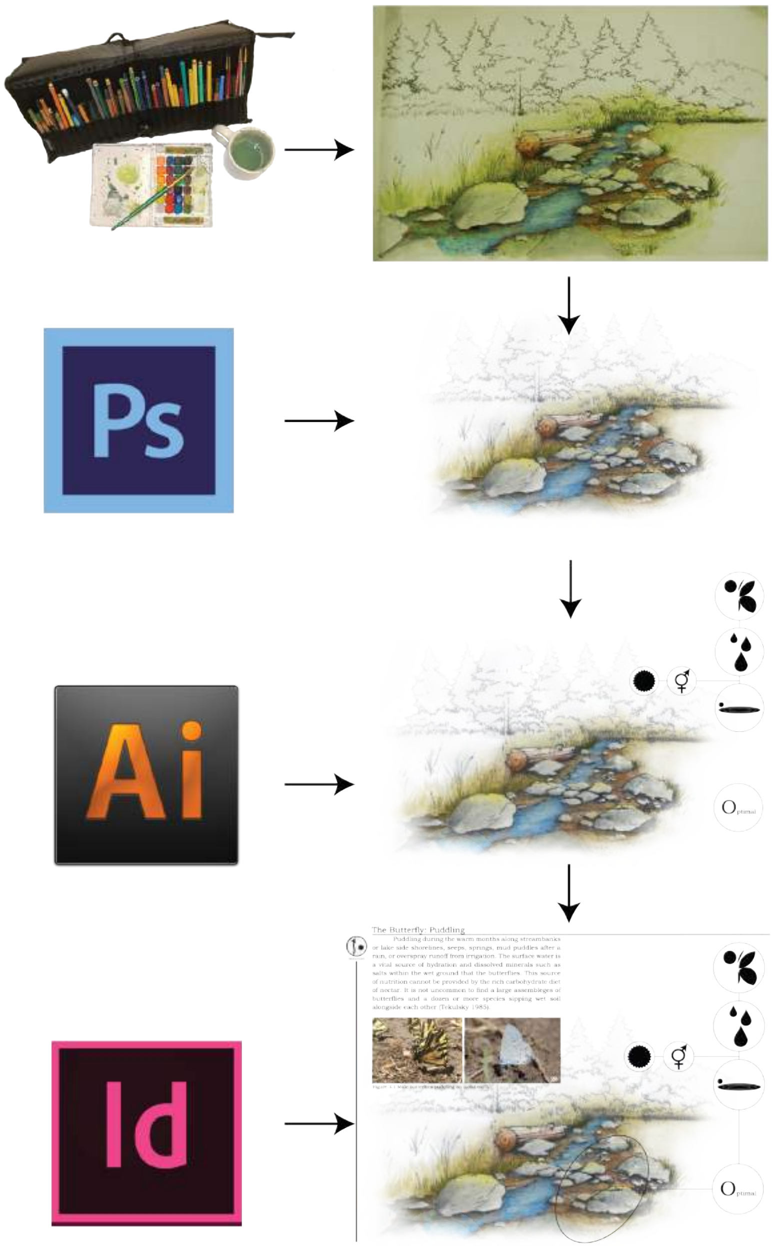


Figure 2.19 The flow chart of drawing to render communicating the process of creating a clear framework language

interacts with their environment. These behaviors are puddling, patrolling, basking, feeding, nectaring, perching, hiding, hilltopping, and roosting.

Some behaviors are need specific. The nectaring behavior is specific to the food need, whereas the need for reproduction lends itself to three separate behaviors; patrolling, perching, and hilltopping. An icon language is key to identify what life cycle component, need and behavior is driving each design decision.

The icons which represent the life cycle components, specified needs, and behaviors represent spatial and temporal design elements. These individual design elements can be arranged and manipulated within a design to form butterfly survival strategies. Many of the design element icons must be combined with other design elements to achieve optimal butterfly survival design strategy. In this way, a new manner of designing a butterfly habitat garden allows the reader to think holistically about how to provide for butterfly survival.

Through analog and digital media, the creation of a clear language allows the reader to understand the process of how each icon (design element) works both individually and in combination with other design element icons. This master's project centers around creating a design process.

The process of design is often omitted from text and published work, thus I provide a program that diagrams the process of design from start to finish, with the aid of a graphic language (Fig. 2.19).

2.8 Generating Design Elements

A system of selecting icons and plugging them into the design at various stages ensures a simplistic but comprehensive approach to building the butterfly habitat garden.

Arranging the design elements in a logical hierarchal framework keeps a clear step by step method visible to both designer and viewer of the design. Although these design element icons appear as two-dimensional objects to the eye, they constitute spatial constructs within the environment and are influenced by other external factors and are very much dependent on many of the other life history design elements to function properly. Thus a flower patch, to be effective for optimal butterfly us,e needs to address spatial constructs of size, height, structure, placement, exposure, distance from other elements and seasonality. Physically it needs to address color, fragrance, flower shape, and nectar quality.

This project sets up a process of plugging in design elements to address each of the butterfly life history components, with a clear tutorial on how this process works. Much like that of the quickguides and color plates with their easy navigation and implementation, the icon language and design element structure operate under the same set of easy step principles. They have all the components of the research embedded into their design. With the design elements, the designer needs only to plug them into the design and arrange them according to the life history information provided by the icons. Thus, the process is a simplified or distilled version on a larger body of knowledge and each maneuver the designer makes by using this process is backed by this same rigorously compiled body of work.

Applying principles of spatial analysis was determined through analyzing the three hierarchal components of the butterfly life histories of the; butterfly life cycle, butterfly needs and butterfly behaviors. In the first section of the research through designing phase, these design elements were converted into an icon language. The next phase is to implement these design elements into design scenarios, arrange them with other design elements, and rework them in different design scenarios. To accomplish this, the basic principles of the butterfly life history must be understood and the external forces that affect the garden, such as wind, temperature, exposure needs to be scrutinized.

The life histories of the butterflies of Eugene are quite complex. To break these down into manageable and understandable components seems a likely way that design can communicate and justify design moves is the strength of the graphic or visual language. I elected to sketch in the field to capture the moment, draw and paint in the studio to refine imagery and then use digital media to keep a clear repeatable visual symmetry that the reader can follow.

2.9 Applying the Framework

The framework of the project revolves around the contents of the guidebook. The guidebook is designed to allow the reader(designer) to quickly assemble a butterfly and plant palette and plug the design element principles into a design quickly and easily. This system has been rigorously researched and repeatedly tested in process to assess the ease and efficiency. It also strives for accuracy and transferability and is designed to be utilized across scale and place.

The rendering of a butterfly habitat garden upon an elementary school grounds in Eugene is a demonstration on the application of the design process framework. For site selection, I used the Willagillespie Elementary School in north central Eugene as my site to carry out the rendering of a butterfly habitat garden. Choosing the site was based on the site demonstrating a vast amount of potential open space in which a design could be carried out. The school also was within a quarter mile of a natural area with an intact upland prairie and oak savanna parkland of five acres. The site also had a working school garden program.

To be clear, a butterfly habitat garden can be designed and implemented upon nearly any site. My choice for the choosing of an elementary school (Willagillespie School) as an appropriate site was based on my criteria. A designer can base site selection any a differing set of values.

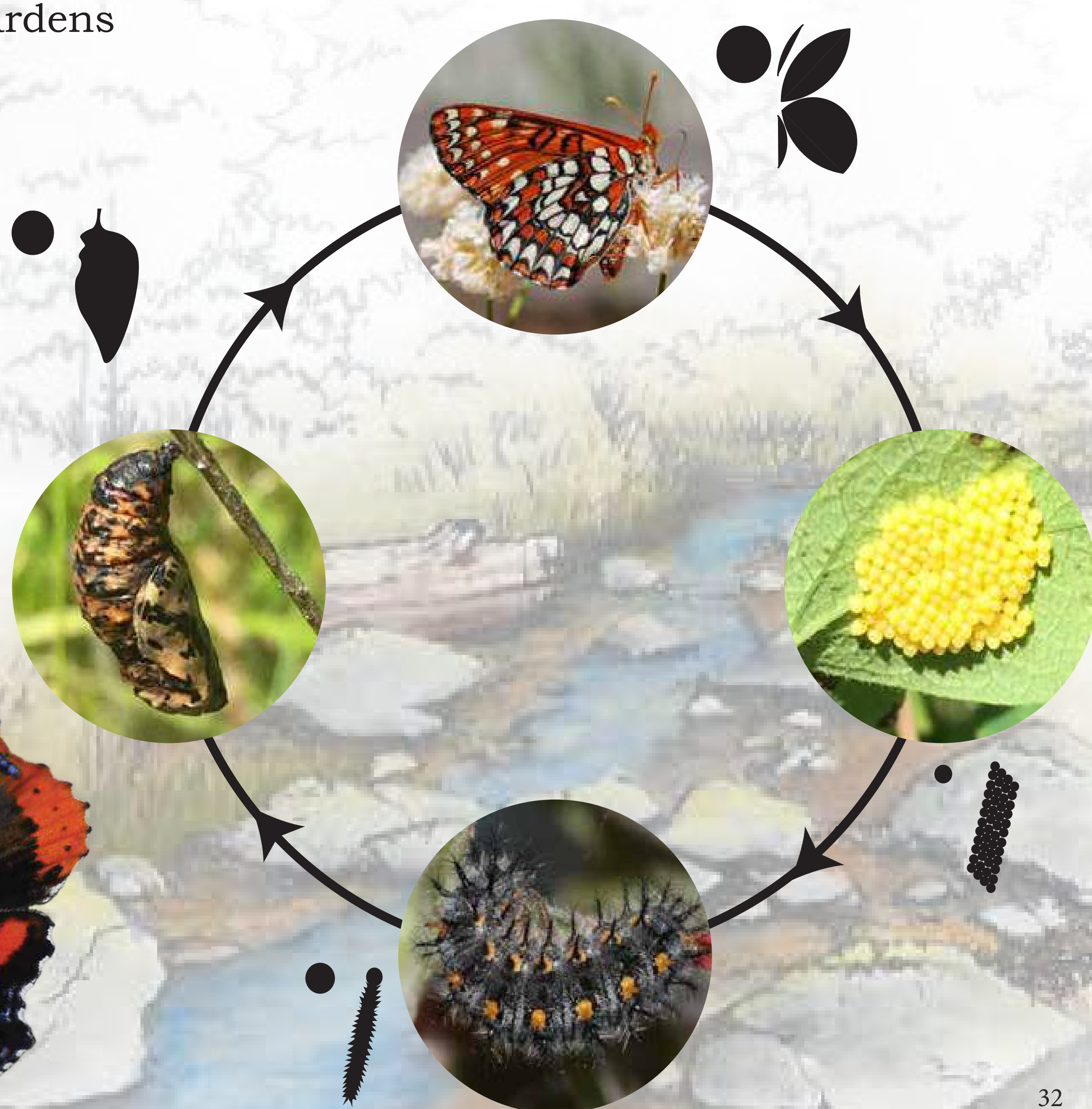
The two phases of research for design and research through designing culminate into creating a framework for the designing of a butterfly habitat garden. From this point forward, this butterfly garden design framework will be referred to as a design process. Chapter three is dedicated to the demonstration of designing a butterfly habitat garden design process based on butterfly life histories. (Fig. 2.20).

Figure 2.20 The guidebook framework

And Then There Were Butterflies

A Design Guidebook: Using Butterfly Life Histories to Design for Urban Butterfly Habitat Gardens

Chad Hawthorne



3 The Guidebook

3.1 Introduction to Butterfly Gardening

A butterfly garden defined

A butterfly garden is a specifically planned space to attract and keep butterflies supplied with the basic elements that they need for their survival; food, sunlight, water, and shelter. The main objective of butterfly gardening is to provide a habitat for these insects through the strategic use of hostplants for the developing caterpillars and nectar plants to sustain the adults (Tekulsky 1985).

In this guidebook, I assert that to think more completely about the survival of butterflies within urban butterfly habitat gardens, that the examination and subsequent design maneuvers within the garden must be based not only on these four basic needs, but focus on the butterfly life cycle, and butterfly behaviors as well.

“An implicit goal of butterfly gardens is to provide butterfly friendly habitat in a matrix that would otherwise be unfriendly because of human domination of the landscape”.

-Desiree Di Mauro

Urbanization and the disappearance of habitat

So why are we building butterfly gardens? In undisturbed habitats, adult butterflies can move freely through their environments, seeking mates, hostplants and resources such as water and nectar. This movement is a natural tendency that butterflies demonstrate and is one factor that allows butterflies to distribute their numbers and expand their territories.

As human disturbance (urbanization) increases, changes in landscape and vegetation matrices often create flight obstacles and decrease butterfly population movement (Singer 1991). Changes in native and intact habitat, do to urbanization, can create patches within contiguous vegetation communities, resulting in habitat fragmentation. The altering of habitat matrices and the creation of this fragmentation reduces connectivity and availability of resources and is recognized as a major contributing factor to population declines for butterflies (Mauro 2007).

Urbanization of a once native landscape is considered an environmental disturbance. Based on studies along the urban/rural gradient, butterfly species diversity decreases as urbanization increases. As human populations grow, and urbanization continues, more productive land that once supported butterfly populations will continue to degrade or disappear. Certain species of butterflies show a greater degree of resilience to urbanization than other species and no two species of butterflies react exactly in the same manner to habitat disturbance. Plants and animals that can make a living in disturbed areas will likely be more successful in an urban setting.

However, the problem of urbanization doesn’t lie within the practice of development but rather the practice of inappropriate design. In areas where wide spread urbanization has occurred, urban gardens are now recognized for their role in supporting wildlife. In England, gardens are now considered their “most important nature reserve”, where cultivated spaces planted with both native and ornamental plant species fill the void where habitat has been lost (Shackleton 2016).

This trend is not unique to European butterfly populations. Worldwide, butterfly populations are in decline. In North America, where environmental changes in land form and land use through agriculture and urbanization practices occur, the problem of decreased butterfly species diversity increases.

The good news is that an urban butterfly garden can contribute to an ever-growing awareness of the need to provide wildlife a place of refuge. As urbanization continues to push further into wild spaces, butterfly gardens can provide vital habitat for declining butterfly populations (Fontaine 2016).

These findings should in no way imply that these gardens can replace natural habitats. Rather, these gardens act more like stopovers or habitat vestiges. Studies by Vickery indicate that butterfly gardens are not “islands of habitat”, where butterfly populations thrive within closed garden borders. Rather, these gardens act as stepping stones for adult butterflies which fly between natural habitats. Furthermore, these gardens are less likely to provide habitat or food for the rare species of butterflies which tend not to visit urban gardens (Mauro 2007).

Thus, the takeaway here is twofold. First, that urban butterfly gardens are most effective for butterfly species that demonstrate a higher fitness level to the disturbance of urbanization, generally identified as the common species. Secondly, that urban butterfly gardens increase in efficacy when natural vegetative habitats remain intact within proximity to these built butterfly gardens. Thus, preserving natural areas where and when possible within urban areas should remain the first priority. The second priority is the involvement of a of landowners and stakeholders to create a network of butterfly habitat gardens. This guidebook addresses the designing of such gardens in hopes of contributing to the survival of urban butterflies.

Why focus on Butterfly Life Histories?

This guidebook focuses on the designing of urban butterfly habitat gardens based on the life histories of the butterflies. These life histories are the butterfly life cycle, the butterfly needs and the butterfly behaviors.

I assert that concentrating on these butterfly life histories can give the designer of these butterfly gardens a more comprehensive view of butterfly survival strategies. Thus, the designer can make spatial design decisions, based on criteria that promote butterfly survival, rather than create spaces that simply promote butterfly visitation to the garden space. Specific described and illustrated butterfly life history information is discussed, and design examples are provided further within this guidebook.

Why Native Plants?

So, if we are building butterfly gardens based on butterfly life histories, then what do these butterfly gardens look like. This is the beautiful part about design. The design can be anything imaginable, as long as the basics are addressed and the reasons for design maneuvers are substantiated by scientifically backed butterfly life history data.

I assert that the number one building block to base the garden on is the habitat that the garden will represent and the native plants that constitute the planting palette.
Native plants should remain the focus of the garden’s planting palette to meet the needs of the various stages of the butterfly life cycle as well as fulfill the various considerations of vegetation layering, design form, and landscape function.

The butterfly habitat that the garden represents should resemble the habitat that existed on the site before the landscape was altered through the modifications caused by European settlement. Thus, the native plants that make up these butterfly habitat garden landscapes should resemble the pre-settlement plant communities.

The argument for the use of native plants, as the plant palette, is demonstrated by examining how energy moves through the food web: Plants gain energy from the sun through the process of photosynthesis. This stored energy within the plant tissues becomes available energy to herbivorous animals. Native plants have evolved to form complex food web relationships with the next tier on the food web, the herbivorous insects. Herbivorous insects, such as butterflies, are a principal food source for many of the other predatory trophic, especially birds (Tallamy 2007).

In a study at the University of Delaware that examined how native plants account for greater insect dependent interaction, professor of entomology Doug Tallamy demonstrated that the native eastern oaks supported 532 species of caterpillars, versus only one species of caterpillar on the exotic Chinese Goldenrain Tree. Combine these numbers with other native plants such as the willow (455 butterfly/moth species), the poplar (368 butterfly/moth species), and the maple (285 butterfly/moth species), it becomes clear that the greater number of native plant species in the garden, the greater degree of biodiversity (Tallamy 2007).

This is what butterfly habitat gardening should strive to do, create as much biodiversity as possible. The butterfly is the driving force for intentional design decisions, but these ambassadors of the insect world are helping bring in all the other contributing plants and animals to these urban garden spaces.

The native plants referenced within this discussion serve as butterfly hostplants. Not every native plant that occurs within a region is a butterfly hostplant. It is intentional that I have designed this guidebook with using only hostplants to fulfill all other aspects of planting design form and function. Information on hostplant interaction is discussed further within this chapter.

Garden Size

If native plants are the answer to form and function of a butterfly habitat garden, then how much space is needed for these butterfly habitat gardens to be successful. The answer to this question isn't so easy and is dependent on a multitude of factors. If you search most butterfly gardening books or websites, the statement that a butterfly garden can be as small as the size of a window box is commonly communicated (Mauro 2007). Thus, any attempt to contributing to butterfly survival can have some means of positive impact on butterfly survival. However, much has been studied on the effects of garden size in relation to butterfly diversity and in fact the larger the butterfly garden, the greater the butterfly diversity and the greater the butterfly abundance (Sankaranarayanan 2018).

Butterfly garden size matters less in lesser urbanized areas where access to wild spaces remains high. However, where urbanization is more intense, larger garden spaces significantly increases butterfly species richness (Fontaine, 2016). Studies that have researched butterfly diversity within urbanized areas have found that larger gardens within urbanized areas of ½ an acre or larger have the highest potential to support a greater amount of butterfly species than smaller gardens (Mauro 2007). Research also shows that gardens which grow 20 or more flowering plants, demonstrate the greatest amount of butterfly diversity (Mauro 2007).

It begins to become clear that garden size, native hostplant selection and diverse and ample nectar source availability become interdependent factors on successful butterfly habitat gardening. Thus, the garden design should focus on the butterfly life histories as well as the specific plant selections to meet butterfly survival requirements.

Why butterflies and why butterfly gardening?

Butterflies are engaging and iconic animals of a garden. People are drawn to butterflies because of their beauty, grace and their sense of freedom. But butterflies are also important ecological components of an ecosystem. Many predators use them as a significant food source and their presence is often a sign of ecological health. Because of the adult butterfly's affinity towards flowers, butterflies can be contributors to ecosystem services as pollinators (Jain 2016).

Perhaps one of the more significant contributions that butterflies can make, is serving as the role of nature's ambassador. Because butterflies are beautiful, people connect with them on a level that they might not with other animals. This connection can lead to environmental engagement and stewardship (Rigolon 2012). It is this stewardship to wild places that can make a real difference in the survival of the natural environment. The beautiful part of butterfly habitat gardening is that not only do you get butterflies, but a whole suite of other insects, birds, mammals, and reptiles move in, creating a wide and diverse range of animals.

This project focuses the use of native plants. Butterfly habitat gardening is driven by planting native plants. Gardening with natives has many advantages. Native plants are important because as urban sprawl continues, the wild animals that occupy the area have two choices, push further to the edge, or move inward to urban green spaces. In Great Brittan, urban gardens are now recognized as vital to the county's biodiversity. Here in this America "gardeners have become important players in the management of our nation's wildlife" (Tallamy 2008).

The Willamette valley has been so altered from the native landscapes of oak savanna and prairie that less than 8% of savanna remains and less than 1% of wet prairie remains (The Nature Conservancy, 2018). The use of a native plant palette can provide vestiges of habitat for butterflies as well as a myriad of other wild creatures. Because the butterfly garden should be designed to resemble the native landscape, these gardens help mitigate habitat loss. This habitat loss has had a profoundly negative effect on butterfly populations. Butterfly gardens can provide much needed vestiges of habitat for butterfly survival. Because butterfly gardens require the use of native plants, the butterfly garden creates a sense of place and identity to the space. Perhaps this passage says it best.

"Butterflies add another dimension to the garden, for they are like dream flowers-childhood dreams-which have broken loose from their stalks and escaped into the sunshine. Air and Angels."

-Miriam Rothschild, entomologist

Basic goals of a butterfly habitat garden

Strive for diversity. The more diverse the plant palette, the more diverse the butterfly populations. Gardens that offer more than 20 species of flowering plants show greater numbers of butterflies occurring within those gardens (Mauro, 2007).

Use mainly native plants. Butterfly diversity increases as the diversity of native plants increases (Oliver, 2015).

The larger the garden the better. Although much is written about there is no size requirement to a butterfly garden and even a window box can count. Research shows butterfly populations and butterfly richness increase in gardens of half an acre or larger (Mauro, 2007).

Native Habitat. Create a habitat gardens based on the habitat that previously existed there. The soils and seed banks may be still viable and any remnant patches of nearby habitat may contain pockets of native butterfly populations that could spill into your garden.

Ten Principles of Butterfly Gardening

Principle 1 Grow plenty of flowers: Most adult butterflies use flowers are their primary food source. Make sure that flowering plants are plentiful throughout the butterfly flight season as certain butterfly species occur early in the year and certain species occur late in the season.

Principle 2 Grow the right hostplants: Many butterfly species have specific species of plants that they feed on as caterpillars. Most of these hostplants are native species and the butterflies have co-evolved with these plant species.

Principle 3 Plant a variety of plants within the garden: Most successful habitat gardens have more than twenty different species of flowering plants, hostplants, and plants that serve as shelter and cover. The more species of plants the more diverse your garden will be.

Principle 4 No pesticides: Even herbicides and harsh fertilizers can be harmful. Pesticides which target specific species can still have catastrophic effects on the entire garden. Natural pest control is always best and the more diverse the garden the greater the chance of balance will be achieved within the insect community.

Principle 5 Know what species of butterflies live in your area: Many butterfly species that occur regionally may not dwell where the garden resides. Walking the area and making a list of what flies where is garden is helps the designer to select the exact butterfly species and the exact hostplants to lure them.

Principle 6 Provide plenty of sunshine: Butterflies are cold blooded, they need plenty of sunshine and warmth to carry out their basic life processes. Creating pockets of warmth through windbreaks and shelter can encourage butterflies to use and perhaps stay within the garden. Open spaces or basking stones help butterflies get warm and stay warm.

Principle 7 Arrange plants strategically. Massing flowering plants encourages butterflies to find and then stay within the space. Spreading the hostplants out encourages the butterflies to disperse their eggs and caterpillars so predators can’t find them in one easy place.

Principle 8 Provide water and minerals: Butterflies, especially males use wet patches of earth to hydrate and gain precious minerals for reproduction. Providing puddling stations helps address this vital stage in butterfly life cycle needs.

Principle 9 Let the garden be wild. Butterflies like it messy or at least in a human perspective of messy. This need for leaves to remain in planting beds and grass to be left unmowed and shrubs to be untrimmed is vital, as many hibernating butterflies in the adult, chrysalis, egg, and caterpillar stages will often be hiding within these unkempt areas during winter.

Principle 10 Experiment: Don’t think that all well laid design plans will result in successfully encouraging butterflies to visit or live within your garden. Each microclimate that is created within the garden may take considerable experimentation to achieve desired results.

Adapted from Tom Terrific Ten Commandments of Butterfly Gardening
@ www.butterflygardening.org

"The most important thing is to preserve the world we live in. Unless people understand and learn about our world, habitats, and animals, they won't understand that if we don't protect those habitats, we'll eventually destroy ourselves."

-Jack Hanna *Author & American Zookeeper*

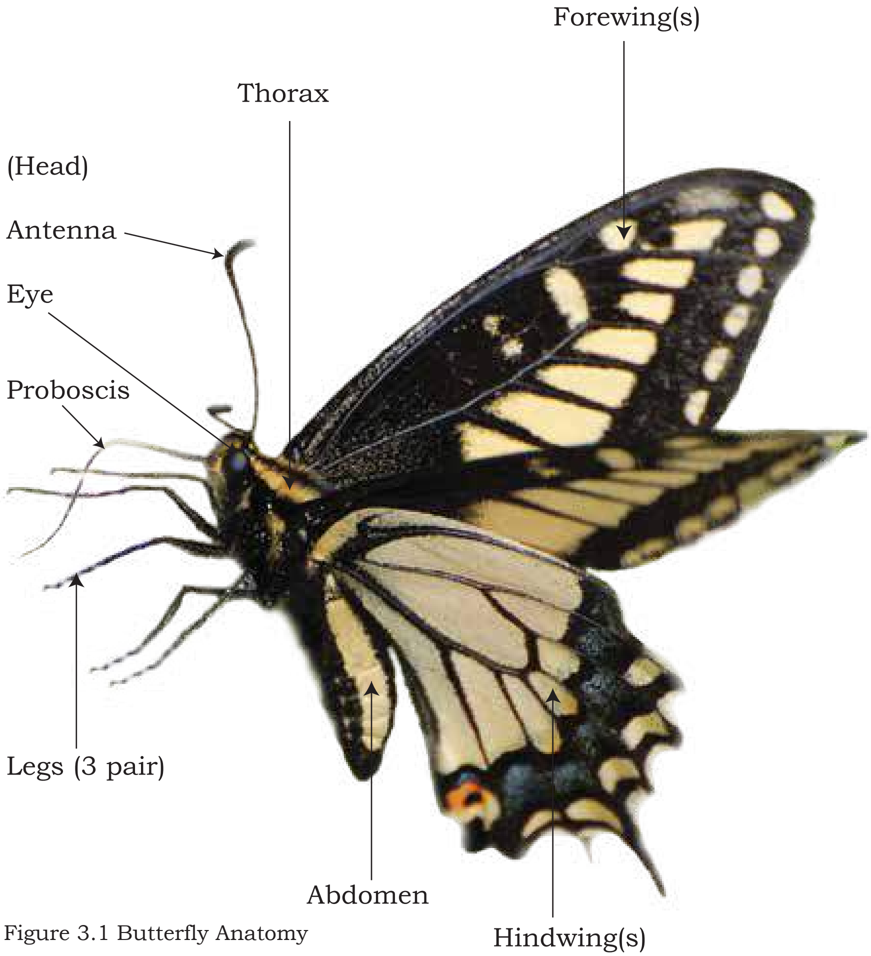


Figure 3.1 Butterfly Anatomy

Butterflies, like all insects, have a three-segmented body; the head, the thorax and the abdomen. The head consists of two large compound eyes, a coiled mouthpart called a proboscis and a set of antennae. The head is attached to a thorax. The thorax is where the butterfly's musculature attach to four scaled wings for flight and three pairs of legs for gripping its environment equipped with feet with tasting capabilities. The abdomen attaches off the thorax and houses such vital organs for breathing, digestion, and reproduction (Fig. 3.1).

Compound eyes-

A butterfly's eyes are composed of hundreds of individualized lenses, an arrangement called a compound eye. The eyes are large compared to its head, giving the butterfly a visual field of view that covers a 344 degrees or 95% of its environment, and allows them to detect fast moving objects (Rutowski 2002). The compound eye is comprised of hundreds of six-sided lenses, which give the butterfly an ability to not only see the colors that we humans can see, but allows the insect to see ultra violet light. Because of the abundance of lenses, the butterfly has a natural nearsightedness, limiting the butterfly to form clear images up to 12 feet, past that images will be less clear (Rutowski 2002).

The ability to detect ultraviolet light gives the butterfly a ability to locate their primary food source, nectar. Flowers have specialized color patches on the inner portion of their petals called nectar guides. These nectar guides become very visible under ultraviolet light allowing pollinators to locate an easy meal (Tekulsky 1985, Yturralde).

Proboscis-

The adult butterfly's diet consists entirely of a liquid-based diet. To acquire this liquid, the butterfly has a tubed mouthpart termed a proboscis. Once the butterfly prepares to feed, the insect uncoils its long tube and places the tip into the source of either food or water and begins sucking, bringing the fluid into the insect's body.

Proboscis length is very species specific. Some species possess a long proboscis, while other species have a shorter proboscis. Proboscis length is indicative of flower feeding specialization, much so, that butterflies who are specialists often avoid urban gardens (Bergerot 2010). Flowers with long nectar tubes, where the nectar source is too deep for butterfly species with a short proboscis, will not be visited. Instead, butterflies with a short proboscis will only visit flower species with shorter flower tubes. As each generation of butterfly and flower co-evolve with each other, a specialization of feeding begins to evolve, giving rise to two distinct butterfly feeding classifications; nectar feeding specialists, and nectar feeding generalists (Tekulsky 1985). Feeding specialists tend to be less common and more limited to both feeding options and habitat diversity. Generalists tend to be more common and more diverse across habitats.

Antennae-

Butterflies have a pair of long outstretched appendages on the top of their head termed antennae. The antennae are long and cylindrical. The end of each antennae flares outward to form a club-like shape. The antennae are equipped with specialized cells which detect scent. The receptors are so sensitive, that they can detect the presence of nectar within the flower without landing on them, thus if the flower is lacking in a food source, the butterfly can keep flying on to the next flower. The antennae serve not only to detect scent of flowers, fruit, mud or minerals, but can also detect the pheromones of the opposite sex. Being small and short-lived animals, finding a mate quickly and reproducing quickly is a worthy pursuit.

Some species of butterflies travel great distances or even seasonally migrate. The ability to find their way during migration is accomplished through an internal navigational sensory system within the antennae. Additionally, this organ allows the butterfly to sense the time of day. The butterfly uses the antennae daily as a clock. When evening begins to approach, the sensory antennae will trigger the butterfly to begin looking for a safe place to rest for the night. Much like a human's inner ear which helps us maintain our balance, the butterfly has a specialized organ at the base of the antennae called the Johnston's organ. This organ helps the butterfly retain its balance during flight. The Johnston's organ also helps with recognition of flight patterns of other butterflies within the area, allowing the butterfly to locate mates easier (butterflycircle.blogspot.com).

Thorax-

The center segment of the butterfly's body is the thorax. The thorax is equipped with strong muscles which attach to the iconic wings to which most people identify butterflies from. The wings are a set of forewings towards the front of the body and the hindwings residing towards the back. Butterfly wings facilitate their locomotion, but also communication with other butterflies through color and patterning. The wings also help in the avoidance of predators through their ability to fly as well as with concealment through cryptic patterns, shapes and camouflage.

Beneath the thorax are three sets of legs to which they grip onto their environment or walk along the ground. The legs have padded feet that are equipped with taste sensory organs. Female butterflies use these taste organs to sample vegetation for appropriate host plant choices.

Abdomen-

The abdomen is where the butterfly's digestive, circulatory, respiratory, and reproductive organs reside. Unlike people, butterflies lack lungs. Rather than lungs, butterflies have tiny holes in the side of the abdomen called spiracles, these spiracles deliver oxygen directly to the body tissues through tiny tubes called tracheae.

The male's reproductive system is equipped with an external set of claspers at the tip of the abdomen to which he holds onto the female with during mating. Females store the male's sperm and her own eggs within her abdomen.

Introducing the framework

In this guidebook I present the concept of butterfly gardening based on butterfly life histories of life cycle, butterfly needs, and butterfly behaviors.

The ideas presented to the viewer may be already known by some who read this document, or these concepts may be completely new to the reader. Regardless of people's sophistication to the knowledge of butterflies, it is my hope that all who read and examine this document gain an understanding of the diversity of the butterflies that share our urban habitat within the city of Eugene and how we as concerned individuals can better understand how to design habitats that ensure the survival of butterflies. It is my further hope that these basic principles and design framework can be transferable across place and scale, and that all persons wanting to provide butterflies with suitable habitat can find this process useful.

In short, I wanted to provide a guidebook that helps people help butterflies, because the world just is a better place with them in it.

The Guidebook

I've created a step by step butterfly habitat garden process framework that designers can use to create butterfly habitat gardens. The complexity of information that was accumulated to produce this book culminates into a very simple step by step process to the designing of these habitat gardens.

I first introduce you to the habitats that can be found in and around the city of Eugene. It is important to understand the habitat theme of the garden before design can transpire, as specific habitats provide for specific butterflies. Because this guidebook advocates for the designing of habitat gardens and not habitat restoration, there is a fair amount of flexibility to how intensive the design goals need to be to bring back a "pre-settlement" habitat. There is however, a generally accepted set of thoughts that advocate to create gardens that reflect the pre-settlement landscape, as the gardens can have greater success with native plants and animals that would have existed there traditionally (Tallamy 2007). Pre-settlement habitats that existed within the Eugene area were the wet prairies, upland prairies, oak savanna, woodlands, riparian forests, and upland forests (Christy 2011). Each of these unique habitats is discussed in detail further in the guide. Once you have established the habitat theme that the garden will provide, the design framework process is very straight forward.

Phase One: Building the Palette

The first phase of this design framework is to build the butterfly, hostplant and nectar source palette. This palette is exactly that, these are the species that make up the basis to your design. You pick the butterfly species that will occupy your garden based on the habitat that the garden rests upon. You pick the butterfly hostplants (food for the butterfly caterpillars), based on the butterfly species and pick the nectar sources (food for the adult butterflies), based on the habitat that the plants naturally occur. <u>It's that simple</u>.

This forms your design palette. In addition to fulfilling the needs of the butterflies, the plants chosen that make up the palette can provide functions of shade, wind buffering, structure, form, color, texture, and so on. The beauty of this process is it is a one stop shop experience for picking the living features of the garden.

In this guidebook I have focused almost entirely on the use of native vegetation to fulfill all biological and design needs of the garden, but there are no rules against adding in exotic plants to the mix as well, as long as the plants in the selected palette make up the core of the planting design.

Phase Two: Designing the Garden

The second phase of the design framework is addressing the life history components of the butterfly life cycle, butterfly needs, and butterfly behaviors. Analyzing, understanding and then designing for each butterfly life history provides a deeper understanding to design and can likely result in greater butterfly usage of the garden and success for the survivability of these butterfly visitors.

This phase, phase two, is based on as much complexity as phase one, but once again has been transformed into a simple step by step process that helps the designer know exactly what each design step is intended to accomplish (Fig 3.4).

The first butterfly life history to look at is the butterfly life cycle. This life cycle consists of four distinct stages; the egg, the caterpillar, the chrysalis, and the winged adult. Each stage has unique characteristics which lead to unique design decisions. Each stage is discussed further within the guidebook. The next butterfly life history that is examined are the butterfly needs. These needs are the need for sunlight, the need for shelter, the need for food, and the need for water. The adult butterfly also has the added need of the need to reproduce. The final butterfly life history that is examined are the butterfly behaviors. These behaviors are how the butterfly interacts with its environment. Some of these behaviors specifically are; nectaring, puddling, perching, patrolling, basking, roosting, and hilltopping.

The way this framework process works, is you make design decisions based on the stage of the life cycle, the need that you are designing for and the behavior that results from that need (Fig. 3.2) Its that simple.

To help the reader understand this design flow of life cycle-need-behavior method, I have designed a graphic language using icons that follow each design maneuver and allows to reader to quickly look at what design maneuver is being carried out and for what exact purpose. The icons are termed “design elements” and their description and the usage of them is discussed further within this guidebook.

How to use this Guidebook “ A Simplified Diagram”

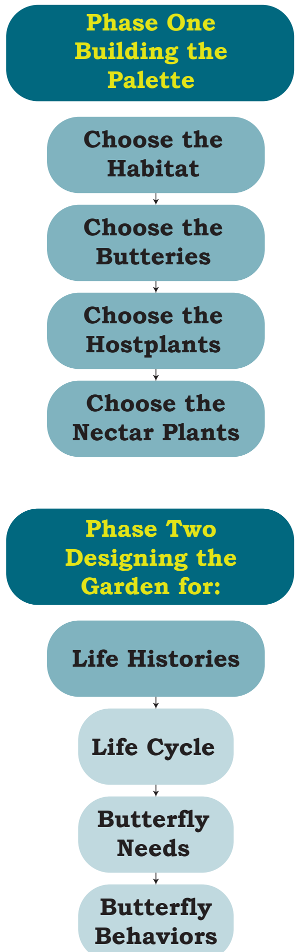


Figure 3.2 Process Flow Diagram Simplified

Figure 3.3 Phase One: Building the Palette

Expanded diagram showing of building the palette

The palette comprises of the butterflies, hostplants and nectar sources that will occupy the garden, but he first step is to determine the habitat type of the butterfly garden (Fig. 3.3). Habitat determination should be based on the native vegetation community that existed on the site before it was altered by European settlement (pre-settlement).

The next step is to determine the butterflies that you wish to garden for. Determining the butterflies is achieved by accessing the butterfly to habitat quickguide to determine which species of butterflies occur in the chosen habitat. Once you've made a list of the butterflies, you will want to research each species of butterfly by using the butterfly color plates. The color plates have detailed information about each species. One particular detail found on the color plates is the "abundance" tab. The abundance tab will show you if the butterfly occurs within Eugene as common or as uncommon. It is recommended that you chose butterfly species that appear within Eugene as common species, as these species are likely to show success with butterfly gardening efforts.

The next step is to determine the hostplants for the chosen butterflies. This is accomplished by accessing the hostplant to habitat quickguide to determine the hostplants that feed your butterflies. The hostplant color plates provide details about each hostplant.

The third and final step is to chose the butterfly nectar sources. This is accomplished by accessing the nectar source to habitat quickguide. Build your nectar source plant palette based on the habitat these plants naturally occur in. Once you have selected the nectar sources, you access the nectar source color plates to find out details about each plant, such as height, bloom color, bloom time, and water and soil requirements.

Phase One provides the designer with the garden palette.

What does this flow process of phase two look like in icon language?

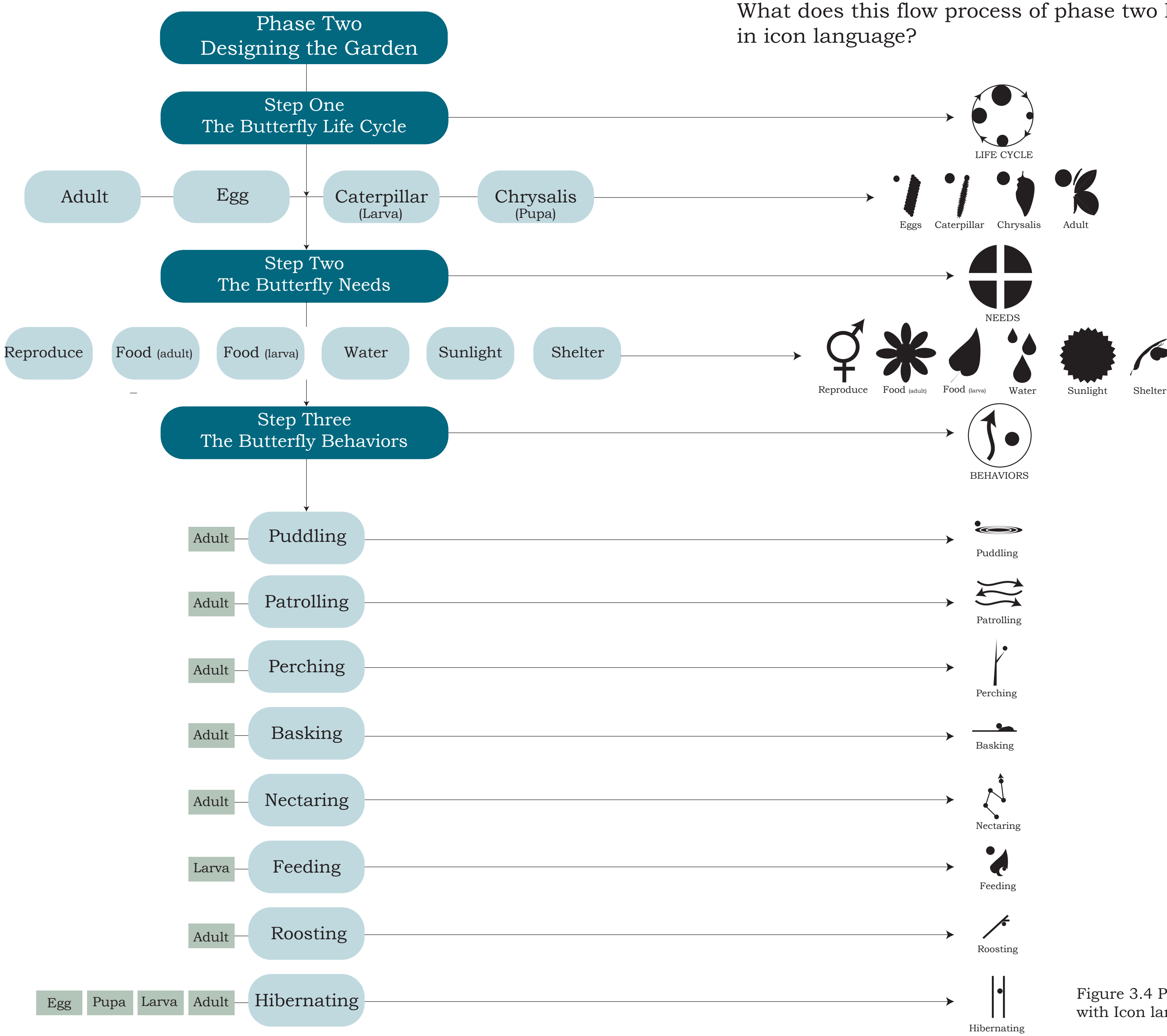
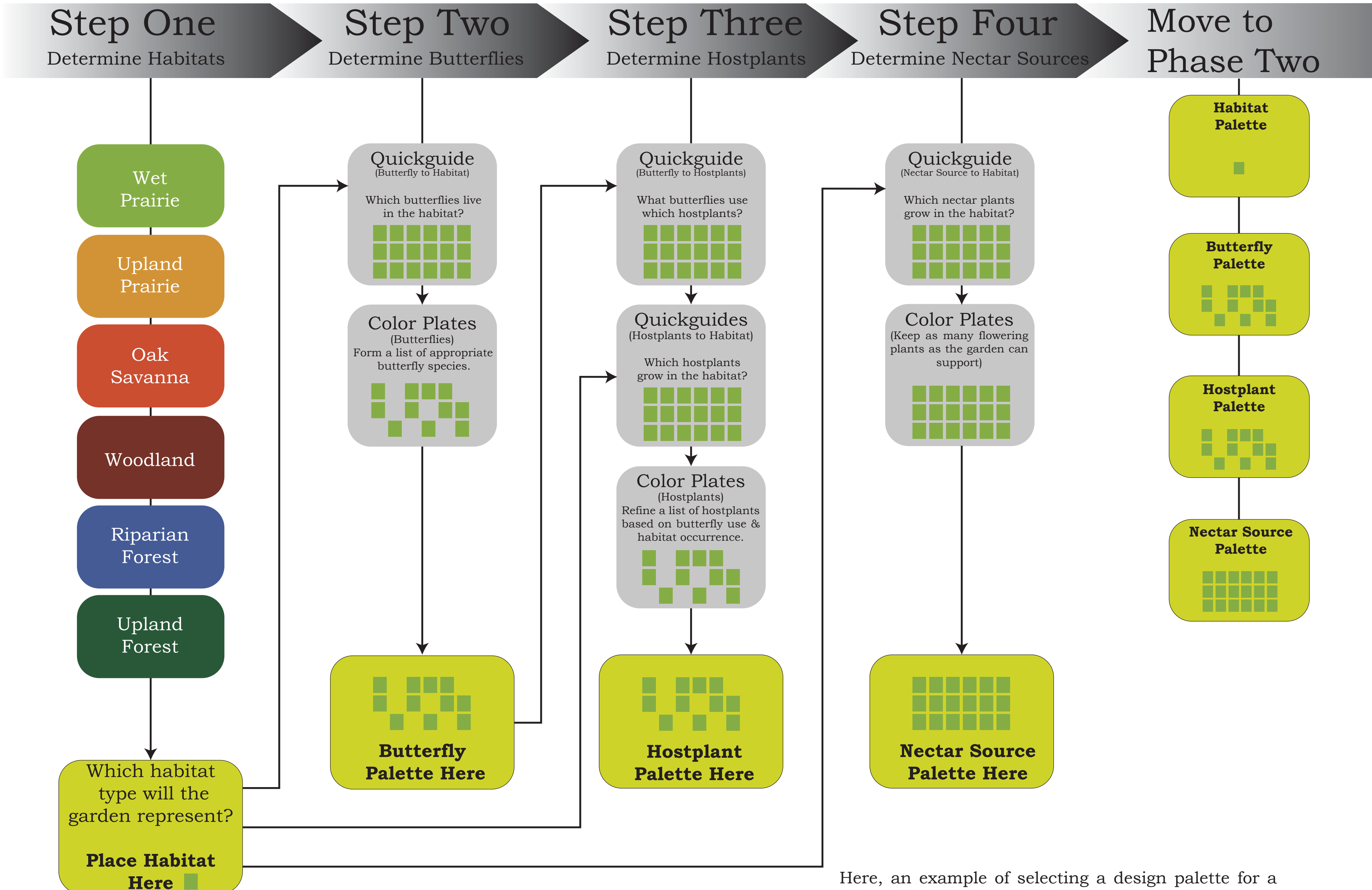


Figure 3.4 Phase Two process with Icon language

Phase One

Building the Palette

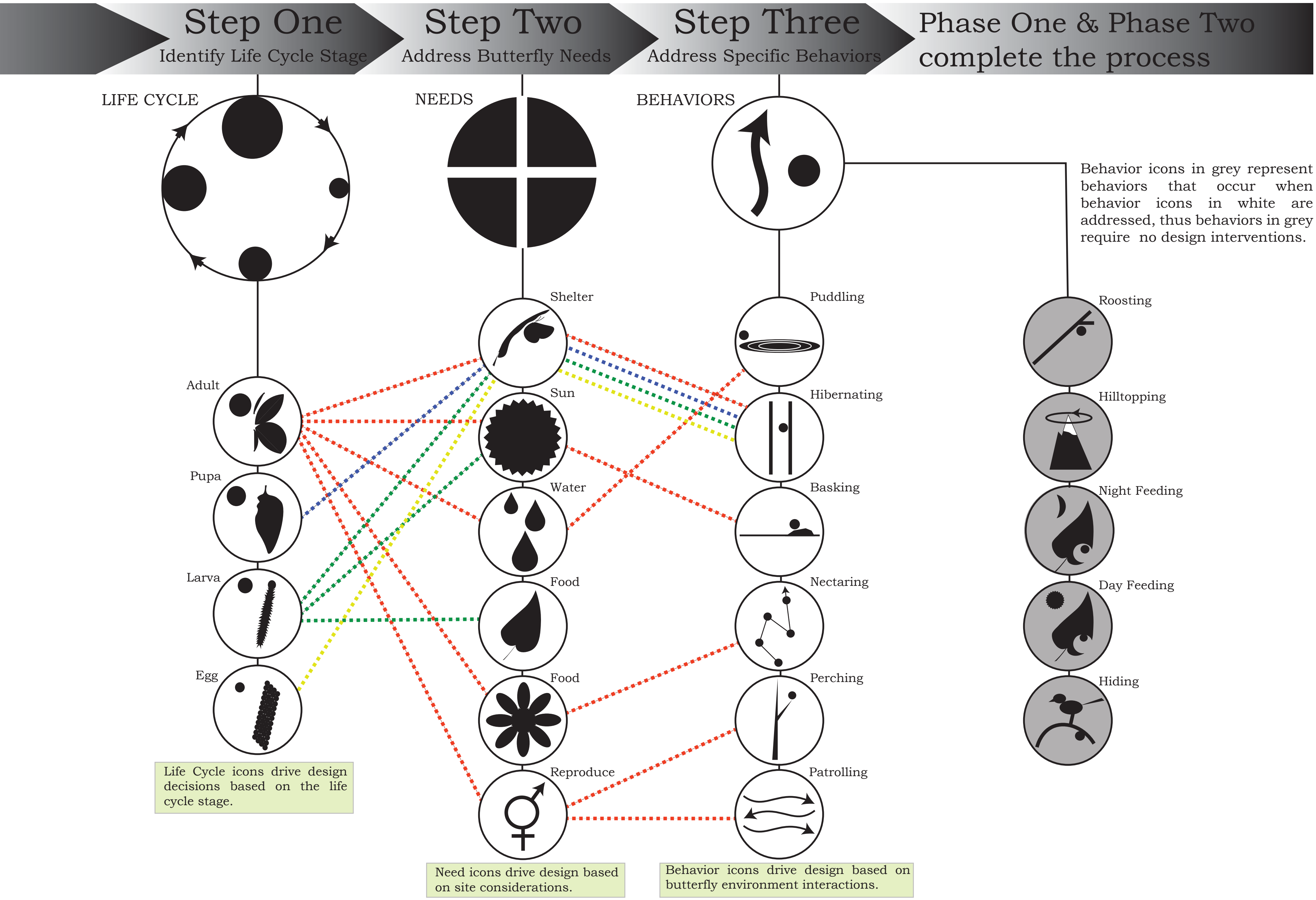


Here, an example of selecting a design palette for a wet prairie design is demonstrated.

Figure 3.5 Road map through the Design Process

Phase Two

Designing for Butterfly Life Histories



3.2 Determining Habitats

Pre-settlement Vegetation

The Willamette Valley was a vast landscape consisting of mixed wet and dry prairie, rolling oak savanna, mixed woodlands, with occasional stands of coniferous forests. Where stream systems cut through the landscape, riparian forests of mixed hardwoods and softwoods stood, with wetlands occupying low flat valley terrain (Hulse 1998).

The Mediterranean climate saw cool wet winters and warm dry summers. Much of the landscape was dependent upon disturbance regimes to maintain health and integrity. During the wet and rainy season, stream systems and river corridors would swell past capacity and flood low lying valleys, depositing nutrient rich silts and clays, building deep soils and keeping riparian forests and wetlands healthy.

Figure 3.6 How the Willamette Valley may have looked before settlement

During the warm and dry seasons, the prairies and savannas were maintained by regular low intensity fires set by the indigenous people of the Willamette Valley, the Kalapuya Indians. These fires kept woody species such as trees and shrubs from establishing on the prairies and savannas and encouraged vegetation to flourish, promoting big game animals for hunting and food production of camas bulbs and tarweed for harvesting (Fig. 3.6).

Soon after European settlement began to occur in the Willamette Valley in the mid 1800's, fire culture was suppressed and woody species such as the Douglas fir, began encroaching upon the traditional landscape. Today, because of agricultural practices and urbanization, less than 1% of the traditional prairies remain (Clark, 2005). And only 12% of traditional savanna and woodland remain.

Agricultural practices saw the draining of wetlands and converting rich prairie habitats to grazing. Cattle, sheep and horses were introduced upon the land and the agricultural practices of the production of hay and grains began, furthering the depletion of native species. Through these agricultural practices, exotic plant species were introduced. These new and often aggressive plant species gained a foothold in these newly converted landscapes, decreasing diversity of native plant communities.

Before European settlement, river systems meandered across the valley, flanked by large stands of riparian forests. These riparian forests averaged one to two miles thick. The riparian forests served to keep waters cool, trap and filter sediment, and provide a vast array of habitat. These forests were maintained through inundation from seasonal floods and acted as filters and buffers for other habitats. Through the construction of dams and the diversion of streams, river dynamics which depended upon disturbance for vigor and health were all but eliminated. Today only 20% of the traditional riparian forests remain, with a reduced width clinging to the water's edge (Hulse 1998).

Fast forward to today, and a new movement to restore these native landscapes is afoot. But because so little of intact habitat remains, conservation of the Willamette Valley remains a pioneer project (Campbell, 2004).

Even with today's increases in human population density within the city of Eugene, remnant pockets of valuable habitats remain. It is important to understand the unique characteristics of each habitat, as each habitat offers features that promote butterfly diversity and survival.

Ninety-five percent of the Willamette Valley landscape falls in private ownership, and though much of the conservation efforts often concentrate on habitat restoration, habitat friendly landscapes are often seen as better strategies for private lands (Campbell, 2004).

The Prairies of the Willamette Valley

The pre-settlement landscape of the Willamette Valley consisted largely of a mosaic of vast prairie habitat. Occurring often side by side within the same landscape, both upland prairies and wet prairies are dominated by grasses and forbs. Generally, tree canopy cover is minimal, averaging only 0 to 5%. This lack of tree canopy promotes plant species that thrive in full sun. Disturbance from fire kept/keeps upland prairies free from encroaching woody shrub and tree species, allowing perennial bunch grasses and herbaceous plants to thrive. Wet prairies too were maintained by fire, but also seasonal inundation, further keeping tree species from establishing.

Although both upland and wet prairies share many of the same plants, there remains a significant number of plants that are exclusive to one or the other. This exclusive plant palette creates plant communities that are unique to that prairie habitat. If the plant in question happens to be a butterfly hostplant, then understanding the plant to habitat relationship becomes an important concept when designing a garden that aims to attract a certain species of butterfly.

Upland Dry Prairie

Characterized by well drained soils and slope, these low-lying vegetation communities of grasses and forbs dominate the habitat. Important upland grass species such as California Oatgrass and Roemer's Fescue serve as host plants for several prairie butterfly species and perennial forbs such as Goldenrod and Wooly Sunflower serve as important nectar sources. The upland prairie is home to the most endangered butterfly species to occupy the Willamette Valley, the Fender's Blue butterfly. Only a handful of populations of the Fender's Blue remain in the Eugene area, the largest residing at the Willow Creek Reserve (The Nature Conservancy). Reliant almost entirely on one species of hostplant, the Kincaid's Lupine, the Fender's Blue butterfly is the focus of intensive restoration projects (Fig. 3.7).

Wet Prairie

Wet prairies can be mixed with dry prairies or occur exclusively as wet prairie. Characterized by water occurring from seasonal inundation, slow draining clay soils or impervious rock strata that promotes surface water. Traditional disturbance regimes of flooding during the wet season and late dry seasonal burning kept these fertile wet prairie habitats intact. Dominate species such as tufted hairgrass, sedges, rushes, and camas help define these prairie communities. A subset of the wet prairies is the vernal pool. Vernal pools are low lying, poorly draining impressions on the prairie floor often containing many unique plant and animal species.

Figure 3.7 Mixed prairie at Eugene's Willow Creek Preserve

Oak Savanna

Closely associated with upland prairie systems are the Oak savannas. These savannas are characterized by open swaths of upland grassland prairie species such as the Lemmon's Needlegrass, Roemer's Fescue and California Oatgrass. The dominant tree presence is the occasional scattering of large Oregon White Oaks. Canopy cover of the savannas range from 5% to 25%. Disturbance regimes of traditional low intensity fires maintain the grass to tree matrix and help ensure that oaks are not crowed out by other faster growing woody species such as the Douglas fir.

Woodland

Tree canopy cover in woodlands generally covers anywhere from 26% to 59% of the habitat. This added shade promotes a greater variety of shrubs and changes grass and forb species communities as well. Oak woodlands were a dominate habitat feature within the Willamette Valley, with over 200 species of vertebrates calling the woodlands home. Even greater were the number of invertebrates, such as butterflies, that occupied these woodlands. (Campbell, 2004)

In oak woodlands, the individual tree canopy spread tends to be narrower than that of the savanna oak. This phenomenon is the result of crowding from the other individual trees. In unique micro-habitats where soils consist of heavy clays and seasonal water saturates the soil, the Oregon Ash tends to form the dominant woodland species.

Oak woodlands tend to create edge communities with open savanna and upland prairies. These edge communities can be rich in wildlife and host a great number of butterfly species. The Common Wood Nymph Butterfly often occupies prairie habitats, but as temperatures rise during the day, these butterflies seek the shade of woodland canopies to cool off. It is the prairie to woodland edge community that promotes the occurrence of butterflies such as the Common Wood Nymph.

Riparian forest

Termed gallery forests, the riparian forests flank water systems of the Willamette valley (Fig. 3.8). Due to intense agricultural practices, most of the thick stands of forests have been reduce to thin stands along river channels. Besides providing considerable habitat for many other plant and animal species, these forests provide stream bank erosion stabilization, regulating cool river temperatures, promoting salmon species and keep the rivers clean and clear (OSU, 2018). Plant species within riparian forests were fast growing hardwoods, adaptive to withstand frequent flood events.

Upland forest

Comprising of nearly 85% coniferous tree species, these forests dominated the northern end of the valley and upslope along the margins of the valley where flooding and fire regimes were less frequent. The dominant tree species was the fast-growing Douglas fir. (Christy, 2011). After European settlement, the suppression of native people's fire management began. The evergreen upland forest species had little trouble colonizing the sunny savannas and prairies, supplanting many diverse ecosystems with dense monotypic coniferous stands (Christy, 2011).

Figure 3.8 A patch of riparian forest along the Willamette River in Alton Baker Park

Structuring the Habitat Garden

Deciding what habitat theme the garden will represent is a straight forward process; base the garden on the pre-settlement plant communities that once existed there. But this shouldn't tie you down to a level of habitat restoration or bind you to the strict growing of plants based the indigenous habitat structure. These are habitat gardens, and are at best a representation of plants and animals best suited for the site. Besides, there may be sections of the property that, although not representative of the native landscape palette, may still have ecological if not landscape structural value. Regardless of the existing conditions and the intensity level of garden design, all sites will need to undergo a site assessment and inventory (Schneck 1992).

Start with the surrounding landscape, look at the neighborhood and existing wild spaces. Although the site may have been traditionally upland prairie, there may be a stand of evergreen trees on or near the property and there may be woodland butterfly species living in this habitat. Though your garden may be theoretically themed as upland prairie, the section where the tree stand resides could foster woodland species, thus you've just expanded your palette and potential butterfly diversity richness.

Once you know what you have, and know what your vision of the site will be, think about the arrangement of the space. Here, think about the structure of the plants and the layers that form the spaces, the inhabitants who will use them and the function that each layer can serve. There are five basic vegetative layers to consider for structural integrity of the habitat.

The ground layer is generally composed of the soil layer the very short grasses and forbs that carpet the soil, the tall grass and forb layer, which is much like the ground layer but can reach the height of five to six feet tall, the shrub layer can range anywhere from six feet to fifteen feet tall, and the tree canopy layer pushes beyond this point.

Each of the six habitat typologies provided on the next pages give you a basic structural idea of how these layers contribute to the overall habitat (Fig. 3.10, Fig. 3.11). The closer to the native landscape your habitat garden becomes, the more likely the intended butterfly species will inhabit the garden. Also, the more diverse your plant palette, the more diverse the potential butterfly and subsequent diversity of all species that will be attracted to the garden space.

If the site is to represent two distinct habitat types, say upland prairie and woodland, the creation of an edge community can be formed (Fig. 3.9). The edge community concept blends habitats along a distinct border and can be one of the most biodiverse structured habitats, and often becomes the most wildlife filled areas in existence (Schneck 1992). Creating an edge community doesn't mean you are abandoning the original goal of habitat representation upon the site, you are simply bringing the best of two habitats together in a strategic way to increase biodiversity.

Figure 3.9 The edge community is created by two distinct habitats

	Typology	Canopy Layer	Shrub Layer	Ground Layer
	Upland Dry Prairie	0-5% Very Sparse Tree Cover Oregon White Oak Black Hawthorn Ponderosa Pine (see colorplates for complete lists)	Low and Patchy Vegetation Blue Elderberry Pacific Serviceberry Red-flowering Currant (see colorplates for complete lists)	95-100% Cover Dominated by Grasses and Forbs Roemer's Fescue Lemmon's Needlegrass Kincaid's Lupine (see colorplates for complete lists)
	Wet Prairie	0-5% Very Sparse Tree Cover Oregon Ash Scouler's Willow Cascara (see colorplates for complete lists)	Low and Patchy Vegetation Western Spirea Red-Twig Dogwood Pacific Ninebark (see colorplates for complete lists)	95-100% Cover Dominated by Grasses and Forbs Tufted Hairgrass Rosy Checkermallow Douglas Aster (see colorplates for complete lists)
	Oak Savanna	5-30% Tree Cover Oregon White Oak California Incense Cedar Ponderosa Pine (see colorplates for complete lists)	Low and Patchy Vegetation 10% of savanna floor cover Snowberry Oceanspray Nootka Rose (see colorplates for complete lists)	70-95% Cover of Grasses and Forbs except under Trees Roemer's Fescue California Oatgrass Western Goldenrod (see colorplates for complete lists)

Figure 3.10 Habitat Types: Wet Prairie, Upland Prairie, Oak Savanna

	Typology	Canopy Layer	Shrub Layer	Ground Layer
	Upland Forest	Over 60% Dense Tree Cover Bigleaf Maple Western Red Cedar Douglas fir (see colorplates for complete lists)	Various Low to High Vegetation Evergreen Huckleberry Lewis's Mock orange Pacific Ninebark (see colorplates for complete lists)	Low to Moderate or Seasonally High California Fescue Pacific Bleedingheart Red Columbine (see colorplates for complete lists)
	Riparian Forest	Over 60% Dense Tree Cover Red Alder Scouler's Willow Black Cottonwood (see colorplates for complete lists)	Various Low to high Vegetation Nootka Rose Red-Twig Dogwood Pacific Ninebark (see colorplates for complete lists)	Low to Moderate or Seasonally High Bigleaf Lupine Alaska Brome Stream Violet (see colorplates for complete lists)
	Woodland	26-59% Tree Cover Oregon White Oak California Incense Cedar Ponderosa Pine (see colorplates for complete lists)	Low to High Snowberry Oceanspray Nootka Rose (see colorplates for complete lists)	Moderate to High or Seasonally High Meadow birdsfoot trefoil California Fescue Pearly Everlasting (see colorplates for complete lists)

Figure 3.11 Habitat Typology Woodlands & Forests

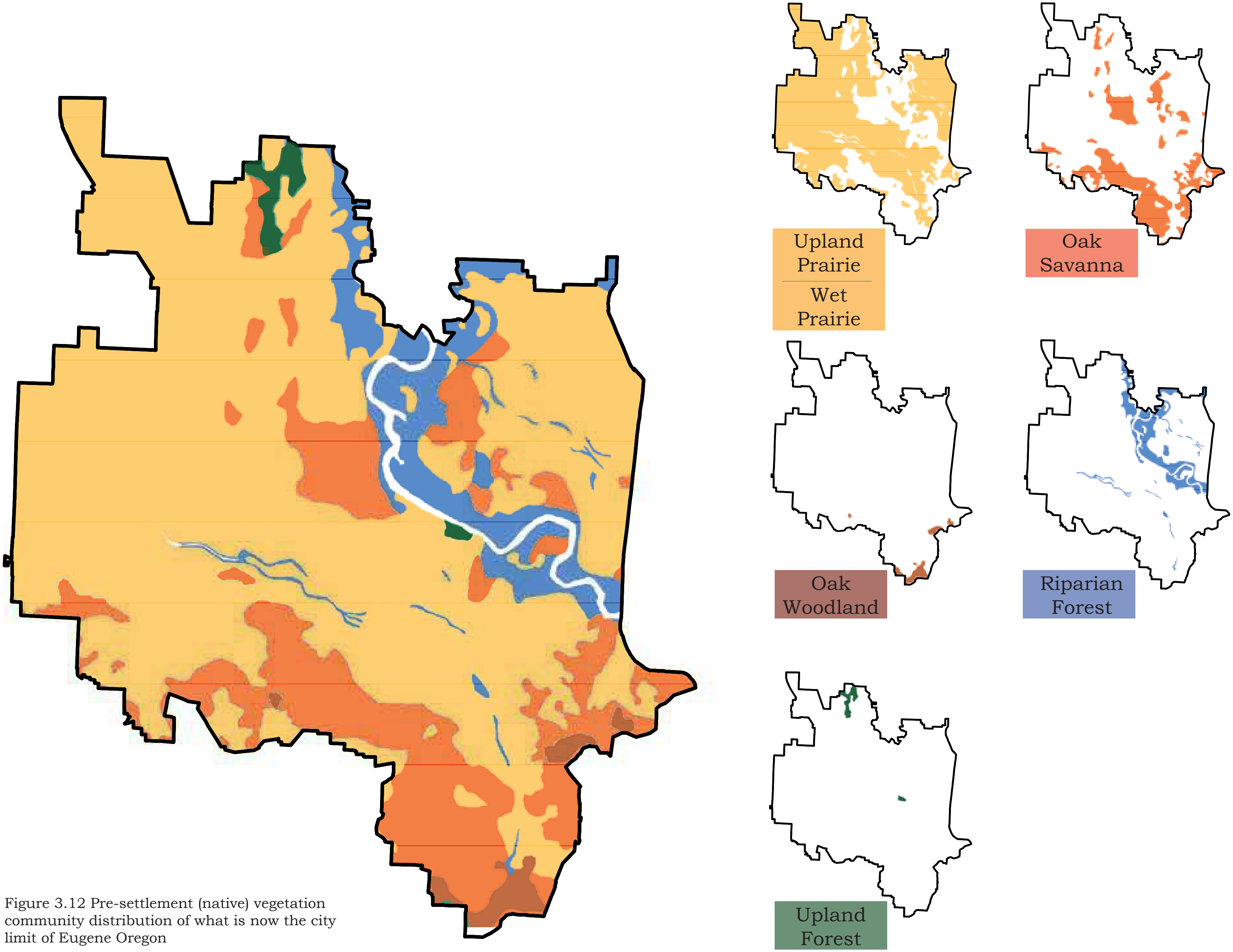


Figure 3.12 Pre-settlement (native) vegetation community distribution of what is now the city limit of Eugene Oregon

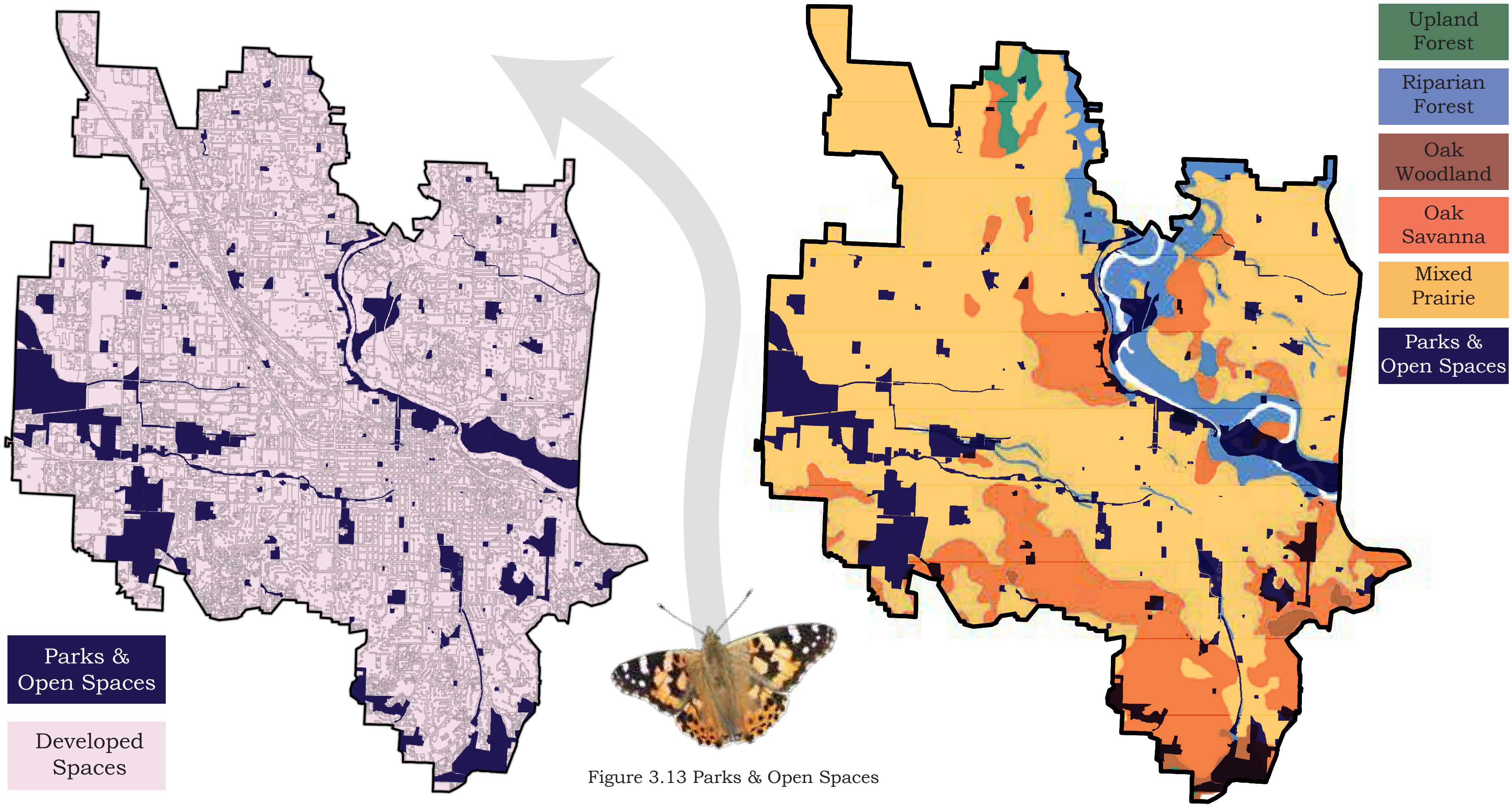


Figure 3.13 Parks & Open Spaces

Butterfly distribution is complex and movement between habitats is motivated by many factors. The search for mates, and other resources such as food, water and hostplants are driving forces for butterfly movement between habitat patches. As fragmentation disrupts traditional butterfly distribution movements, butterfly populations begin to fray and decline. Butterflies which travel in search of resources within urban areas can do so with fruitless efforts.

Certain species are dependent on movement across habitat gradients, finding resources and establishing new colonies along the way. The best known example is the three thousand mile migration patterns of the Monarch Butterfly.

Butterfly species who don't travel great distances still tend to move within their territory, establishing colonies or breeding populations within localized areas. Urban green spaces such as school grounds, residential properties, parks and open spaces can provide for both permanent or temporary habitat for butterflies. Butterfly habitat gardens that reside within a short distance from natural open spaces (shown in dark blue) can help expand butterfly populations as they seek out new territory (Fig. 3.13). The creation of habitat patches within these urban environments is termed "stepping stone" habitats. The building of a network of urban butterfly gardens can allow for butterfly movement from patch to patch across the urban gradient.

3.3 Selecting Butterflies for the Garden

Determining the butterfly species that will likely visit or take up residence within a designed butterfly garden may be a mystery at first, but the first step to determining which species to target, is to establish which species occupy which specific habitats. I've devised a simple chart called the quickguide which helps the viewer determine which species can be found in the six typical habitats found within Eugene. The quickguide can be viewed at the beginning of the butterfly color plate section of this chapter.

The quickguides were a combination of researching local and regional field guides and the combining of over seventeen years worth of butterfly census data conducted by the local chapter of the North American Butterfly Association annual butterfly surveys. The quickguides use the color matching system of the habitat typology charts. Thus, the same color system allows for quick habitat identification.

Once the garden has an established habitat theme or themes, such as a woodland theme or an upland prairie theme, the next step is determining the butterflies that naturally occur within those habitats. It is worthy to say that not all species that occur within a specified habitat, will be found at the same degree of population strength or the same level of occurrence. This is the basis for using the common versus uncommon status for determining whether certain species make good choices for design efforts.

The Need to Observe

Even with the information of butterfly to habitat occurrence provided by the quickguides, direct observation is a vital step to confirming the presence of potential butterflies on or near your site. Visiting local parks and walking neighborhood gardens not only confirms which butterflies are commonly found within the area, but how these insects are interacting within their environment is vital information for design decision making (Tekulsky 1985).

Watching and observing butterflies first hand, will allow you understand butterfly interactions with preferred nectar sources, what type of messy versus manicured yards they are preferencing, the number of species and number of individuals you find, and the time of year that you are encountering them.

While there are no hard rules for selecting appropriate butterfly species to be invited into your prospective butterfly habitat garden, most books, and scholarly articles advocate for the targeting of commonly occurring butterfly species for monitoring and gardening. These common species are common to their environment for various reasons, but the two main factors which lead to butterfly common versus rare status, are butterfly to hostplant feeding specialization relationships and adult butterfly to flower feeding specialization relationships. Feeding specialization can keep butterfly populations low or confined to select habitats. A helpful way to determine if butterflies are common or rare is based on annual census data (Table 3.1). Below is a chart that categorizes common versus rare butterflies, based on annual field count surveys.

Target Group (green) — Non-Target Group (blue)

Superabundant	500 individuals in a given place per day or 2000 individuals on seasonal census counts
Abundant	20 or more individuals in a given place per day or 500 individuals on seasonal census counts
Common	5-20 individuals in a given place per day or 100 individuals on seasonal census counts
Fairly common	1-4 individuals in a given place per day or 10 individuals on seasonal census counts
Uncommon	1-4 individuals seen per season but not daily
Occasionally common	5-20 individuals in one season
Locally common	0 individuals in most locations, but in specific locations 5-20 individuals per day
Rare	Individuals rarely seen at any location, Less than 5 individuals per season
Irruptive	Species are absent from most locations but abundant under favorable conditions

Table 3.1 Determining Butterfly Abundance. Chart adapted from “Butterflies of New Jersey”

Common vs Rare, the Generalist to Specialist Discussion

Most butterfly species react negatively to the impacts of urbanization. As the disappearance of habitat continues to increase, butterfly populations continue to decrease (Tekulsky 1985). However, certain butterfly species can demonstrate considerable resilience to urbanization, with some species appearing quite at home within an urban environment.

The bright and conspicuous Cabbage White butterfly, which feeds in great numbers on garden cabbages and kales within suburban gardens seems quite at home within urban spaces. The large yellow and black Tiger Swallowtail butterfly can be commonly found drifting in and out of city streets and back yard gardens. The migratory Painted Lady is quite at home within back yard flower patches. And the Woodland and Sachem Skippers are common visitors to front street gardens and parks. From Spring through Fall, it is not uncommon to find a Grey Hairstreak butterfly zipping around suburban green spaces.

These species are common for a good reason, they are all feeding generalists. As juveniles, these butterfly species can use a wide range of hostplants to carry out their caterpillar stage of their life cycle. Because of this, the adult butterflies can expand their territory into new habitats and establish populations along a broad spectrum of vegetation communities. These butterflies are also feeding generalists in the adult stage of their life cycle as well. These species will visit a myriad of different flowering plant species of both native and exotic origin. These feeding generalist butterfly species are still subject to urbanization pressures and thus still need considerable butterfly habitat design strategies to ensure their survival, but the reason that these species make good choices for butterfly target species to base the garden on, is seen in the likelihood that these species will locate and use the garden space, in the intended manner.

I have compiled a chart that identifies the common to rare status of the documented 47 butterfly species that can occur within the Eugene area. Out of these 47 species, 20 occur with a high degree of regularity and thus can be considered common butterflies. These common butterfly species make good choices for butterfly habitat gardening efforts, as these species are likely to use the garden.

Does this mean than the remaining 27 species of butterflies make poor choices for butterfly gardening efforts within urban settings, and we should not make efforts help these species along? Of course not. Some of these butterfly species are rare because they are feeding specialists and thus are confined to very specific habitats. Some of these species are restricted to certain habitats that occur in very specific regions of Eugene, and thus may never travel far from their isolated colonies. Some of these species occur in low numbers naturally, others react poorly to urbanization and due to fragmentation, and thus demonstrate poor mobility or movement between habitat patches.

"*Efforts to nurse a natural island within the sea of urban expansion, particularly on the behalf of any rare local species, can encourage their ongoing prosperity*"

-Tekulsky

I assert that gardening for the commonly occurring species within your area should form the bases for the garden and that the choosing of a select few rare or uncommon butterfly species to target as "specialty species" is warranted, but should not constitute most of your efforts.

Thus, referencing the abundance chart will help the viewer determine the common to rare butterflies. The quickguides will help formulate the list of butterflies that will likely occur within the habitat, and the color plates will help communicate specifics about each species, so that design maneuvers are exacting, and intended efforts are rewarded.

No.	Species Name	Average number of individuals encountered per year across 36 sites (0 10 20 30 40 50 100 200 300 400 500+)	Ave/Day	Abundance
1.	Tiger Swallowtail	398	11/day	Common
2.	Anise Swallowtail	20	<1/day	Uncommon
3.	Pale Swallowtail	12	<1/day	Uncommon
4.	Clodius Parnassian	22	<1/day	Uncommon
5.	Orange Sulphur	703	19/day	Common
6.	Cabbage White	656	18/day	Common
7.	Western White	1 (Not seen every year)	<1/day	Rare
8.	Marginated White	4 (Not seen every year)	<1/day	Rare
9.	Ochre Ringlet	2146	59/day	Abundant
10.	Common Wood Nymph	1196	33/day	Abundant
11.	Common Checkered Skipper	377	10/day	Common
12.	Arctic Skipper	1 (Not seen every year)	<1/day	Rare
13.	Silver-Spotted Skipper	1 (Not seen every year)	<1/day	Rare
14.	Propertinus Skipper	83	2/day	Fairly Common
15.	Woodland Skipper	1037	33/day	Abundant
16.	Sachem Skipper	2021	56/day	Abundant
17.	Dun Skipper	152	4/day	Fairly Common
18.	Sonora Skipper	75	2/day	Fairly Common
19.	Juba Skipper	2 (Not seen every year)	<1/day	Rare
20.	Monarch	1 (Not seen every year)	<1/day	Rare
21.	Great Copper	1 (Not seen every year)	<1/day	Rare
22.	Grey Hairstreak	133	4/day	Fairly Common
23.	Cedar Hairstreak	2 (Not seen every year)	<1/day	Rare
24.	Hedgerow Hairstreak	12	<1/day	Uncommon
25.	Western Tailed Blue	3 (Not seen every year)	<1/day	Rare
26.	Eastern Tailed Blue	791	21/day	Abundant
27.	Acmon Blue	9	<1/day	Uncommon
28.	Fender's Blue	30	<1/day	Uncommon
29.	Silvery Blue	174	4/day	Fairly Common
30.	Spring Azure	179	5/day	Common
31.	Variable Checkerspot	39	<1/day	Uncommon
32.	Great Spangled Fritillary	3 (Not seen every year)	<1/day	Rare
33.	Mourning Cloak	11	<1/day	Uncommon
34.	California Tortoiseshell	50	1/day	Irruptive
35.	Lorquin's Admiral	96	2/day	Fairly Common
36.	California Sister	88	2/day	Fairly Common
37.	Mylitta Crescent	251	6/day	Common
38.	Field Crescent	414	11/day	Locally Common
39.	Red Admiral	13	<1/day	Uncommon
40.	West Coast Lady	3 (Not seen every year)	<1/day	Rare
41.	Painted Lady	124	3/day	Fairly Common
42.	American Lady	4 (Not seen every year)	<1/day	Rare
43.	Satyr Comma	9	<1/day	Uncommon
44.	Common Buckeye	1 (Not seen every year)	<1/day	Rare
45.	Brown Elfin	0 (Not seen every year)	<1/day	Rare
46.	Pine Elfin	0 (Not seen every year)	<1/day	Rare
47.	Pine White	1 (Not seen every year)	<1/day	Rare

Table 3.2 Butterfly census data based on NABA Eugene/Springfield Chapter census counts from 2001-2017

"The butterfly lover studies and protects butterflies-is awed by them and tries to be their friend. But in the end they fly away. Perhaps this carefree independence is what, in part, makes butterflies so appealing. They cannot be wheedled into perching on the windowsill each day at a particular hour. Rather they charge through the garden like a wild roller coaster-up to a treetop, over the roof, and down to the meadow".

-Jo Brewer *Notes from a Butterfly Gardener*

	Western Tiger Swallowtail	Anise Swallowtail	Pale Swallowtail	Clodius Parnassian	Orange Sulphur	Cabbage White	Western White	Marginated White	Ochre Ringlet	Common Wood Nymph	Common Checkered Skipper	Arctic Skipper	Silver-Spotted Skipper	Propertinus Duskywing	Woodland Skipper	Sachem Skipper	Dun Skipper	Sonora Skipper	Juba Skipper	Monarch Butterfly	Great Copper	Grey Hairstreak	Cedar Hairstreak	Hedgerow Hairstreak	Western Tailed Blue	Eastern Tailed Blue	Acmon Blue	Fender's Blue	Silvery Blue	Spring Azure	Variable Checkerspot	Great Spangled Fritillary	Mourning Cloak	California Tortoiseshell	Lorquin's Admiral	California Sister	Mylitta Crescent	Field Crescent	Red Admiral	West Coast Lady	Painted Lady	American Lady	Satyr Comma	Common Buckeye	Brown Elfin	Pine Elfin	Pine White
Plate Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Upland Forest	X	X	X	X		X		X				X			X							X	X	X						X		X	X	X		X	X		X	X	X	X	X		X	X	X
Riparian Forest	X	X	X	X		X		X				X	X		X							X							X	X		X	X	X		X	X		X	X	X	X	X		X	X	X
Woodland	X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X
Savanna	X	X			X	X	X		X	X	X		X	X	X	X	X	X	X	X		X			X	X	X		X	X	X		X	X	X		X	X	X	X	X	X	X	X	X		
Upland Prairie	X	X			X	X	X		X	X	X		X	X	X	X	X	X	X	X		X			X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X		
Wet Prairie	X	X			X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X			X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X				
Urban Gardens	X	X			X	X					X		X		X	X	X	X	X	X		X				X				X		X	X	X	X		X		X	X	X	X	X	X	X		

Using the Quickguide

The quickguide is a chart designed to give the reader a means to form a quick list of target butterfly species that may occur and survive within a specified butterfly garden based on the habitat that the garden represents.

Once a list is compiled of target butterfly species, the reader needs to reference the butterfly color plates to gain detailed information about each selected butterfly species. This process will help the designer better decide which species are likely candidates for the butterfly garden design.

Important information about the specific life cycle, behavior, and survival needs are provided within the detailed sections of the butterfly color plates.

The quickguides are a valuable first step in the decision making process of butterfly species selection.

All butterfly species that occur on the quickguide chart are documented to occur to some degree within the Eugene area and are native to the region. However, not all species that occur within a specific habitat may be found with great regularity.

Species that occur within each distinct habitat may occur as common, uncommon, or rare. Uncommon or rare species may be difficult to design for, thus it is recommended to invest design efforts that target commonly occurring species within the Eugene area.

Rare or uncommon butterfly species design may be warranted and may be incorporated as a specialty section within the overall design, but should not be the focus of the garden. You can access the common versus rare status of each butterfly by checking the Butterfly Abundance list.

Common name

Scientific name

Image of the adult butterfly. Use This image to track references to design considerations throughout this document.

Maximum adult size

Describes key identifiable wing features.

Most commonly occurring in these areas, however, species may be found in other areas.

Common or uncommon.

Number of generations/year.

Typical habits and behavior that adults display. Use this to maximize design and improve observational opportunities.

Juvenile traits and tendencies. Use this to design and maintain garden.

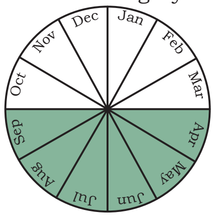
Food plants for larvae.

Suggestions for design and decision making process.

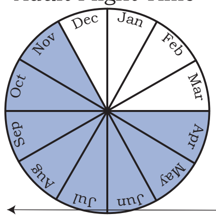
Painted Lady

Vanessa cardui

Larval Feeding Cycle



Adult Flight Time



Wingspan: 1” 2” 3” 4”

Description: Dorsal side is orange with the orange fading to pink in the forewing with black mottling and white spots in the upper corner. Ventral aspect is mottled grey with cream patches and a row of five eyespots in the lower boarder of the hindwing.

Habitat: Upland forest clearings, riparian forest clearings, open woodlands, savanna, upland prairie, wet prairie and urban gardens.

Abundance: “Common”

Broods: Four

Conservation Status: Secure

Adult behavior: Each spring, massive migrations of painted ladies fly north from Mexico and California to repopulate the region. Adults are fast and explore new territories looking for mates. In the fall, adults migrate south. Both sexes are avid flower visitors. Males perch low to the ground waiting for females to fly by.

Larval behavior: Larvae are solitary feeders building webbed nests to hide in. Caterpillars are covered with spines for protection from predators. No overwintering.

Host Plants: Thistles and mallows

Design Considerations: Plant a wide range of flowers that will provide blooms from early in the season until late fall.

Design Level: Easy, as adults explore new territory.

The months in green are probable periods when caterpillars of this species can be found feeding in the field. Factors such as unseasonable weather can effects feeding times.

The months in blue are probable periods when adult of this species can be found flying in the field. Factors such as unseasonable weather can effects flight times.

Plate number. Use this number to reference this species on other images and charts.

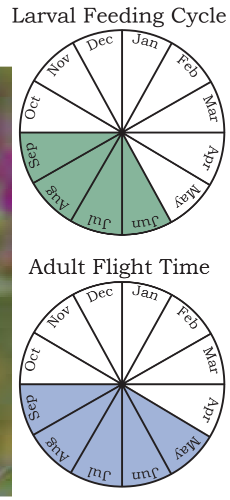
Color plates. These colors correlate with the habitat quick-guides for cross referencing and choosing appropriate species to match potential habitat gardens.

- Upland Forest
- Riparian Forest
- Woodland
- Savanna
- Upland Prairie
- Wet Prairie
- Cultivated Beds

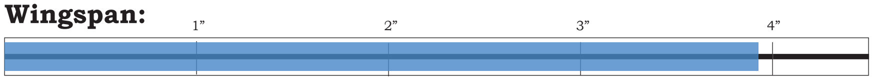
Note: See habitat section for details.

Western Tiger Swallowtail

Papilio rutulus



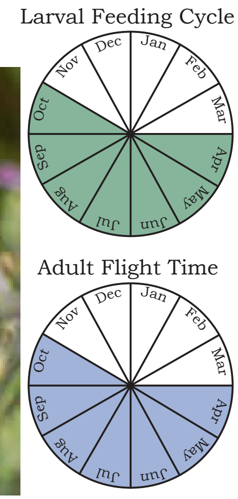
Wingspan:



Description: Both upper and underside of both males and females are a conspicuous bright yellow with bold black stripes, making the butterfly very visible from great distances.
Habitat: Forests clearings, riparian corridors, woodlands, savanna, mixed prairie, and urban gardens.
Abundance: Common. One of the most abundant and visible butterflies within the Eugene area.
Broods: One.
Conservation Status: Secure
Adult behavior: Males patrol every habitat from forest clearings to urban neighborhoods, slowly gliding through established flight-ways. Some perching occurs on taller vegetation. Especially fond of hilltopping, males circle and battle each other in a tireless aerial display. Males puddle.
Larval behavior: Caterpillars, are solitary and use eyespot patterns for defense to ward off predators. Caterpillar wanders off of hostplant to pupate on vegetation near the ground. Chrysalis overwinters.
Host Plants: Maples, ash, willows, cottonwoods, alder, apple, and birch.
Design Considerations: The host plants can serve as windbreaks, backdrops, and shade. Plant mid summer flowering plants.

Anise Swallowtail

Papilio zelicaon



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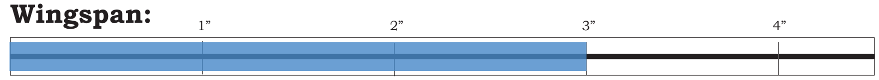
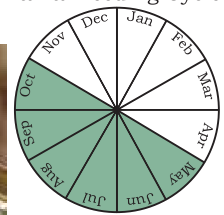


Description: Smaller and deeper yellow than the Tiger Swallowtail, with dominant black bands on the forewing and large orange eyespots on the hind wings.
Habitat: Forest clearings, riparian corridors, open woodlands, savanna, mixed prairies and hilltops.
Abundance: Uncommon. Although common as a species, the Anise Swallowtail is infrequently seen in urban areas.
Broods: Two to Three depending on the year
Conservation Status: Secure
Adult behavior: Males are fond of puddling with other individual butterflies and are commonly encountered on hilltops and bluffs. Hilltopping is common for the Anise Swallowtail, males are very territorial and can be seen chasing other species of butterflies from established territories.
Larval behavior: Larvae are solitary feeders and use scent glands secreted by specialized organs to defend themselves. Caterpillars can wander long distances off of the hostplant before pupating on low lying stems. Chrysalis overwinters.
Host Plants: Hostplants are in the parsley family, both native and garden cultivated species and varieties.
Design Considerations: A vegetable garden which grows anise, dill, fennel, and parsley are great ways to attract female butterflies.

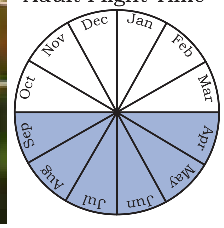
Pale Swallowtail

Papilio eurymendon

Larval Feeding Cycle



Adult Flight Time



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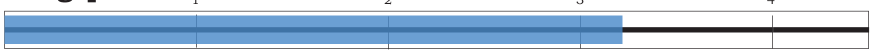


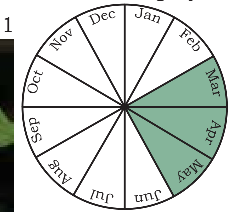
Description: White to creamy white with bold black stripes. Hindwing has a long black tail.
Habitat: Upland forest openings, riparian corridors, woodlands, moist canyons, hilltops, open meadows.
Abundance: “Uncommon”, although not as frequently found in the valley. Much more common in more mountainous areas and higher elevations.
Broods: One
Conservation Status: Secure
Adult behavior: Males frequently puddle and are often found hilltopping. Males patrol open meadows and river corridors in search of females. When hilltopping, males battle other species of butterflies. Both sexes visit flowers.
Larval behavior: Caterpillars are solitary leaf feeders. Use eyespot patterns, scent and camouflage to ward off predators. Chrysalis overwinters on hostplant.
Host Plants: Wide variety of shrubs and trees; cascara, ceanothus, cherry, hawthorn, alder, apple, spiraea, serviceberry, and oceanspray.
Design Considerations: Provide a puddling area near nectar sources. Hostplants are trees and shrubs, thus can be used as design elements to provide shelter and act as a backdrop. Schools in the South Hills may find more success in attraction this butterfly.

Clodius Parnassian

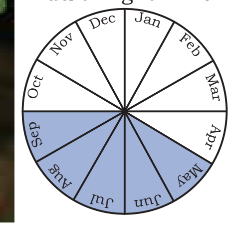
Parnassius clodius

Photo 3.1

Larval Feeding Cycle



Adult Flight Time



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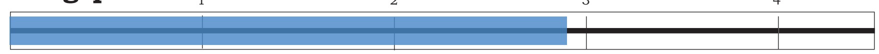
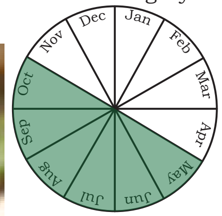


Description: Off white scales give way to clear bands on the forewings that lack scaling thus giving the wing a transparent quality.
Habitat: Upland forest clearings, riparian forest and woodlands, moist meadow clearings.
Abundance: “Uncommon”. Although common as a species in mountainous areas, the parnassian is rarely seen in the valley.
Broods: One
Conservation Status: Secure
Adult behavior: Both sexes visit flowers and patrol open spaces looking for mates.
Larval behavior: Caterpillars are specialist leaf feeders. Caterpillars are solitary feeders, wandering off to hide in leaves and duff on the forest floor only returning to feed at night to avoid detection from predatory birds. During the day caterpillars hide in leaf debris off of the hostplant. Both eggs and Chrysalis overwinter. Pupates at the base of host.
Host Plants: Western Bleedingheart.
Design Considerations: Because of its rarity in the Eugene area, designs should use the hostplant as an attractive addition to shady areas within the butterfly garden but not expect frequent parnassian usage. Leave last season’s leaves in place around host for the overwintering pupae.

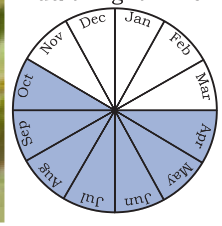
Orange Sulphur

Colias eutytheme

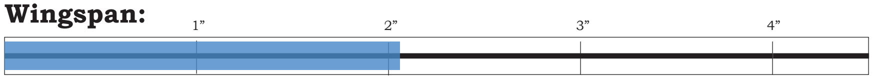
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: Males are yellow to yellow orange on the dorsal side with solid black bands on the boarders of the wings. Females can be either yellow or occur in an albino "white" form.

Habitat: Savanna, upland prairie, wet prairie, open fields, and urban gardens and parks.

Abundance: "Common". Very abundant

Broods: Three to four

Conservation Status: Secure

Adult behavior: Males and females patrol in open fields traveling at high speeds close to the ground and vegetation searching for mates and nectar sources. Both sexes visit flowers, males frequently puddle in groups. Southern populations migrate north each spring, expanding territories.

Larval behavior: Larvae are generalist feeders on a variety of hostplants. Caterpillars are leaf feeding and solitary. Caterpillars use camouflage coloration to avoid predators. Neither larvae or chrysalis overwinter do to the inability to survive the cold winters.

Host Plants: Legumes; Alfalfa, deervetch, clovers, pea family, lupines, vetches.

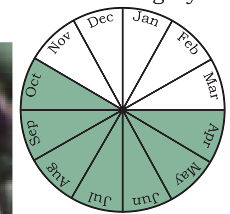
Design Considerations: Provide open fields with low growing flowers and exposed wet soil for puddling.

Design Level: Easy as sulphur travel great distances.

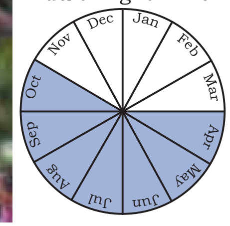
Cabbage White

Pieris rapae

Larval Feeding Cycle



Adult Flight Time



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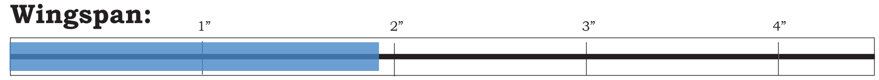


Description: Both sexes are pure white. Males have a single black spot on the upper forewing, females have two spots on the upper forewing.

Habitat: Virtuously any open habitat from forest clearings to prairie, urban gardens, and open fields.

Abundance: "Common". Perhaps the most common butterfly within the urban gardens of Eugene. Many gardeners consider the Cabbage White a pest, as they are a constant presence in the vegetable garden feeding on cabbages.

Broods: Four or more

Conservation Status: Secure. Considered a garden pest.

Adult behavior: Males and females explore and patrol in search of mates and nectar sources. Most adults stay long periods of the day flying about flower tops.

Larval behavior: Larvae are general leaf and flower feeders. Caterpillars are use camouflage to avoid be seen by predators. Pupates on or close to host. Chrysalis overwinters.

Host Plants: Mustard family. Garden varieties of cabbage, broccoli, kale, radish and nasturtium.

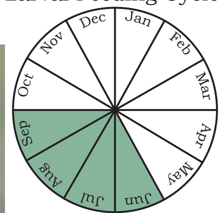
Design Considerations: Plant a vegetable garden. Provide a variety of flowers all season long.

Design Level: Easy. Butterflies visit vegetable gardens. Perhaps the easiest butterfly to garden for because of the many home grown vegetable gardens.

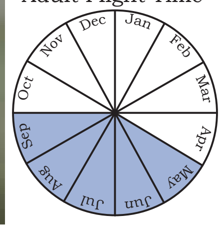
Western White

Pontia occidentalis

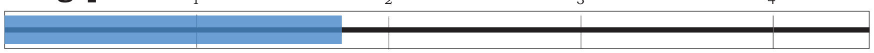
Larval Feeding Cycle



Adult Flight Time



Wingspan:

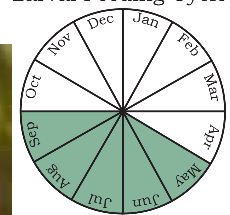


Description: Similar to the cabbage white but with more dark markings. Ventral hindwing veins lined with green markings.
Habitat: Woodland clearings, savanna, upland prairie, wetland prairie and open fields.
Abundance: “Common” as a species but less frequent on the west side of the Cascades than the east side.
Broods: Two to three
Conservation Status: Secure
Adult behavior: Adults travel at high speeds paroling for mates and nectar sources and especially common on hill-tops throughout its range. Males gather at mud puddles. Both sexes frequently visit flowers.
Larval behavior: Caterpillars are both leaf and flower feeders. Caterpillars use camouflage to avoid predators. Chrysalis and larvae overwinter.
Host Plants: Mustard family; Black mustard, prairie pep-perweed, even garden mustard family species like brussel sprouts and radish.
Design Considerations: Creation of open prairie habitats with mustards and wet soil patches for puddling can attract the Western White.
Design Level: Difficult do to not commonly encountered within the city limits of Eugene.

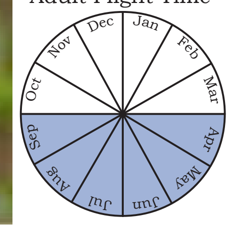
Marginated White

Pieris marginalis

Larval Feeding Cycle



Adult Flight Time



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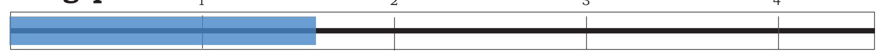
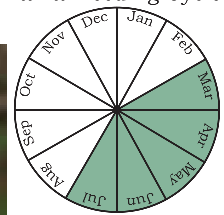


Description: Males dorsal side wings are pure white, females can have two faint grey spots. The butterfly has two distinct forms. The spring form has hark venation patterns on the ventral side, the summer form is very pale with limited venation pattern.
Habitat: Upland forest clearings, riparian forest clearings, roadsides
Abundance: “Uncommon” Although common as a species, more common in mountainous regions, the marginated white is infrequently encountered within the Eugene area.
Broods: Two.
Conservation Status: Secure
Adult behavior: Males and females fly through forest clear-ing, stopping to bask, perch and nectar frequently. Males are especially fond of puddling.
Larval behavior: Caterpillars are solitary feeders using camouflage to avoid predators. Caterpillar wanders off the hostplant to pupate. Chrysalis overwinters.
Host Plants: Brassicaceae; Bittercess, watercress and rockcress
Design Considerations: Create small sunny openings in coniferous forests with fresh water for hostplants.
Design Level: Moderately difficult do to infrequency.

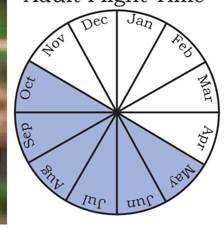
Ochre Ringlet

Coenonympha tullia

Larval Feeding Cycle



Adult Flight Time



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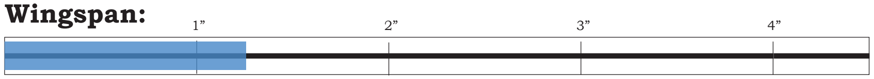
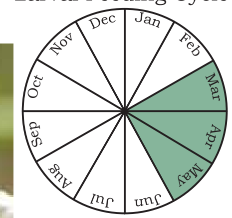


Description: Dorsal wings of both males and females range from creamy beige to a dark creamy orange. Ventral wings are darker with a dusting of brown with white highlights to match the vegetation.
Habitat: Open forest clearings, savanna, upland prairie, wet prairie where grasslands are plentiful.
Abundance: “Common”. Flies in large colonies.
Broods: Two
Conservation Status: Secure
Adult behavior: Males and females continuously fly just above tall grass prairie vegetation often ducking into the vegetation patrolling for mates. The ringlets weave through vegetation, landing occasionally but flower visitation is limited. Even on the hottest summer days, these ringlets seem the most active. Colonies are large.
Larval behavior: Larvae feed singly at night and use camouflage to avoid predation. Larvae overwinter in grass.
Host Plants: Grasses; Kentucky bluegrass, needlegrass, Roemer’s fescue, bromes and sedges.
Design Considerations: Open prairie meadow design with tall grasses of preferably of an acre or more. Because adults are constantly on the move and rarely visit flower patches, large meadows are suggested.
Design Level: Easy.

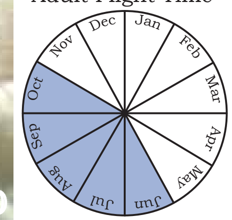
Common Wood Nymph

Cercyonis pegala

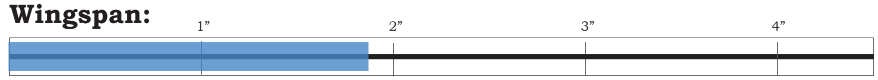
Larval Feeding Cycle



Adult Flight Time



Wingspan:

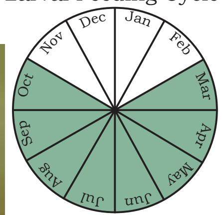


Description: Both sexes dorsal wings are dark brown. Forewings possess two large dark eye spots with a yellow ring around each spot. The spots on the female are larger. The hindwings ventral surface has a cryptic pattern that matches dry leaves or bark. This pattern helps the butterfly blend in with their environment.
Habitat: Woodlands, savanna, upland prairie, wet prairie, and urban gardens.
Abundance: “Common”. Flies in large colonies.
Broods: One
Conservation Status: Secure
Adult behavior: Adults fly just above, weaving through tall grass vegetation, landing on the ground or vegetation near the ground basking momentarily before resuming their patrolling for mates. During the hot hours of the day, adults retreat to the shade of woodland shadows to cool off. Females enter a state of aestivation during the late summer, conserving energy during the warmer days.
Larval behavior: Larvae feed at night on grasses. Larvae overwinter, then resume feeding in the spring.
Host Plants: Grasses, Kentucky bluegrass, fescues.
Design Considerations: Creation of a prairie habitat next to a woodland stand would simulate their habitat.
Design Level: Easy

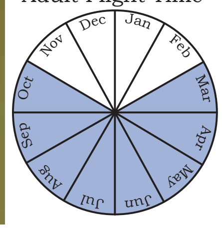
Common Checkered Skipper

Pyrgus communis

Larval Feeding Cycle



Adult Flight Time



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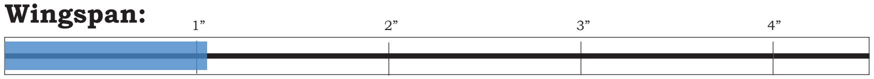


Description: Dusty grey and white checkered wings can look almost blue in appearance when the butterfly is in flight.

Habitat: Woodland clearings, savanna, upland prairie, wet prairie and urban gardens

Abundance: “Common”. Butterflies area adaptable.

Broods: Two to three.

Conservation Status: Secure

Adult behavior: Adults can be found singly or in large colonies. Male skippers perch on grass or flower tops and defend their territories by chasing anything that flies near them. Although primarily a perching butterfly, some patrolling does occur. Both sexes visit flowers, males puddle.

Larval behavior: Caterpillars are solitary leaf feeders. Caterpillars build a silken nest on the hostplant, sewing leaves together to conceal themselves, feeding occurs at night. Chrysalis overwinters.

Host Plants: Mallows; Oregon checkermallow, streambank globemallow, cheeseweed and hollyhock.

Design Considerations: Design trails and seating near trails, hostplants and meadow flower patches as butterflies are small and hard to see from a distance.

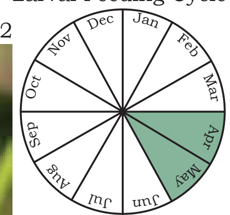
Design Level: Easy

Arctic Skipper

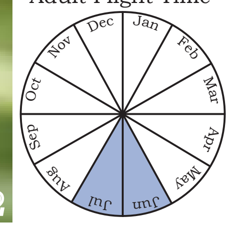
Carterocephalus palaemon

Photo 3.2

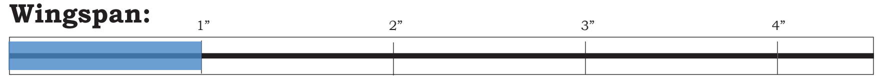
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: Brown with dark orange checkers on both forewing and hindwings, with ventral side of hindwings exhibiting creamy yellow/white spots.

Habitat: Upland forest clearings and riparian forest clearings where meadow and stream systems occur.

Abundance: “Uncommon”. The arctic skipper is infrequently encountered, as colonies are small and far and few between. The South Hills of Eugene does support some small colonial populations.

Broods: One

Conservation Status: Secure

Adult behavior: Adults bask and perch on low lying vegetation along streams and meadows systems. Males fond of puddling.

Larval behavior: The larvae are grass specialist leaf feeders. They are solitary feeders, feeding at night to avoid predators. Caterpillars build silken nests and fold leaves to conceal themselves. Larvae overwinter.

Host Plants: Grasses; Purple Reedgrass, and Brome species.

Design Considerations: Creating a glen or meadow opening within a forest setting where fresh water can flow through the landscape.

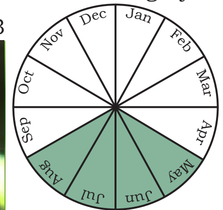
Design Level: Difficult, due to its rarity.

Silver-Spotted Skipper

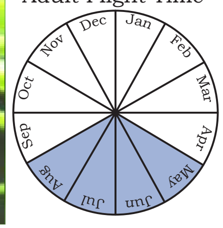
Epargyreus clarus

Photo 3.3

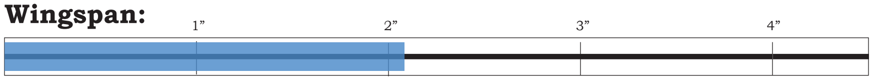
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: Both sexes are dark brown with bronze overtones. The forewing has a muted large gold spot pattern in the upper wing. The ventral surface of the hindwing has a large silvery white patch.

Habitat: Woodland clearings, savanna, upland prairie, wet prairie, and urban gardens.

Abundance: “Uncommon”.

Broods: One

Conservation Status: Secure

Adult behavior: Adults fly rapidly from flower to flower. Perching occurs on the ground or on low vegetation on large flat surfaces such as broad leaves. Both sexes are avid nectar feeders, males are fond of puddling.

Larval behavior: Larvae feed singly at night. During the day caterpillars roll leaves and hide within them to avoid detection from predators. Chrysalis overwinters.

Host Plants: Legumes; specifically big deervetch

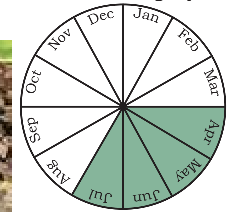
Design Considerations: Within woodland designs, create open areas for butterfly to bask. Provide plenty of flowering plants as butterflies are heavy feeders.

Design Level: Moderately difficult, because of the irregular frequency of encounter. Schools in the South Hills may see better results for visitation.

Propertinus Duskywing

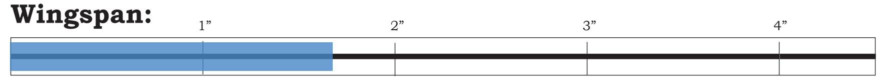
Erynnis propertius

Larval Feeding Cycle



Adult Flight Time

Wingspan:



Description: Both males and females have dusty grey and black checkered forewings with chocolate brown underwings, with females being lighter in color. The ventral sides of the wings are mainly chocolate brown.

Habitat: Oak Woodland, savanna, upland prairie, wet prairie where oaks are prevalent.

Abundance: “Common”.

Broods: Generally one

Conservation Status: Secure

Adult behavior: Both sexes are avid flower feeders and dart from flower to flower. Males are especially fond of visiting mud puddles. Males are found of basking on bare patches of ground or gravel pathways. These bare patches serve as perches where they await a passing female.

Larval behavior: Larvae are specialist feeders, exclusively feeding on oaks. Caterpillars are solitary feeders where they role oak leaves to hide from predators. Larvae hibernate in rolled leaves and spend the winter in leaf litter. In the spring, the caterpillar pupates.

Host Plants: Oregon White Oak

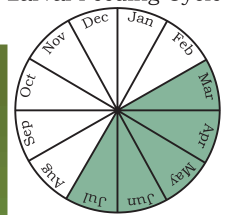
Design Considerations: Adults prefer open flowery meadows near stands of oaks. Do not rake away oak leaves in the Fall, as overwintering larvae may be present.

Design Level: Easy

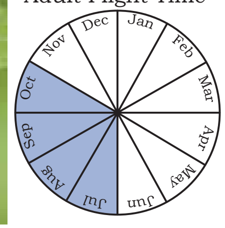
Woodland Skipper

Ochlodes sylvanoides

Larval Feeding Cycle



Adult Flight Time



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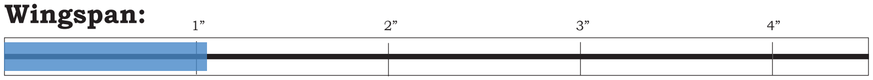


Description: Both sexes are a bright orange with darker brown margin patterns. The Male has a thin dark dash on the forewing. The Female has a larger less dark slash on the forewing.

Habitat: Upland forest clearings, riparian forest clearings, woodlands, savanna, upland prairie, wetland prairie, open fields, and urban gardens.

Abundance: “Common”

Broods: One

Conservation Status: Secure

Adult behavior: Butterflies occur is large colonies. Males perch and sun themselves on low vegetation and are quick to take flight and chase any butterfly out of their territory. Both sexes spend the majority of their day feeding from flowers, males can be found puddling.

Larval behavior: Larvae feed on grasses at night, hiding in webbed nests during the day. Larvae overwinter.

Host Plants: Grasses

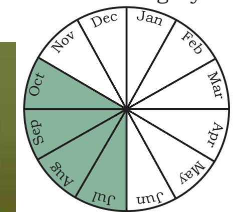
Design Considerations: Provide ample flowers. Butterflies will occur in large numbers and are as easily encountered in open grasslands, gathering in large numbers asters and goldenrod. They are equally common in large numbers in woodland clearings where nectar plants are numerous.

Design Level: Easy

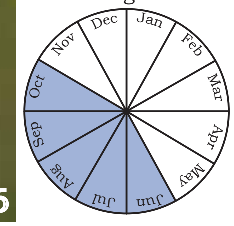
Sachem Skipper

Alalopedes campestris

Larval Feeding Cycle



Adult Flight Time



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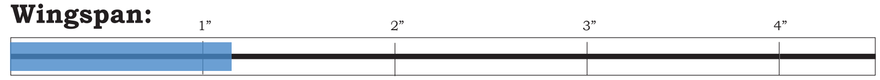


Description: Both sexes are bright orange and resemble the woodland skipper except that on the forewing of the dorsal wings on the Sachem, the black dash is replaced by a large black square spot.

Habitat: Found in many habitat clearings and meadows especially found of urban garden lawns.

Abundance: “Common”

Broods: Two to three

Conservation Status: Secure

Adult behavior: Sachem skippers occur in large numbers and are avid flower visitors. In more natural settings, the skippers prefer goldenrod and asters, within urban gardens, zinnias, lavender and mints are favored. Males perch on low vegetation and the ground waiting for females.

Larval behavior: Larvae are grass feeders, rolling leaves together to feed in safety from predators. Larvae overwinter.

Host Plants: Grasses

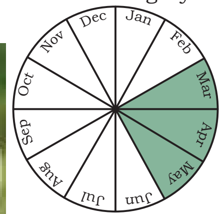
Design Considerations: Provide plenty of flowers that flower late in the season, (asters, goldenrod)

Design Level: Easy. Very commonly encountered within urban gardens. The Sachem uses turf grasses as well as naturally occurring grasses as hostplants, thus a manicured lawn should create a viable habitat for the Sachem.

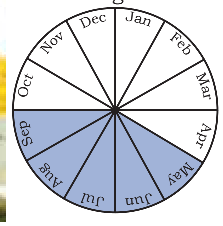
Dun Skipper

Euphyes vestris

Larval Feeding Cycle



Adult Flight Time



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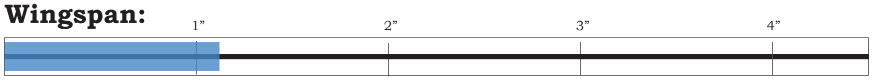
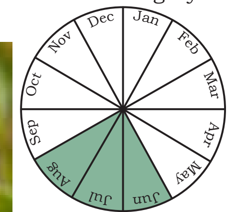


Description: Both sexes are deep ruddy brown. Males have a black dash on the forewing and females show three light brown square spots in the upper forewing.
Habitat: Woodland clearings, savanna, mixed prairie, and urban gardens where sedges grow.
Abundance: “Common’. Although the Dun Skipper occurs in lower numbers than the Sachem or Woodland skippers, the Dun Skipper can generally be found on outings in grassy meadows where sedge is nearby.
Broods: One
Conservation Status: Secure
Adult behavior: Both sexes are avid flower visitors. Males perch low to the ground and chase other Dun Skippers out of there territory.
Larval behavior: Larvae are specialist feeders, exclusive to sedges. Caterpillars feed at night to avoid predators. Hiding during the day occurs by rolling leaves together into a silken nest. Caterpillar overwinters.
Host Plants: Sedges
Design Considerations: Create areas of swales or low lying drainages where sedges can thrive. Adults frequent prunella flowers, dogbane, milkweed, and Indian hemp and other low growing mid summer flowers.
Design Level: Easy

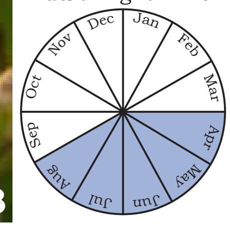
Sonora Skipper

Polites sonora

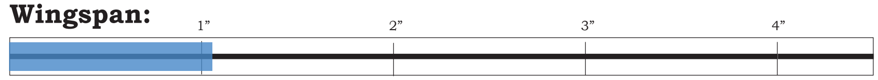
Larval Feeding Cycle



Adult Flight Time



Wingspan:



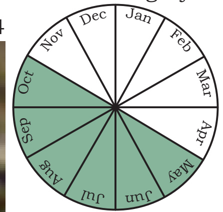
Description: Rudy orange and brown dorsal forewings with darker brown hindwings. The ventral hindwing has distinct creamy yellow dashes set against dark orange colors which are quite distinct from other skippers within the Eugene area.
Habitat: Open woodland, savanna, upland prairie, wet prairie and open fields and occasional gardens.
Abundance: “Fairly Common”, large populations found from time to time, but generally only a few individuals seen.
Broods: Two
Conservation Status: Secure
Adult behavior: Adult skippers visit daisies within clearings and meadows. Males perch on the ground or low growing vegetation and chase rival males.
Larval behavior: Larvae are grass feeding specialists. Larvae roll leaves together to form nests to avoid predators. The larvae overwinter.
Host Plants: Grasses; especially fescues
Design Considerations: Open grassland or woodland clearing designs with flowers that bloom early in the season.
Design Level: Easy. Although one of the less encountered skippers compared to the Woodland Skipper, habitat that mimics mixed prairie is recommended.

Juba Skipper

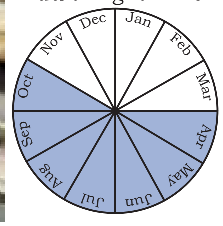
Hesparia juba

Photo 3.4

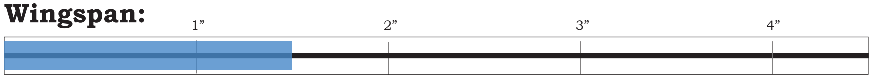
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: One of the larger grass feeding skippers. Males are bright orange with dark brown boarders and a thin black dash on the forewing. The ventral side hindwing has large silver white dash patterns set against bright olive scaling.

Habitat: Open woodlands, savanna, upland prairie, wet prairie and urban gardens.

Abundance: “Rare”, infrequent in numbers. it is thought that this butterfly, although non migratory, can travel long distances, expanding its range.

Broods: Two

Conservation Status: Secure

Adult behavior: Both sexes are avid flower visitors, especially daisies. Males perch on gravely surfaces and low vegetation.

Larval behavior: Larvae are generalist feeders. Larvae feed singly at night, rolling leaves together during the day to conceal themselves from predators. Larvae overwinter at the base of grass hostplants.

Host Plants: Feeding on bromes, Kentucky bluegrass, tufted hairgrass, and needlegrass

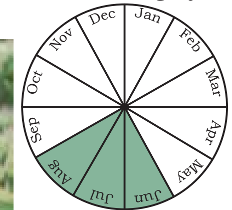
Design Considerations: Open Grassland concepts. Provide open gravelly patches for perching.

Design Level: Easy, despite occurring in low numbers.

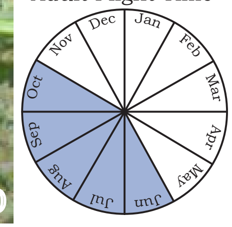
Monarch Butterfly

Danaus plexippus

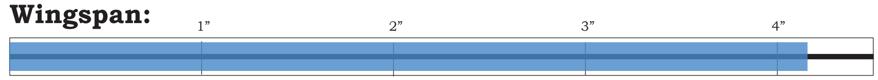
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: The largest and most conspicuous of butterflies within Eugene. Males are bright orange with black scaling over each wing vein. Black borders with white spots line the edges of the wings. The female has a forewing that is slightly dustier in color.

Habitat: Open woodlands, savanna, upland prairie, wet prairie, river waterways, and urban gardens.

Abundance: “Rare”. Common species, but rare in Eugene

Broods: One to two depending on the year

Conservation Status: Threatened. This species is a federal species of concern and is one of the more well known butterfly conservation species.

Adult behavior: Both sexes migrate northward, breeding along the way, giving rise to the next migratory generation. Males patrol looking for females and nectar patches, females patrol looking for milkweed patches.

Larval behavior: Larvae feed and pupate singly and conspicuously on the hostplant. Larvae are toxic.

Host Plants: Milkweed

Design Considerations: Design Monarch waystations with plenty of nectar plants that bloom long periods of time for adults and large patches of milkweed for larvae.

Design Level: Easy in concept, but may not produce consistent annual visitors.

Great Copper

Lycaena xanthoides

Unknown
Larval Feeding Cycle

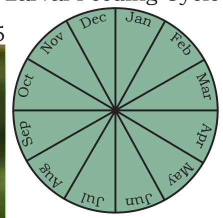
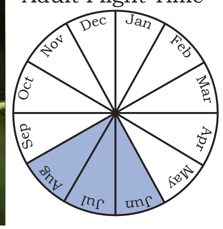
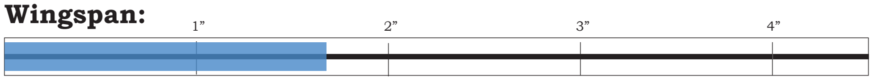


Photo 3.5

Adult Flight Time



Wingspan:

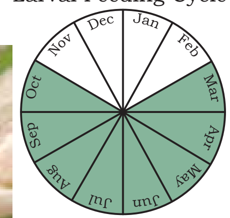


Description: Males are large and light grey on the dorsal aspect of the wings with a light orange band on the lower hindwing. Females are grey with spotting and creamy scaling on the forewing. Ventral sides of the wings are covered in black spots.
Habitat: Open savanna, upland prairie and wet prairie.
Abundance: "Rare". One of the more rare species within the Willamette valley with only a few specimens seen annually by butterfly monitoring experts,
Broods: One
Conservation Status: Secure through its range but efforts are being made to improve prairie habitat.
Adult behavior: Both sexes feed on prairie flowers such as Indian hemp and gumweed. Males perch on grasses waiting for females. Populations are colonial. Males can travel at high speeds across long distances.
Larval behavior: Larvae are leaf feeding specialists.
Host Plants: Willow-leafed dock
Design Considerations: Creating open wet prairie with ample host plants and ample nectaring flowers that peak during its flight times. Planting Valley Gumweed is recommended as this seems to be the butterfly's most used nectar source.
Design Level: Difficult, due to the butterfly's rarity.

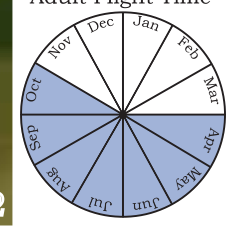
Grey Hairstreak

Strymon melinus

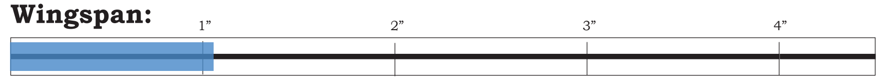
Larval Feeding Cycle



Adult Flight Time



Wingspan:

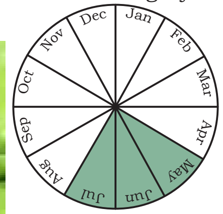


Description: Upperside of both sexes are dark grey on both forewing and hindwings. The dorsal side of the lower hindwing has a bright orange spot with a small black center. At the base of each hindwing is a thin tail. The ventral sides of the wings are lighter in color with again an orange spot on the hindwing.
Habitat: Woodlands, savanna, upland prairie, wet prairie, open fields, and urban gardens.
Abundance: "Common". Usually only a few seen at a time.
Broods: Three
Conservation Status: Secure
Adult behavior: Both sexes visit flowers and bask on vegetation at about the shrub layer level. Males perch or bask on mid to intermediately high vegetation in sunny locations waiting for females. Flight is fast and erratic, but landing often. Both sexes upon landing move their hindwing tails back and forth used as a decoy for would-be predators.
Larval behavior: Larvae are generalist feeders and use a variety of hostplants. Chrysalis overwinters.
Host Plants: Clover, sedum, oak, strawberry, knotweed, dock, deervetch, mallows, legumes and blackberry and pines.
Design Considerations: Mallows are recommended
Design Level: Easy

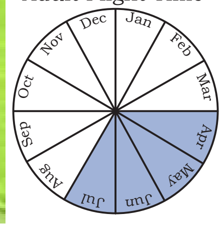
Cedar Hairstreak

Callophrys gryneus

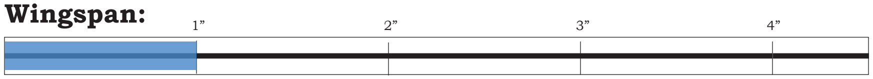
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: Dorsal sides of both males and females are ruddy brown. When the butterflies are newly hatched, the butterfly’s ventral side of the wings are a vibrant range of pinks, purples, and magenta set against a reddish brown base. A white stripe runs through the forewing to the hindwing. Each hindwing has a small thin tail at the base.

Habitat: Upland forest clearings, riparian forest clearings, open woodlands, and roadsides.

Abundance: “Rare”. Populations increase as the elevation increases and plant communities change from oak to fir and cedar belts.

Broods: One

Conservation Status: Secure

Adult behavior: Males and females spend much of their time feeding on yarrow and buckwheats along roadsides and clearings.

Larval behavior: Larvae are solitary. Chrysalis overwinters.

Host Plants: Incense Cedar, Western Red Cedar

Design Considerations: Planting evergreens

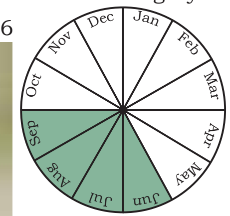
Design Level: Difficult. Due to low populations

Hedgerow Hairstreak

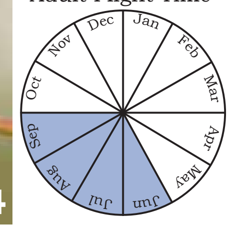
Satyrium saepium

Photo 3.6

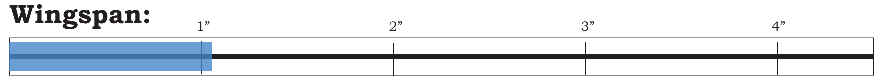
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: In both sexes, dorsal aspects of the wings are a dark ruddy red brown. The ventral sides are light brown with light linear banding. At the base of the hindwing is a blue dusting of scales and a small black tail.

Habitat: Woodland clearing, and open upland prairies

Abundance: “Uncommon”. However, as elevations

Broods: One

Conservation Status: Secure

Adult behavior: Both sexes are avid flower feeders especially ceanothus, dogbane, buckwheats, goldenrods and pearly everlasting.

Larval behavior: Larvae feed primarily on flower buds. Camouflage is the primary means of larval concealment from predators. Eggs overwinter.

Host Plants: Ceanothus species

Design Considerations: Planting ceanothus shrubs in massings.

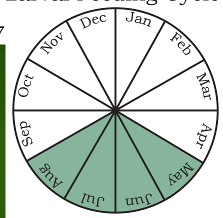
Design Level: Difficult, as populations within the valley are very uncommonly encountered.

Western Tailed Blue

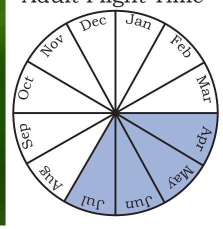
Cupido amyntula

Photo 3.7

Larval Feeding Cycle



Adult Flight Time



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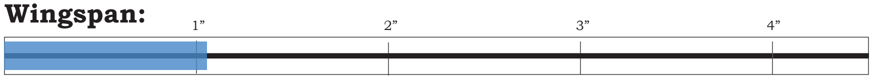
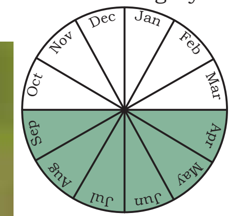


Description: Males are bright purple blue with small thin tails on the hindwing. Females are dark brown with small thin tails on the hindwing. The ventral side both sexes show a very grey underside, more grey and unmarked than the Eastern Tailed Blue.
Habitat: Open savanna, upland prairie and wet prairie.
Abundance: “Uncommon”. Less frequently encountered than the Eastern tailed Blue
Broods: One
Conservation Status: Secure.
Adult behavior: Both sexes feed on prairie flowers.
Larval behavior: Larvae are flower feeding specialists by burrowing into flowers as the grow into pods and feed from the inside of the pods, thus the pod serves as a place of safety. Ants attend then caterpillars and defend them in exchange for sugary honeydew.
Host Plants: Legumes, peas, vetches, lotus,
Design Considerations: Creating an area where children can view these tiny butterflies close up such as hostplants near seating or trails.
Design Level: Difficult due to the butterfly's rarity.

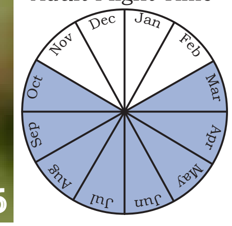
Eastern Tailed Blue

Cupido comyntas

Larval Feeding Cycle



Adult Flight Time



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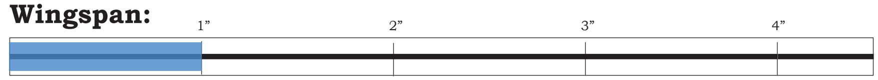
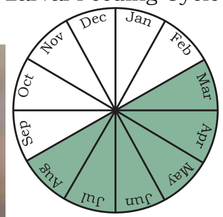


Description: Males are bright iridescent deep blue with an orange spot in the lower boarder of the hind wing with a small thin tail. Females are grey to deep chocolate brown with an orange spot in the lower hind wing with a small thin tail.
Habitat: Woodlands, savanna, upland prairie, wet prairie, open fields, and urban gardens.
Abundance: “Common”
Broods: Two
Conservation Status: Secure
Adult behavior: Both sexes visit flowers and bask on vegetation at ground level to low shrub level. Males perch or bask in sunny locations waiting for females. Flight is fast and erratic but often land quickly to feed on flowers.
Larval behavior: Larvae are general feeders and use a variety of legumes. Ants tend caterpillars and defend them in exchange for a sugary honeydew. Caterpillars overwinter.
Host Plants: Clover, vetches, Spanish clover, lupines.
Design Considerations: Place hostplants near trails.
Design Level: Easy

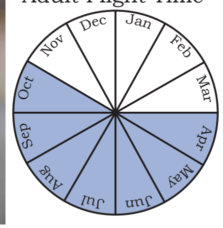
Acmon Blue

Plebejus acmon

Larval Feeding Cycle



Adult Flight Time



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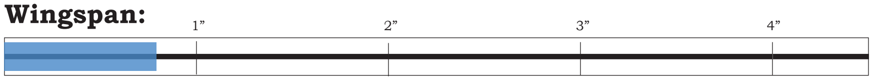


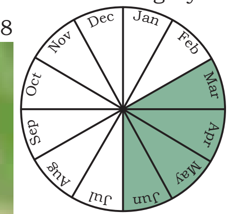
Description: Males are a bright iridescent blue lavender with orange bands on the hind wing, females are a dark gray to ruddy brown with an orange band on the hind wing.
Habitat: Open woodland clearings, savanna, and prairies, roadsides, and open fields.
Abundance: "Uncommon". The Acmon Blue is a common butterfly species but within Eugene, encounters in the field can be infrequent.
Broods: Two
Conservation Status: Secure.
Adult behavior: Males are attracted to mud puddles. Males patrol low to the ground and low growing vegetation in search for females. Both sexes visit flowers.
Larval behavior: Caterpillars feed mainly on hostplant flowers, and are solitary feeders. Caterpillars have a mutualistic relationships with ants. Larvae overwinter.
Host Plants: Legumes and buckwheats. Especially found of flower feeding. See quickguide.
Design Considerations: The Acmon Blue is a small butterfly and can be difficult to see during flight, thus providing plenty of low growing flowers both in the early spring and again in late summer near pathways will keep these butterflies close to the garden.

Fender's Blue

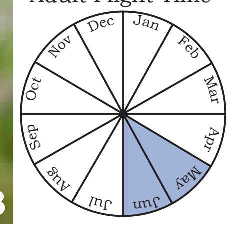
Icaricia icarioides fenderi

Photo 3.8

Larval Feeding Cycle



Adult Flight Time



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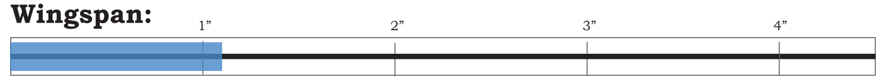
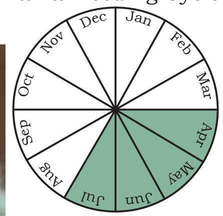


Description: Males are iridescent blue on the upper-side and gray underside. Females are dusty grey with some blue scaling.
Habitat: Confined to a limited few populations on wetland and upland short grass prairies within the Willamette Valley.
Abundance: "Rare". Only a few populations exist in Oregon.
Broods: One
Conservation Status: Critically imperiled.
Adult behavior: Adults form small bands of colonies near their hostplants, lupines. Males patrol vegetation in search of females. Neither males or females venture far from host-plant patches, generally less than 100 meters.
Larval behavior: Larvae feed on lupine leaves and flowers until the plant comes out of flower, at that time the caterpillar drops off of the plant and enters diapause until the following spring.
Host Plants: Kincaid's lupine, sickle keeled lupine, and spurred lupine.
Design Considerations: Because of the Endangered status of the butterfly and the regulations that are involved with Fender's Blue recovery guidelines, the Fender's Blue would prove a difficult species to design for on a public school grounds.

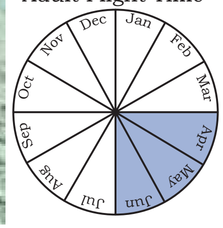
Silvery Blue

Glaucopsyche lygdamas

Larval Feeding Cycle



Adult Flight Time



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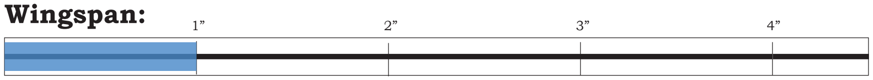
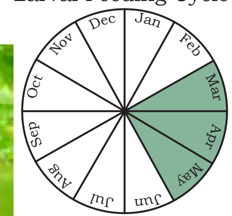


Description: Males are iridescent blue with a small thin black boarder on both forewing and hindwing. The females are often all grey or present with a slight blue dusting. Ventral wings are grey with black spots.
Habitat: Riparian meadows, open woodlands, savanna, upland prairie and wet prairie.
Abundance: “Common”
Broods: One
Conservation Status: Secure
Adult behavior: Both sexes feed on prairie flowers especially vetch and lupines. Males congregate around puddles and will even land on people who are sweating. Populations are colonial. Males patrol open grassy slopes and prairie in search of females.
Larval behavior: Larvae feed on both leaves and especially fond of flowers and unripened seed pods. Larvae are tended by ants which defend the caterpillars in exchange for sweet honeydew produced by the caterpillar. Larvae wander of hostplant and pupate on the ground. Chrysalis overwinters.
Host Plants: Legumes including lupines, vetch, lotus, and wild peas.
Design Considerations: Creating open wet prairie with ample early flowering nectar plants.
Design Level: Easy

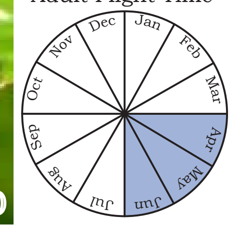
Echo Blue (Spring Azure)

Celastrina echo

Larval Feeding Cycle



Adult Flight Time



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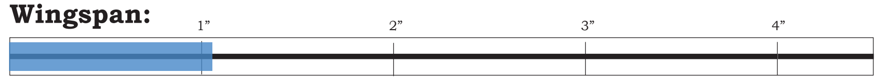
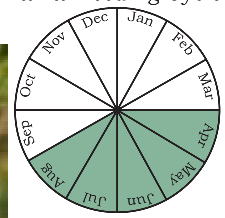


Description: Males are bright iridescent purple blue. Females are a dusty grey with light dusting of blue towards the body. Both sexes’ ventral forewings and hindwings are light grey with minimal markings.
Habitat: Upland forests, riparian forests streamsides, woodlands, savanna, upland prairie, wet prairie, open fields, and urban gardens.
Abundance: “Common”
Broods: One
Conservation Status: Secure
Adult behavior: Both sexes visit flowers and bask on vegetation at about the shrub layer level. Males bask in sunny locations but patrolling is the determined method for searching for females. Males are avid puddlers and will congregate in large numbers along streamsides.
Larval behavior: Larvae feed on flowers but also feed on leaves. Caterpillars use camouflage as a defense from predators. Larvae wander off of the host to pupate. Chrysalis and larvae both overwinter.
Host Plants: Dogwoods, ceanothus, spirea, oceanspray, elderberry, madrone, blueberries.
Design Considerations: Place hostplants near water, in swales or depressions where seasonal water congregates.
Design Level: Easy

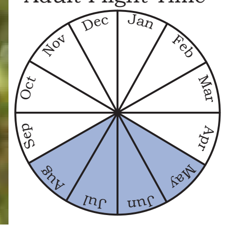
Variable Checkerspot

Euphydryas chalcedona

Larval Feeding Cycle



Adult Flight Time



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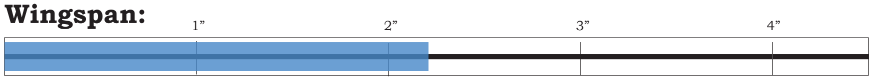
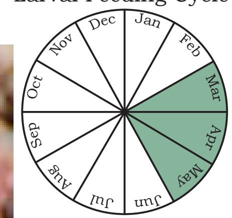


Description: Males and females are black with creamy spots on the dorsal sides of the wings. The ventral sides of wings are red with white spots. Females are larger than males.
Habitat: Open woodland, savanna, upland prairie and wet prairie, especially along roadsides.
Abundance: “Uncommon” throughout Eugene but there are populations in the South Hills.
Broods: One
Conservation Status: Secure
Adult behavior: Checkerpsots occur in large colonies. Males perch on open ground and gravel roads and defend their territories by chasing all butterflies from their territory. Both sexes prefer daisies for nectar.
Larval behavior: Larvae feed for several weeks in colonial silken tents before going dormant for the summer and through winter. Once spring arrives the following year caterpillars come out of hibernation to resume feeding. Caterpillars wander off plant and pupate on grasses.
Host Plants: Snowberry
Design Considerations: Creating an upland prairie habitat with snowberry nearby and an open gravel path for males to patrol.
Design Level: Moderately difficult do to scarcity of colonies.

Great Spangled Fritillary

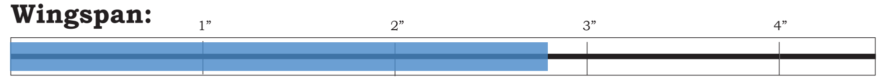
Speyeria cybele

Larval Feeding Cycle



Adult Flight Time

Wingspan:

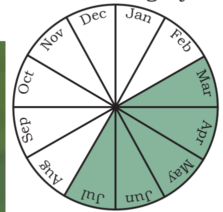


Description: Upperside of males is bright orange with black spots. Females are black and creamy yellow with black spots. Both sexes have silver spots on the ventral side of the wings.
Habitat: Upland forests clearings and woodland clearings.
Abundance: “Rare”
Broods: One
Conservation Status: Secure
Adult behavior: Both sexes visit flowers. Males hatch up to three weeks before females and establish territories that they patrol. Females mate and then go into a aestivate stage for nearly a month before laying eggs near dead and dry violets in September.
Larval behavior: Larvae hatch in September then immediately go into dormancy until the following spring. Upon resuming activity in the spring, caterpillars feed at night on violets and crawl off into the leaf litter during the day.
Host Plants: Violets.
Design Considerations: Design in upland forest areas keeping in mind that leaf litter on the ground near violets are where growing caterpillars are likely to spend there days.
Design Level: Difficul, as the butterfly is infrequent in Eugene.

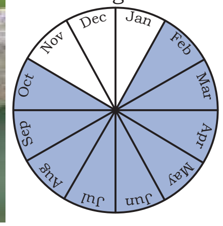
Mourning Cloak

Nymphalis antiopa

Larval Feeding Cycle



Adult Flight Time



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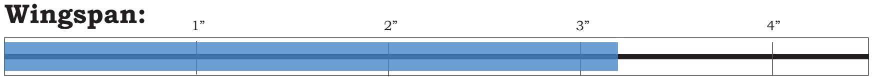


Description: Dorsal sides of the wings are reddish brown with a wide golden boarder flanked by light blue dashes. Ventral sides of the wings are bark patterned for camouflage.

Habitat: Riparian forest clearings, woodlands, savanna, upland prairie and wet prairie, river courses and urban gardens.

Abundance: “Uncommon”, individuals are infrequently encountered but as a species it is a common butterfly.

Broods: One

Conservation Status: Secure

Adult behavior: Rarely do Mourning Cloaks visit flowers, their diet consists of sap, rotting fruit, and puddling. Adults can live for a year and migrate to lower elevations to overwinter in rock walls, beneath tree bark. During spring, males perch on gravel, rocks or even low hanging branches.

Larval behavior: Larvae are colonial, feed in webbed nests.

Host Plants: Willows, cottonwoods, birch, spirea

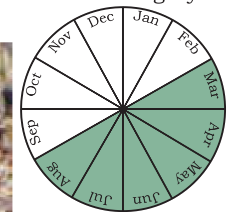
Design Considerations: Planting a willow thicket next to water or a swale. Create a stream corridor or an opening in a woodland where males can set up a territory. Provide a rock pile or a habitat log for hibernating adults.

Design Level: Although scarce, planting willow patches for other more common butterflies may bring in this species.

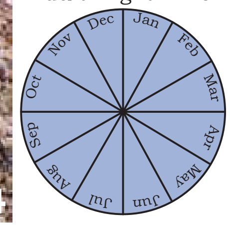
California Tortoiseshell

Nymphalis californica

Larval Feeding Cycle



Adult Flight Time



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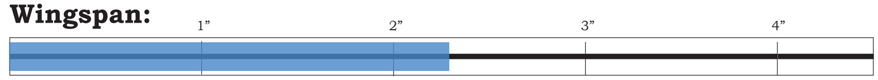


Description: Upperside dorsal wings are bright orange with black spotting. Underside ventral coloration resembles bark and the jagged wings complete the look of bark.

Habitat: Upland forests, riparian forests, woodlands during the summer, migrating to the valley in fall.

Abundance: “Irruptive” Common in the mountains.

Broods: One

Conservation Status: Secure

Adult behavior: Populations are prone to large explosions where the roads and trails of the mountainous regions are covered with adult tortoiseshell butterflies. In the late summer or early fall, the butterflies migrate to the valley. Adults feed on sap, carrion, scat and are extremely fond of puddling. Male perch on the sides of trees or low handing branches, but the majority of the butterfly’s time is spent visiting moist soil and the occasional flower.

Larval behavior: Larvae are colonial, feeding in webbed nests when young, abandoning the nests as the mature.

Host Plants: Ceanothus.

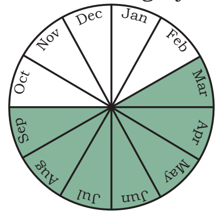
Design Considerations: Plant Ceanothus for any spring caterpillars, a habitat log for adult hibernation. Provide habitat for overwintering adults; tree snags, rock piles.

Design Level: More difficult, as overwintering adults tend to migrate to higher elevations in the spring to breed.

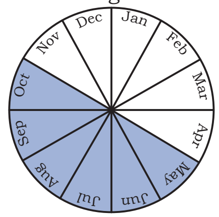
Lorquin's Admiral

Limenitis lorquini

Larval Feeding Cycle



Adult Flight Time



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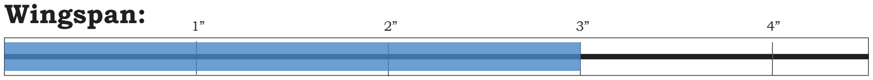
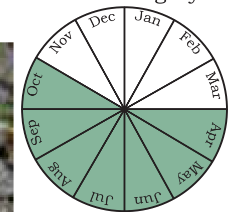


Description: Upper wings are dark brown to black with a large white central stripe and an orange tip on the forewing. Females are larger than males.
Habitat: Upland forest clearings, riparian forest clearings, woodlands, savanna, upland prairie and wet prairie and urban gardens.
Abundance: "Common" although populations occur in low numbers
Broods: Two
Conservation Status: Secure
Adult behavior: Females feed on flowers more actively than males. Males sit atop shrub or low tree branch perches at about 8 feet off the ground and keep a sharp eye out for females. Males also leave their perches to occasionally visit flowers but are much more fond of puddling.
Larval behavior: Larvae are solitary and mimic bird scat, thus escaping the attention of predatory birds.
Host Plants: Willow, cottonwood, serviceberry, spirea, oceanspray, crabapples, ceanothus, and cherries.
Design Considerations: Place hostplants and taller shrubs near trails so males can use them as perches.
Design Level: Easy

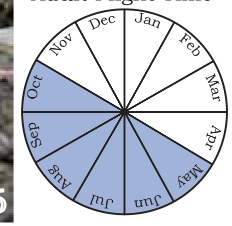
California Sister

Adelpha californica

Larval Feeding Cycle



Adult Flight Time



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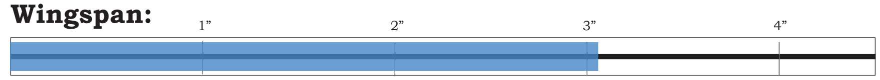
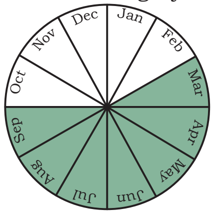


Description: Upperside is dark black with a white central stripe with a large orange tip. Ventral wings have lavender blue and orange spots. Coloration serves as warning colors of toxicity.
Habitat: Upland forest clearings, riparian forest clearings, woodlands, savanna, upland prairie, wet prairie, open fields, and urban gardens.
Abundance: "Common"
Broods: Three
Conservation Status: Secure
Adult behavior: Males establish perches atop shrubs and small trees along trails and watercourses to keep a sharp eye out for passing females. Males visit puddles and scat, but rarely flowers. Males that perch are easily startled but will return to the same perch almost immediately.
Larval behavior: Larvae specialist feeders on oak leaves. Caterpillars build a silken pier to rest on, in the fall caterpillars and chrysalis overwinter in leaf litter under the surrounding oaks.
Host Plants: Oregon White oak.
Design Considerations: An oak woodland design where butterflies can perch along a trail and puddle. Leave litter on the ground as overwintering takes place in fallen leaves.
Design Level: Easy

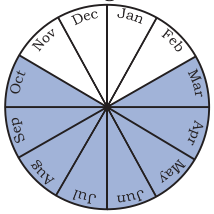
Mylitta Crescent

Phyciodes mylitta

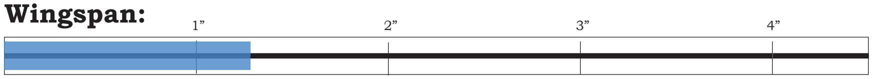
Larval Feeding Cycle



Adult Flight Time



Wingspan:

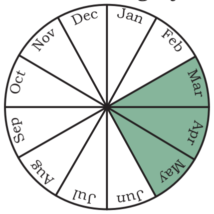


Description: Bright orange with brown mottling and spotting, giving the butterfly an overall orange appearance. Ventral sides of the wings are covered in creamy white spots, set against orange.
Habitat: Forest openings, oak woodland, savanna, upland prairie and wet prairie and urban gardens.
Abundance: “Common” One of the more butterflies
Broods: Three
Conservation Status: Secure.
Adult behavior: Both sexes feed on flowers low to the ground. Males perch on the ground, using roads and gravel pathways. They are easily startles but will return to their roost if left undisturbed.
Larval behavior: Larvae are leaf feeding specialists, feeding in webbed nests either singly or in small groups. Caterpillars are covered in spines for protection against predators. Caterpillars overwinter.
Host Plants: Thistles, both native and non-native.
Design Considerations: Creating open gravel pathway or patches within meadows or clearings for males to perch. Provide ample host plants and ample nectaring flowers that bloom over its flight times.
Design Level: Easy.

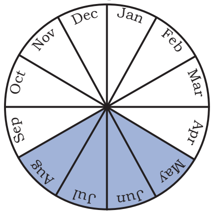
Field Crescent

Phyciodes pulchella

Larval Feeding Cycle



Adult Flight Time



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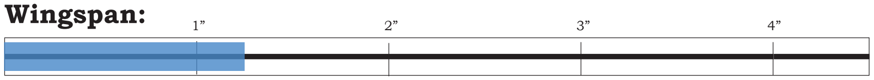
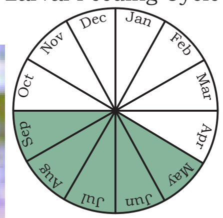


Description: Dorsal wings are dark brown with creamy yellow and orange spots. Males are darker with less light spotting than females. This pattern gives an overall darker colored butterfly. Ventral side of wings are deep orange with muted markings.
Habitat: Woodland clearings, savanna, upland prairie, wet prairie, open fields, and meadow systems.
Abundance: “Common”
Broods: One
Conservation Status: Secure
Adult behavior: Both sexes visit flowers and bask on vegetation. This butterfly forms large colonies. Males bask in sunny locations. Both sexes are frequent flower visitors. Males patrol over meadow vegetation canvasing the habitat for females and nectar. Males puddle.
Larval behavior: Larvae feed in colonies in webbed nests during the night and are covered with spines to protect themselves from predators.
Host Plants: Asters.
Design Considerations: Plant meadow with asters and flowers that bloom in June through August.
Design Level: Easy

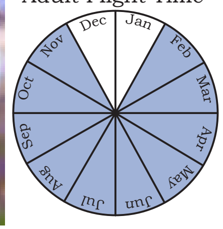
Red Admiral

Vanessa atalanta

Larval Feeding Cycle



Adult Flight Time



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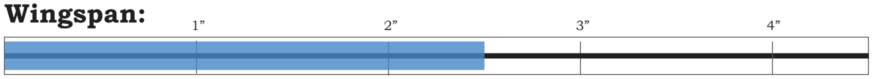
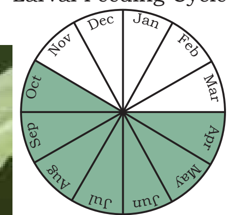


Description: Dorsal side is black with a dark orange band cutting across the forewing and a dark orange band bordering the hindwing. The forewing has a series of white spots. The ventral side is mottled blue and grey set against black.
Habitat: Upland forest clearings, riparian forest clearings, open savanna, upland prairie, wet prairie and urban gardens.
Abundance: "Uncommon" in encounters and not found in great abundance. But as a species the butterfly is common.
Broods: Three
Conservation Status: Secure
Adult behavior: Both sexes feed regularly on flowers, males perch in clearings on low lying shrubs or on open patches of bare earth. Adults migrate to warmer climates and overwinter, repopulating in the spring.
Larval behavior: Larvae feed singly in a folded leaf which they sew together with silk.
Host Plants: Stinging nettle
Design Considerations: Plant hostplant patch such be planted far from human contact. Although visiting flowers in open sunny meadows, red Admirals are commonly found in shaded forest trails and clearings.
Design Level: Difficult, only due to the stinging nettle. However, if nettle is planted, they likelyhood is pretty good.

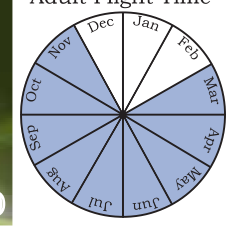
West Coast Lady

Vanessa annabella

Larval Feeding Cycle



Adult Flight Time



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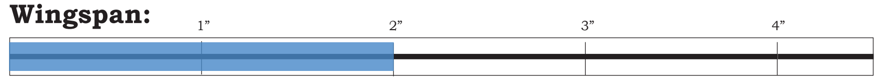
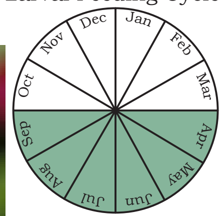


Description: Upperside dorsal aspect of the wings are bright orange with black mottling in the upper forewing corner, hindwing has a row of four blue spots. Ventral aspect of the wings are orange with grey and cream colored mottling.
Habitat: Forest openings, woodlands, savanna, upland prairie, wet prairie, and urban gardens.
Abundance: "Rare". As a species the butterfly is common.
Broods: Three
Conservation Status: Secure
Adult behavior: Both sexes visit flowers and bask on vegetation at about the shrub layer level. Males perch or bask in sunny locations waiting for females. Flight is fast and erratic. Adults migrate to warmer climates and overwinter, repopulating habitats the following spring.
Larval behavior: Larvae are solitary feeders building webbed nests to protect themselves from predators.
Host Plants: Mallows, and nettles.
Design Considerations: Mallows are recommended as stinging nettle may cause injury to people.
Design Level: Difficult do to the stinging nettle and the low numbers of individuals encountered within the Eugene area, however, if nettles and mallows are planted the chance of a breeding population could occur.

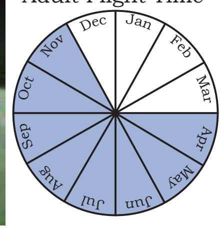
Painted Lady

Vanessa cardui

Larval Feeding Cycle



Adult Flight Time



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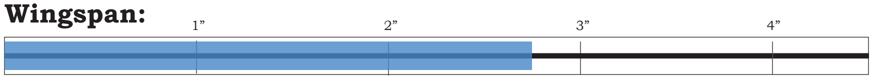


Description: Dorsal side is orange with the orange fading to pink in the forewing with black mottling and white spots in the upper corner. Ventral aspect is mottled grey with cream patches and a row of five eyespots in the lower boarder of the hindwing.

Habitat: Upland forest clearings, riparian forest clearings, open woodlands, savanna, upland prairie, wet prairie and urban gardens.

Abundance: "Common"

Broods: Four

Conservation Status: Secure

Adult behavior: Each spring, massive migrations of painted ladies fly north from Mexico and California to repopulate the region. Adults are fast and explore new territories looking for mates. In the fall, adults migrate south. Both sexes are avid flower visitors. Males perch low to the ground waiting for females to fly by.

Larval behavior: Larvae are solitary feeders building webbed nests to hide in. Caterpillars are covered with spines for protection from predators. No overwintering.

Host Plants: Thistles and mallows

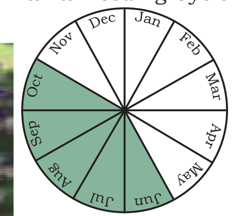
Design Considerations: Plant a wide range of flowers that will provide blooms from early in the season until late fall.

Design Level: Easy, as adults explore new territory.

American Lady

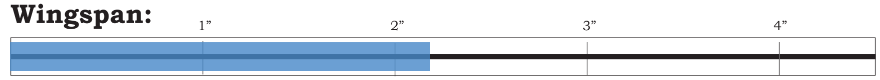
Vanessa virginiensis

Larval Feeding Cycle



Adult Flight Time

Wingspan:



Description: Upperside of both sexes is bright orange with black mottling and white spots in the upper corner of the forewing. The pattern is softer looking than that of the Painted Lady. The hindwing of the ventral aspect has a prominent and distinct eyespot.

Habitat: Woodlands, savanna, upland prairie, wet prairie, open fields, and urban gardens.

Abundance: "Rare". Not that the butterfly is rare, the solitary nature keeps encounters infrequent.

Broods: Two

Conservation Status: Secure

Adult behavior: Both sexes visit flowers and bask on vegetation at about the ground and grass layer level. Males perch or bask on low vegetation or bare earth. Unable to survive the cold temperatures of the Pacific Northwest, American Ladies emigrate from the south and repopulate Oregon each spring.

Larval behavior: Larvae feed singly at the base of host-plants, concealed in silken nests. No overwintering.

Host Plants: Pearly everlasting, cudweed.

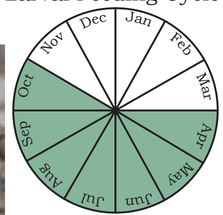
Design Considerations: Promote low lying wet prairie.

Design Level: Easy, as adults explore new territory.

Satyr Comma

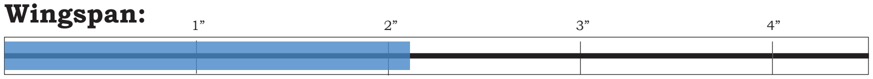
Polygonia satyrus

Larval Feeding Cycle



Adult Flight Time

Wingspan:

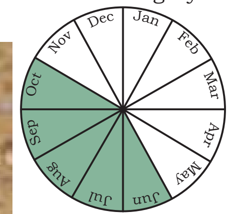


Description: Dorsal surface is bright orange with black spotting close to the body, fading to brown spotting near the edges of the wings. Wings are jagged and resemble tattered leaves. Ventral aspects are cryptic patterns of wood to give camouflage against trees.
Habitat: Upland forests, riparian forests, and woodlands.
Abundance: “Uncommon”
Broods: Three
Conservation Status: Secure
Adult behavior: Both sexes feed flowers, sap, scat, or rotting fruit. Males puddle. Males perch at about low shrub to moderate height along forest trails in hopes to intercept females that enter into their territory. Adults overwinter locally in tree crevasses or cracks in stone. Adults may emerge on any warm winter day.
Larval behavior: Larvae fold leaves and make tents to hide in while feeding.
Host Plants: Nettles, possibly willow
Design Considerations: Creating at pathway through a forest near nettle patches may produce butterflies. Nettle patches need to be placed in areas not frequented by people. Provide overwinter logs or rock piles for hibernating adults.
Design Level: Difficult, due the butterfly’s scarcity.

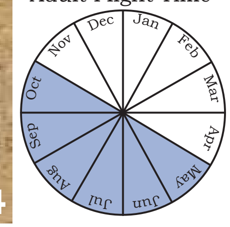
Common Buckeye

Junonia coenia

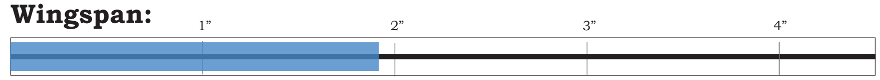
Larval Feeding Cycle



Adult Flight Time



Wingspan:

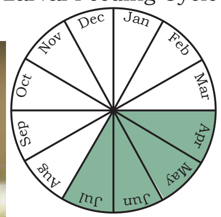


Description: Upperside of both sexes are chocolate brown. The forewing has a creamy white band with a large black eyespot with a blue center, two orange chevrons flank each side of the body, the hindwing has two large eyespots of orange and pink. Ventral coloring is dusty brown to match the color of earth.
Habitat: Woodlands, savanna, upland prairie, wet prairie, open fields, and urban gardens.
Abundance: “Uncommon”, more than likely, Buckeye’s emigrate northward from California each spring looking to expand their range.
Broods: One in Oregon
Conservation Status: Secure
Adult behavior: Both sexes visit flowers and bask on bare earth. Males perch or bask in sunny locations on bare earth almost exclusively. Flight is steady and low to the ground. Both sexes visit flowers regularly.
Larval behavior: Larvae feed openly on vegetation.
Host Plants: Plantains, penstemons, and paintbrush.
Design Considerations: Provide wide open trails with plantain and low growing flowers in the warmest months.
Design Level: Difficult, due to the scarcity of Buckeyes within the Willamette Valley.

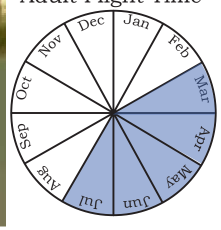
Brown Elfin

Callophrys augustinus

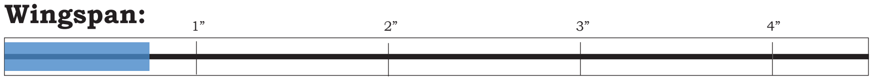
Larval Feeding Cycle



Adult Flight Time



Wingspan:



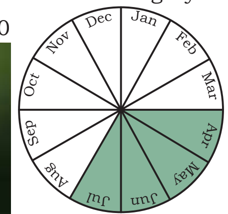
Description: Both upper and underside of both sexes are purplish brown and considerably less marked than the Western Pine Elfin.
Habitat: Forests clearings, riparian corridors, woodlands, savanna, mixed prairie, and urban gardens especially fond of meadows or roadside flower patches.
Abundance: Uncommon. Although a very common butterfly within Oregon, but uncommon in Eugene based on census.
Broods: One.
Conservation Status: Secure
Adult behavior: Males perch on taller vegetation like broad leafed shrubs or low lying tree branches, staking out a territorial perch which it uses repeatedly.
Larval behavior: Caterpillars, are solitary and feed on the flowering parts of the hostplant including developing seeds in which they will burrow into and create a hole to hide within. Chrysalis overwinters at the base of its hostplant in leaf litter.
Host Plants: Salal, ceanothus spp. manzanita spp., service-berry, Oregon grape, blueberries.
Design Considerations: Because the hostplants of this butterfly are so varied, these plants can serve as multi-use structural functions within the garden in both sun and shade gardens.

Western Pine Elfin

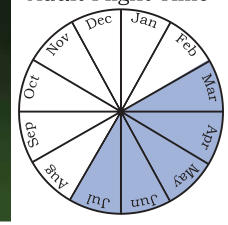
Callophrys eryphon

Photo 3.10

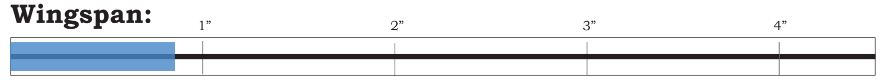
Larval Feeding Cycle



Adult Flight Time



Wingspan:

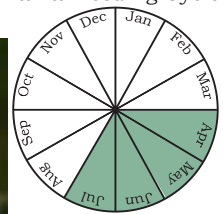


Description: Wing patterns on the underside are striking and with zig-zag patterns and chevron markings. Coloration can be ruddy to purple brown when first emerged.
Habitat: Forest clearings and meadow systems where pine belts dominate as the forest tree species.
Abundance: Uncommon. Although common as a species within the cascades, populations in Eugene are limited.
Broods: One
Conservation Status: Secure
Adult behavior: Butterflies are avid flower visitors often seeking out low growing clustering headed flowers such as buckwheats, yarrow or daisies. Males perch near evergreen hostplants low lying vegetation such as grass heads or flower tops, using the same perching place repeatedly.
Larval behavior: Larvae are solitary feeders and use only new growing pine needles or pine candles for food. Larvae are striped and blend in completely with the pine needles, thus camouflaging themselves. Chrysalis is formed either on or off the host without creating a nest and overwinters.
Host Plants: Pines are the preferred host, especially *P. ponderosa*, but also spruce and larch are used.
Design Considerations: The best scenario is to plant a grove of ponderosa pine within the edge of a site.
Design Level: Difficult, do to infrequent occurrence.

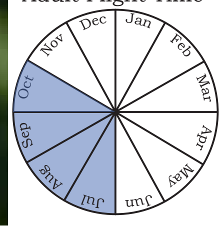
Pine White

Neophasia menapia

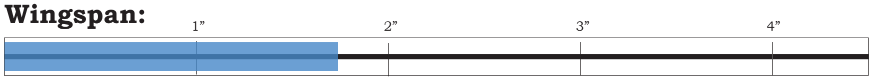
Larval Feeding Cycle



Adult Flight Time



Wingspan:



Description: Both upper and undersides are a very clear white, marked with a black to brownish black patterning especially within the upper portion of the forewings.
Habitat: Forests clearings, woodlands, suburban gardens especially fond of meadows or roadside flower patches where conifer forests dominate.
Abundance: Uncommon. Although a very common butterfly within Oregon, uncommon in Eugene based on census.
Broods: One.
Conservation Status: Secure
Adult behavior: Males and females patrol the upper canopy of evergreen trees in search of mates. These butterflies tend to stay adrift through the day in the upper canopy except for mornings and late afternoon when they slowly descend from the trees to feed in groups on flowers such as asters.
Larval behavior: Eggs are laid in clusters on pine needles in the fall and the eggs overwinter on the hostplant. Eggs hatch in spring and caterpillars feed in small groups until summer when the descend to lower vegetation and pupate.
Host Plants: Conifers such as pines, firs, and hemlock.
Design Considerations: Use the evergreen trees for this butterfly as groves or windbreaks or backdrops to the other part of the garden.
Design Level: Difficult due to infrequency in Eugene.

3.4 Selecting the Host Plants

Establishing what species of butterflies will likely visit your butterfly garden is a key to the overall success of the butterfly garden. To increase the likelihood of successfully attracting and keeping butterfly species within the designed garden space, carefully selecting plants that will meet the various life cycle stages of the butterfly is paramount. For the developing caterpillar, that plant is the host plant.

Host Plant defined-

"A species of plant or plants, that do to their chemical structure, are suitable for female butterflies to oviposit their eggs upon and subsequently nourish the growing caterpillars".

The feeding needs of butterflies are complex. Juvenile butterflies, called caterpillars, feed on the fleshy leaves, stems and flower parts of their host plants. The butterfly species which have a limited array of host plants that provide the proper nutrition to see a caterpillar through development to adulthood, are considered feeding specialists. The Monarch butterfly which feeds exclusively on plants in the milkweed family, is considered a feeding specialist. Whereas the Western Tiger Swallowtail butterfly, which uses a vast variety of broad-leaf trees, across a broad spectrum of plant genera, can be considered a feeding generalist (James 2011).

The degree of specificity of caterpillar feeding patterns can affect the level of butterfly occurrence within a habitat. Many butterfly species whose hostplant choice range is more varied, can move across habitats and establish breeding populations at a greater frequency than those species which are feeding specialists (Fontaine 2016). Knowing which host plants attract certain butterflies, and the likelihood of these species utilizing these hostplant resources is the central focus of this section of the guidebook.

Although host plant feeding specialty can affect the degree of common to rare status of a butterfly species, there are examples of common butterflies that are feeding specialists. Despite rare encounters within Eugene, Oregon, the Monarch butterfly is a considered a commonly occurring butterfly, and is considered a feeding specialist. But because milkweed grows naturally in habitats across North America, the Monarch can be found commonly across North America.

In the case of the Fender's Blue butterfly, the butterfly is limited to where its hostplant, the Kincaid's Lupine thrives, the upland prairies of the Willamette Valley. Such a limited host plant range restricts the movement of the butterfly, leading the rarity of the butterfly. Thus, planting milkweed patches in your habitat garden would more likely see positive butterfly visitation from Monarch butterflies, than the planting of Kincaid Lupines to bring in Fender's Blue butterflies, even though the occurrence of Monarch butterflies is rare or infrequent within Eugene (Fig. 3.14).

Fender's Blue and Kincaid's Lupine

Monarch and the Showy Milkweed

Figure 3.14 The specialist Monarch is a commonly occurring species found across North America, the specialist Fender's Blue is confined to the Willamette Valley.

Native Host Plants

Butterfly use of habitat gardens increase substantially when the correct host plants are selected. Selection of host plants should focus primarily on the native species of plants that occur naturally within the historical plant communities of the Willamette Valley and that have traditionally served as host plants for local butterfly species.

The complex relationship that has co-evolved between host plant and butterfly remains intact with choosing native plants as host plants. Native plants increase biodiversity, not only for butterflies, but for other animals that share these gardens (Heritage 2015)

Native plants that serve as host plants for local butterfly species are often plants that can be acquired from local growers and native plant nurseries.

I advocate the use of native plants to preserve the integrity of the ecological services that these native plants provide for biodiversity. However, within very urbanized areas, certain butterfly species have shown the ability to jump from the use of native plant species as host plants and incorporate exotic plants into their life cycle.

Exotic Plants Serving as Host Plants

"Invasion by exotic species is second only to direct habitat loss in reducing and eliminating native biodiversity"

-The Native Plant Society of Oregon

Rapidly reproducing exotic species often out compete native species and subsequently occupy the spaces within the landscape that native vegetation once inhabited. This replacement from native to exotic can lead to the extirpation of invertebrates such as butterflies who were once dependent upon this native flora be it a nectar or host source (NPSO 2008).

The consequence of losing native plant species to exotic plant species can have a trickle up effect, where the disappearance of one group of animals such as the butterfly, which serves as a prey species, can lead to the disappearance of another group of animals who depend upon them as a food source, such as birds (Tallamy 2007).

Many exotic plant species within natural landcsapes are the result of escaped cultivated plants from either urbanized landscapes or from agricultural practices. Once escaped plants gain a foothold within an ecosystem, the results can be dramatic, causing degradation to waterways, productive agricultural lands, and of course habitats. Exotic plants species that supplant native plants within natural habitats are known as invasive species (NPSO 2008).

However, not all exotic plant species will become invasive. Many environmental factors keep most exotic plants from gaining a foothold within native environments.

In regions that have been intensely cultivated for many years through agriculture and later by urban development, such as the Central Valley of California, exotic plant species have become a significant food source, be it host or nectar, for many butterfly species (Shapiro 2002). Within the city of Davis, California, exotic "weed" species play a large role in the survival of many local butterfly species, where over forty percent of all fauna has become completely dependent on non-native plants as host plants where no known native hosts remain. (Shapiro 2002)

Here within Eugene, I observed a Grey Hairstreak butterfly lay eggs on a cultivated hollyhock along a suburban sidewalk planter. I personally reared Painted Lady and Mylitta Crescentspot butterfly larvae on the invasive Canada Thistle. These two example show the ability for local butterflies to adapt to a changing environment when native plant communities begin to shift from pre-settlement, to a mixed exotic palette.

Deciding whether to foster exotic plants as butterfly host plants is a decision that needs further discussion of the long-term benefits or harm to local butterfly ecology.

How butterflies locate their host plants

Butterfly species have many strategies for egg dispersal throughout their habitat. Some species such as the Tiger Swallowtail will lay a single egg on a suitable host plant and then move on another suitable host plant to deposit another egg (James 2011). Since butterfly egg clutches can range into the hundreds, the Tiger Swallowtail needs a lot of habitat for proper egg disbursement.

Other butterfly species, such as the colonial Variable Checkerspot, will lay an entire clutch of eggs clustered on a single leaf of a selected host plant (James 2011). Thus host plants of size and number are needed for proper egg disbursement. The Variable Checkerspot butterfly tends to be less likely to venture far from its colony, thus eggs laid in a single place promote the colonial progeny (Singer 2003). Some butterflies will avoid laying eggs on a hostplant that other butterflies have already laid eggs on. While other species will continue laying eggs on host plants, regardless of the presence of other butterfly eggs (Shapiro 1981).

Female butterflies use all their senses to locate suitable host plants. Visually they search the habitat for suitable plant species. Their vision is accompanied by their sense of smell guided by their antennae (Masumoto 1993). Once a host plant of a suitable species is located, the female butterfly will land on the plant, and with specialized organs located on the pads of her feet, taste the plant. This tasting is the butterfly determining whether the plant is of the correct species of plant and if the plant has a high degree of health and chemical characteristics that will sustain her caterpillars' nutritional needs (James 2011). Thus host plant quality and host plant quantity contribute for a habitat's increased butterfly carrying capacity (Curtis 2015).

Proper spatial distribution of host plants

1. Fitness of Plants: Distributing the host plants evenly through the site will help ensure there will be healthy stands of plants. Microclimates, soil types, drainage and slopes all contribute to plant fitness. Not all plants do as well in some locations as other locations. Distributing host plants over a greater area can help ensure that healthy patches of plants will exist within the space (Floater 2001).

2. Dispersing the Eggs and Caterpillars: Distributing host plants evenly across the garden, will help female butterflies distribute the eggs evenly through the habitat. This reduces caterpillar concentration, thus predators can not locate caterpillars as easily can avoid predator detection better (Floater 2001).

3. Hostplant Depletion: An overabundance of caterpillars in a concentrated patch of plants can put a strain on host plant health. The overcrowding of caterpillars can reduce food supplies is plausible, but to this date, unquantified (Dempster 1983).

4. Competition for Space: Some species of butterflies will avoid laying eggs on plants that are already occupied with caterpillars. Distributing host plants evenly gives more egg laying and habitat carrying capacity (Shapiro 1981).

These recommended spatial distribution guidelines for host plants within a garden space is derived from literature but are still my general assertions. These guidelines do not address species specific spatial egg laying patterns by female butterflies within the Willamette Valley. For that, further research needs to be conducted.

For further reading on spatial and temporal butterfly host plant selection processes I recommend: "*Butterflies: Ecology and Evolution Taking Flight*" edited by Boggs, Watt and Ehrlich and "*Egg-laying patterns in butterflies in relation to their phenology and the visual apparency and abundance of their host plants*" by Wiklund.

The Guidebook: Butterfly To Host Plant Reference Quickguide

	Plate Number	Western Tiger Swallowtail	Anise Swallowtail	Pale Swallowtail	Clodius Parnassian	Orange Sulphur	Cabbage White	Western White	Marginated White	Ochre Ringlet	Common Wood Nymph	Common Checkered Skipper	Arctic Skipper	Silver-Spotted Skipper	Propertinus Duskywing	Woodland Skipper	Sachem Skipper	Dun Skipper	Sonora Skipper	Juba Skipper	Monarch Butterfly	Great Copper	Grey Hairstreak	Cedar Hairstreak	Hedgerow Hairstreak	Western Tailed Blue	Eastern Tailed Blue	Acmon Blue	Fender's Blue	Silvery Blue	Spring Azure	Variable Checkerspot	Great Spangled Fritillary	Mourning Cloak	California Tortoiseshell	Lorquin's Admiral	California Sister	Mylitta Crescent	Field Crescent	Red Admiral	West Coast Lady	Painted Lady	American Lady	Satyr Comma	Common Buckeye	Brown Elfin	Western Pine Elfin	Pine White
Plate Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Oregon White Oak	1														■								■														■											
Pacific Dogwood	2																														■																	
Cascara	3			■																																												
Black Hawthorn	4			■																														■														
Red Alder	5	■		■																														■		■												
Western Serviceberry	6			■																																■												
Scouler's Willow	7	■																																■		■								■				
Black Cottonwood	8	■																																■		■												
Oregon Ash	9	■																																														
Bigleaf Maple	10	■																																■														
Vine Maple	11	■																																														
Pacific Madrone	12																														■																	
California Insense Cedar	13																							■																								
Ponderosa Pine	14																						■																								■	■
Western Red Cedar	15																							■																								
Douglas fir	16																																															■
Western Hemlock	17																																															■
Pacific Ninebark	18																														■																	
Blue Elderberry	19																														■																	
Western Spirea	20																														■																	
Mountain Balm	21																								■						■				■											■		
Oceanspray	22			■																											■			■		■												
Deerbrush	23			■																											■				■											■		
Red Twig Dogwood	24																														■																	
Nootka Rose	25																																	■														

	Plate Number	Western Tiger Swallowtail	Anise Swallowtail	Pale Swallowtail	Clodius Parnassian	Orange Sulphur	Cabbage White	Western White	Marginated White	Ochre Ringlet	Common Wood Nymph	Common Checkered Skipper	Arctic Skipper	Silver-Spotted Skipper	Propertinus Duskywing	Woodland Skipper	Sachem Skipper	Dun Skipper	Sonora Skipper	Juba Skipper	Monarch Butterfly	Great Copper	Grey Hairstreak	Cedar Hairstreak	Hedgerow Hairstreak	Western Tailed Blue	Eastern Tailed Blue	Acmon Blue	Fender's Blue	Silvery Blue	Spring Azure	Variable Checkerspot	Great Spangled Fritillary	Mourning Cloak	California Tortoiseshell	Lorquin's Admiral	California Sister	Mylitta Crescent	Field Crescent	Red Admiral	West Coast Lady	Painted Lady	American Lady	Satyr Comma	Common Buckeye	Brown Elfin	Western Pine Elfin	Pine White
Plate Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Red-Flowering Currant	26			■																																												
Snowberry	27																															■																
Evergreen Huckleberry	28																														■																	
Spanish Clover	29					■																					■	■		■																		
Birdsfoot Trefoil	30																						■				■	■		■																		
Big Deervetch	31													■									■			■				■																		
Springbank Clover	32					■																	■				■																					
Kincaid's Lupine	33																												■	■																		
Bigleaf Lupine	34																						■							■																		
Riverbank Lupine	35					■																	■				■			■																		
Stinging Nettle	36																																							■	■	■		■				
Showy Milkweed	37																				■																											
Narrowleaf Milkweed	38																				■																											
Willowleaf Dock	39																					■																										
Seep Monkeyflower	40																															■													■			
Rosy Checkermallow	41											■											■																		■	■						
Henderson's Checkermallow	42											■											■																		■	■						
Cusick's Checkermallow	43											■											■																		■	■						
Pacific Bleedingheart	44				■																																											
Cluster Thistle	45																																					■				■						
Barestem Buckwheat	46																											■																				
Pearly Everlasting	47																																										■					
Lowland Cudweed	48																																										■					
Narrowleaf Plantain	49																																												■			
Fernleaf Biscuitroot	50		■																																													

	Plate Number	Western Tiger Swallowtail	Anise Swallowtail	Pale Swallowtail	Clodius Parnassian	Orange Sulphur	Cabbage White	Western White	Marginated White	Ochre Ringlet	Common Wood Nymph	Common Checkered Skipper	Arctic Skipper	Silver-Spotted Skipper	Propertinus Duskywing	Woodland Skipper	Sachem Skipper	Dun Skipper	Sonora Skipper	Juba Skipper	Monarch Butterfly	Great Copper	Grey Hairstreak	Cedar Hairstreak	Hedgerow Hairstreak	Western Tailed Blue	Eastern Tailed Blue	Acmon Blue	Fender's Blue	Silvery Blue	Spring Azure	Variable Checkerspot	Great Spangled Fritillary	Mourning Cloak	California Tortoiseshell	Lorquin's Admiral	California Sister	Mylitta Crescent	Field Crescent	Red Admiral	West Coast Lady	Painted Lady	American Lady	Satyr Comma	Common Buckeye	Brown Elfin	Western Pine Elfin	Pine White
Plate Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Cow Parsnip	51		■																																													
Garden Crucifers	52						■																																									
Douglas Aster	53																																						■									
Stream Violet	54																																■															
Pacific Aster	55																																						■									
Blue Violet	56																																■															
Brewer's Bittercress	57								■																																							
White Watercress	58								■																																							
Foothill Sedge	59									■								■																														
Dense Sedge	60					■				■								■																														
Roemer's Fescue	61									■	■								■																													
Red Fescue	62									■	■						■		■																													
California Fescue	63									■	■								■																													
Alaska Brome	64									■			■							■																												
Kentucky Bluegrass	65									■	■						■		■																													
Pine Bluegrass	66									■	■								■																													
Poverty Oat Grass	67										■					■																																
California Oatgrass	68										■					■																																
Lemmon's Needlegrass	69									■										■																												
Tufted Hairgrass	70									■										■																												
Blue Wildrye	71															■																																
Slender Wheatgrass	72															■																																
Mustards	73							■																																								

	Oregon White Oak	Pacific Dogwood	Cascara	Black Hawthorn	Red Alder	Western Serviceberry	Scouler Willow	California Black Cottonwood	Oregon Ash	Bigleaf Maple	Vine Maple	Pacific Madrone	California Incense Cedar	Ponderosa Pine	Western Red Cedar
Plate Number (H)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Upland Forest		X	X	X	X	X				X	X	X	X	X	X
Riparian Forest		X	X	X	X	X	X	X	X	X	X				X
Woodland	X	X	X	X	X	X				X	X	X	X	X	X
Savanna	X		X	X								X	X	X	
Upland Prairie	X		X	X		X									
Wet Prairie			X		X	X	X	X	X						
Urban Gardens	X	X	X	X	X	X			X	X	X	X	X	X	X

	Douglas Fir	Western Hemlock	Pacific Ninebark	Blue Elderberry	Western Spirea	Mountain Balm	Oceanspray	Deerbrush	Red Twig Dogwood	Nootka Rose	Red-Flowering Currant	Snowberry	Evergreen Huckleberry	Spanish Clover	Birdsfoot trefoil
Plate Number (H)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Upland Forest	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Riparian Forest	X		X	X	X				X	X		X	X		
Woodland	X		X			X	X	X	X	X	X	X	X	X	X
Savanna			X			X	X			X	X	X		X	
Upland Prairie						X	X			X	X			X	
Wet Prairie			X		X				X	X				X	X
Urban Gardens	X	X	X		X		X		X	X	X		X		

	Big Deervetch	Springbank Clover	Kincaid's Lupine	Bigleaf Lupine	Riverbank Lupine	Stinging Nettle	Showy Milkweed	Narrowleaf Milkweed	Willowleaf Dock	Seep Monkeyflower	Rosy Checkermallow	Henderson's Checkermallow	Cusick's Checkermallow	Pacific Bleedingheart
Plate Number (H)	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Upland Forest	X			X		X						X		X
Riparian Forest	X			X	X	X						X		X
Woodland	X			X		X	X	X			X	X	X	X
Savanna			X	X		X	X	X	X		X	X	X	
Upland Prairie			X	X		X	X	X	X		X	X	X	
Wet Prairie		X	X	X		X	X	X	X	X	X	X	X	
Urban Gardens				X			X	X			X	X	X	X

	Cluster Thistle	Barestem Buckwheat	Pearly Everlasting	Lowland Cudweed	Narrowleaf Plantain	Fernleaf Biscuitroot	Cow Parsnip	Garden Crucifers	Douglas Aster	Stream Violet	Pacific Aster	Blue Violet	Brewer's Bittercress	White Watercress	Foothill Sedge
Plate Number	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Upland Forest		X	X		X	X	X		X	X		X	X	X	
Riparian Forest			X		X		X		X	X		X	X	X	
Woodland	X		X		X	X	X		X	X		X			
Savanna	X	X	X		X	X	X		X		X	X			
Upland Prairie	X	X	X		X	X	X		X		X	X			X
Wet Prairie	X		X	X	X		X		X		X	X	X	X	X
Urban Gardens			X		X	X	X	X	X	X	X	X		X	X

	Dense Sedge	Roemer's Fescue	Red Fescue	California Fescue	Alaska Brome	Kentucky Bluegrass	Pine Bluegrass	Poverty Oat Grass	California Oatgrass	Lemmon's Needlegrass	Tufted Hairgrass	Blue Wildrye	Slender Wheatgrass	Mustards
Plate Number	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Upland Forest			X	X	X	X		X				X		
Riparian Forest			X	X	X	X								
Woodland		X	X	X	X	X	X	X		X		X	X	
Savanna		X	X	X	X		X	X	X	X		X	X	X
Upland Prairie		X	X	X	X		X	X	X	X		X	X	X
Wet Prairie	X		X		X	X		X	X		X	X	X	
Urban Gardens	X	X	X	X	X	X					X			X

Water requirement icons that convey the degree of moisture that the plant requires for optimal growth. Factors such as soils and micro-climate will effect overall water require-

Moist to Wet: Thrives in areas that are seasonable wet or soil moisture remains high. In gardening terms, the plant thrives in soils that do not dry.

Average Moisture: Thrives in areas that are seasonable wet or moist, but tolerates seasonal drying. In gardening terms, water deeply once per week.

Dry Conditions: Thrives in areas that are seasonable wet or moist, but needs seasonal drying. In gardening terms, water deeply only on occasion, or none once established.

Full Shade: Plant survives or thrives in 3 hours of sun per day.

Partial Shade: The plant requires or tolerates less than 6 hours of sun per day.

Full Sun: Plant requires 6 or more hours of direct sunlight per day.

General light exposure requirements for optimal health.

Most commonly occurring in these areas, however, species may be found in other areas.

- Upland Forest
- Riparian Forest
- Woodland
- Savanna
- Upland Prairie
- Wet Prairie
- Cultivated Beds

Note: See habitat section for details.

Image of a typical representation of a mature plant demonstrating its growth habits and prominent features.
Complete with more detailed image of a prominent feature for better identification.

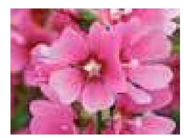
Sidalcea cusickii

Cusick's checkermallow

Malvaceae

H: 2-5' W: 2-5'

Type: Perennial



Die-down in the fall

Butterflies That Use Host

Habitat: Found in open riparian areas such as wet prairie and streambanks in sunny locations.

Design Uses: A vital component as both a nectar source for all species of pollinators as well as a hostplant for butterfly species. Plant in mass and in the back of smaller plants.

Common name

Scientific name

Plant Family.

Maximum growth size

Life cycle

Habits during dormancy

Butterfly plates that show which species use this as a hostplant.

Butterfly plate number to for easy referencing.

Hostplant plate number for easy referencing with the quickguides and throughout the document.

Details on the habitat that the plant occurs naturally.

Suggestions for design and decision making process.

Quercus garryana

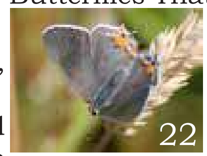
Oregon White Oak

Fagaceae

H: 90’ W: 90’

Type: Tree

Butterflies That Use Host



Habitat: Upland prairie, savanna, woodland and dry slopes

Design Uses: Plant oak singly and give plenty of room for them to spread lateral branches. Allow oak leaves to remain on the ground through winter, they may contain overwintering larvae and pupa.

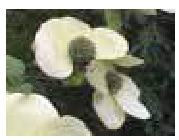
Cornus nuttallii

Pacific Dogwood

Cornaceae

H: 35’ W: 20’

Type: Tree



Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forest

Design Uses: Use as a specimen tree or focal point. Plant singly or in groups of three, set trees against conifer stands, as white flowers will be highly visible in the spring. Red fruit attracts birds.

Rhamnus purshiana

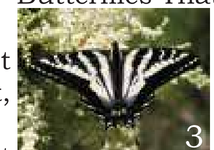
Cascara

Rhamnaceae

H: 35’ W: 25’

Type: Tree to Tall Shrub

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, woodland, upland forest, riparian forest

Design Uses: Line streams or forest edge designs. Plant along trails in woodland landscapes as the height of the Cascara is well suited for perching butterflies.

Crataegus douglasii

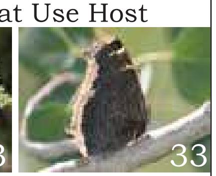
Black Hawthorn

Rosaceae

H: 20’ W: 20’

Type: Small Tree

Butterflies That Use Host



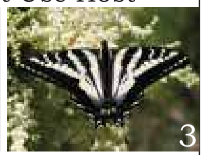
Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest

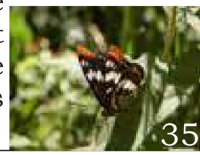
Design Uses: Valuable for habitat restoration, prolific flowers bring in pollinators and berries bring in birds. Plant in mass to form a thicket for cover or a wind shelter.

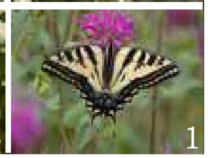
Alnus rubra
Red Alder

Betulaceae
H: 75' W: 50'
Type: Tree

Butterflies That Use Host





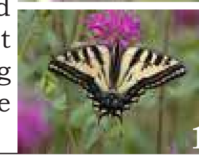


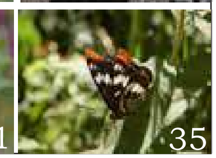
Habitat: Wet prairie, woodlands, upland forest, riparian forest
Design Uses: Thrives in nutrient poor soils and used to stabilize stream banks. Fast growing. Plant singly or in small groupings. Large leaves provide shelter, windbreaks for butterflies during rain events.

Salix scouleriana
Scouler's Willow

Salicaceae
H: 30' W: 30'
Type: Tree

Butterflies That Use Host





Habitat: Wet prairie, woodland streams banks, open upland forest streams, riparian forest corridors
Design Uses: Moist meadows and stream or edges of ponds. Excellent plant for erosion control along banks. Forms thickets and can be used as shelter of windbreaks.

Amelanchier alnifolia
Western Serviceberry

Rosaceae
H: 35' W: 20'
Type: Small Tree

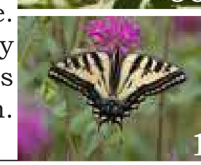
Butterflies That Use Host

Habitat: Upland prairie, wet prairie, woodland, upland forest stream edges, riparian forest
Design Uses: Plants Form dense thickets. Use for pollinating insects, berries for birds. Mass planting for hedgerows, windbreaks, used as butterfly perches along trails.

Populus trichocarpa
Black Cottonwood

Salicaceae
H: 180' W: 50'
Type: Tree

Butterflies That Use Host



Habitat: Wet prairie, riparian forest corridors
Design Uses: Trees are large and fast growing and can be brittle. Plant trees far from human activity or buildings as trees can fall. Use as a riparian stream buffer for erosion. Use as a backdrop and windbreak.

Fraxinus latifolia
Oregon Ash

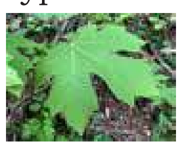
Oleaceae
H: 75' W: 50'
Type: Tree

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest streams, riparian forest
Design Uses: Moist meadows and inundation zones, tolerant of heavy clay and standing water. Trees can be used to form dense woodlands along wet prairie habitats.

Acer macrophyllum
Bigleaf Maple

Aceraceae
H: 90' W: 75'
Type: Tree



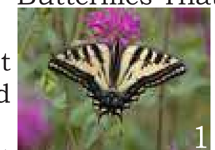
Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forest
Design Uses: A large spreading tree if planted singly with space, but also can form dense woodland stands. Serves as shelter and shade during hot weather. Seeds provide food for animals.

Acer circinatum
Vine Maple

Aceraceae
H: 15' W: 15'
Type: Small Tree

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest
Design Uses: Occurs in most conditions. Can be used as a thicket of small trees to line a forest trail. Excellent for the California Sister to use as a perch.

Arbutus menziesii
Pacific Madrone

Ericaceae
H: 60' W: 30'
Type: Tree

Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forest
Design Uses: Intolerant of summer irrigation. Use in dry bed designs and as part of the woodland community. Specimens should be planted near trails as the peeling bark is irresistible to touch.

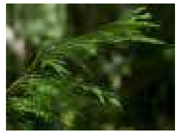
Calocedrus decurrens

Incense Cedar

Cupressaceae

H: 90’ W: 30’

Type: Tree



Butterflies That Use Host

Habitat: Savanna, woodland, upland forest

Design Uses: Performs well in dry conditions and can be used alongside the Pacific madrone and vine maples. Use as an evergreen backdrop to frame the garden meadow or create a windbreak.

Pinus ponderosa

Ponderosa Pine

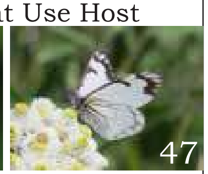
Pinaceae

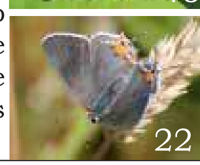
H: 200’ W: 30’

Type: Tree

Butterflies That Use Host

Sandra Koski





Habitat: Upland prairie, savanna woodland, open upland forest

Design Uses: Anchors the garden in both size and form. Plant next to trails as the bark has a puzzle appearance. Deep fissures in the bark provide overwintering homes for the California Tortoiseshell.

Thuja plicata

Western Redcedar

Cupressaceae

H: 180’ W: 60’

Type: Tree

Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forest

Design Uses: Requires moist soil unlike the Incense Cedar. Use as a backdrop for Pacific Dogwood. Use as an evergreen screen to protect garden from winter winds as tree retain thick lower branches.

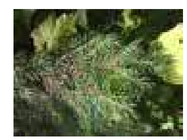
Pseudotsuga menziesii

Douglas Fir

Pinaceae

H: 200’ W: 50’

Type: Tree



Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forest but if left unchecked will grow into savanna and prairie

Design Uses: Use as an evergreen backdrop to create rooms within the garden. Can be combined with madrone and dogwoods and vine maples.

Tsuga heterophylla

Western Hemlock

Pinaceae

H: 200’ W: 40’

Type: Tree

Butterflies That Use Host

Habitat: Upland forest, riparian forest

Design Uses: Moist soils are preferred. Use as an evergreen screen or windbreak. The thick green vegetation creates a backdrop for shrubs and flowering plants, combine with dogwoods.

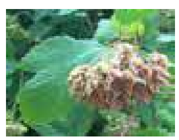
Physocarpus capitatus

Pacific Ninebark

Rosaceae

H: 10’ W: 10’

Type: Shrubs



Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forest where water accumulates

Design Uses: Use as a wetland shrub along streams or bogs. Plant in massings to create a thicket for shelter. Although it prefers moist soil, it is quite drought tolerant.

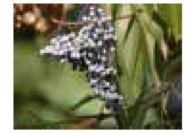
Sambucus caerulea

Blue Elderberry

Caprifoliaceae

H: 12’ W: 12’

Type: Shrub



Butterflies That Use Host

Habitat: Upland forest clearings, open woodland, riparian corridors

Design Uses: Can be found in very dry areas. Use with arid landscape plantings along side Ponderosa Pine, Incense cedar and Madrone. Plant near trails for children to see the blue berry clusters.

Spiraea douglasii

Western Spirea

Rosaceae

H: 3’ W: spreads

Type: Shrub

Butterflies That Use Host

Habitat: Wet prairie, woodland clearings along streams, riparian forest streambanks

Design Uses: Moist meadows and bogs. Plant in massing, spirea forms a low growing thicket. Plant near trails so children can watch the Echo Blues fly atop the shrubs.

Photo 3.10

Ceanothus velutinus

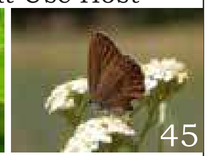
Mountain Balm Lilac

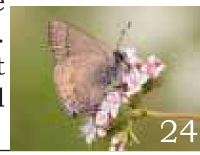
Rhamnaceae

H: 6’ W: 6’

Type: Perennial

Butterflies That Use Host





Habitat: Upland prairie, savanna, woodland, open upland forest

Design Uses: Plant in massings on slopes for soil stabilization. The massings form a continuous patch. Sculpt trails through the thicket with ponderosa pine, madrone and blue elderberry.

Photo 3.11

Ceanothus integerrimus

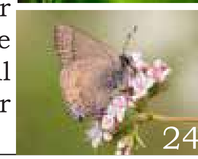
Deerbrush

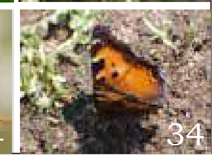
Rhamnaceae

H: 12’ W: 12’

Type: Shrub

Butterflies That Use Host





Habitat: Open woodland, upland forest clearings

Design Uses: Use on slopes for stabilization. Set against conifer stands to accentuate their white flowers. Use singly or is small massings. Use as wind shelter or cover from rain.

Holodiscus discolor

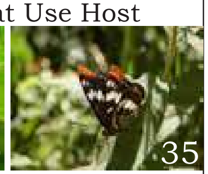
Oceanspray

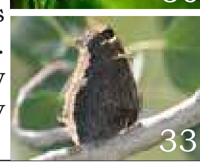
Rosaceae

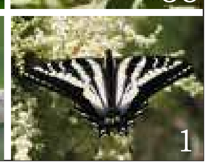
H: 15-20’ W: 15’

Type: Shrub

Butterflies That Use Host







Habitat: Upland prairie, savanna, woodland, upland forest

Design Uses: Very drought tolerant growing in cutbanks of hillsides and disturbed areas. Use on slopes. Give the plant enough room to allow the pendulus blossoms to freely hang.

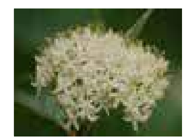
Cornus sericea

Red Twig Dogwood

Cornaceae

H: 10-15’ W: spreads

Type: Shrubs



Butterflies That Use Host

Habitat: Wet prairie, moist woodland, upland forest, riparian forest

Design Uses: Moist meadows, bogs and streambanks. Swales and low areas where water collects during the wet months. Red stems become even more vibrant as weather cools.

Rosa nutkana

Nootka Rose

Rosaceae

H: 3-6'   W: spreads

Type: Shrub

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest

Design Uses: Moist meadows and forest clearings. Highly scented, plant near where people gather but far enough from trails because of the thorns they produce.

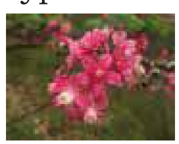
Ribes sanguineum

Red-Flowering Currant

Grossulariaceae

H: 8-10'   W: 10'

Type: Shrub



Butterflies That Use Host

Habitat: Upland prairie, savanna, woodland, open upland forest

Design Uses: Plant on forest edges where prairie meets woodlands. Plant singly or in groups of three where people gather. Use as an intermediate vegetation layer between grasses and trees.

Symphoricarpos albus

Common Snowberry

Caprifoliaceae

H: 3-4'   W: spreads

Type: Shrub

Butterflies That Use Host

Habitat: Savanna, woodland, upland forest, riparian forest

Design Uses: Best in massings, as shrubs form a low thicket. Plant massings on the edges of forest clearings for butterflies. Birds eat the fruit, but are toxic to humans.

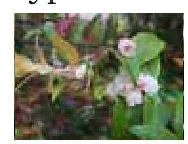
Vaccinium ovatum

Evergreen Huckleberry

Ericaceae

H: 3-15'   W: 3-15'

Type: Shrub



Butterflies That Use Host

Habitat: Moist woodlands, upland forest, riparian forest

Design Uses: Useful in both open sunny locations where it stays under 5 feet tall, or within shady woodlands where it reaches to 15 feet tall. Fruit is edible to humans.

Lotus unifoliolatus

Spanish Clover

Fabaceae

H: 6-18” W: 6-18”

Type: Annual forb

Died-own in the late

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest clearings

Design Uses: Moist meadows. Place seed along pathways where short vegetation is likely to prevail. Place hostplant were people can see butterflies visiting the plant.

Photo 3.12

Lotus crassifolius

Big Deervetch

Fabaceae

H: 1-4’ W: 1-4’

Type: Perennial forb

Died-own in the late fall

Butterflies That Use Host

Habitat: Moist woodland, upland forest, riparian forest

Design Uses: Plant in clearings along mixed forest edges where soils are likely to retain or receive moisture. Use at the base of established oaks, along streambanks or pathways to observe feeding larvae.

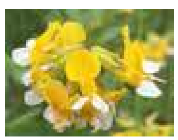
Lotus pinnatus

Meadow birdsfoot trefoil

Fabaceae

H: 8-18” W: 8-18”

Type: Perennial



Die-down in summer

Butterflies That Use Host

Habitat: Wet prairie, wet meadow within woodlands, upland forest,

Design Uses: Moist meadows. Dry the summer. Best placed away from trails and areas where camas, allium, and annual yellow monkeyflowers thrive in vernal areas.

Photo 3.13

Trifolium willdenowii

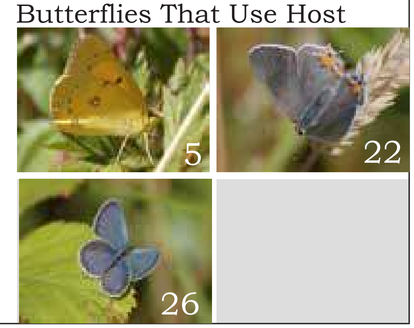
Springbank Clover

Fabaceae

H: 6-12” W: spreads

Type: Perennial

Butterflies That Use Host

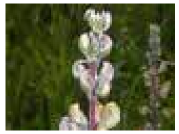


Habitat: Wet prairie and vernal pools

Design Uses: Moist meadows in areas where water collects during the cooler months. Combine this clover with monkeyflower, tufted hairgrass, camas, onion, Spanish clover and low growing plants.

Lupinus sulphureus
Kincaid's Lupine

Fabaceae
H: 15-30" W: 15-30"
Type: Perennial



Die-down in the fall

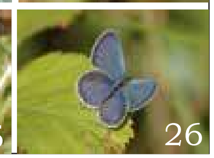
Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna
Design Uses: Plant lupines patches alongside mule's ears and checkermallows and with low growing fescue grasses in areas where some moisture remains in the soil.

Lupinus rivularis
Riverbank Lupine

Fabaceae
H: 3' W: 3'
Type: Perennial

Butterflies That Use Host



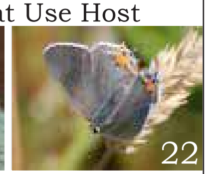
Habitat: Riparian forest streambanks where flooding is prone
Design Uses: Gravely soil and distributed areas along stream systems. This lupine can be set in front of willows and be combined with bright yellow tarweeds.

Lupinus polyphyllus
Bigleaf Lupine

Fabaceae
H: 1-2' W: 1-2'
Type: Perennial

Die-down in the fall

Butterflies That Use Host



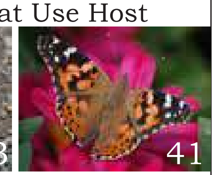
Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest
Design Uses: Moist meadows, but drought resistant. Create open landscape rooms with oaks and conifers. Combine with mule's ears to contrast blue.

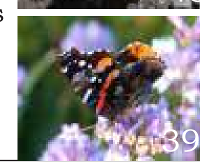
Urtica dioica
Stinging Nettle

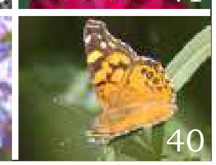
Urticaceae
H: 3-9' W: 3-9'
Type: Perennial

Die-down in winter

Butterflies That Use Host







Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest
Design Uses: Vital to butterflies as a hostplant, stinging nettle causes skin rashes. Place plant in remote areas of the garden where people do not come in contact with the

Asclepias speciosa
Showy Milkweed

Asclepiadaceae
H: 2-4’ W: 2-4’
Type: Perennial

Die-down in the fall

Butterflies That Use Host

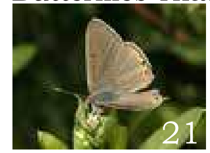
Habitat: Upland prairie, wet prairie, savanna, woodland
Design Uses: Moist meadows and open clearings within woodlands. Plant milkweed along with high nectar producing companion plants to form a Monarch waystation.

Rumex salicifolius
Willow-leaf Dock

Polygonaceae
H: 1-3’ W: 1-3’
Type: Perennial

Die-down in the fall

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, riparian stream banks
Design Uses: Moist meadows. Plant dock in massings to increase the likelihood of butterflies finding them. Plant Valley Gumweed alongside for nectar source.

Photo 3.14

Asclepias fascicularis
Narrowleaf Milkweed

Asclepiadaceae
H: 2-4’ W: 2-4’
Type: Perennial

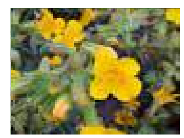
Die-down in the fall

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland
Design Uses: Moist meadows and open clearings within woodlands. Plant milkweed along with high nectar producing companion plants to form a Monarch waystation.

Mimulus guttatus
Seep Monkey Flower

Phrymaceae
H: 6”-3’ W: 6”-18”
Type: Annual



Die-down in summer

Butterflies That Use Host

Habitat: Wet prairie, riparian open spaces
Design Uses: Moist meadows. Use as an early season annual alongside camas, onion, and other annuals within swales or stream sides.

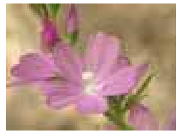
Sidalcea virgata

Rose Checkermallow

Malvaceae

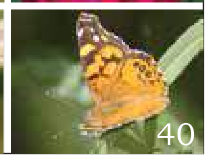
H: 1-2’ W: 1-2’

Type: Perennial



Die-down in the fall

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, woodland
Design Uses: Moist meadows, along side other prairie species such as camas, mule’s ears and lupine and low growing grasses. Plant in mass for visual strength and for butterflies to find.

Sidalcea cusickii

Cusick’s checkermallow

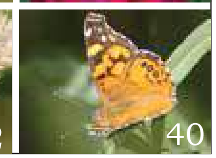
Malvaceae

H: 2-5’ W: 2-5’

Type: Perennial

Die-down in the fall

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, woodland clear-ings
Design Uses: Use tall grasses to accompany this tallest of the checkermallows, mule’s ears and lupine. Plant in mass for visual strength and for butterflies to find.

Photo 3.15

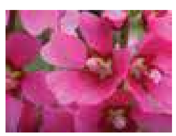
Sidalcea hendersonii

Henderson’s Checkermallow

Malvaceae

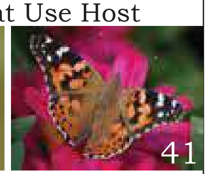
H: 1-3’ W: 1-3’

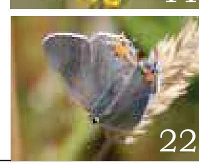
Type: Perennial

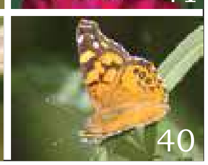


Die-down in the fall

Butterflies That Use Host







Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest
Design Uses: Moist meadows, along side other prairie such as camas, mule’s ears and lupine. Plant in mass for visual strength and for butterflies to find.

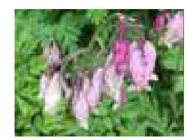
Dicentra formosa

Western Bleedingheart

Papaveraceae

H: 1’ W: 2-3’

Type: Perennial



Die-down in the fall

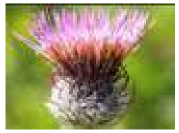
Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forests.
Design Uses: Moist woodland areas. Plant plants in massings along trails and beneath trees. Planting in mass gives the space a soft cool green texture. To add additional color add columbines.

Photo 3.16

Cirsium brevistylum
Cluster Thistle

Asteraceae
H: 2-7' W: 2'
Type: Biennial



Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland
Design Uses: Moist meadows and open clearings within woodlands with taller grass species work well with this tall thistle.

Anaphalis margaritacea
Pearly everlasting

Asteraceae
H: 1-3' W: 1-2'
Type: Perennial

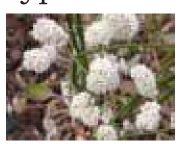
Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest
Design Uses: These plant perform well in garden beds and in areas that resemble rocky slopes. Combine pearly everlasting with wooly sunflower, fleabanes and grasses.

Photo 3.17

Eriogonum nudum
Barestem Buckwheat

Polygonaceae
H: 1-5' W: 3'
Type: Perennial

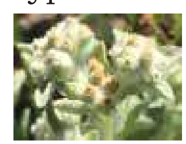


Butterflies That Use Host

Habitat: Upland prairie, savanna, open forest clearings
Design Uses: Dry rock areas such as slopes and open fields. Rock gardens mixed with stones, wooly sunflower, pearly everlasting, and fescue grasses mimic a more natural design.

Gnaphalium palustre
Lowland Cudweed

Asteraceae
H:1-12" W: 1-12"
Type: Perennial



Butterflies That Use Host

Habitat: Wet prairie
Design Uses: Moist meadows especially in low lying vernal swales

Plantago lanceolata
Lanceleaf Plantain
Plantaginaceae
H: 6”-2’ W: 6”-12”
Type: Biennial

Die-down in the fall

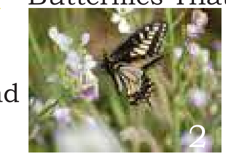
Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest
Design Uses: Moist meadows and open clearings within woodlands. Drought resistant. Spread seeds over any flat surface in direct sun, they will join the prairie palette.

Heracleum lanatum
Cow Parsnip
Apiaceae
H: 3-10’ W: 3-8’
Type: Perennial

Die-down in summer

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest
Design Uses: Moist meadows to riparian forest, streambank. Use as large backdrop to a forest edge or stream design. Plants die down in the summer, leaving a void space.

Lomatium dissectum
Fernleaf Biscuitroot
Apiaceae
H: 2-5’ W: 2-5’
Type: Perennial

Die-down in the fall

Butterflies That Use Host

Habitat: Upland prairie, savanna, woodland, upland forest
Design Uses: Use lomatium in dryer areas of the design, with well drained or even rocky soil. Companion plants could be barestem buckwheat, wooly sunflower, fescue grasses, or fleabanes.

Garden Crucifers
Brassicaceae
H: NA W: NA
Type: Perennial/Annual

Butterflies That Use Host

Habitat: Garden and flower beds
Design Uses: Success for the attraction of the cabbage white butterfly is easy. Plant a vegetable garden and grow any number of plants from the mustard family including cabbage, mustard, kale, broccoli, and nasturtiums

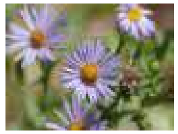
Aster subspicatum

Douglas Aster

Asteraceae

H: 2-4’ W: 2-4’

Type: Perennial



Die-down in the fall

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest

Design Uses: The Aggressive Douglas Aster works well with planting them in tall prairie grasses. In planting beds, the aster can overwhelm other plants.

Viola glabella

Stream Violet

Violaceae

H: 1-12” W: spreads

Type: Perennial

Die-down in the fall

Butterflies That Use Host

Habitat: Woodland, upland forest, riparian forest

Design Uses: Moist meadows and slopes. Excellent groundcover for forest beds, along trails, in clearings and slopes. Plant with columbine, ferns, bleedingheart and native coralbells.

Symphyotrichum chilense

Pacific Aster

Asteraceae

H: 1-3’ W: 1-3’

Type: Perennial

Die-down in the fall

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna

Design Uses: Moist meadows. Plant in seasonally wet meadows along with tall grasses, goldenrod, mule’s ears, lupines, and checkermallows. Plant plants evenly throughout the meadow.

Photo 3.18

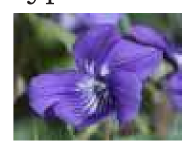
Viola adunca

Early Blue Violet

Violaceae

H: 4” W: spreads

Type: Perennial



Die-down in the fall

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest

Design Uses: Moist meadows. Plant along pathways, clearings in forested areas, use as a substitute for a lawn or between stepping stones

Cardamine breweri

Brewer's Bittercress

Brassicaceae

H: 6"-2' W: 6"-2'

Type: Perennial

Die-down in the fall

Butterflies That Use Host

Habitat: Wet prairie, upland forest streams, bogs and springs.

Design Uses: Moist meadows and forest openings where fresh water is constantly provided. This design should incorporate an existing spring or stream on the property. Simulation of a pond may work.

Nastutium officinale

White Watercress

Brassicaceae

H: 6"-18" W: spreads

Type: Perennial

Butterflies That Use Host

Habitat: Wet prairie, upland forest waterways, riparian forest waterways, bogs, springs

Design Uses: Moist meadows. Use this nonnative in place of the Brewer's Bittercress if no plants can be found. Use in wet soil to pond environments in woodlands.

Photo 3.19

Carex tumulicola

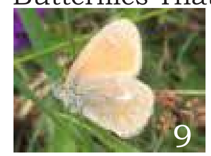
Foothill Sedge

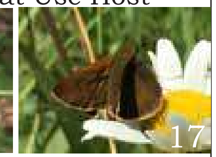
Cupraceae

H: 1-2' W: 2-3'

Type: Perennial

Butterflies That Use Host





Habitat: Wet prairie, wet areas in savanna, wet woodland clearings

Design Uses: Moist meadows. Use in combination with camas, mule's ears, checkermallows and rush. Evergreen anchors the prairie design. Can be a lawn substitute.

Photo 3.20

Carex densa

Dense Sedge

Cupraceae

H: 18-30" W: 18-30"

Type: Perennial

Butterflies That Use Host

Habitat: Wet prairie, streams and sloughs that run through woodlands, and wet areas in forest clearings

Design Uses: Moist meadows, vernal wet areas, streams. Use in combination with tall grasses, taller perennials such as lupine.

Festuca roemeri

Roemer's Fescue

Poaceae

H: 1-5'   W: 2'

Type: Perennial

Cool season grass

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland

Design Uses: Upland prairie design. Plant in massing to create this shorter grass prairie. Combine with Kincaid's lupine, checkermallow. Lawn substitute, mowing only two times per growing season.

Photo 3.22

Festuca californica

California Fescue

Poaceae

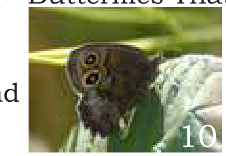
H: 2-5'   W: 2'

Type: Perennial

Garden Coach Photos

Cool season grass

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest

Design Uses: Moist meadows to dry meadows. Especially well suited for shady areas where it succeeds better than other bunch grasses in shade. Use under trees.

Photo 3.21

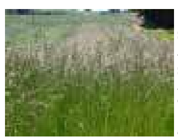
Festuca rubra

Red Fescue

Poaceae

H: 12-40"   W: 18"

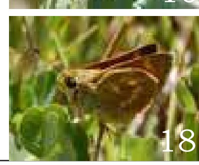
Type: Perennial

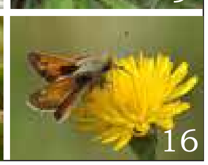


SevenOaks Native Nursery

Cool season grass

Butterflies That Use Host





Habitat: Grows in most habitats as both a turf grass and in natural settings.

Design Uses: Moist meadows to drought resistant. Very tolerant of foot traffic, thus use as a lawn turf grass with occasional to frequent mowing. Infrequent mowing is best

Photo 3.23

Bromus sitchensis

Alaska Brome

Poaceae

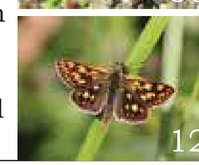
H: 2-5'   W: 2'

Type: Perennial

Heritage Seedlings

Warm season grass

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest

Design Uses: Moist meadows, with drought resistance. Use in forest clearing and meadow designs in sunny locations. Combine with tall perennial flowers such as lupines.

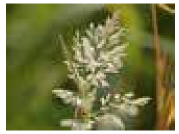
Poa pratensis

Kentucky Bluegrass

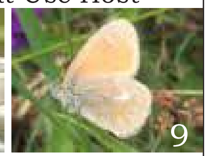
Poaceae

H: 4”-15” W: spreads

Type: Perennial



Butterflies That Use Host



Habitat: Wet prairie, woodland, upland forest, riparian forest
Design Uses: Moist meadows and open clearings within woodlands. Highly used as a turf grass, responds well to weekly mowing. Left unmowed, massing will form a physical and visual softness.

Photo 3.25

Danthonia spicata

Poverty Oatgrass

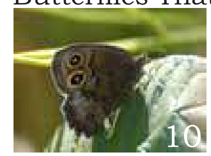
Poaceae

H: 1-2’ W: 1’

Type: Perennial

Cool season grass

Butterflies That Use Host



Habitat: Upland prairie, savanna, woodland, upland forest clearings
Design Uses: Dry meadows. It can be used as a turf grass and only needs an annual mowing in the late winter before new foliage emerges. Excellent short-grass prairie design.

Photo 3.24

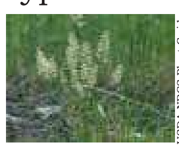
Poa secunda

Pine Bluegrass

Poaceae

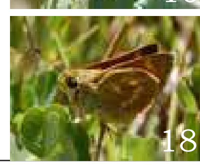
H: 12-24” W: 12”

Type: Perennial



USDA NRCS Plant Guide

Butterflies That Use Host



Habitat: Upland prairie, wet prairie, savanna, woodland
Design Uses: Moist meadows though drought tolerant. Use as cool-season short-grass prairie. Combine with Roemer’s fescue, as the two should be comapatable, occupying different niches.

Photo 3.26

Danthonia californica

California Oatgrass

Poaceae

H: 1-3’ W: 18”

Type: Perennial

Cool season grass

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland
Design Uses: Moist meadows and recommended for clay soils where drainage is slow to sandy well drained soils. Responds well to foot traffic and can be used as a native turf grass with infrequent mowing.

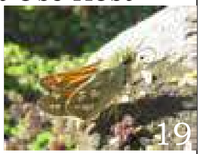
Photo 3.27

Achnatherum lemmonii
Lemmon's Needlegrass

Poaceae
H: 3' W: 18"
Type: Perennial

Cool season grass

Butterflies That Use Host



Habitat: Upland prairie, savanna, dry woodlands
Design Uses: Slow growing but long lived, Thus plant alongside other grasses that act as companion plants until the grass establishes. Design for dry savanna and prairie. Fire adapted, thus annual

Photo 3.28

Elymus glaucus
Blue Wildrye

Poaceae
H: 5' W: 18"
Type: Perennial

Cool season grass

Butterflies That Use Host

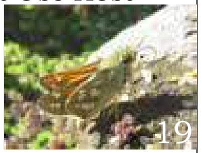
Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest clearings
Design Uses: Moist meadows to dry savanna. Use in swales to oak woodland designs. Large seed production brings in foraging birds and mammals increasing diversity.

Deschampsia cespitosa
Tufted Hairgrass

Poaceae
H: 15"-5' W: 2'
Type: Perennial

Cool season grass

Butterflies That Use Host



Habitat: Wet prairie
Design Uses: Moist meadows, bogs and swales. Use tufted hairgrass in areas where water collects, ditches, vernal pools and bioswales. An extremely attractive landscape plant can be used in both formal and informal plantings.

Photo 3.29

Elymus trachycaulus
Slender Wheatgrass

Poaceae
H: 2' W: 2'
Type: Perennial

Cool season grass

Butterflies That Use Host

Habitat: Upland prairie, wet prairie, savanna, woodland
Design Uses: Moist meadows but drought tolerant. A short lived grass, it can act as a quick start to creating a prairie habitats while other slower grasses like Lemmon's Needlegrass establish.

3.5 Selecting the Nectar Sources

So far I have taken you through the first three steps of phase one, the building the butterfly habitat garden palette. Step one was determining the correct habitat garden theme. Step two was determining which butterfly species will likely use the habitat garden. Step three was choosing the correct hostplants that will encourage and sustain the butterflies' larval development. Now we come to the final step in developing a butterfly habitat garden, step four, selecting the nectar sources for the adult butterfly.

I would argue that the planting of flowers has historically been the primary focus of most butterfly garden efforts. Justifiably so, flowers are a spectacular addition to any garden space and they in fact do bring to the garden colorful and beautiful butterflies. But it is vital to understand that the consideration of flowering plants, that elicit the attention of adult butterflies, must be seen as a step within a larger process, and a step that needs careful design consideration to effectively meet the needs of adult butterflies.

For most adult butterflies, the flower is the primary food source for sustaining energy levels to achieve its primary activities. Providing high quality nectar sources that will attract and sustain butterflies throughout the various seasons of the butterfly flight period warrants careful planning.

Choosing Flower Species

One of the very first design decisions for choosing nectar plants for your butterfly habitat garden should be based on will these plants grow well in the given habitat garden. Within this guidebook, the nectar source to habitat quickguide provides a fast and easy way to formulate a list of high quality nectaring plants based on the habitat that your garden will represent.

The flowering plants that form the quickguide represent locally or regionally native plant species which have been shown to attract butterflies within the state of Oregon.

Once the designer has generated a list of potential flowering plant species from the quickguide, the next step is to access the color plates to gain detailed information on the selected plants bloom times, cultural needs, flower color, growth habits and more. These color plates are designed to help group and arrange plants both spatially and structurally within the garden space and address temporal design decisions which match specific butterfly species flight times with flowering plants bloom season. The flowering species provided within the quickguide and color plates only represent a fraction of the total options of flowering species that could or should be used for generating a successful butterfly garden nectar source palette. The more flowering plants added to a butterfly habitat garden space, the more likely the garden will used by local butterfly species. Gardens that have planted twenty or more flowering plant species within the space have demonstrated increased butterfly diversity and use (Mauro 2007). Experimenting and researching which plants will provide for the most successful outcome for butterflies within the garden, is a primary goal.

Because of the complex pollination relationships that have formed between native flowering plants and local butterflies, the primary goal for the provision of nectar should be derived from native flowering plant sources (Bergerot 2009). However, butterflies have shown to benefit from exotic flowering plant species and commercially grown flowering cultivars. This benefit of adding exotic flowering species to a garden increases in areas with a high degree of urbanization and where native plant communities have been replaced by exotic plant palettes (Shapiro 2002). Adding exotic flowering plants to a designed butterfly habitat garden may see increased benefits to local butterfly populations.

Native Flowers vs Exotic Flowers

"Native plants have formed symbiotic relationships with native wildlife over thousands of years, and therefore offer the most sustainable habitat. A plant is considered native if it has occurred naturally in a particular region, ecosystem, or habitat without human introduction."

"Exotic plants that evolved in other parts of the world or were cultivated by humans into forms that don't exist in nature do not support wildlife as well as native plants."

-National Wildlife Federation

Most exotic flowers will never become an ecological competitor with native vegetation. However, some exotic flowering species can become invasive and out compete native vegetation, disrupting ecosystems. The images below represent of a group of invasive flowering plants in Oregon.


Blackberry


Butterfly Bush


Queen Anne's Lace


Teasel


Pennyroyal


Canada Thistle

Butterflies benefit from native flowers that drive the food reward/pollination relationships. Butterfly gardens have also benefited from the addition of carefully selected cultivated exotic flower plants to extend the bloom season when native flowers begin to fade from productive nectaries. Careful selection and thus incorporation of exotic flower species can make a positive impact on native butterflies. The following is a small sample of some proven productive nectar sources that will serve butterfly needs, without perturbing the native ecosystem within Oregon's wild lands.


Echinacea


English Lavender


Tall Verbena


Zinnia

The butterfly quickguide and butterfly color plates help guide the designer through the creating of a flowering plant palette to serve the needs of local butterflies throughout the adult butterfly flight season. The flower species provided within this guidebook, introduce the reader to some of the more productive native flowering species, but is not intended to be a comprehensive list. As always, experiment and see what works, as each garden will contain unique characteristics that affect garden success.

Plate Numbers(N)		Upland Forest	Riparian Forest	Woodland	Savanna	Upland Prairie	Wet Prairie	Cultivated Beds
1	Common Madia			■	■	■	■	
2	Mule's Ears			■	■	■	■	
3	Douglas Aster	■	■	■	■	■	■	■
4	Western Goldenrod		■	■	■	■	■	■
5	Yarrow	■	■	■	■	■	■	■
6	Valley Gumweed				■	■	■	■
7	Pearly Everlasting	■		■	■	■	■	■
8	Wooly Sunflower			■	■	■	■	■
9	Indian Hemp				■	■	■	■
10	Showy Milkweed			■	■	■	■	■
11	Oregon Geranium	■	■	■	■	■	■	■
12	Narrowleaf Milkweed			■	■	■	■	■
13	Bigleaf Lupine	■	■	■	■	■	■	■
14	Riverbank Lupine		■					
15	Woods Strawberry	■	■	■	■	■	■	■
16	Rosy Plectritis				■	■	■	
17	Lanceleaf Selfheal	■	■	■	■	■	■	■
18	Rosy Checkermallow			■	■	■	■	■
19	Bluehead Gilia			■	■	■	■	■
20	Cusick's Checkermallow			■	■	■	■	■
21	Hall's Aster			■	■	■	■	■
22	Fernleaf Biscuitroot			■	■	■		
23	Camas					■	■	■
24	Tiger Lily	■	■	■	■	■	■	■
25	Lewis's Mockorange	■	■	■	■	■	■	■
26	Nootka Rose	■	■	■	■	■	■	■
27	Blue Elderberry	■	■	■				■
28	Oceanspray	■		■	■	■		■
29	California Poppy			■	■	■		■
30	Red Columbine	■		■	■	■		■
31	Slender Cinquefoil		■	■	■	■	■	
32	Congested Snake Lily			■	■	■		
33	Willamette Daisy					■	■	■
34	Crown Brodiaea				■	■	■	
35	Deltoid Balsamroot			■	■	■	■	■
36	Sneezeweed						■	■
37	Giant Blue-Eyed Mary	■	■	■	■	■		■
38	Pacific Bleeding Heart	■	■	■				■
39	Lovage	■	■	■			■	
40	Showy Fleabane				■	■		■
41	Oregon Iris	■	■	■	■	■	■	■
42	Clustered Thistle			■	■	■	■	
43	Spreading Dogbane			■	■	■		
44	Hall's lomatium			■	■	■		
45	Oregon Saxifrage						■	
46	Fragrant Popcorn Flower						■	
47	Seep Monkeyflower		■				■	

Much like the butterfly to habitat and the hostplant to habitat quickguides, the native nectar source to habitat quickguide is a chart designed to help the reader identify what native flowering plants match up well to the proposed habitat garden themes.

Many of the flowering plant species on this chart can be found across a multitude of habitats, thus they are very versatile for design use. However, some plants, like the Riverbank Lupine will be limited to habitats where water has shaped the habitat and deep gravely soils predominate.

The quickguide is designed to give the designer a fast plant palette to chose from. Accessing the native nectar source color plates is the next step. The color plates have detailed information concerning cultural needs of the plants, bloom time, height and width, plant communities that these plants grow well with and more.

Because we are designing for butterfly habitat gardens, and not intensive restoration programming, there should be a fair amount of creativity and experimentation in choosing plant palettes for the garden. The advantage to the quickguide is to give the designer a fast and easy to reference starting point for forming these plant palettes.

Though the quickguide only addresses native flowering species, and the color plates only provide information concerning these native flowers, I do support and advocate for the use of exotic flowering plant species that have proven themselves a valuable nectar resource for native butterflies when native flowering species begin to fall out of season and nectar sources begin to deplete. A list of preferred exotic nectaring plants has been provided at the back of the color plate section.

Water requirement icons that convey the degree of moisture that the plant requires for optimal growth. Factors such as soils and micro-climate will effect overall water require-

Moist to Wet: Thrives in areas that are seasonable wet or soil moisture remains high. In gardening terms, the plant thrives in soils that do not dry.

Average Moisture: Thrives in areas that are seasonable wet or moist, but tolerates seasonal drying. In gardening terms, water deeply once per week.

Dry Conditions: Thrives in areas that are seasonable wet or moist, but needs seasonal drying. In gardening terms, water deeply only on occasion, or none once established.

Full Shade: Plant survives or thrives in 3 hours of sun per day.

Partial Shade: The plant requires or tolerates less than 6 hours of sun per day.

Full Sun: Plant requires 6 or more hours of direct sunlight per day.

General light exposure requirements for optimal health.

Most commonly occurring in these areas, however, species may be found in other areas.

- Upland Forest
- Riparian Forest
- Woodland
- Savanna
- Upland Prairie
- Wet Prairie
- Cultivated Beds

Note: See habitat section for details.

Image of a typical representation of a mature plant demonstrating its growth habits and prominent features.

Asclepias speciosa

Showy milkweed

Asclepiadaceae

H: 2-4’ W: 2-4’

Type: Perennial

6

Culture: Plants spreading. Plant in massings. Plant with tall grasses, goldenrod, yarrow.

Habitat: Prairie systems, savannas, open woodlands, fields, farmlands, streambanks and cultivated beds.

Notes: Many species of butterflies nectar at milkweed

Growing Conditions: Moist well drained gravely soil, drought resistant although will take average watering.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Nectar Source plate number for easy referencing with the quickguides and throughout the

Details on the habitat that the plant occurs naturally.

Butterfly interactions.

Soils and water preferences.

Scientific name

Common name

Plant Family.

Maximum growth size

Numeric ranking of flower preferencing by butterflies based on the top 50 nectar native flowering plants. A 6 representing the highest use and 1 showing the least

6 5 4 3 2 1

Plant community and growth habits

Bloom period.

Madia elegans

Showy Tarweed

Asteraceae

H: 1-3’ W: 1-2’

Type: Annual

2

Culture: Self sows, competes well with short grasses, other annuals, perennials, and bulbs.

Habitat: Upland prairie, wet prairie, savanna, woodland mostly in clearings but will spread into edge of woodlands.
Notes: Highly fragrant, Flowers close by mid-day.
Growing Conditions: Grows in well drained soils, but also clay tolerant. Drought tolerant, deer resistant.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Aster subspicatum

Douglas aster

Asteraceae

H: 2-4’ W: 2-4’

Type: Perennial

6

Culture: Aggressive and spreading. Plant with tall grasses, goldenrod, yarrow, and other asters.

Habitat: Upland prairie, wet prairie, savanna, woodlands, upland forest clearings, riparian edges
Notes: Flowers when many other natives are finished.
Growing Conditions: Moist well drained soils, but drought resistant, competes well with grasses.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Wyethia angustifolia

Mule’s ears

Asteraceae

H: 3’ W: 3’

Type: Perennial

3

Culture: Compatible with tall grasses, camas, checkermallows in areas of wet then dry soils.

Habitat: Upland prairie, wet prairie, savanna in wet soils where water remains close to the surface.
Notes: Seed heads remain on plant through fall.
Growing Conditions: Moist meadows, found in moist areas but is seasonally drought resistant.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Solidago lepida

Western goldenrod

Asteraceae

H: 2-5’ W: 2-5’

Type: Perennial

6

Culture: Compatible with tall grasses, and other aggressive plants such as asters, yarrow.

Habitat: Upland prairie, savanna, woodland clearings, riparian corridors
Notes: Plant in massings to attract pollinators.
Growing Conditions: Well drained soils, drought resistant but performs well with average water.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Achillea millefolium

Yarrow

Asteraceae

H: 1-3’ W: 1-2’

Type: Perennial

3

Culture: Aggressive and spreading. Plant with both short & tall grasses, goldenrod, and asters.

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forests and riparian corridors and cultivated beds

Notes: Foliage has a pleasant aroma

Growing Conditions: Grows well in all soils from wet to dry soils in open meadows and fields.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Anaphalis margaritacea

Pearly everlasting

Asteraceae

H: 1-3’ W: 1-2’

Type: Perennial

6

Culture: Aggressive and spreading. Plant with tall grasses, goldenrod, yarrow and other asters.

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest clearings, riparian forest clearings and cultivated beds

Notes: Plant has a musky fragrance

Growing Conditions: Well drained stony soils, drought resistant and tolerant of clay soil

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Grindella intergrifolia

Gumweed

Asteraceae

H: 1-3’ W: 1-3’

Type: Perennial

2

Culture: Establishes well from seed and requires little care.

Habitat: Upland prairie, wet prairie and cultivated beds. It is often found growing in wetlands, pastures, ditches

Notes: Favored nectar source for the Great Copper.

Growing Conditions: Moist meadows, to dry rock uplands and even salt marshes.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Eriophyllum lanatum

Wooly Sunflower

Asteraceae

H: 1-2’ W: 1-2’

Type: Perennial

3

Culture: Establishes well from seeds but sold as container stock in nurseries.

Habitat: Upland prairie, savanna, woodland, upland forest clearings, and cultivated beds, rocky areas, open fields.

Notes: Nectar source of the Fender’s Blue Butterfly

Growing Conditions: Well drained soils, drought resistant usually found in dry open rock soils and especially slopes.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Apocynum cannabinum
Indian Hemp

Apocynaceae
H: 2-4’ W: 2-4’
Type: Perennial

4

Culture: Aggressive and spreading. Plant with tall grasses, goldenrod, yarrow and other asters.

Habitat: Upland prairie, wet prairie, savanna, woodland and cultivated beds
Notes: Nectar source of the Common Nymph.
Growing Conditions: Grows best in moist soils in open wetland and upland prairie.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Asclepias speciosa
Showy milkweed

Asclepiadaceae
H: 2-4’ W: 2-4’
Type: Perennial

6

Culture: Plants spreading. Plant in massings. Plant with tall grasses, goldenrod, yarrow.

Habitat: Upland prairie, wet prairie, savanna, open woodlands, streambanks and cultivated beds
Notes: Many species of butterflies nectar at milkweed
Growing Conditions: Moist well drained gravely soil, drought resistant although will take average watering.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Geranium oreganum
Oregon Geranium

Asteraceae
H: 1-2’ W: 1-2’
Type: Perennial

4

Culture: Spreading. Plant with short grasses, mule’s ears, or columbine in wooded gardens.

Habitat: Upland prairie, wet prairie, savanna, open woodland, upland forest clearings and cultivated beds
Notes: Nectar source for spring flying butterflies.
Growing Conditions: Moist humus rich soils in both meadows and in forest clearings.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Photo 3.30

Asclepias fascicularis
Narrowleaf milkweed

Asteraceae
H: 2-4’ W: 2-4’
Type: Perennial

2

Culture: Spreading. Plant with tall grasses, goldenrod, yarrow.

Habitat: Upland prairie, wet prairie, savanna, woodland and cultivated beds
Notes: Many species of butterflies nectar at milkweed
Growing Conditions: Well drained soils, drought resistant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Lupinus polyphyllus
Bigleaf Lupine

Fabaceae
H: 3-5’ W: 3-5’
Type: Perennial

3

Culture: Plant in mass with non competitive plants with short grasses, columbine, potentilla.

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest cultivated beds
Note: Plant serves also as a hostplant for butterflies
Growing Conditions: Grows best in well drained moist soils, with some drought resistance

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Fragaria vesca
Woodland Strawberry

Rosaceae
H: 6” W: spreading
Type: Perennial

3

Culture: Plant in mass with woodland and forest plants such as columbine, tiger lily, and ferns.

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest cultivated beds
Notes: Flowers use by early spring butterflies
Growing Conditions: Performs best in fertile well drained soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Lupinus rivularis
Riverbank Lupine

Fabaceae
H: 1-4’ W: 1-4’
Type: Perennial

3

Culture: Plant in mass with non competitive plants with short grasses, columbine, potentilla.

Habitat: Upland prairie, wet prairie, riparian forest streambanks, cultivated beds
Notes: Plant serves also as a hostplant for butterflies
Growing Conditions: Moist well drained gravely or sandy soils, streambanks, washes

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Plectritis congesta
Rosy Plectritis

Valerianaceae
H: 6-12” W: 6-12”
Type: Annual

3

Culture: Plant in mass with non competitive plants with short grasses, potentilla, and

Habitat: Upland prairie, wet prairie and opening within savannas
Notes: Early spring butterflies use this for nectaring
Growing Conditions: Moist soils, competes poorly with other grasses and perennials

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Prunella vulgaris var. lanceolata

Lance leaf Self Heal
Lamiaceae
H: 6”-18”
Type: Perennial

3

Culture: Spreading groundcover. Plant with short grasses and yarrow and other asters.

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest clearings, riparian forest clearings and cultivated beds
Notes: Favorite nectar source for skipper butterflies.
Growing Conditions: Grows best in well drained soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Gilia capitata

Blue-Headed Gilia

Polemoniaceae
H: 1-3’ W: 1-3’
Type: Perennial or annual

2

Culture: Plant with tall grasses, goldenrod, yarrow and other asters and annuals.

Habitat: Mainly in meadow systems of upland prairie, savanna, woodland clearings and cultivated beds.
Notes: Nectar used by skippers and Whites.
Growing Conditions: Well drained soils, drought resistant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Sidalcea virgata

Rosy Checkermallow

Malvaceae
H: 1-3’ W: 1-3’
Type: Perennial

3

Culture: Plant with tall grasses, goldenrod, yarrow and other asters, and many perennials.

Habitat: Upland prairie, wet prairie, savanna, open woodlands and clearings.
Notes: Used as both a hostplant and a nectar source.
Growing Conditions: Adaptable from moderately wet to dry soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Sidalcea cusickii

Cusick’s Checkermallow

Malvaceae
H: 2-4’ W: 2’
Type: Perennial

1

Culture: Plant with tall grasses, goldenrod, yarrow and other asters, and many perennials.

Habitat: Upland prairie, wet prairie, savanna, riparian clearings and cultivated beds.
Notes: Used as both a hostplant and a nectar source.
Growing Conditions: Adaptable from moderately wet to dry soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Symphyotrichum hallii
Hall's Aster

Asteraceae
H: 2-5' W: 2-5'
Type: Perennial
2

Culture: Plant with both tall and short grasses and yarrow, goldenrod, mule's ears

Habitat: Upland prairie, wet prairie, savanna moist woodland edges
Notes: Used as both nectar source and hostplant
Growing Conditions: From moist to dry soils amongst tall grasslands.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Camissia quamash
Common camas

Liliaceae
H: 1-2.5' W: 18"
Type: Perennial
2

Culture: Plant with grasses, rush, sedge, mule's ears, checkermallow & yarrow

Habitat: Wet prairies or upland prairies where water stays near the surface
Notes: Used by early spring butterflies like Blues
Growing Conditions: Wet soil when active, dry soil when dormant and cultivated beds

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Lomatium dissectum
Fernleaf Buscuitroot

Apiaceae
H: 2-5' W: 2-5'
Type: Perennial
2

Culture: Plant with short grasses and yarrow, wooly sunflower, and rocky soil perennials

Habitat: Upland prairie, savanna, woodland usually on the eastern slope of the Cascades.
Notes: Key nectar source for early season butterflies
Growing Conditions: Well drained soil, rocky slopes, drought resistant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Photo 3.31

Lilium columbianum
Columbia lily

Liliaceae
H: 1-4' W: 1'
Type: Perennial
2

Culture: Plant with short grasses and woodland flowers like columbine & strawberry

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest and cultivated beds
Notes: Favored by large butterflies like swallowtails
Growing Conditions: Moist to well drained soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Philadelphus lewisii
Mock Orange
Hydrangeaceae
H: 6-12’ W: 6-12’
Type: Shrub 2

Culture: Plant singly or in small group. Use a taller backdrop shrub

Habitat: Upland prairie, savanna, woodland, upland forest, riparian forest and cultivated beds
Notes: Flowers very fragrant, attracts swallowtails.
Growing Conditions: Well drained moist soils to very dry soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Holodiscus discolor
Oceanspray
Rosaceae
H: 12’ W: 12’
Type: Shrub 1

Culture: Plant in mass against conifers to show off the cascading flowers. Best in dryer soils.

Habitat: Upland prairie, savanna, woodland, upland forest, riparian forest and cultivated beds
Notes: Both large and small butterflies use flowers.
Growing Conditions: Well drained soils, drought tolerant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Rosa nutkana
Nootka Rose
Rosaceae
H: 6-8’ W: spreads
Type: Shrub 2

Culture: Plant in mass. Will form a thicket. Produces thorns, thus plant far from foot traffic.

Habitat: Upland prairie, wet prairie, savanna, woodland, upland forest, riparian forest and cultivated beds
Notes: Roses have a cinnamon scent.
Growing Conditions: Moist meadows, well drained

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Sambucus caerulea
Blue elderberry
Caprifoliaceae
H: 15’ W: 15’
Type: Shrub 1

Culture: Tall shrub can reach a small tree status, best planted singly for specimen

Habitat: Upland prairie, savanna, woodland, upland forest, riparian forest and cultivated beds
Notes: White flowers turn into edible blue berries.
Growing Conditions: Well drained soils, drought tolerant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Eschscholzia californica
California Poppy

Papaveraceae
H: 6-18” W: 6-24”
Type: Biennial 2

Culture: Plant with short grasses, goldenrod, asters yarrow, lomatium, many perennials in dry areas.

Habitat: Upland prairie, wet prairie, savanna, woodland and cultivated beds, roadsides and open fields.
Notes: Mylitta Crescent frequents poppies in summer
Growing Conditions: Grows best in well drained soils, very drought tolerant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Brodiaea congesta
Congested snake lily

Liliaceae
H: 1-3’ W: 1-3’
Type: Perennial 3

Culture: Plant with tall grasses, goldenrod, yarrow and other asters, and many perennials.

Habitat: Upland prairie, savanna, woodlands and open grassy forest corridors
Notes: Highly sought by skippers and swallowtails
Growing Conditions: Well drained soils, drought tolerant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Aquilegia formosa
Western red columbine

Ranunculaceae
H: 1-3’ W: 1-3’
Type: Perennial 2

Culture: Plant with tall shady perennials such as tiger lily, strawberry, licorice root and ferns.

Habitat: Upland prairie, savanna, woodland, upland forest, riparian forest and cultivated beds
Notes: Flowers used by swallowtails.
Growing Conditions: Prefers well drained soils in moist meadows to dryer forests.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Potentilla gracilis
Slender cinquefoil

Rosaceae
H: 1-2’ W: 1-2’
Type: Perennial 2

Culture: Plant with short grasses, goldenrod, yarrow and other perennials and annuals.

Habitat: Upland prairie, wet prairie, savanna, woodland, riparian forest
Notes: Used by early to late spring butterflies.
Growing Conditions: Wet to moist soils but can also flourish in dryer soils.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Erigeron decumbens
Willamette Daisy

Asteraceae
H: 6”-2’ W: 3’
Type: Perennial

1

Culture: Plant with both tall and short grasses and yarrow, wooly sun-flower and Brodiaea.

Habitat: Upland prairie, wet prairie and cultivated beds
Notes: Very rare and endangered(critical) native plant
Growing Conditions: Grows best in moist soils from inundated wetlands to upland prairie soils.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Balsamorhiza deltoidea
Deltoid Balsamroot

Asteraceae
H: 1-3’ W: 1-3’
Type: Perennial

2

Culture: Plant with both tall and short grasses and yarrow, goldenrod, bigleaf lupine, asters

Habitat: Upland prairie, savanna, woodland clear-ings, meadows and cultivated beds
Notes: Foliage dies back during hot summer days.
Growing Conditions: Well drained soils, drought resistant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Brodiaea coronaria
Crown Brodiaea

Liliaceae
H: 1’ W: 6”
Type: Perennial

1

Culture: Plant with both short grasses, yarrow, wooly sunflower, Califor-nia poppy, and annuals

Habitat: Upland prairie, wet prairie, savanna or sunny edges of woodlands.
Notes: Swallowtail butterflies frequent this flower.
Growing Conditions: Moist soils seasonally, then tolerating dry summers.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Helenium autumnale
Common sneezeweed

Asteraceae
H: 1-4’ W: 1-4’
Type: Perennial

6

Culture: Plant with both tall grasses and yarrow, goldenrod, mule’s ears, and camas in wet areas

Habitat: Wet prairies, streamsides, ditches, pond edges and cultivated beds
Notes: Frequented by many pollinators
Growing Conditions: Wet to moist soils, thrives in clay and soils which retain moisture.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Collinsia grandiflora
Giant blue-eyed Mary
Scrophulariaceae
H: 6”-18” W: 12”
Type: Annual
1

Culture: Plant with both short grasses and yarrow, wooly sunflower, pearly everlasting

Habitat: Upland prairie, wet prairie, savanna, woodland clearings, upland and riparian forest clearings.
Notes:
Growing Conditions: Tolerates both wet and dry prairie soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Ligusticum appifolium
Lovage
Apiaceae
H: 3-4’ W: 3-4’
Type: Perennial
2

Culture: Plant in wet areas with tiger lily, columbine and bleeding-heart, and ferns

Habitat: Wet prairie, woodland, upland forest, riparian forest
Notes: Visited by the Marginated White.
Growing Conditions: Wet soils, swales, drainages where water accumulates

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Dicentra formosa
Western Bleedingheart
Fumariaceae
H: 6”-2’ W: spreads
Type: Perennial
2

Culture: Plant with columbine, woodland strawberry, ferns and base of trees and shrubs

Habitat: Woodland, upland forest, riparian forest and cultivated beds
Notes: Also the hostplant for the parnassian.
Growing Conditions: Moist soils in shady locations to full sun with afternoon shade in the warmer

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Erigeron speciosus
Showy fleabane
Asteraceae
H: 6”-2’ W: 6”-2’
Type: Perennial
2

Culture: Plant with short grasses and yarrow, wooly sunflower, pearly everlasting

Habitat: Upland prairie, savanna, woodland and cultivated beds
Notes: Nectar used by skippers, crescents, sulphurs
Growing Conditions: Well drained soils, drought resistant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Iris tenax
Oregon Iris
Iridaceae
H: 6”-18” W: 6“-18”
Type: Perennial
2

Culture: Plant with both short grasses and yarrow, wooly sunflower, pearly everlasting

Habitat: Upland prairie, savanna, woodlands, upland forest and riparian clearings and cultivated beds.
Notes: Used by swallowtails in spring
Growing Conditions: Moist well drained soil to dry soils

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Apocynum androsaemifolium
Spreading Dogbane
Apocynaceae
H: 6”-18”
Type: Perennial
3

Culture: Plant with wooly sunflower, pearly everlasting

Habitat: Woodland, upland forest clearings especially in disturbed areas
Notes: Nectar source for fritillaries, and checkerspots
Growing Conditions: Rocky well drained soils along roadsides and slopes

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Cirsium brevistylum
Cluster Thistle
Asteraceae
H: 1’-7’ W: 2’
Type: Perennial
3

Culture: Plant with tall grasses, asters, golden-rod, pearly everlasting, mule’s ears

Habitat: Upland Prairie, wet prairie, woodland clearings, upland forest clearings
Notes: Used as both hostplant and a nectar source
Growing Conditions: Moist meadow soils to seasonally dry meadows.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Photo 3.32

Lomatium hallii
Hall’s Desert Parsley
Apiaceae
H: 6” W: 6”
Type: Perennial
2

Culture: Plant with short grasses and yarrow, wooly sunflower, pearly everlasting

Habitat: Upland prairie, savanna, woodland and cultivated beds
Notes: Good southern slope early summer flower
Growing Conditions: Well drained rocky soils, drought resistant

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Saxifraga oregana
Oregon Saxifrage

Saxigragaceae
H: 1-3’ W: 6”
Type: Perennial
2

Culture: Plant with camas bulb, rosy plectritis and lanceleaf selfheal.

Habitat: Marshlands, wet prairies, stream banks from low to high meadow systems
Notes: Nectar source for early spring butterflies.
Growing Conditions: Grows best in moist soils in open wetland and upland prairie.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Mimulus guttatus
Seep Monkeyflower

Scrophulariaceae
H: 6”-3’ W: 6”
Type: Annual
1

Culture: Spreading or upright. Plant with other annuals along water edges and streams.

Habitat: Grows along most habitats where water is present; bogs, streams, vernal pools and annual seeps.
Notes: Nectar source for spring flying butterflies.
Growing Conditions: Moist soils.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Plagiobothrys figuratus
Fragrant Popcorn Flower

Boraginaceae
H: 1-2’ W: 1-2’
Type: Perennial
2

Culture: Plants spreading. Plant in massings. Plant with tall grasses, lupine, and camas.

Habitat: Wet prairie, bogs, vernal pools
Notes: Mid summer butterflies use this flower
Growing Conditions: Moist soils, especially low lying swales or pools within open sunny prairies.

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Phase Two- The Design

In phase one, I introduced the process of building a butterfly and plants palette for an urban butterfly habitat garden. The habitat chosen for the theme of the butterfly garden was based on the natural habitat that existed upon the site before it was altered by European settlement. The butterflies selected for the garden were based upon the common species that are most likely to use and benefit from the habitat garden. The host plants were selected by determining plants that thrive in the selected habitat of the garden will also serve as the food source for the developing stage of the butterfly, the caterpillar. The native nectar sources were selected that best meet the food source energy needs of the adult butterflies within the designed garden. This constitutes phase one, the building of the palette.

So then, what do you do with all of these plants and animals How do you create spaces within the garden site that best suits the survival needs of these selected butterflies, and how are these plants best suited to meet these needs? Phase two is where we answer these questions; the designing of the butterfly garden.

Phase two of this design process concentrates on meeting the survival requirements of local butterfly species by addressing the basic butterfly life histories of the butterfly life cycle, the butterfly needs which are directly derived from the butterfly life cycle, and the butterfly behaviors, which are directly derived from the butterfly needs.

The life histories of butterflies are quite complex, and although much has been studied and learned about these life histories, much is still unknown to science. The basics are recognizable and identifiable, such as the four stages of the butterfly life cycle of egg, larva, chrysalis, and adult.

The Design Challenges

Identifying life histories may be straight forward, but what do these butterfly life histories look like when applied to landscape design and how can the examination of such life histories help with urban butterfly survival? This is what phase two of the design process is attempting to address. The scientific community has contributed a vast amount of valuable butterfly life history information and much is constantly being learned, but the designing of butterfly habitat gardens and the use of butterfly life histories to generate new theory and approaches to ways of thinking about butterfly gardening is fairly limited.

Butterfly life history information can be quite complex, thus simplifying the process through explaining and demonstrating design interventions which promote these life histories, has to be done in a consistent and graphically simple manner. I chose to represent these various butterfly life histories through the creation of a graphic language using icons. These icons are designed to be used as both an identifier of the life history that is being discussed, and describe the flow of the design process. The discussion of how these icons are used and what they signify, is the topic of the next few pages.

Navigating Phase Two

Phase two is the section of the guidebook that demonstrates how to make decisions within the design, based on butterfly life histories.

The first items encountered within phase two is the graphic language of the design element icons. These design element icons are graphic representations of the butterfly life histories. I see the icon language as a hierarchal system, that begins with the butterfly life cycle, progresses to the butterfly needs, and leads to the butterfly behaviors. Each Icon is created to represent either a stage or an action that is unique to that life history.

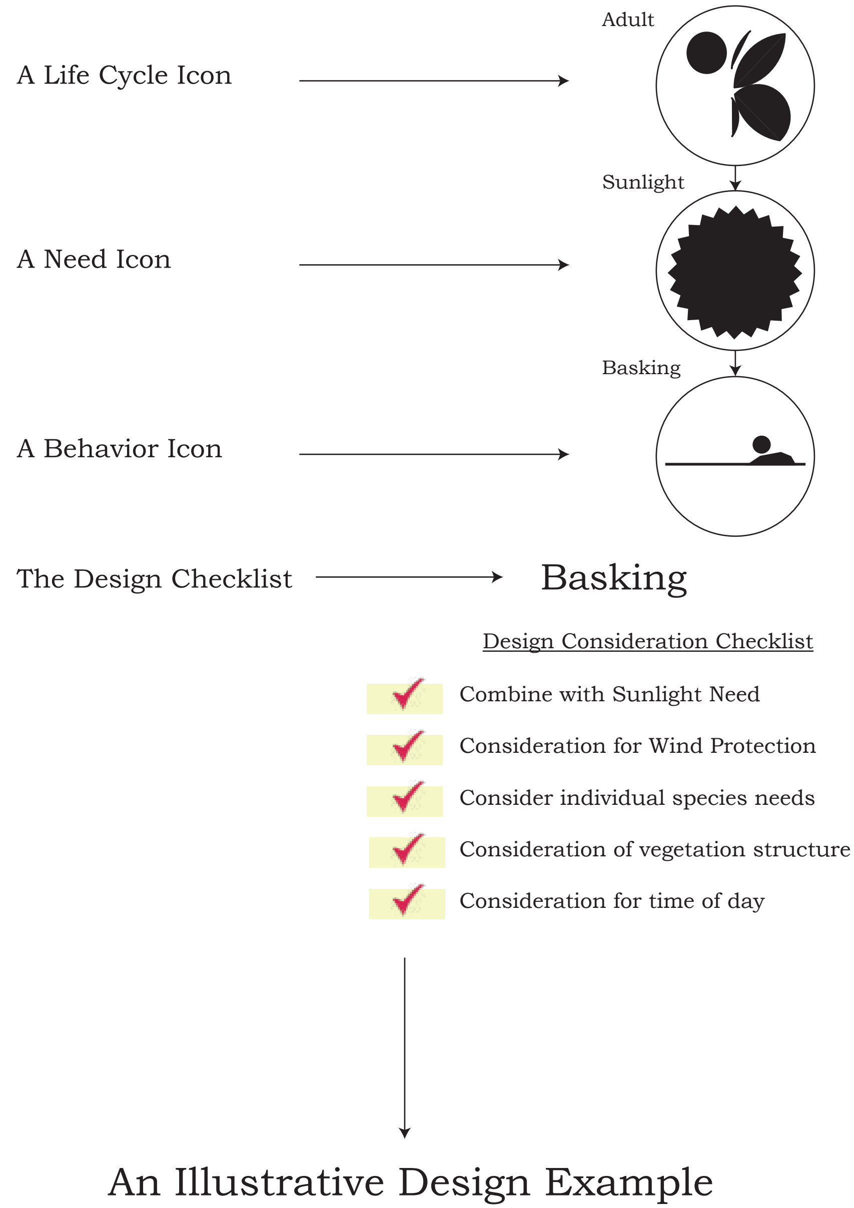
The reason why I've chosen to use icons for the creation of a design process, is to keep the reader in constant awareness of exactly what the design decision is attempting to accomplish and for what stage within the butterfly development these design decisions are addressing. Each icon is explained in detail on the following pages in both what these icons represent and how to follow the icon design flow process.

Once you have experience with understanding the design element icon flow process, I start you at the beginning, with the butterfly life cycle. Once we finish with the life cycle we move to the butterfly needs. When we finish with the needs, we move to the butterfly behaviors. Its that simple, That is the flow: life cycle-needs-behaviors. This process is always transitioned in the same flow method.

At the beginning of each new life history, there is a page of text describing detailed information about that life history. Each section starts with a design checklist. The checklist acts as a reminder of what each design element needs to be considered for proper design to occur. To further assist the reader in understanding the design process, examples of how to use the design element icons within a design are provided.

The Process Example

Lets take you through a simplified sample of what this process looks like within the phase two design framework.

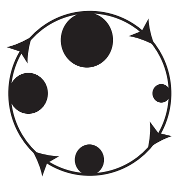


3.6 Creating a Graphic Language

Creating a language through graphic representation is an effective means of communicating clear ideas with minimizing the need to add written descriptions to documents and illustrations. Communication is generated through visual cues, breaking down language barriers.

The icons seen on this chart are presented in a hierarchal arrangement. The butterfly life cycle, the needs of butterflies and the behaviors of butterflies all generate spatial design elements and strategies. Strategies represented through iconology on garden design layouts give the viewer a quick and easy language to follow for the function of design.

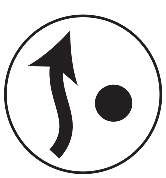
First Level Design Element Icons


LIFE CYCLE

The life cycle is the first level of hierarchy within the graphic language of the icons. Each of the four stages of butterfly life cycle of; egg, caterpillar, chrysalis and adult have specific characteristics which give rise to needs.


NEEDS

The needs of food, water, shelter, and sunlight effect each of the life cycle in a different way. Design considerations for specific needs to take into consideration each stage. Needs at each stage lend themselves to behaviors.


BEHAVIORS

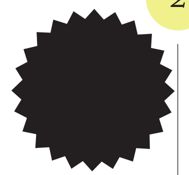
The third level of the icon hierarchy are the behaviors such as puddling, perching, patrolling, nectaring and basking all occur in specific spatial ways dependent upon species.

Second Level Design Element Icons


Adult

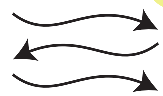
1

A second level life cycle icon shows more specific information. Here, the adult stage of the butterfly lifecycle is represented by the winged adult.


Sunlight

2

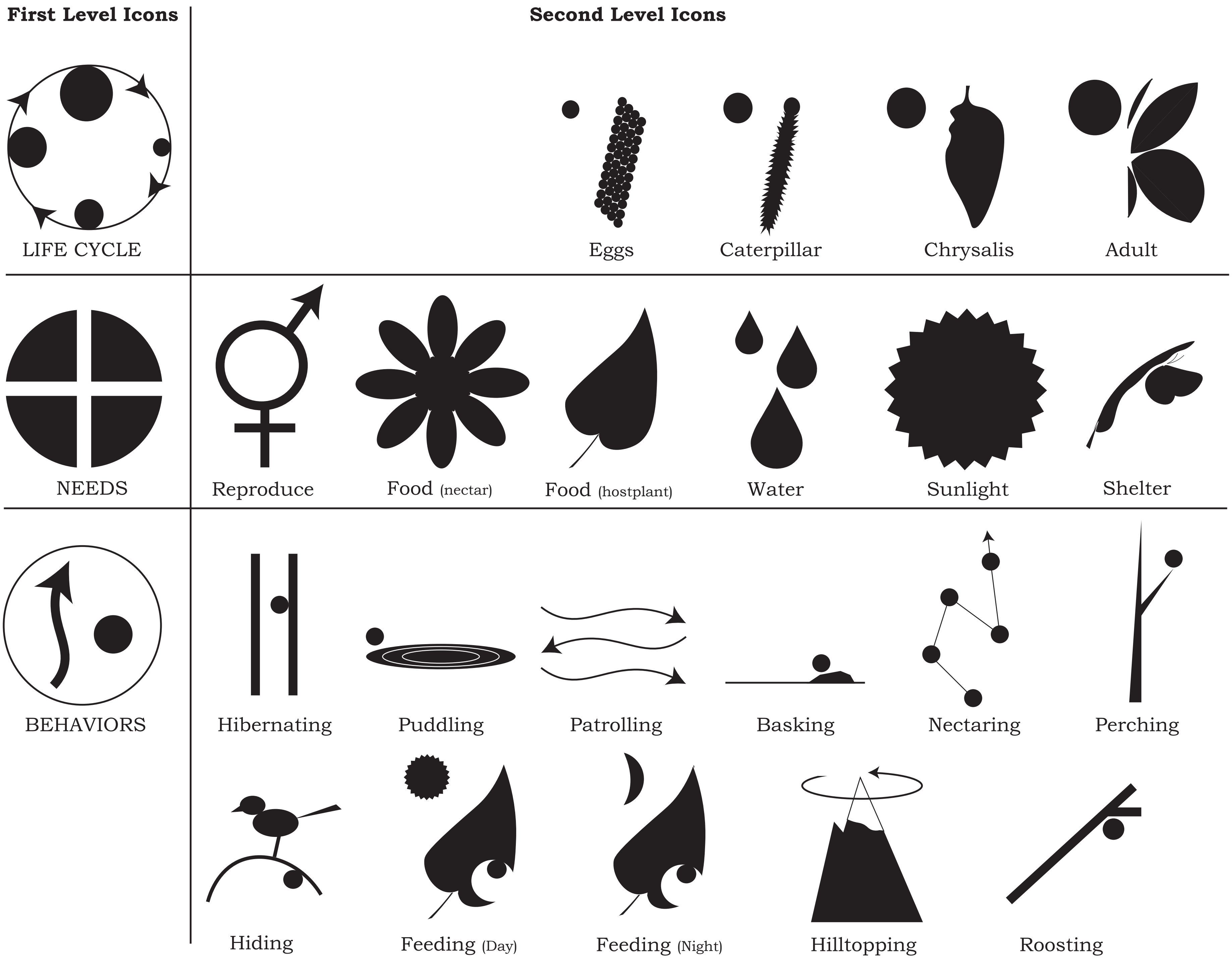
A second level needs icon of sun represents the need for bright sunlight and warmth necessary for butterfly activity to remain at a high functioning capacity.

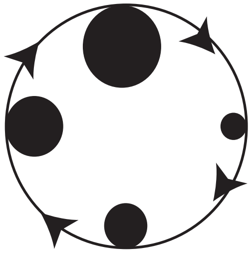

Patrolling

3

A second level behavior icon represented here shows the behavior that males butterflies engage in called patrolling, in which males search for females to mate with.

Because the icons always follow the same work flow from life cycle to need to behavior, the reader can always clearly understand which phase the design is referencing.


First Level Icons
Second Level Icons
LIFE CYCLE
Eggs
Caterpillar
Chrysalis
Adult
NEEDS
Reproduce
Food (nectar)
Food (hostplant)
Water
Sunlight
Shelter
BEHAVIORS
Hibernating
Puddling
Patrolling
Basking
Nectaring
Perching
Hiding
Feeding (Day)
Feeding (Night)
Hilltopping
Roosting



LIFE CYCLE

LIFE CYCLE ICONS. A time driven consideration icon, the life cycle is the first level of hierarchy for design consideration. Each of the four stages of butterfly life cycle; egg, caterpillar, chrysalis and adult have characteristics which give rise to specific needs.

EGG ICON: The egg is a sedentary stage of the butterfly life cycle. Specific needs for eggs within the design are the consideration for shelter.

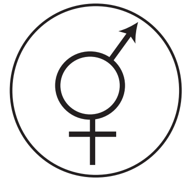
CATERPILLAR ICON: The caterpillar icon represents a stage in the butterfly life cycle that is more mobile and thus generates high need considerations.

CHRYSALIS ICON: The chrysalis icon represents the stage in the butterfly that returns to a more sedentary stage and like the egg requires only shelter.

ADULT ICON: The adult icon represents the most dynamic and active stage in the butterfly life cycle and thus requires considerable design considerations.

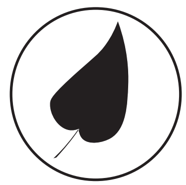
NEEDS

NEED ICONS: A site consideration icon, the need of food, water, shelter, and sunlight effect each of the life cycle in a different way, with the adult having the additional need of reproduction. Needs lend themselves to specific butterfly behaviors both spatially and temporally.



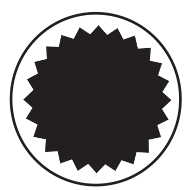
REPRODUCTION ICON: The reproduction icon represents need specific to the adult butterfly’s need to reproduce its species.

FOOD ICON (ADULT). The adult food icon represents the majority of an adult butterfly’s food source, the flowers.



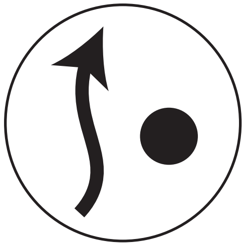
FOOD ICON (CATERPILLAR): The caterpillar food icon represents the sole source of nutrition for the developing butterfly, the hostplant.

WATER ICON: The water icon represents an adult butterfly's need for hydration as well as the need to take up dissolved minerals found within water.



SUN ICON: The sun icon represents both the adult and larval stages of the butterfly need to gain heat to carry out their daily activities.

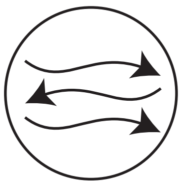
SHELTER ICON: The shelter icon is representing the need for shelter from excessive wind, rain, and heat.



BEHAVIORS

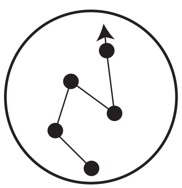
BEHAVIOR ICONS: The third level of icons are the design interventions termed behaviors. Behaviors arise from needs and occur in specific spatial constructs. Behaviors are more specific to each species and thus have a finer level of design intervention.

PUDDLING ICON: This icon represents the adult need for water in a design oriented construct. Although the need for water and reproduction drives puddling.



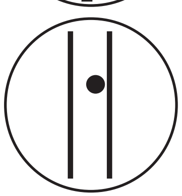
PATROLLING ICON: The patrolling icon represents the adult behavior of mate location by the adult butterfly actively canvasing their environment.

BASKING ICON: This icon represents the adult need to take in solar energy through resting in warm and sunny locations to attain heat energy.



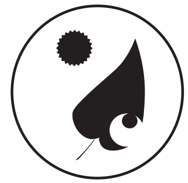
NECTARING ICON: .This icon represents an active adult butterfly's behavior of foraging through their environment in search of a nectar rich diet from flowering plants.

PERCHING ICON: This icon represents a adult butterfly's male mate location behavior of selecting a perch to rest upon in hopes of encountering a female passing by.



HIBERNATING ICON: This icon can be a representative behavior at any of the stage of the butterfly life cycle in which the butterfly undergoes at state of dormancy.

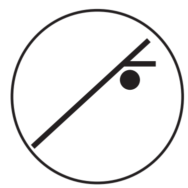
HIDING ICON: The hiding icon represents the behavior that both adult butterflies and caterpillars show to avoid predictor detection.



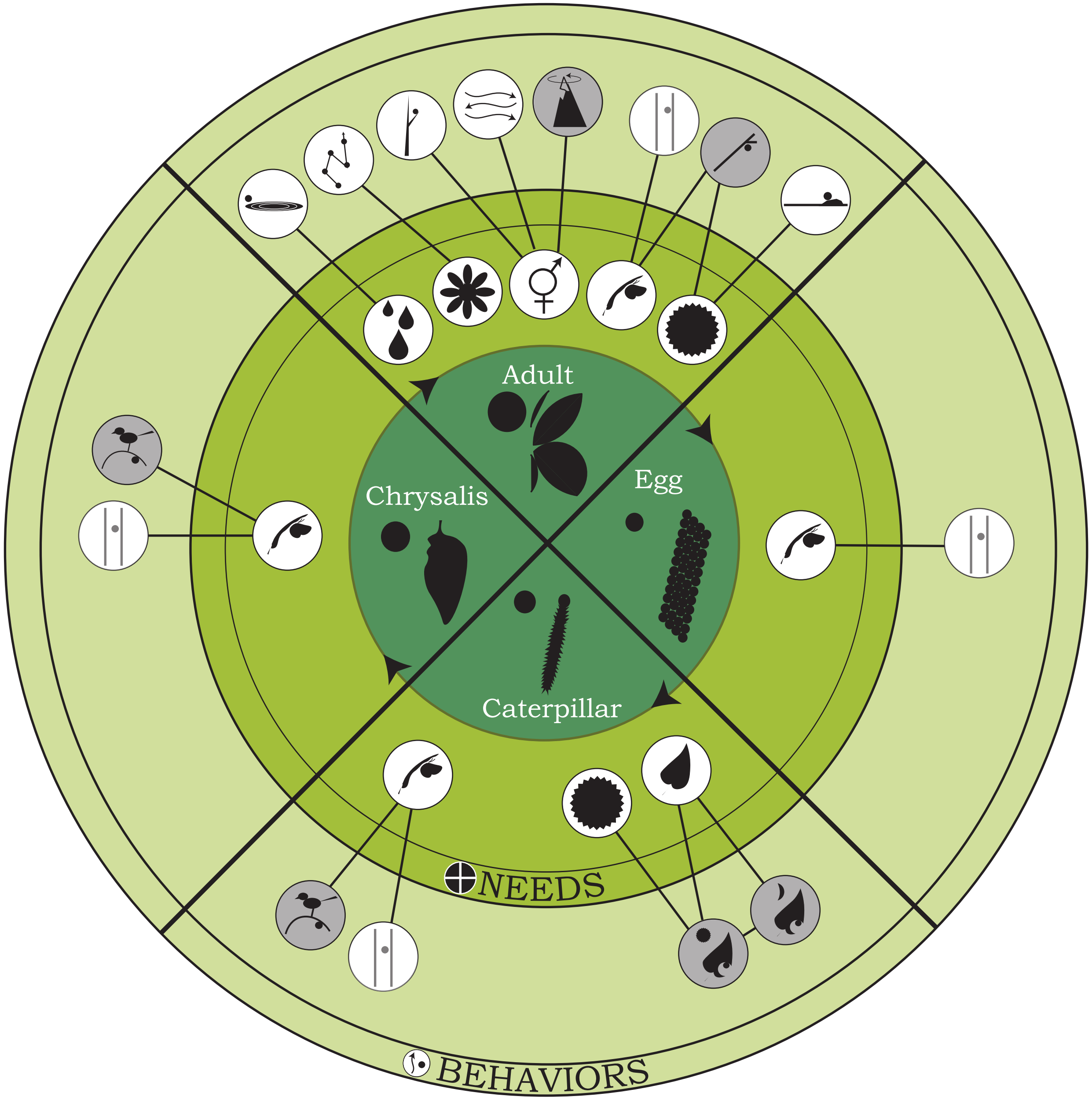
FEEDING ICON (DAY). This behavior indicates that the caterpillar feeds on its vegetative hostplant during daylight hours.

FEEDING ICON (NIGHT): This behavior indicates that the caterpillar feeds on its vegetative hostplant during nighttime hours to avoid being seen by predators.

HILLTOPPING ICON: This hilltopping icon represents a mate finding behavior where male butterflies congregate on the tops of hills and mountains to locate females.



ROOSTING ICON: The roosting icon shows the adult butterfly's behavior for seeking a safe or concealed place to rest throughout the nighttime hours.



Design Element Diagram

Life Cycle

The four stages of the butterfly life cycle of the adult, egg, caterpillar, and chrysalis starts the icon language hierarchy model. This life cycle gives rise to the needs of the butterfly at each stage. The egg and chrysalis stages are much more sedentary and need less intervention, whereas the caterpillar and adult are more active and require more design intervention.

Needs

The four basic needs of the butterfly of food, water, sunlight and shelter and the fifth need of reproduction which is exclusive to the adult stage require careful design considerations to optimize the garden design to meet the needs at each phase of the butterfly's life cycle.

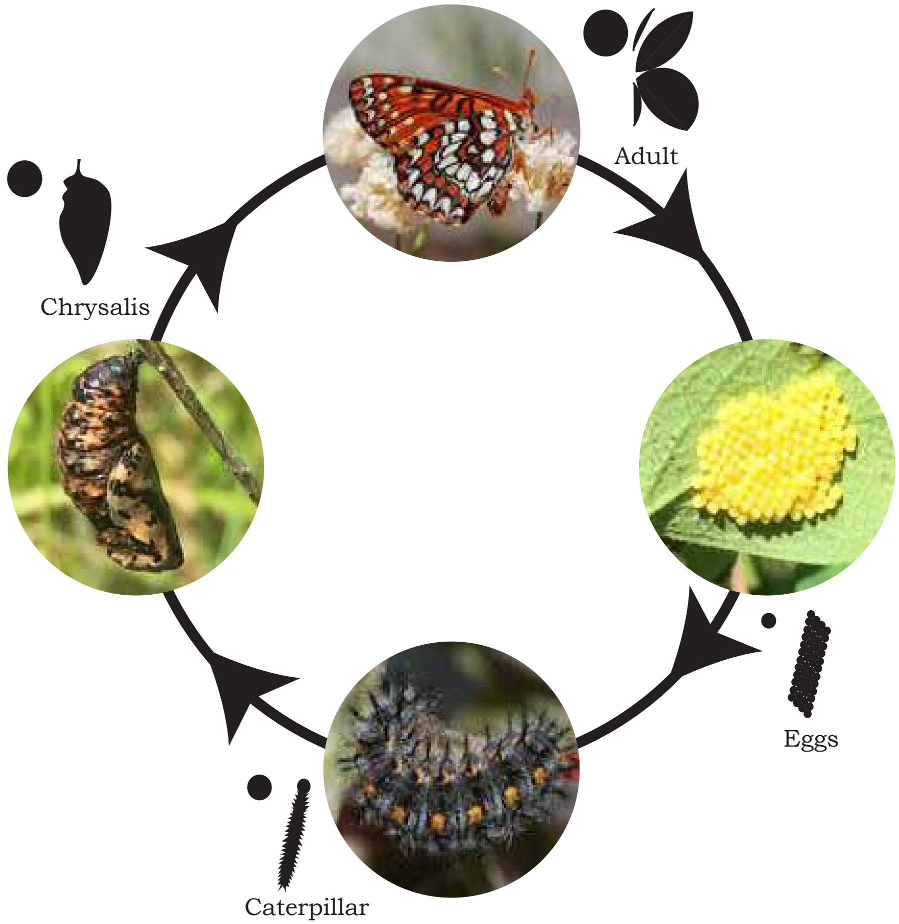
Behaviors

The third tier of the design element diagram constitutes the butterfly behaviors. Some behaviors are directly promoted through specific interventions within the garden design, these are marked on the digram in white. Other behaviors will occur automatically within the garden when the primary needs and behaviors are met. The icons in grey require no intervention to occur.

Behavior Icons

Icons in grey require no design innervation for behaviors to occur.

Icons in white require design intervention for optimal behavior to occur.



Life Cycle of butterflies

When people think of the term butterfly, images of a colorful flying insect visiting flowers in a sunny garden comes to mind. But this stage of the butterfly is only one part in an amazing life cycle. Depending on the species, the adult butterfly may live for several months to less than three weeks. Evolution has allowed the butterfly a survival strategy in which the insect spends a year or more advancing through four distinct stages of life. No matter the butterfly species, all butterflies go through the process of complete metamorphosis (James 2011). This life cycle consists of the egg, the caterpillar, the chrysalis and then the recognizable winged insect known as the adult (askabiologist.asa.edu). With complete metamorphosis, each stage of the butterfly life cycle has a unique set survival strategies and functions. As the butterfly passes from egg to larva and pupa to adult, the butterfly changes, to an almost unrecognizable form from the previous stage, into a new and functionally different version of itself. Recognizing the needs of each stage of a butterfly's life cycle is a key component to successful butterfly gardening (Xerces Society 1990). Design strategies that promote the success of the butterfly at each stage will be discussed further.

1. Egg-

All butterflies start out their life in the form of an egg. This egg is laid externally from the female either on or near a suitable food supply for the soon to be developing caterpillar. Since most butterfly species are host plant specific, the female butterfly is very particular about the host plant she chooses to lay her eggs upon. Some species of butterflies lay their eggs on the underside of the host plant leaf, some lay their eggs on the top side of leaves, some species lay their eggs on flowers, and some species lay their eggs near the plant but not directly on the plant (James 2011).

Some species of butterflies will lay only one egg per plant, other species will lay large clusters of eggs on a single plant. Most butterfly eggs hatch within three to seven days after being laid. What hatches from this egg is a tiny caterpillar, the second stage of the life cycle. Many butterfly caterpillars hatch during the warm months of spring and summer, grow and eventually pupate within a very short period of time. However, some butterfly species, whose eggs are laid in the fall or late summer may overwinter as an egg, riding out the long cold days of winter, until spring returns and vegetation becomes available again (James 2011).

The egg stage of the lifecycle is a very sedentary stage and the most inconspicuous phase of butterfly development. Most butterfly eggs are very small and are laid hidden from view. Even the most experienced butterfly gardener may not find these tiny eggs hidden within the vegetation. But if the host plants are growing within the habitat and the butterfly species is known to exist there, then the likelihood of butterfly eggs being in the area is generally high.

The Caterpillar-

The second stage of the life cycle of a butterfly is the larval stage known as the caterpillar. A caterpillar's chief concern is eating. Caterpillars have chewing mouthparts and will consume most any part of the fleshy parts of their host plant including leaves, stems, and flowers (Tekulsky 1985). The caterpillar grows rapidly. As it outgrows its old skin it molts, sheds its old skin and increases in size. Each molt is termed an instar (James 2011). Caterpillars typically undergo five instar stages until the caterpillar has grown sufficiently in size to form the next stage of development, the chrysalis (James 2011). Most butterfly species spend three to four weeks in the larval phase (Tekulsky 1985). Some larvae only spend ten days as a caterpillar before pupation (James 2011).

Caterpillars generally spend most of their life cycle on a single host plant. However, there are many species in whose caterpillars move about their environment in search of new food supplies (Dennis 2010). For certain species of butterflies, whose eggs hatch in the summer and when vegetation begins to dry, the caterpillar goes into a dormant stage known as diapause, a stage of hibernation. These butterfly caterpillars may remain in this dormant state for months, only to return to feeding again when conditions return to favorable (Tekulsky 1985).

Because caterpillars are larger and more mobile then the egg, they draw considerable attention to themselves from birds and other animals that eat caterpillars. Because of predation, infertility or disease, on average only 1% to 2% of butterfly eggs laid in the wild will make it to adulthood (butterfly-fun-facts.com 2018).

As butterfly garden designers, certain design strategies can be employed to increase survivability of butterfly caterpillars within the garden.

As important as sunlight and warmth is to the adult butterfly, microclimates which promote early season warmth and higher temperatures throughout the day, promote faster caterpillar development (Weiss 1988). These microclimates which encourage increased temperatures can be employed in the same manners as for creating microclimates for flying butterflies such as hedgerows, windbreaks, and southerly exposures with direct sunlight.

Butterfly caterpillars have many defenses against foraging predators; camouflage, mimicry, and hiding are effective means to avoid predation. However, predatory insects and birds still account for considerable butterfly caterpillar mortality (Tekulsky 1985).

What remains unclear are the spatial configurations for optimal host plant placement within a garden design that can decrease foraging predator success while increasing caterpillar survival. Studies demonstrate that when host plant health and abundance increase, caterpillar numbers increase, but so does predation (Bereczki 2012).

A logical solution may be to plant an abundance of host plants and spatially distribute them evenly throughout the garden. This in turn may promote an even butterfly caterpillar distribution. Spatial distribution of host plants may have additional benefits for caterpillar species which are prone to walking off hosts in search for other host patches. Caterpillars run the risk of starvation if host plant patches are depleted and no additional host plant patches are provided or dispersed appropriately (Dennis 2010).

The Chrysalis-

Once large enough, the caterpillar undergoes a transformational phase called pupation. Pupation is where the insect changes from a mobile feeding caterpillar into a sedentary non-feeding chrysalis (James 2011).

How the caterpillar pupates is very species specific. Some species will crawl off the host plant, termed "wanders", in search of another more favorable location to pupate (James 2011). Others will pupate on the host plant, still others will pupate on or in the soil (James 2011). Generally, the caterpillar will attach itself to a suitable surface by means of a silk threads and begin to shed its outer skin for the last time. This time the skin gives way to a shell-like structure, the chrysalis (James 2011). Within the chrysalis, the caterpillar is changing into a butterfly. This phase sees a complete transformation from a worm-like caterpillar to a winged adult. Some butterfly species can spend an entire winter in the chrysalis phase (diapause), only to hatch when weather conditions become warm and favorable.. However, during the warm months, most butterfly species typically spend 1-2 weeks as a chrysalis and then hatch to become flying adults (Tekulsky 1985).

The Adult-

The most conspicuous phase of the butterfly's life cycle is the adult. Here the adult butterfly encloses (hatches) from the chrysalis as a winged insect. The butterfly emerges with its wings small and undersized, like a deflated balloon. Once hatched, the butterfly quickly pumps fluid through a series of veins. This pumping of fluids expands the wings into their full form. It takes only minutes to fill the wings and increase them to their appropriate size but will take a couple hours for the wings to harden and become flight ready.

Butterflies enclose during the morning so that by the time the sun is warm enough for the adult to become active, their wings will be dry and hardened and ready for flight (James 2011).

The wings are decorated by colorful powdery scales. The scales are arranged in very specific patterns which give the butterfly a unique set of identifiable characteristics which serve many purposes, chiefly the ability to recognize other butterflies of the same species for reproduction.

However, wing patterning also serves many other purposes. Some species have wings with cryptic rock-like or bark-like patterns which match their surroundings, providing camouflage to avoid detection by predators. Some butterfly species have bright orange or red coloration to serve as a warning sign to predators that they may be toxic if eaten, as in the case of the well-known Monarch Butterfly. While other butterfly species use their coloration and patterns to mimic a set of large eyes, as seen with the Common Wood Nymph, to confuse or scare off would be predators (Tekulsky 1985). And still other butterfly species, such as the Silvery Blue, may use iridescent flashes to confuse their would-be enemies to their exact whereabouts. The coloration and patterning of a butterfly's wings is a delicate balance of being seen by potential mates and not being seen by potential enemies (Tekulsky 1985).

Wing shape is another survival characteristic that adult butterflies demonstrate. Some species such as the Mourning Cloak have a jagged shape along the edges of their wings to simulate rough bark or dead and tattered leaves. The Tiger Swallowtail, Grey Hairstreak, and Eastern Tailed blue all have long wing appendages (tails) at the end of their hind wings to divert the attack of a would-be predator to the tail and not the butterfly's head, thus allowing the escape with nothing more than a chip missing from the wing (Tekulsky 1985).

Of all the benefits that wings provide for adult butterflies, flight is their main purpose. Flight allows adult butterflies to find mates, to find food, escape predators, and to find new habitat and territory to expand their numbers and distribute their species.

Water

<u>Design Consideration Checklist</u>

- ✓ Consideration for spatial layout
- ✓ Consideration for Sunlight Need
- ✓ Combine with Shelter Wind Protection
- ✓ Consideration of water source
- ✓ Consideration for Puddling Behavior

Butterflies need, not only nectar from flowers, but water as well. Often on warm afternoons, butterflies will congregate at the edges of streams, ponds, or wet patches of ground to sip water from the earth. Puddling, mainly a male butterfly behavior, has more motivations than the attainment of water for hydrating their bodies. Dissolved mineral salts within the puddles are taken in by males for reproductive fitness, helping maturate their sperm (Sculley 1996). This stored sodium is then passed to the female during mating, helping nourish the female's clutch of eggs (Molleman 2005).

Water is one of the four basic needs of the butterfly. Caterpillars gain hydration through the consumption of fleshy leaves from their host plants, but the adult butterfly must travel throughout its environment in search of both food and water.

Considering the source of water for butterflies is key to successfully meeting the butterflies survival needs. Spatial considerations of what an appropriate water source will look like and where to place the water source has been scarcely studied. However, based on observation of butterfly puddling behavior, design considerations can be applied.

Determining the size and design of the water source (puddle station) is up to the individual designer of the garden, provided some basic principles are considered both spatially and environmentally.

The water source needs to be located in a sunny part of the garden where direct sunlight will fall upon the puddle station from the hours of 10am until 4pm (peak butterfly activity hours). The puddle station should consist of moist soil, gravel or sand, and not allow standing water to accumulate. Butterflies will avoid standing water, due to the fact that butterflies cannot wade or swim (Tekulsky 1985).

The puddle station should receive a constant supply of fresh water, be it from irrigation or a natural source. The area that you place the puddle station should be protected from strong winds that can chill the air and drop temperatures below butterfly flight values of 55 degrees Fahrenheit (Greely, 2007).

The puddle station should remain free of vegetation so it can be easily found by visual searching butterflies. Some butterflies will seek puddle stations based on sight, others will use their sense of smell through using their antennae. Keeping the puddle station out in the open where vegetation doesn't block access and trees can't shade the area is a primary design consideration.

Butterfly puddling activity will usually increase as summer temperatures rise and the environment becomes increasingly arid. If the puddle station is a naturally occurring source that is subject to drying up during the warmer months, a secondary water source such as a sprinkler that replenishes the puddle station on a daily basis should be designed into the garden.

Although there are no hard design parameters to a butterfly puddle station, aside from depth, I assert that a more naturalistic design, may be more appropriate and may elicit more puddling activity. That being said, have fun and be creative.

Sunlight

Design Consideration Checklist

- ✓ Consideration for Basking Behavior
- ✓ Consideration for Perching Behavior
- ✓ Consideration for Nectaring Behavior
- ✓ Consideration for Patrolling Behavior
- ✓ Consideration for Puddling Behavior
- ✓ Combine with Wind Protection
- ✓ Consider time of day

Butterflies are cold blooded animals and thus rely on external temperatures for warmth. In the Pacific Northwest where temperatures can be cool and seasons rainy, creating conditions that promote warmth is a chief concern for the designing of butterfly friendly spaces.

During cold weather or at night, a butterfly's body temperature will be close to the ambient temperatures. Only when the sun's rays begin to warm up the environment can butterflies again become active. Minimum and maximum temperatures needed for flight are dependent upon species and location, however accepted general minimum and maximum ambient air temperatures for butterfly flight are generally between 55-60 degrees Fahrenheit with a maximum of 108 degrees Fahrenheit. The optimal body temperatures ranging between 82 degrees and 100 degrees (www.uky.edu). Because of overnight temperatures drop below flight temperature thresholds. Within Eugene, butterflies are generally not found flying through the sky until around 9am.

In the early morning, butterflies engage in the behavior of basking in which the lay their wings out in a position to collect solar radiation, much like solar panels. Most butterfly species have darkened scales close to their body to better absorb the sun's energy, and most butterflies will choose areas to bask in that retain or promote heat; like rocks, patches of gravel, or broad leaves (www.uky.edu).

During days of intermittent sunshine, butterflies will be on the wing when the sun is out and duck into cover when clouds move across the sun. The act of flying in cooler weather causes wind to move across their body, lowering their internal temperature (Wilson 2018). Therefore, butterflies rarely fly during cloudy days or in times of moderate to high winds. Creating warm and sunny microclimates within a garden space can afford butterflies precious flight time to find food and locate mates.

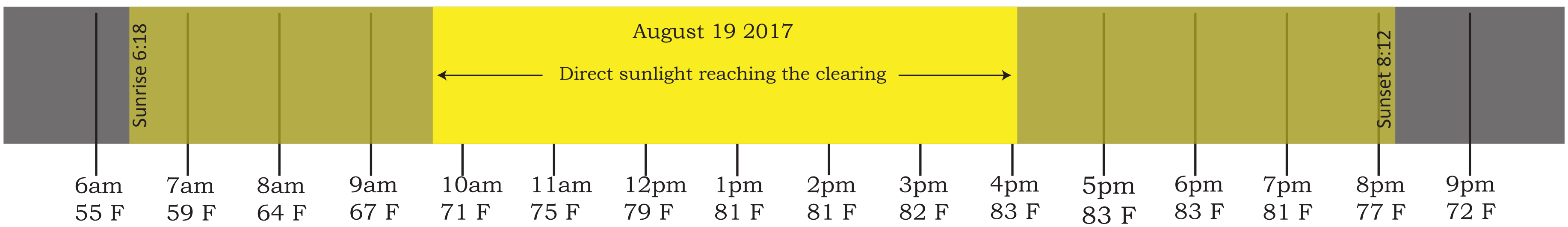
The butterfly's primary food source as an adult is nectar from flowers. Planting flowers in the sunlight will produce a greater yield of flowers within the garden and thus increase butterfly usage. The designed butterfly garden should aim to give the space direct full sun, preferably from sunrise until 4pm.

Direct sunlight in the early hours of the day helps butterflies warm their bodies quicker than if the garden was in shadows throughout the morning. Since butterflies can not regulate their own body temperatures, the need to provide shade from trees during the hottest times of the day provides butterflies relief from the sun, cooling off their bodies and preventing overheating.

Sunlight that bathes the garden from early morning through mid afternoon will keep the space warm, and butterfly activities productive.

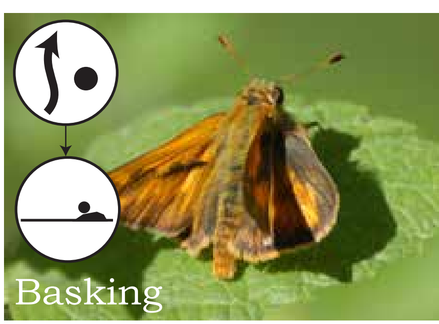
Understanding where and when the site receives sunlight is key to designing a butterfly garden. On the following pages I show a sunlight/daylight study that I conducted near my home in Eugene.

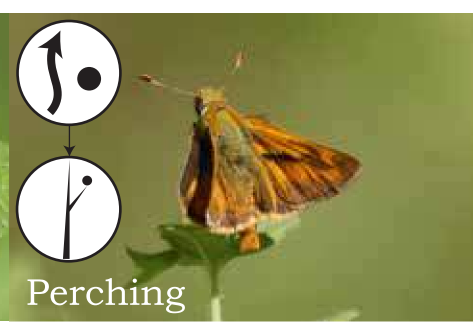
The Guidebook: Sunlight/Daylight Study

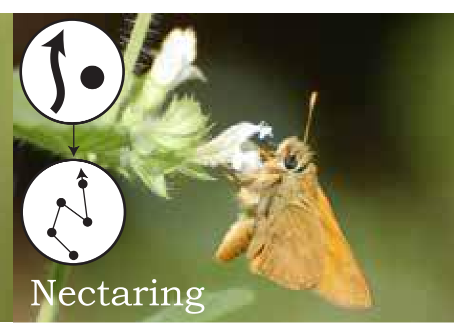


	6am	7am	8am	9am	10am	11am	12pm	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm
Total Adults	**0**	**0**	**1**	**27**	**73**	**75**	**60**	**64**	**40**	**22**	**15**	**5**	**2**	**0**	**0**	**0**
Basking/Perching	0	0	1	14	32	33	13	5	6	4	2	4	2	0	0	0
Nectaring	0	0	0	13	41	42	47	59	34	18	13	0	0	0	0	0
Reproduction	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0

Sunlight

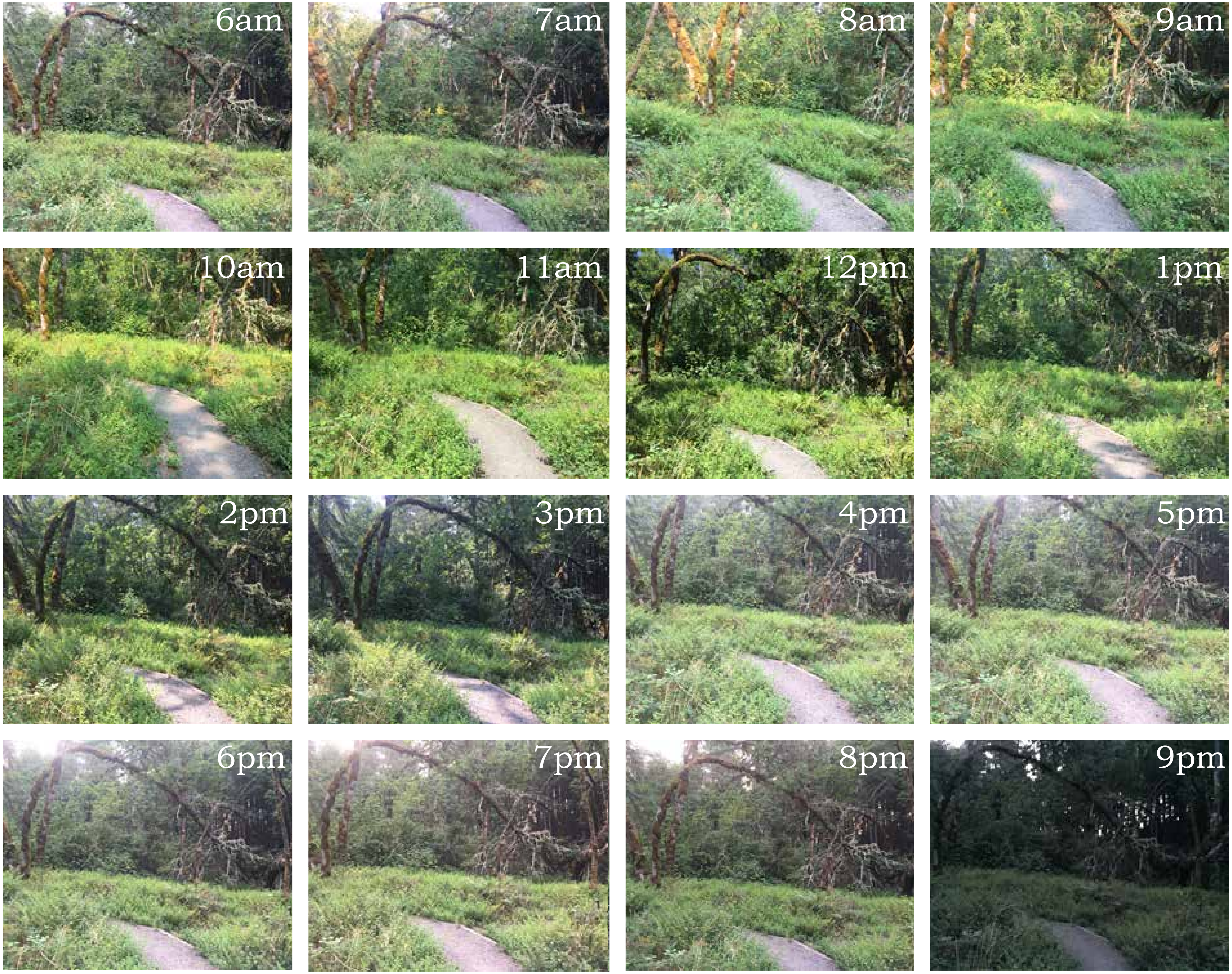






Daylight activity study in South Eugene, revealing the behaviors of the Woodland Skipper butterfly

NEEDS



Daylight study site South Eugene, showing how sunlight moves across the clearing

NEEDS

Shelter

Design Consideration Checklist

- ✓ Consideration for Wind Protection
- ✓ Consideration for Rain Protection
- ✓ Consideration for Heat Protection
- ✓ Consideration for Perching Behavior
- ✓ Consideration for Puddling Behavior
- ✓ Consideration for Basking Behavior
- ✓ Consideration for Nectaring Behavior
- ✓ Consideration for Patrolling Behavior
- ✓ Consider spatial vegetation layering

A fundamental need of butterfly survival is shelter. Small and fragile, butterflies can succumb to the elements of heat and cold, wind and rain quite easily. In addition, butterflies seek shelter to avoid being found by predators. Analyzing the individual components of the need for shelter can lead to design decisions within the garden that can better provide for butterfly survival.

Wind-

Although many migratory butterfly species rely on seasonal winds to aide them in moving northward in the spring and south in the fall, most butterflies will not be active in flight when winds reach over 25 mph (Grealey, 2007). Wind carries away heat from objects, both living and non. As wind speed increases, heat loss increases, a phenomenon is known as wind chill (Booth 2012). Butterflies can lose body heat while in flight on cool sunny days as wind flows across their wings and body (Wilson 2018). Thus, an understanding of wind and how to design for changes in wind and the creation of microclimates that reduce wind are essential to butterfly garden success.

An understanding of seasonal wind direction can inform design decisions within the garden. Since butterflies reduce their activity during wind events, creating sheltering buffers and microclimates is important. Structures such as buildings, fences and walls are effective windbreaks, but these can also act as barriers to butterfly movement and in some cases, do to their density, wind can actually increase as it passes around or over the top of such structures. Vegetation can serve both as habitat and wind buffering elements. Height and density of vegetation can greatly influence wind reduction (Booth 2012). Massing plants together that form thick matrices of leaves and branches can provide an effective wind buffer, creating a calmer microclimate and promoting butterfly activity.

In Eugene, the butterfly flight season starts in early April and progresses until early November, with most of the butterfly activity for flighted adults occurs between late May until late September (NABA). The local wind patterns within the Willamette Valley show that winds predominantly travel from the south from January until late April. Designing for early spring butterflies demonstrates a need to create wind shelters that block southerly winds. From May through late September, the winds switch from a southerly direction to a northerly direction (WRCC). Here, designing for summer flying butterflies, needs to address design components that block the north winds. In October, the wind direction switches once more to moving predominately from a southern direction. Fall butterflies and hibernating butterflies will benefit from both directional wind buffers.

A wind rose analysis will allow the designer to quickly understand seasonal wind direction and allow for design solutions to create microclimates which promote optimal adult butterfly activity.

The exact vegetative wind buffer that can be used to reduce wind is up to the creative mind of the designer. However, there are some basic principles to consider. The vegetation buffer should represent all three of the vegetative layers of the ground layer, the shrub layer, and the tree canopy layer. Buffering the garden by creating a diversified layering of plants helps break up winds that move along the ground as well as up through the tree canopy.

Shelter from rain-

Inclement weather in the form of rain can pose a serious threat of injury or death to a butterfly that weighs less than a gram (Raupp, Scientific American). Thus, aside from the lack of warmth from the occluded sunshine, rain showers send butterflies seeking shelter to avoid injury. Because temperatures during rainstorms are often too cold to adequately warm the butterfly's flight muscles, the insect must not only seek refuge from the storm, but do so in a manner where they cannot be seen by active predators such as birds, which remain active even in stormy weather. (Raupp, Scientific American)

This vegetation can take the form of tall grasses, woody thickets, perennial herbaceous plants, rock overhangs, or even against man-made structures. Tree canopies slow down rain drop velocity, buffering butterflies from large quantities of rain. (Raupp, Scientific American)

Prolonged storms, which are typical in the spring around the Eugene area, can be especially harmful to butterflies (Scott 1975), as the long duration of sheltered inactivity increases susceptibility to predation from foraging birds and mammals. Butterflies remain inactive during long storm events, the lack of resupplying their energy through the inability to find food can lead to butterfly mortality.

Since a butterfly may only live a short week or two as an adult, long storm events that last a week or more can be devastating to butterfly populations. Because of this, butterflies are ready to spring back into action as soon as the weather warms up and the sun emerges. Generally, within minutes after a storm has passed and the sunshine warms up the environment, a butterfly can be back on the wing.

Shelter from heat-

As much as butterflies are dependent upon heat for flight, too much heat can be dangerous. During flight, a butterfly builds up heat through friction of moving its flight muscles back and forth. If temperatures begin to rise above 100 degrees, butterflies run the risk of overheating (www.uky.edu). On hot afternoons, many butterflies that you would normally expect to find flying across flower tops, can instead, be found resting in the shade. Here in the shadows, butterflies cool down their bodies by hanging from the cooler vegetation.

Deciduous trees are a valuable design component, in that block solar radiation in the spring and summer, when temperatures rise and allow for solar radiation to reach and warm the ground in fall and winter. During the warm months the tree canopy can cool ambient temperatures by 15 degrees (Booth 2012).

The next few pages give a visual demonstration on the importance of creating shelter from chilling winds, extreme temperatures and rain events. A very helpful tool to analyze wind speed and wind directional patterns is the wind rose. The wind rose analysis can allow the designer to visualize exact placement of vegetative buffering plantings to address season wind direction. For calculating how much shade is needed, a shade analysis can be run. For creating shelter form rainy storm events, vegetation layering is an effective measure for slowing down rain drops.

NEEDS

Shelter from Rain

Broad leaf trees can slow and trap anywhere from 10-40% of the rain that might otherwise fall to lower vegetation (Penn State 2008). Some butterfly species will take advantage of these denser canopies during storm events, while others will ride out a storm deep within grasses or forbs. Broad leaves give a distinct umbrella-like advantage for shelter, a feature that this pine tree can not provide.

Shelter from Heat

During hot weather, butterflies run the risk of overheating from both ambient temperatures and friction caused by muscular contraction during flight. To reduce their bodies temperature, butterflies must take rest. One strategy that butterflies will use, is the seeking of shaded areas within their habitat during peak heat hours, as shaded areas can range up to 15 degrees cooler than in the sun (Booth 2012).

Creating shade in the garden then becomes a must, but too much shade will compromise the goal of a sunny garden space. Performing a shade analysis will help the designer know exactly where to place shade trees, based on the tree's projected hight to the angle of the sun during the warmest times of the day, thus a shadow length can be calculated to determine optimal shade tree placement (Fig. 3.15).

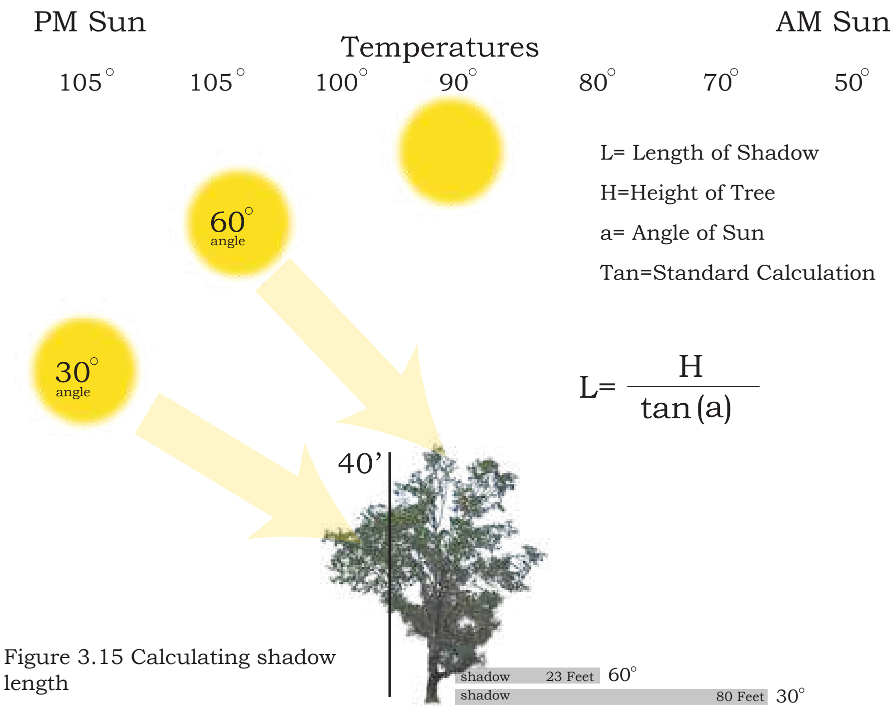


Figure 3.15 Calculating shadow length

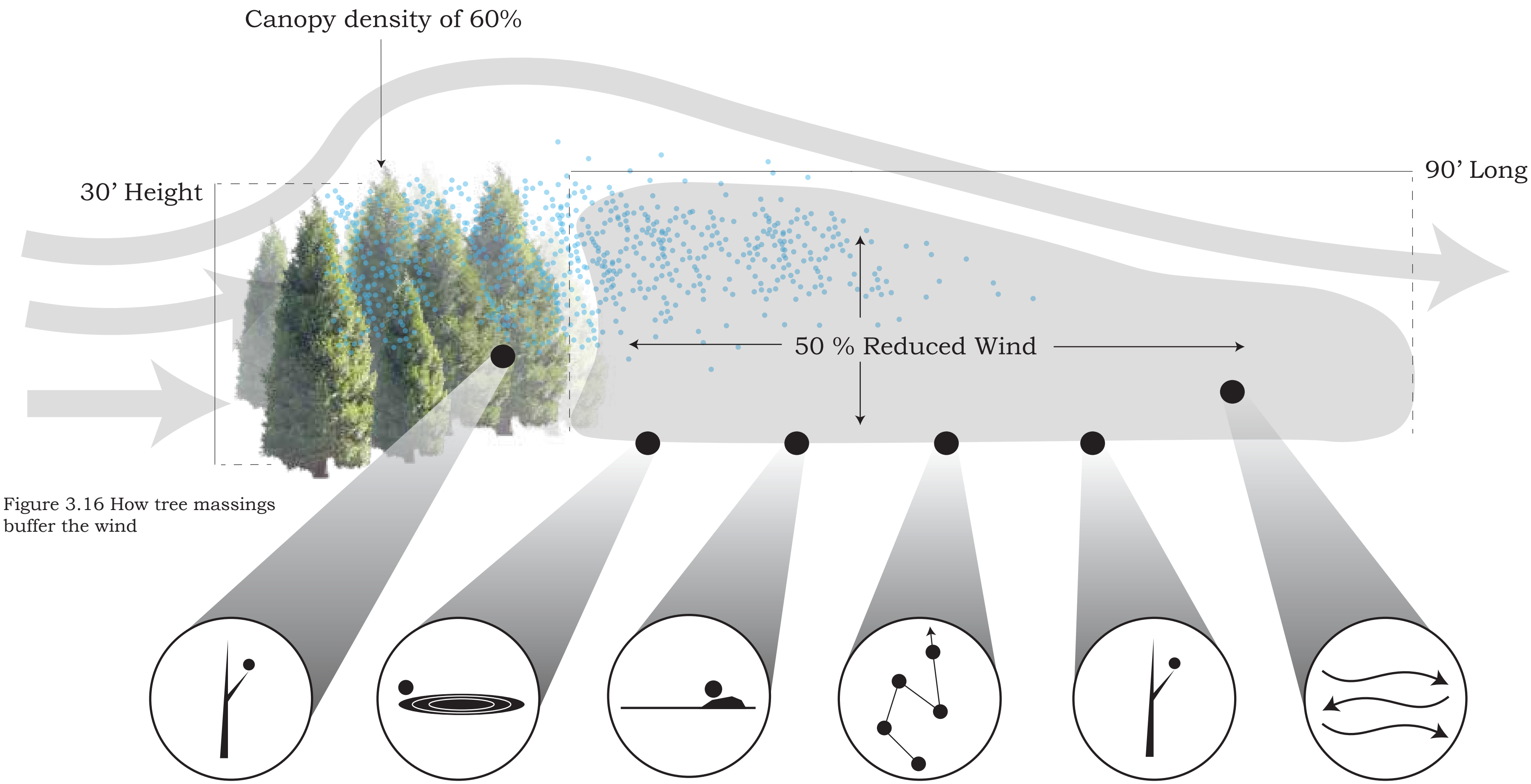


Figure 3.16 How tree massings buffer the wind

As a rule, trees and shrubs can reduce wind velocity of up to 50 percent for a distance of 10 to 20 times the height of the canopy. Of course, this buffer begins to lose efficacy the further you travel from the buffer (Booth 2012). The greatest protection occurs within the first 3-10 times distance from the massing. Thus, a stand of shrubs at 10 feet tall reduces the wind speed the greatest from 30 to 100 feet from the massing.

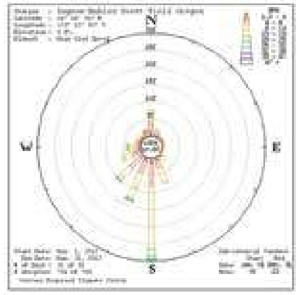
The density of canopy needs to be roughly 60 percent to reduce wind effectively (Booth 2012). Too dense of a vegetative windbreak, can cause the wind to push up and over the massing. When this happens, the wind speed on the leeward side of the buffer can accelerate, causing more wind across the garden space.

By providing wind protection in the appropriate proportions, nectaring plants, basking zones, perching and patrolling stations and puddling stations are more likely to be utilized by butterflies (Tekulsky 1985).

The Guidebook: Shelter- Wind Direction

January

February



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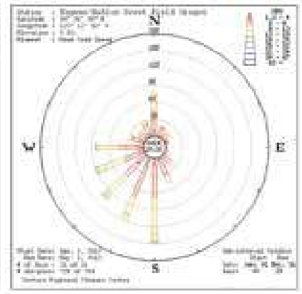
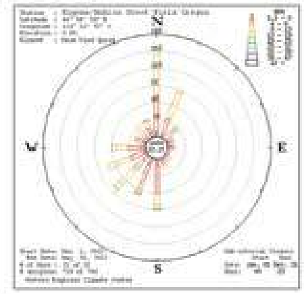
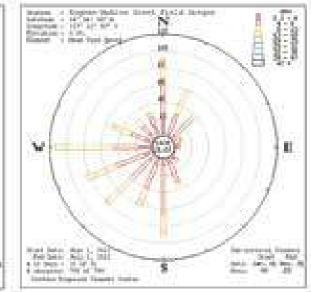


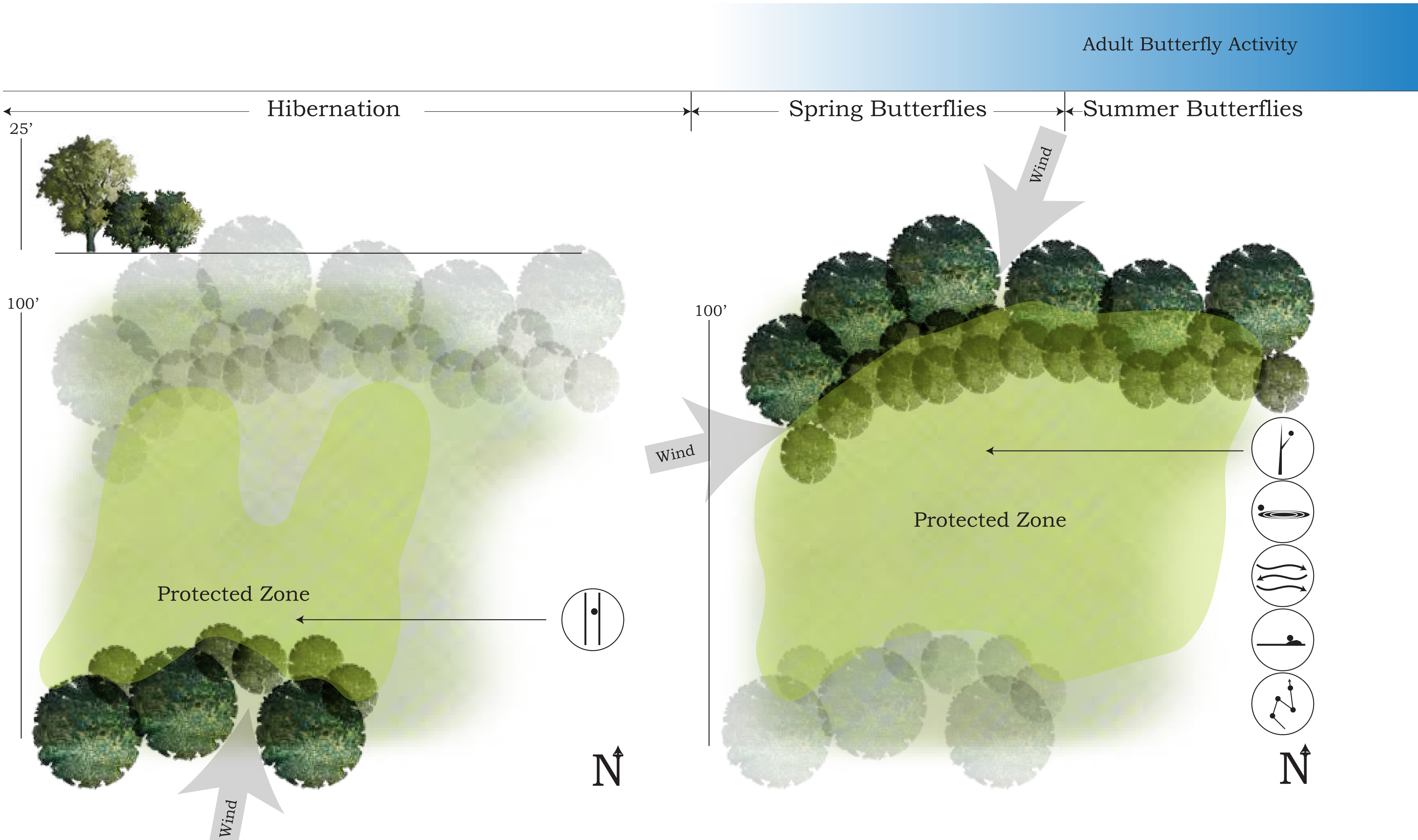
April



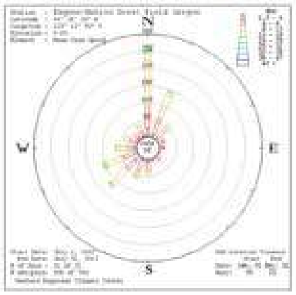
May



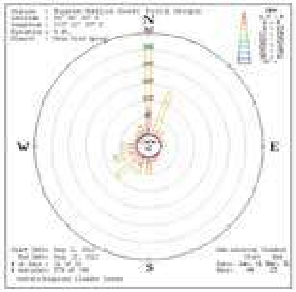
June



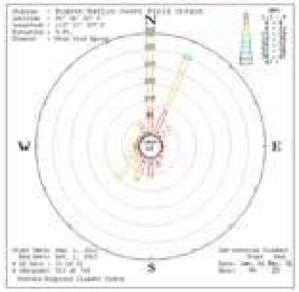
NEEDS



July

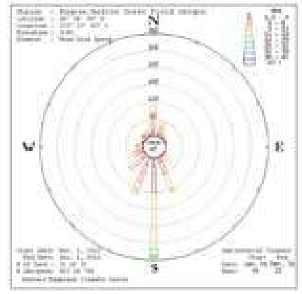


August

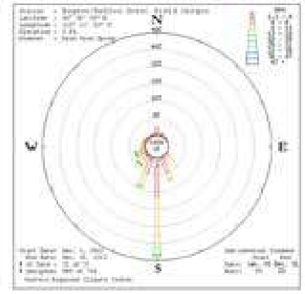


September

October



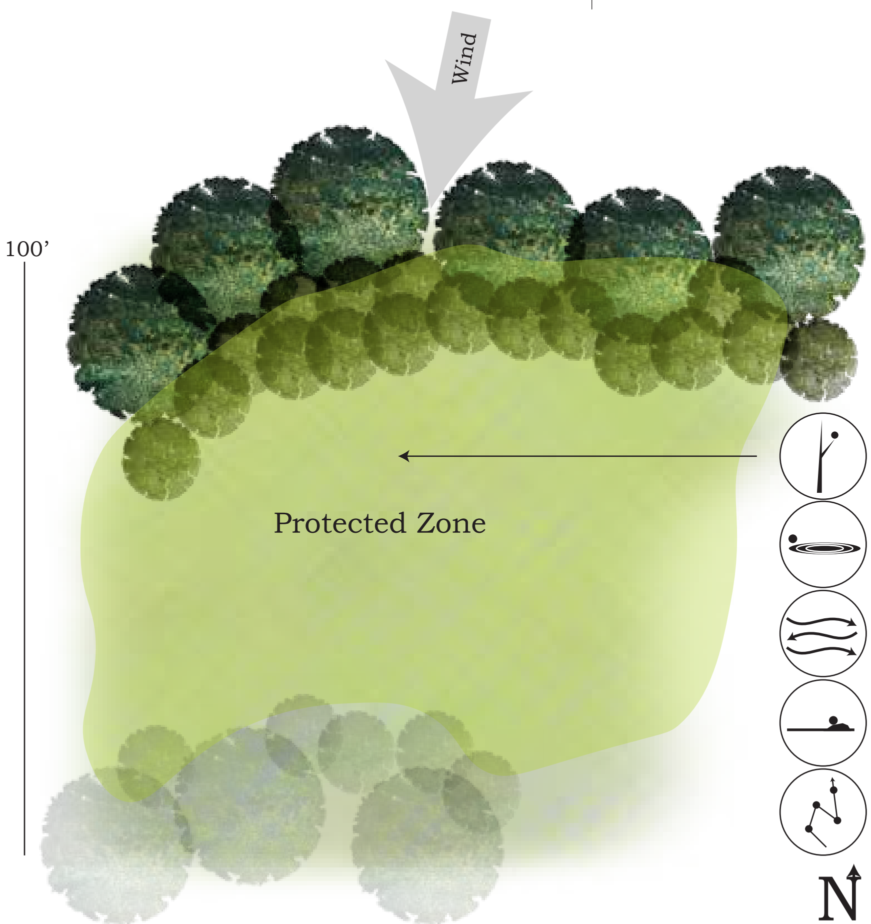
November

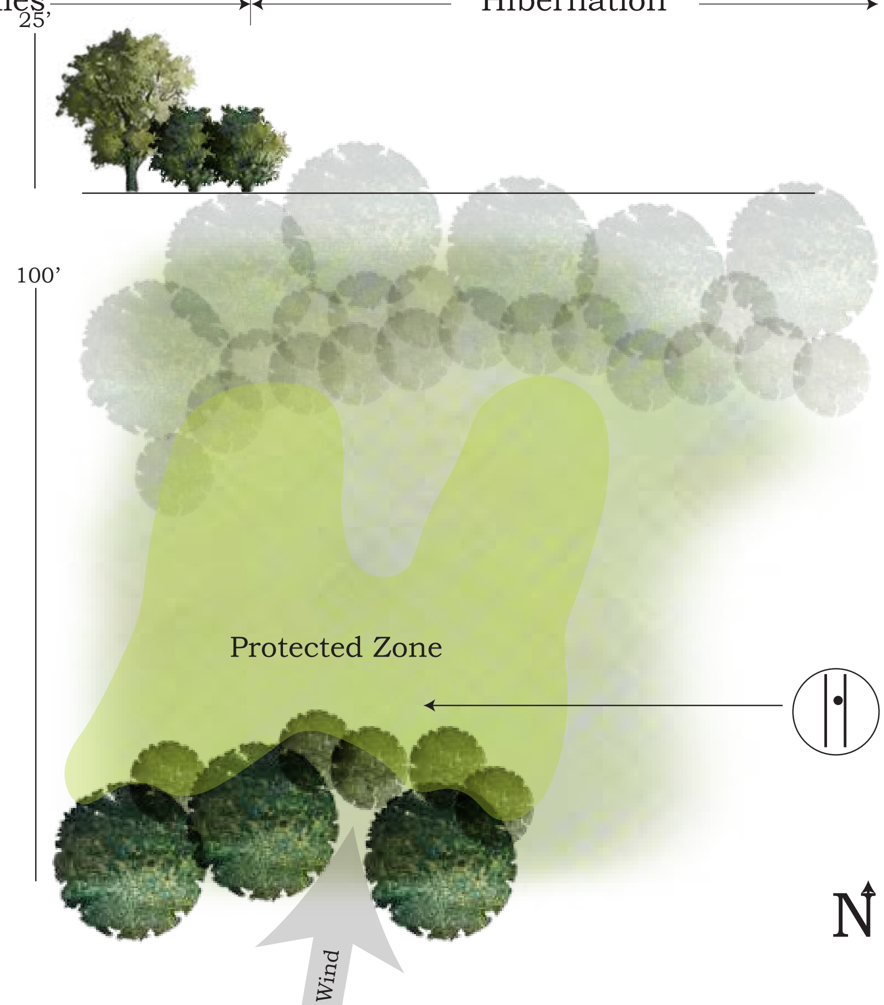


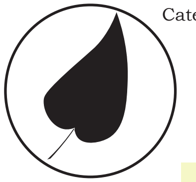
December

Adult Butterfly Activity

Summer Butterflies → | Fall Butterflies → | Hibernation →







Caterpillar

Food

Design Consideration Checklist

- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Configuration of spatial structure
- ✓ Consideration for host plant species
- ✓ Consideration for Habitats
- ✓ Consideration for vegetation structure

Host plants

A butterfly host plant is a species of plant that the larval stage of the butterfly, the caterpillar, uses as its primary food source. Generally, the caterpillar feeds exclusively on the leaves of its host plant, but there are species that feed on the flowers, stems and young seedpods. Most butterfly caterpillars spend their entire larval life cycle feeding on a single species of plant, often on the same plant on which they hatched from as an egg (Tekulsky 1985).

Some species of butterflies are host plant specific, using only one species or one family of plants to serve as an adequate food source. The Monarch butterfly, which only feeds on plants in the milkweed family, is one such species. This narrow range of host plant usage is termed a “feeding specialist”. Other butterfly species will use a wide range of host plants to carry out their caterpillar development. The Grey Hairstreak butterfly caterpillar will feed on oak leaves, mallows, clover, blackberry or sedums. This type of wide range of host plant usage is termed a “feeding generalist”.

Host plants are generally native plants that are found growing naturally within the region where the butterfly occurs. These native plants form the majority of the usable species of host plants for locally occurring butterflies. However, exotic plants within people’s gardens or escaped plants into the wild, that are closely related to native host plants, will often be adopted as suitable host plants by local butterflies (Tekulsky 1985). Many invasive thistles are used as host plants for the Mylitta Crescentspot or the migratory Painted lady.

Host plants form the backbone to a butterfly habitat garden as they provide the sole food and water source for the developing young butterflies. Without these host plants, the butterfly garden will fail to keep butterflies from taking up residency and establishing themselves in the yard. Remember, the primary purpose of a butterfly habitat garden is to provide suitable habitat to fulfill all life cycle stages for the survival of butterflies.

When determining the plants needed for the butterfly host plants, using locally grown native plant stock should be the first choice. Locally grown plants are well adapted to the soils and climatic conditions of the region and because the plants come from genetically local collected stock, the complex interactions between plant and butterfly remain intact (Michigan State). Native plants, if cared for properly, should flourish with more success than foreign stock or exotic material due to the selective pressures that these plants have evolved within the Willamette Valley (Heritage 2015).

Host plant dispersal is a key consideration. Host plants should be planted throughout the garden in evenly spaced patches. Dispersing the hostplants over a greater area helps ensure that female butterflies will visit a greater amount of plants as they fly throughout their environment and deposit more eggs within the garden. The spreading out of the hostplants helps ensure that not all caterpillars will be concentrated in one location, making it harder for predatory insects and birds to find them as well as reducing food competition between caterpillars (Masumoto 1993).

Adult

Food

Design Consideration Checklist

- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Configuration of spatial nectaries
- ✓ Consideration for flower species
- ✓ Consideration for Habitats
- ✓ Consideration for flower color
- ✓ Consideration for bloom time
- ✓ Consideration for vegetation structure

Food for Adult Butterflies-

Perhaps the most familiar component of the butterfly garden, besides the butterfly, is the flower. Flowers produce a sweet, carbohydrate rich liquid called nectar. Not only does nectar sustain the adult butterfly for energy needed for daily activity, nectar contains vital amino acids that aid in reproduction (Mevi-Schutz, 2005).

The sole purpose of the nectar is to offer a reward to the visiting pollinator, and in exchange, the flower is fertilized. For most butterflies, nectar makes up the majority of the adult butterfly's diet (Tekulsky 1985).

Although there is much debate whether butterflies constitute much benefit to flower pollination, butterflies do display a strong sense of flower fidelity. Butterfly flower feeding specialists who prefer native flowers display fidelity which increases flower visitation, a behavior which promotes the likelihood of successful pollination (Jain 2016).

Specifically designing for butterfly nectar sources requires the designer to pay attention, to not only the species of flowering plants that will be placed within the garden space, but looking closely at flower color, bloom time, sun requirements and the arrangement of these plants both spatially and structurally.

Not all butterfly species see the exact same color spectrum evenly, nor do all butterfly species visit flowers with the same level of enthusiasm (Tekulsky 1985). However, there are some general color schemes that show butterfly preferencing. Purple, yellow, pink and white flowers tend to be the favored colors of both native and exotic flowering plants (Tekulsky 1985). Bloom time is important to consider, as you will want to provide plenty of flowering plants within the garden that bloom at different times throughout the season (NABA). Not all butterflies will be on the wing when certain flowers are peaking in their bloom cycle. Match flowering cycles with butterfly flight time by referencing the butterfly flight times and flower bloom times found in the color plate sections.

Planting flowers in specific quantities and in certain arrangements is important for butterflies to locate these nectar sources. Butterflies are naturally nearsighted and massing flowering plants in large colorful blocks and drifts will help butterflies locate the nectar sources more easily and keep their attention, thus keeping them flying about the garden (Yturralde). The flower garden structure should show the tallest flowers blooming towards the back or center of flower massings and the shortest flowers towards the front or pathways (Xerces Society 1990).

Because full sun promotes a greater diversity of flowering plants and a greater number of flowers per plant, the majority of the nectaring blocks and drifts should receive full sun. Protection from strong winds should be considered, thus flower patches should be placed along the leeward side of wind buffers such as thickets or forest edges.

Nectaring

Design Consideration Checklist

- ✓ Consideration for flower species
- ✓ Consideration for flower massing
- ✓ Consideration for flower color
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day
- ✓ Consideration of bloom time

Nectar sources-

Most adult butterflies feed on a variety of flower types. Shape, color, height, fragrance and time of bloom all factor into flower choice and frequency of visitation (Tekulsky 1985). Butterflies which tend to visit a variety of flower types are termed feeding generalists. These feeding generalists tend to move from flower to flower, visiting and sampling a wide range of bloom types (Shackleton 2016). The advantage of nectar feeding generalist behavior, is as flowers move in and out of bloom cycles, butterflies can switch to new species of flowers which come into bloom, promoting the butterfly's distribution and extending flight times.

Alternately, there are certain butterfly species which tend to be picky about flower choice and flower fidelity. Nectar feeding specialists prefer native flowers and often form a co-evolution towards certain flowering plant species (Jain, 2016). The advantage here is the flowers are visited more exclusively and thus are pollinated at higher rates. The disadvantage for the butterfly, is when the flower stops blooming, the food supply is limited. As habitat is reduced and exotic flowers replace native flowers, nectar feeding generalist butterflies can adapt to these new resources.

Studies have documented that feeding specialization places butterfly species at a greater extinction risk (ScienceDaily, 2016). The lack of quality nectar sources is considered one of the factors for butterfly population declines (Shackleton, 2016)

Nectar feeding specialist butterflies tend to visit native flowers more exclusively (Jain 2016). Where generalist feeding butterflies seem to move from native flowers to exotic garden varieties more easily. Although I assert gardening with native flowering species should be the emphasis within a butterfly habitat garden, the advantages of providing a select few high performing, high quality exotic flowering species may provide for butterfly survival.

With exotic flower species, caution should be used. Many commercially grown garden flowers have been hybridized for bloom size, bloom performance, color, and overall garden performance. These flower choices may appeal to the aesthetics of people, but may prove of little value to butterflies, as many lack quality nectar or have petals are too large or too great in number for insects to reach existing nectaries (Tekulsky, 1985).

However, because of habitat loss and the lack of native flower sources, the use of commercially grown flowering plants does warrant consideration. Cultivated exotic flowering plants can provide excellent sources of nectar for hungry butterflies, and because these cultivated plants generally have a longer bloom season than native plants, the planting of them can extend the flight season of many butterflies. A list of high quality exotic flowering plants has been provided in this guidebook.

Color-

Butterflies display a wide color preference range within flower groups and show a wide range of food foraging strategies. Certain species are more adaptable to sampling a greater range of flower colors than others, but upon examining flower visitation data, certain color preferences begin to arise (Briggs, 2017). Although any flower color has the potential for attracting nectar seeking butterflies, butterflies are most attracted to purple, white, yellow and pink, with blue and red a distant choice for flower selection (www.gardenstylesantonio.com).

Although butterflies possess excellent color vision, butterflies are nearsighted, planting plants in drifts or large patches of colorful flowers can draw butterflies from greater distances than if a few sparing flowers were to be modestly placed. Thus, more color in large uniform patches will have a positive effect on the fidelity of the visitation of butterflies (Xerces Society, 1990).

Shape-

In addition to color preferencing, the shape of the flower plays a large part in what specific butterfly species will visit and then ultimately frequent the flower. Large butterflies such as the Tiger Swallowtail or Monarch seek flowers with greater surface that support their body size and weight (Tekulsky 1985). Other smaller butterflies, such as the Woodland Skipper or Eastern Tailed Blue can be found seeking nectar from tiny, almost inconspicuous flowers.

Basic flower shape varies to some degree, but flower morphology can be a key determining factor to the attraction of butterflies (Tekulsky 1985).

Butterflies prefer an inflorescence (multiple flowers clustering atop a single stem) rather than a solitary flower, as the multiple inflorescence offers multiple nectar rewards. An inflorescence gives the butterfly a large pad to rest upon while feeding (Tekulsky 1985).

Because flowers that produce an inflorescence provide butterflies with an ample nectar supply within a single location, butterfly use of these types of flowers increases and are sought out by many butterfly species. In return, because of butterfly fidelity, pollination of these flowers increase (Tekulsky 1985).

Fragrance-

In addition to color and shape, fragrance is key to elicit butterfly interest and is a co-evolutionary trait that flowers and pollinators share (Tekulsky 1985). Butterflies have excellent sense of smell and fragrance draws them to the source (butterfly circle 2017). This is the reason for flowers producing fragrance. Native flowers have evolved complex relationships with their pollinators. Producing a flower is one of the most energy costing efforts a plant undergoes. Producing these complex chemical fragrance compounds that elicit the attention of passing by insects such as butterflies needs to be as effective as possible to ensure pollination occurs.

However, in this human age of hybridizing flowers, fragrance unfortunately, has been selected out at the expense of the visual value to flowers. Given the choice between two flowers of equal size and color, the one that is the most fragrant will be visited often. We as designers of butterfly gardens, need to make flower choices based on the benefit analysis of nectar reward to pollination relationships.

Again, the choice of native plants, that have regionally evolved with local butterfly species should continue to be the primary choice for nectar sources.

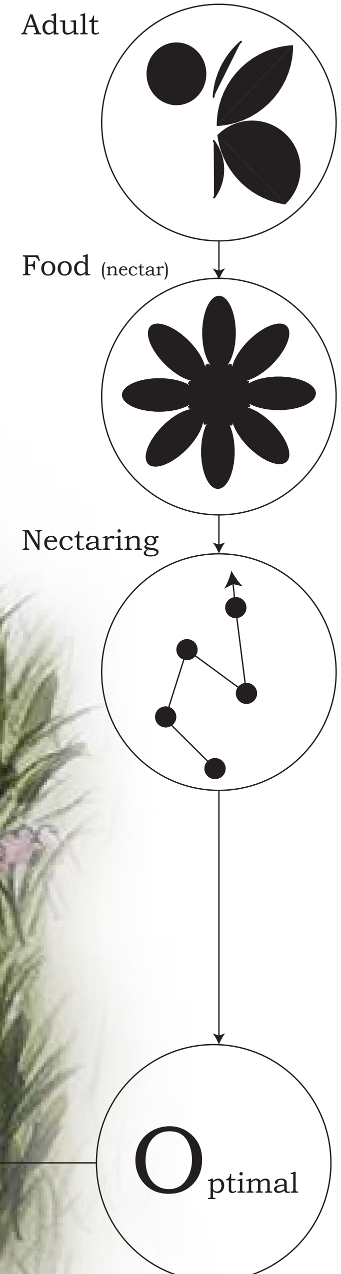
"Use locally-sourced plants to assure the biochemistry and phenology to which local pollinators are adapted"

-Bruce Newhouse
salixassociates.com

The Guidebook: Butterfly Nectaring

BEHAVIORS

Perhaps the most familiar component of the butterfly garden is the flower. Flowers produce a sweet, carbohydrate rich liquid called nectar. Not only does nectar sustain the adult butterfly for energy needed for daily activity, nectar contains vital amino acids that aid in reproduction.

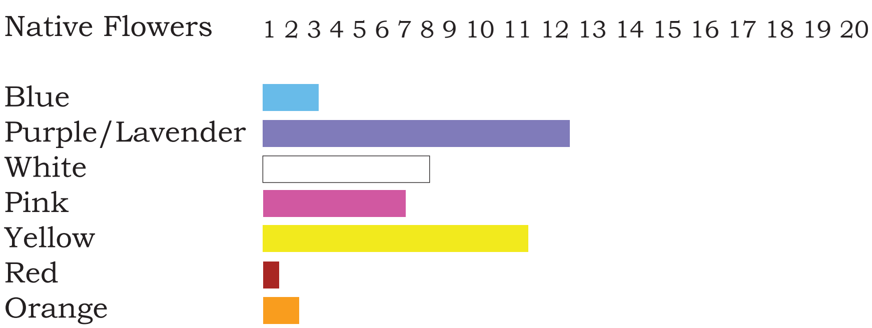


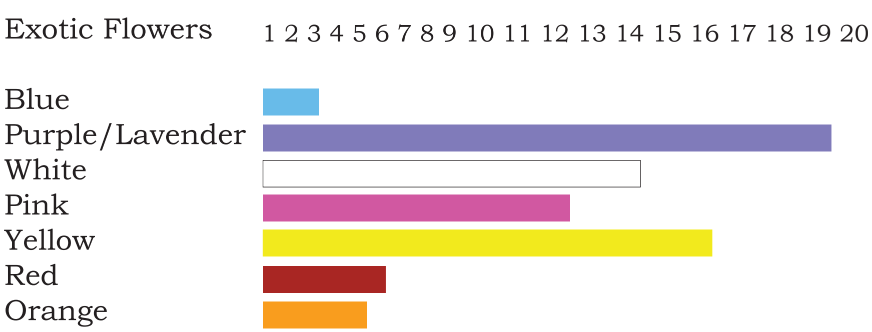
The color of the flower is a vital consideration for flower choice for the butterfly garden. Butterflies are extremely color sensitive and possess the ability to see color better than any other animal (Osorio 2008).
But exactly what colors of flowers do butterflies prefer?

The following chart below shows the spatial range of flower color preference based on nectar source visitation lists and in-field observation flower to butterfly visitation studies. This graph demonstrates that both native and exotic flower color, attract butterflies at nearly the exact same ratios.

The native flower list comprised of 50 flower species, the exotic flower list comprised of 75 flower species. The purpose was to examine butterfly flower visitation based on color. Results show butterflies universally prefer the same colored flowers regardless of the flower's origin (Fig 3.18).

What colors of flowers do butterflies prefer?





Butterflies see across a light wavelength spectrum that includes ultraviolet light (Osorio 2008). This ability to detect ultraviolet light allows butterflies to detect flower colors that human color perception (Tekulsky 1985).

Some flowers have nectar guides that are visible to the human eye and often give the flower petals a characteristic dark ring around the center. However, many flowers have nectar guides that are invisible to the human eye and can only be seen under the ultraviolet spectrum of light.

Figure 3.17 Flower petal color guides as seen by butterflies. Images curtsy of Insecta Spectra

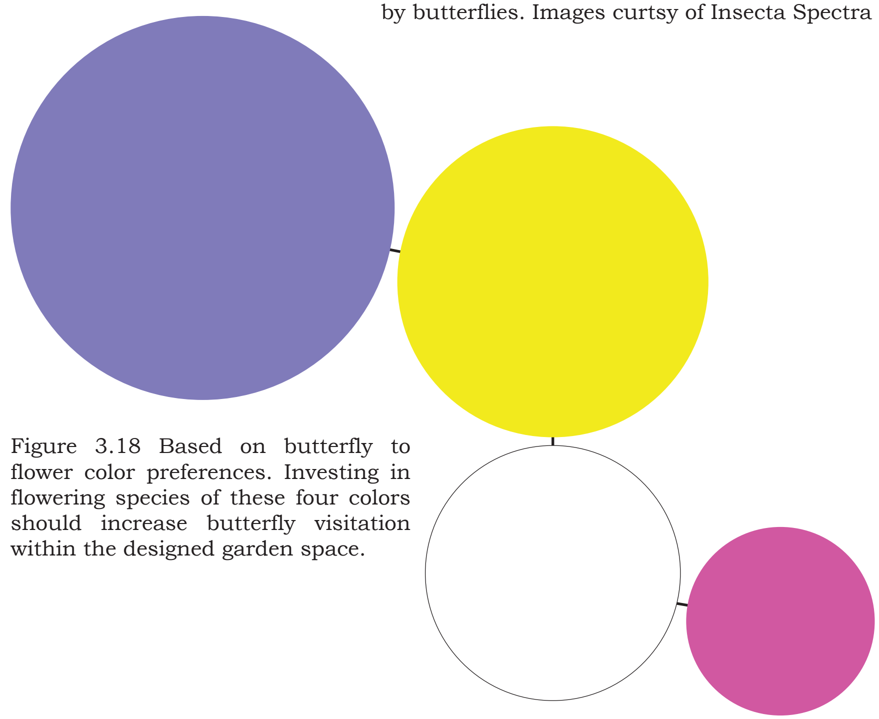
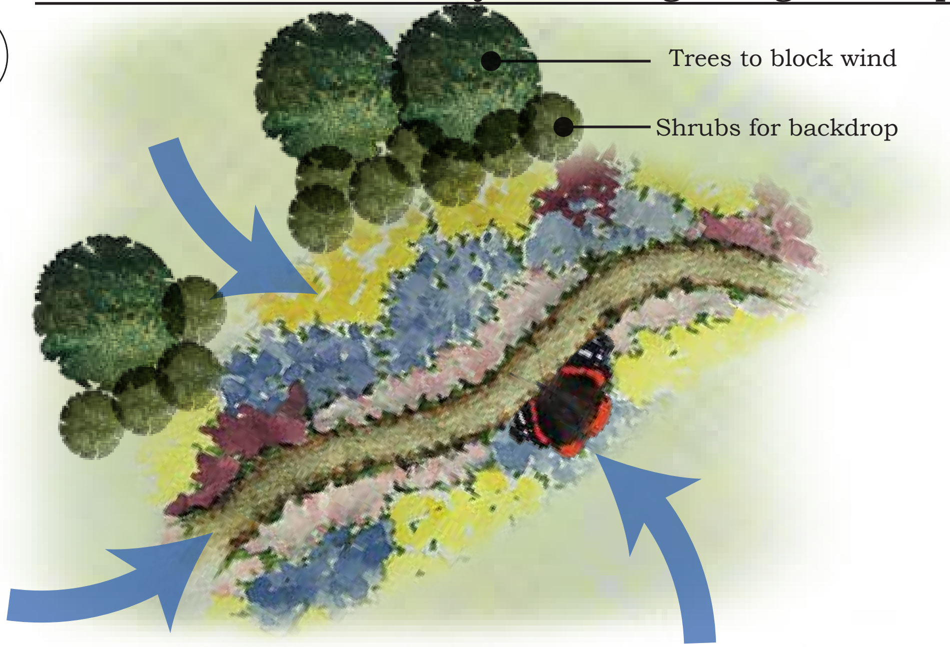
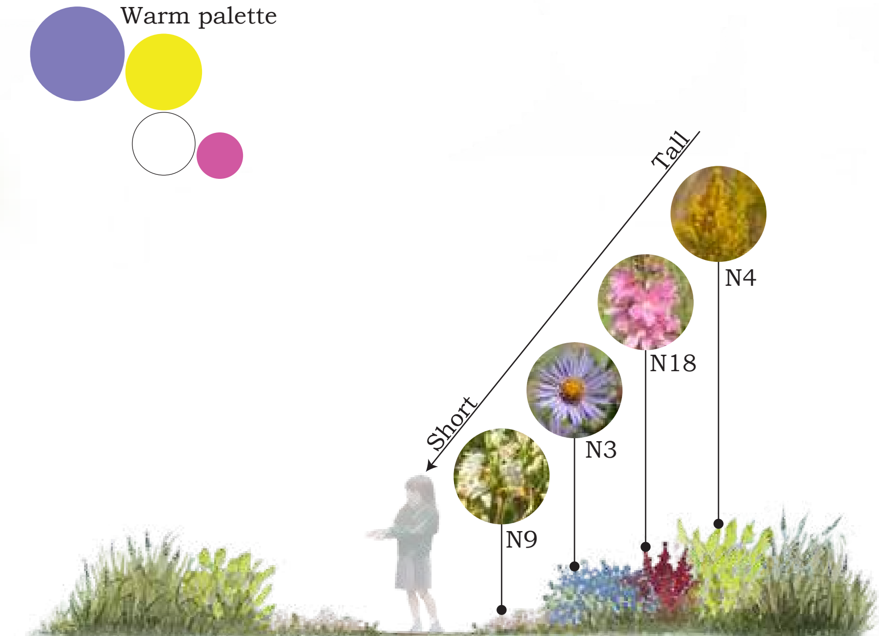


Figure 3.18 Based on butterfly to flower color preferences. Investing in flowering species of these four colors should increase butterfly visitation within the designed garden space.

The Guidebook: Butterfly Nectaring Design Examples

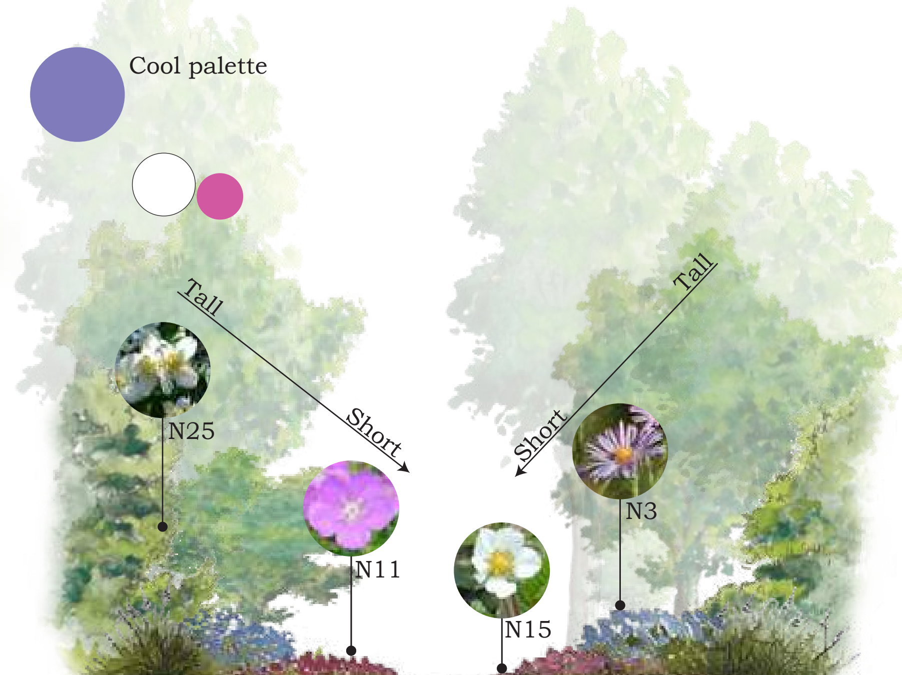


Prairie/Savanna Nectar Massing Design: Full sun exposure. Place color massings of flowers in groups to catch the eye of butterflies.



Sun gardens drive a warmer color palette. Place these warm colors next to cooler colors to compliment and bring attention to cooler colors.

Woodland/Forest Nectar Massing Design: Dappled sun exposure. Place color massings in open sunny clearing along trails.



Shade gardens drive a cooler color palette. Place these cooler colors in masses according to their height. Tallest to the back, shortest to the trail.

List Making Process

When accessing a butterfly gardening book or web page, generally a list of preferred butterfly attracting flowering plants is provided. What isn't provided is how these plants became part of these lists. To address this lack of data, I devised a system for researching the top butterfly attracting flowers, both for native flowering plant species and for exotic flowering plant species, based on reputable butterfly gardening resources.

For native flowering species, I compiled data from six separate local butterfly gardening sources. Each time a flower species appeared on a list, I gave that plant a check mark. After the six separate sources of data were compiled, I was able to see which flowering plants appeared on the lists repeatedly. If a flower appeared on all six sourced lists, it was ranked as a six out of six, meaning these flowers are documented to elicit butterfly nectaring usage at reliable rates. The same ranking and selection process was applied to the exotic flower lists, with an eight out of eight source list ranking.

To further verify my lists were accurate, I used direct observation, in both natural habitats and residential gardens throughout Eugene, to confirm that these plants were actually being used by butterfly species as previously documented. I feel that I have provided flowering plants that are of high quality and should serve in meeting the needs of local butterfly species (Table 3.3).

These lists are by no means a complete list of the flowering species that can meet the needs of local butterflies. Rather, this is a starting point of flowering species for consideration as appropriate plant selections. Not all species of flowering plants will perform well in all gardens and not all flowering plant species will elicit butterfly use in the same manner. The key is to experiment and use what works for the butterfly garden.

Native Nectar Sources		Exotic Nectar Sources	
1. Western Goldenrod	(6)	1. English Lavender	(8)
2. Pearly Everlasting	(6)	2. Cone flower	(8)
3. Douglas Aster	(6)	3. Tall Verbena	(8)
4. Showy Milkweed	(6)	4. Sneezeweed	(7)
5. Indian Hemp	(4)	5. Cardinal Flower	(7)
6. Oregon Geranium	(4)	6. Common lilac	(7)
7. Yarrow	(3)	7. New England aster	(7)
8. Wooly Sunflower	(3)	8. Fleabane spp.	(7)
9. Mule's Ears	(3)	9. Butterfly weed	(7)
10. Bigleaf Lupine	(3)	10. Honeysuckle spp.	(6)
11. Riverbank Lupine	(3)	11. Garden thyme	(6)
12. Rose Checkermallow	(3)	12. Sage spp.	(6)
13. Lance selfheal	(3)	13. Sweet Williams	(6)
14. Woods Strawberry	(3)	14. Pincushion flower	(6)
15. Rosy Plectritis	(3)	15. Goldenrod cultivars	(6)
16. Showy tarweed	(3)	16. California lilac spp.	(6)
17. Cluster thistle	(3)	17. Tickseed	(6)
18. Spreading dogbane	(3)	18. Cosmos	(6)
19. Congested snakelily	(3)	19. Rosemary	(5)
20. Fernleaf biscuitroot	(2)	20. Blazing star	(5)
21. Hall's Desert parsley	(2)	21. Lantana	(5
22. Narrowleaf milkweed	(2)	22. Mint spp.	(5)
23. Willamette Valley gumweed	(2)	23. Oregano	(5)
24. Hall's Aster	(2)	24. Garden phlox	(5)
25. Slender cinquefoil	(2)	25. Stonecrop	(5)
26. Oregon Iris	(2)	26. Black eyed Susan	(5)
27. Mockorange	(2)	27. Bluebeard	(5)
28. Common camas	(2)	28. Globe thistle	(5)
29. Pacific Bleeding Heart	(2)	29. Red valerian	(5)
30. Columbia (Tiger) lily	(2)	30. Yarrow varieties	(5)
31. Narrowleaf onion	(2)	31. Zinnia	(5)
32. California poppy	(2)	32. Bee balm species	(4)
33. Bluehead gilia	(2)	33. Michaelmas Daisy	(4)
34. Red columbine	(2)	34. Pot marigold	(4)
35. Nootka Rose	(2)	35. Chives	(4)
36. Oregon saxifrage	(2)	36. Blanket flower	(4)
37. Showy fleabane	(2)	37. Sweetclover	(4)
38. Common cowparsnip	(1)	38. Ornamental onion	(4)
39. Willamette Daisy	(1)	39. Floss flower	(4)
40. Deltoid balsamroot	(1)	40. Candytuft	(4)
41. Lovage	(1)	41. Hebe spp.	(4)
42. Cusick's checkerbloom	(1)	42. Shasta daisy	(4)
43. Oceanspray	(1)	43. Dusty Miller	(4)
44. Blue elderberry	(1)	44. Garden violet	(4)
45. Giant Blue-eyed mary	(1)	45. Sweet alyssum	(3)
46. Seep monkeyflower	(1)	46. Buttonbush	(3)

Table 3.3 Top performing nectar producing flowering plants

Perching

Design Consideration Checklist

- Combine with Sunlight Need
- Consideration for Wind Protection
- Combine with Reproduction Need
- Consider Hostplant association
- Consideration of perching species
- Consideration of vegetation structure
- Consideration for time of day
- Consideration of Habitats
- Consideration of Basking Behavior

Perching-

Perching is a mate-location behavior exhibited by male butterflies of certain butterfly species. (Dennis, 1988). In perching, male butterflies will pick out a strategic spot in their habitat that will provide them with a favorable vantage point for locating female butterflies. Perches are generally used by a solitary male for one to several days (Scott 1975). Males will rest atop vegetation, on a rock or bare earth. Male butterflies that have established a perch will defend that location from other rival males that enter their territory. When a rival male does enter a perching male's perch zone, the intruder is pursued and driven off (Dennis 1988).

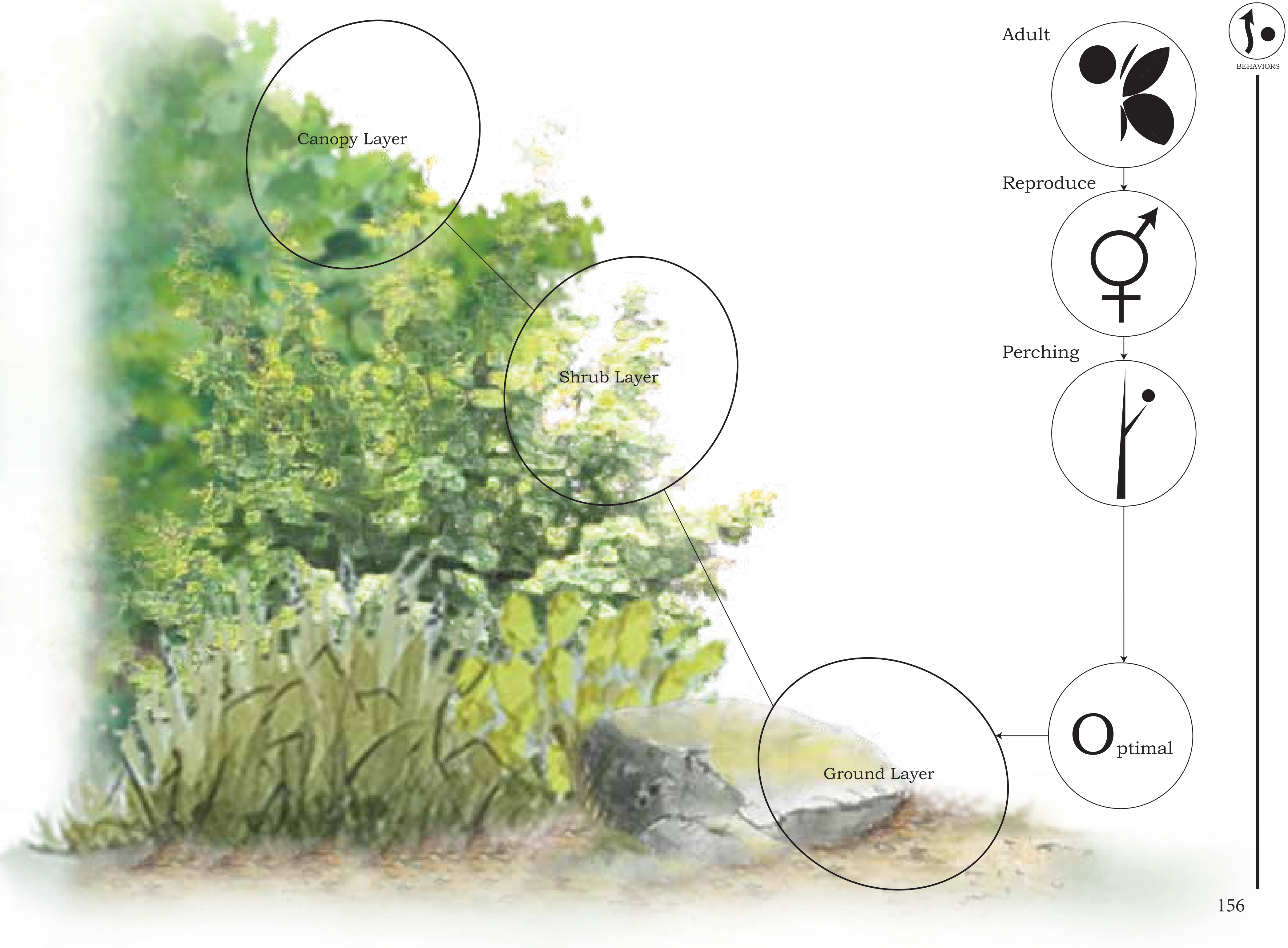
Perching has energy saving advantages, where the butterfly does not expend costly energy in constant flight looking for a female. The disadvantage to perching is chance. Establishing a perch and counting on a female to pass by can be a gamble. It has been long accepted that perching occurs in areas that are near areas where female will visit; nectar sources and hostplants (Rutowski 1991).

Certain species tend to favor specific height variances when perching (Scott 1975). Some species are nearly always found perching on bare ground. Other species perch two to three feet off of the ground, while other species prefer an elevated perch some atop large shrubs or tree limbs. Certain species can tolerate multiple males within their perching areas, where other species tend to have little tolerance towards rival males and will chase them away upon sight (Dennis 1988).

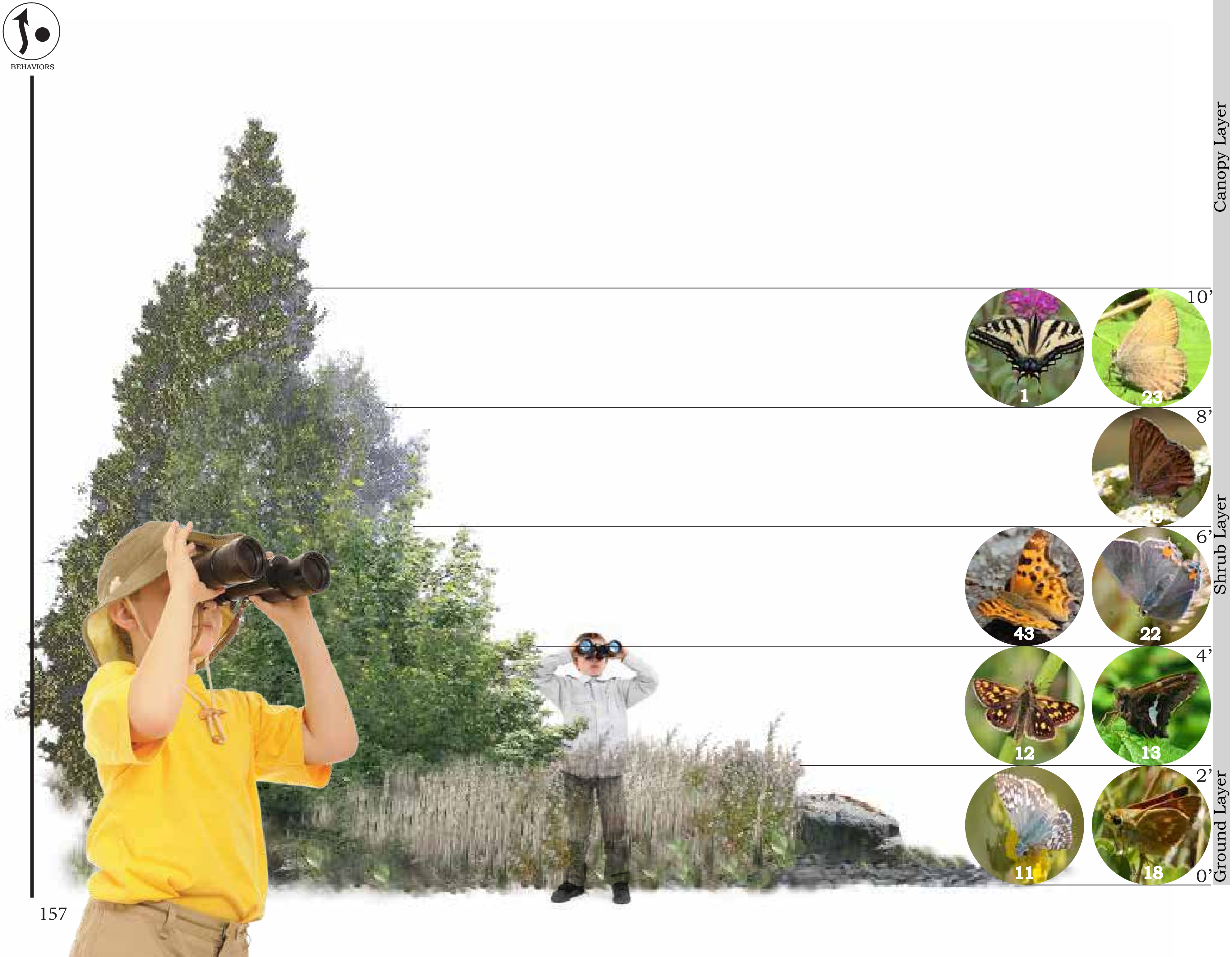
It is impossible to predict the efficacy of a designed perching station. However, I assert, that thoughtful design should increase use and fidelity. Perching stations should be a gradient of mixed height vegetation, structured in a way that allows a perching male to have an unobstructed view of an open area. A ground perching species should be given a gravel or bare earth pad, free from vegetation. A large shrub perching species should have plants planted on the edge of a clearing or pathway. Because butterfly visual acuity is roughly 10-12 feet (Yturralde), perches should be given adequate space for males to clearly see objects entering their perching zones. If multiple perching stations are designed within a garden, separating them beyond a butterfly's visual range will decrease conflict between rival males.

Butterfly species not only perch at different heights, but also at different times of the day (Scott 1975). Most perching stations should be placed in areas that receive protection from winds and where sunlight enters the area.

Lastly, nectar sources and host plants should be closely placed if not purposefully used within perching stations. Butterflies use these host plant-habitat matrices to establish mate-finding behaviors in both males and females. Having nectaring plants and host plants near the perching station could increase male to female encounters (Dennis, 1988).

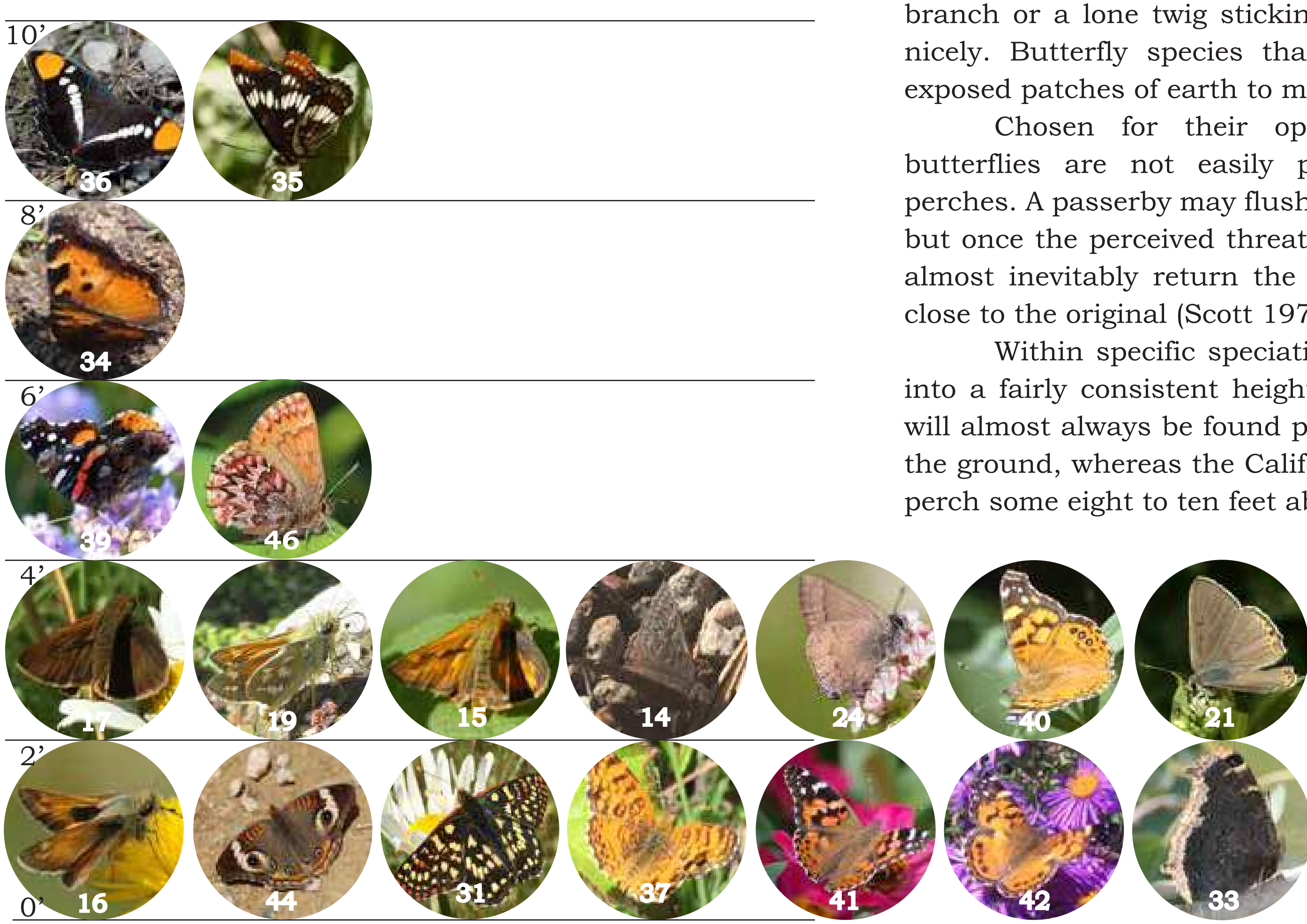

Canopy Layer
Shrub Layer
Ground Layer
Adult
Reproduce
Perching
Optimal
BEHAVIORS

BEHAVIORS


Canopy Layer
10’
1
23
8’
Shrub Layer
6’
43
22
4’
12
13
2’
Ground Layer
11
18
0’

This diagram demonstrates the spatial relationships of perching butterfly species to their environment. Though there are often exceptions to the use of specified heights that particular species will use for perching, this guide should provide a visual cue for the most consistent and likely height that each of these perching species will use.

Spatial relationships between vegetative or ground planes can have a profound effect on butterfly occurrence within both naturally occurring habitats and the built garden environment.



Perching is a mate-finding strategy in which male butterflies select a designated territory within their environment in hopes of encountering a female butterfly of their species (Scott 1975).

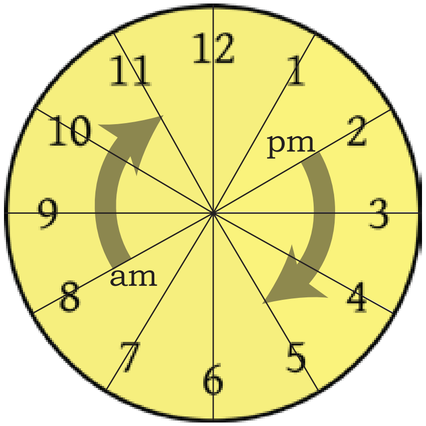
Spatially the perch, depending on the species, can be situated anywhere from the bare earth ground layer, to far into the canopy layer of trees (Dennis 1988).

The perch is generally an object that the butterfly can rest atop with a clear view in all directions to detect oncoming females, ward off would-be rival males, or detect danger from predators (Dennis 1988). A leaf at the end of a branch or a lone twig sticking above the vegetation works nicely. Butterfly species that perch on the ground, use exposed patches of earth to maximize their visual field.

Chosen for their optimal visual location, male butterflies are not easily persuaded to abandon their perches. A passerby may flush out a butterfly from its perch, but once the perceived threat has ceased, the butterfly will almost inevitably return the very same perch or one very close to the original (Scott 1975).

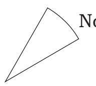
Within specific speciation, perch heights tend to fall into a fairly consistent height range. The Mylitta Crescent will almost always be found perching within the first foot of the ground, whereas the California Sister prefers claiming a perch some eight to ten feet above a trail or clearing.

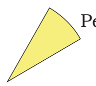
BEHAVIORS

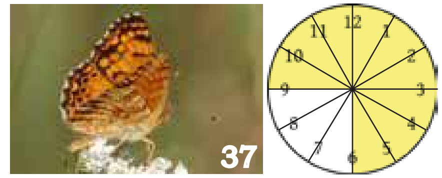


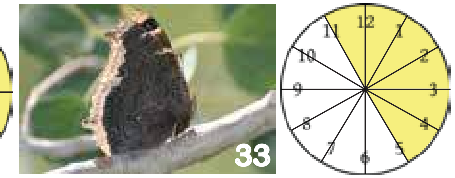
Butterflies perch at different times throughout the day. Based on observation studies, species in the field have been observed perching at the following times. Represented on a human clock, the hours in which the optimal perching time is noted for each species.

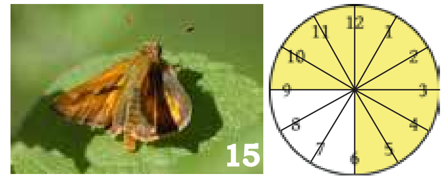
<u>This clock starts at 6am and ends at 6pm (not 24 hr cycle).</u>

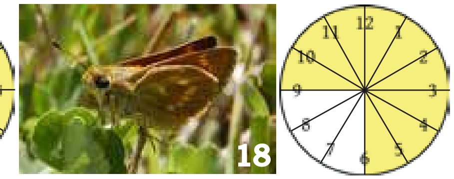

Non-perching

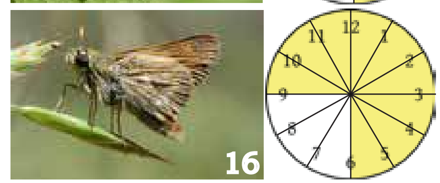

Perching

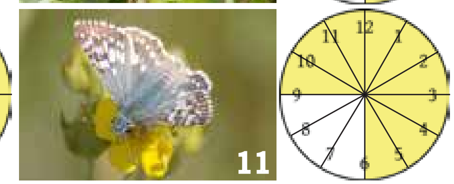


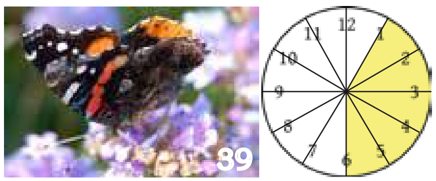


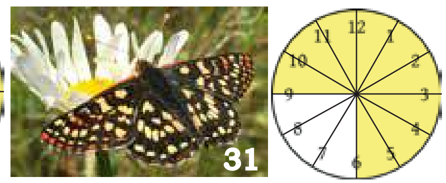


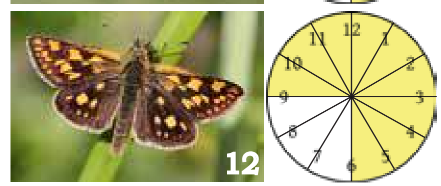


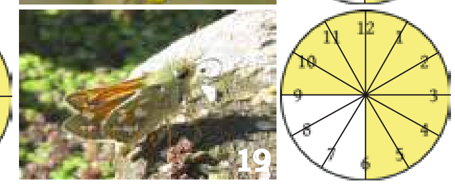


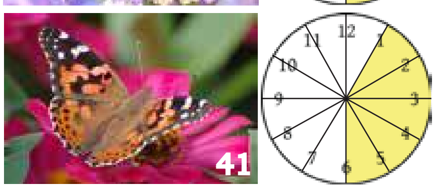


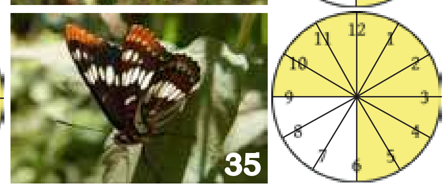


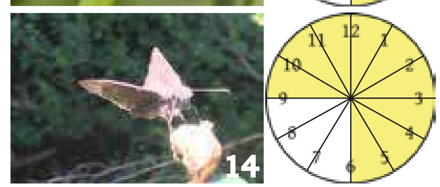


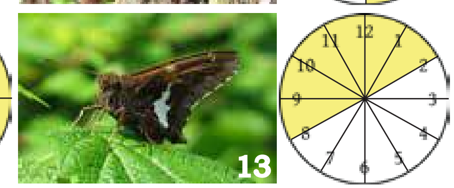


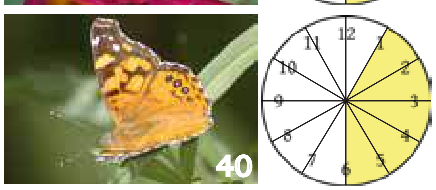


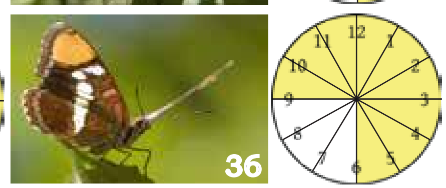


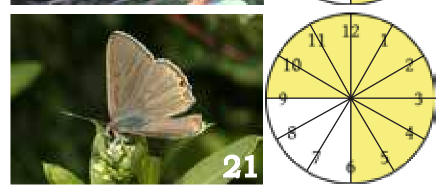


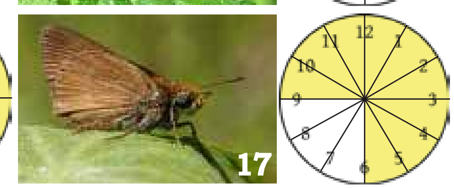


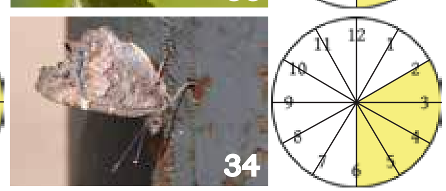


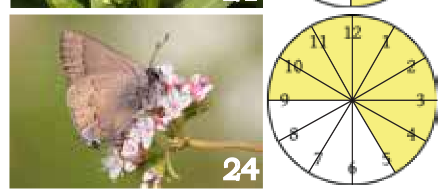


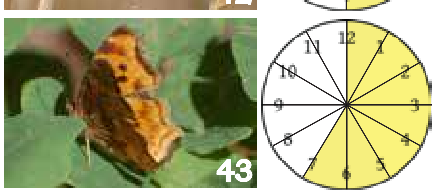


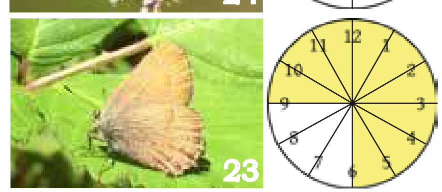


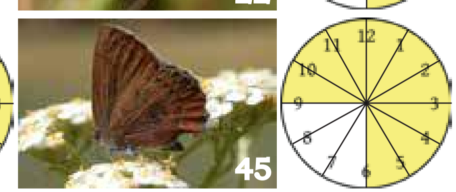












Perching Species

Red Admiral- Males perch singly on the ground, low growing shrubs or sides of trees near nettle patches. In urban areas, perch on rooftops or sides of buildings.

Painted Lady- Males perch singly on open patches of ground or on low growing vegetation.

West Coast Lady- Males perch singly on low lying vegetation and bare patches of earth in open sunny areas.

American Lady- Males perch singly on low lying vegetation and bare patches of ground

Satyr Comma- Males perch singly on intermediate hight shrubs within dappled forest clearings, often near nettle patches.

Variable Checkerspot- Males perch singly or in groups on bare ground, roads, trails or on low lying vegetation. Males will often occupy the same perching spaces.

Lorquin's Admiral- Males perch singly high on taller shrubs or low lying tree limbs in both open sunny areas or within sunny patches within forested areas.

California Sister- Males perch singly on elevated perches atop taller shrubs or low hanging tree limbs along forest edges near or within oak woodlands.

California Tortoiseshell- Males perch singly on low hanging tree limbs or on the sides of trees in wooded clearings.

Common Buckeye- Males perch singly almost exclusively on bare earth, especially in hot open areas such as gravel roads and even pavement.

Mylitta Crescentspot- Males perch singly almost exclusively on bare open ground such as roads and trails.

Woodland Skipper- Males perch singly or in colonies on low lying vegetation, often engaging in aerial battles with other males in groups of six or more butterflies.

Sachem Skipper- Males perch singly on low growing vegetation or on bare earth, sidewalks, or open or manicured turf grass lawns.

Arctic Skipper- Although colonial, males perch singly on low lying vegetation near hostplant grasses.

Propertius Skipper- Males perch singly on low lying vegetation.

Great Copper- Males perch singly atop prairie vegetation.

Hedgerow Hairstreak Males perch at about three feet off the ground on low lying vegetation.

Cedar Hairstreak- Males perch singly on their hostplant, the western red cedar on elevated branches.

Mourning Cloak- Males perch singly on the ground or atop taller shrubs near willow patches or stream systems, but will also break from perching to patrol.

Sonora Skipper- Males perch singly on the ground or on low lying vegetation.

Common Checkered Skipper- Males perch singly, although can be found in colonies atop low vegetation or bare earth.

Juba Skipper- Males perch singly on low lying vegetation.

Silver Spotted Skipper- Males perch singly, although colonial on low lying vegetation.

Dun Skipper- Males perch singly on low lying vegetation near sedge patches.

Grey Hairstreak- Males perch in the later part of the day atop taller shrubs.

Brown Elfin- Males perch low to the ground to more elevated taller shrubs.

Pine Elfin- Males perch low to the ground atop low lying evergreen tree branches.

Note: Butterfly patrolling behavior information was attained through the publications of James A. Scott and through the Montana Field Guide butterfly series (fieldguide.mt.gov/), and through my direct observation.

BEHAVIORS

Patrolling

Design Consideration Checklist

- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Combine with Reproduction Need
- ✓ Consider Hostplant association
- ✓ Consideration of patrolling species
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day
- ✓ Consideration of Habitats

Patrolling-

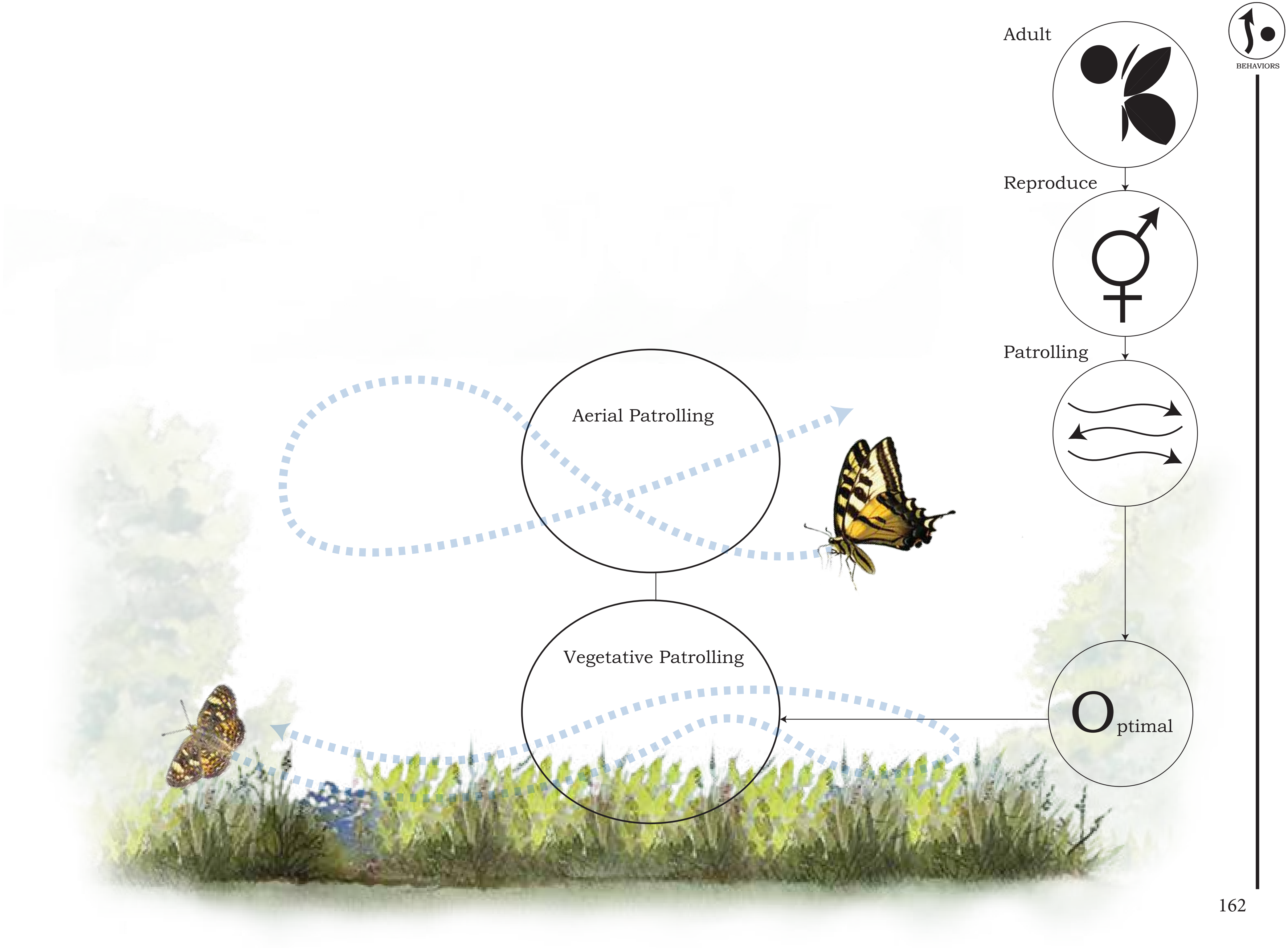
Patrolling is a mate finding behavior exhibited by specific species, in which butterflies continuously fly within their habitat looking for mates. Generally, both sexes of a patrolling species engage in this behavior, with the male playing a more dominant mate-locating role (Scott 1975). Patrolling species engage in this behavior throughout the day and thus are likely to mate at any time during flight hours (Scott 1975). Because of the higher energy costs that continuous flight obligates to a patrolling butterfly, these species show higher flight endurance tendencies. Research also shows that paroling species are less visually acute and rely on each other's movement to find a mate (Wickman 1992).

Patrolling species patrol a territory that is not marked by prominent landmarks but rather patrol their preferred habitat where both nectar and hostplants occur (Wickman 1992). However, some patrolling species show tendencies for patrolling select areas, usually a clearing in a forest, or a path along the edge of a meadow or even a stream's edge (Scott 1975).

Some species such as the Western Tiger Swallowtail use prominent landmarks to establish a territorial flight path. The male Tiger Swallowtail will use a circular or looping pattern in which the insect will fly in a continuous back and forth motion. A sunny opening within a forest clearing or a loop around a few joined back yards in a suburban neighborhood does nicely (Tekulsky 1985).

Within the prairies of the Willamette valley, the Ochre Ringlet butterfly can be seen continuously and methodically bobbing and weaving in and out of the tall prairie grasses in search of mates. Whereas the Orange Sulphur canvases vast amounts of habitat in a more hurried manner. Each butterfly species patrols their environment in their own unique way. The goal of patrolling is to canvas as much habitat during the sunny hours of the day and find a mate. For patrolling species, mating potentially occurs at all hours of active butterfly flight times (Scott 1975). Thus, patrolling species demonstrate a more continuous flight tendency over the more sedentary perching species (Dennis 1988).

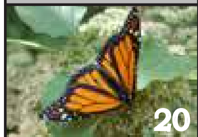
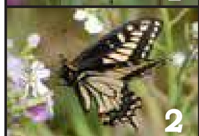
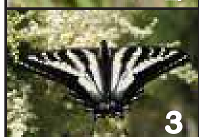
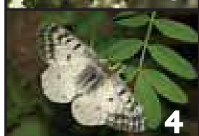
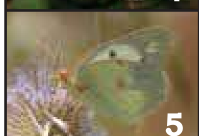
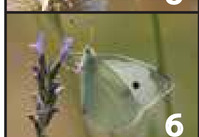
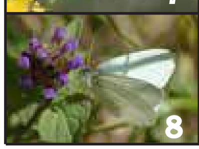
Because patrolling species need to be in constant flight, the habitat needs to be conducive for flight. Creating the vegetation structure that resembles their preferred habitat is key. The habitat garden needs to be bathed in sunshine during the butterfly's patrolling hours, often all day. The area should receive plenty of wind protection by establishing protective wind buffering vegetation stands to keep the garden warm and butterflies in the air. Many patrolling species patrol in areas where their hostplant grows. Distributing the hostplant evenly throughout the garden can help patrolling species gives more space to patrol, promoting more butterflies within the garden. Plant plenty of nectaring plants to keep patrolling butterflies well nourished as patrolling behavior is very energy intensive (Dennis 1988).

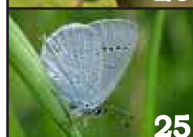
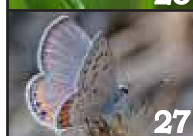
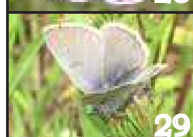
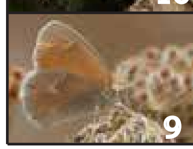

Adult
Reproduce
Patrolling
Optimal
Aerial Patrolling
Vegetative Patrolling
BEHAVIORS

BEHAVIORS

The Guidebook: Butterfly Patrolling Behavior Chart

Patrolling is a mate-seeking behavior where male butterflies canvas their environment looking for mates. Most species patrol within their habitats where their hostplants occur. This chart explains their habitats and suggests some design strategies to promote patrolling behavior.

Species	Habitats	Plant Community	Hostplant(s)	Design
 20		Open Fields Grasslands	Milkweed	Plant a Waystation with lots of milkweed and flowers.
 1		Riparian Corridors Forest Clearings	Willow Ash	Create openings in forests and plant willow stands.
 2		Riparian Corridors Veggie Gardens	Wild Carrot Dill	Plant Dill or Fennel in a vegetable garden.
 3		Forest Edges Riparian Corridors	Ceanothus Cascara	Create openings in forests and plant willow stands.
 4		Meadows Forest Edges	Bleedingheart	Create openings in forests and plant willow stands.
 5		Open Fields Meadows	Clover Alfalfa	Create open fields with plenty of clover and flowers.
 6		Veggies Gardens Urban Gardens	Cabbage Kale	Plant a veggie garden with cabbage plants.
 7		Open Fields Hilltops	Wild Mustard	Create open fields with mustards.
 8		Forest Clearings Riparian Clearings	Watercress	Create openings in riparian forests with hostplant.

Species	Habitats	Plant Community	Hostplant(s)	Design
 32		Forest Edges Open Meadows	Native Violets	Create openings in forests with violets along edges.
 38		Meadows Grasslands	Native Asters	Create meadow of half an acre or more with asters.
 30		Forest Clearings Riparian Corridors	Western Spirea	Create openings in forests and plant spirea massings.
 26		Open Fields Grasslands	Spanish Clover	Create fields with Spanish Clover alongside pathways.
 25		Open Fields Grasslands	Spanish Clover	Create fields with Spanish Clover alongside pathways.
 27		Open Fields Grasslands	Spanish Clover	Create fields with Spanish Clover alongside pathways.
 28		Grasslands	Kincaid's Lupine	Plant large patches of Kincaid's lupine in grassland.
 29		Open Woodlands Grasslands	Vetch Lupines	Create open woodland with plenty of vetch throughout.
 10		Open Woodlands Grasslands	Grasses	Create a grassland of half an acre or more with a woodland.
 9		Grasslands	Grasses Sedges	Create a grassland of half an acre or more.

Patrolling species

Western tiger Swallowtail- Males patrol all day at about six to twelve feet off the ground, males may establish a route in which they continuously patrol in either a back and fourth or circular pattern. Habitats include Hilltops, forest clearings, river corridors and suburban neighborhoods.

Pale Swallowtail- males patrol all day on hilltops, streams banks or forest edges

Anise Swallowtail- Males patrol all day on hilltops, or near hostplant patches.

Clodius Parnassian- Males patrol all day across meadow systems and along forest edges, flying near or between shrubbery, often near hostplants.

Orange Sulphur- Males patrol all day across open areas, flying fast above vegetation.

Cabbage White- Males patrol all day near hostplants, especially within rural and urban vegetable gardens, or riparian habitats.

Western White- Males patrol all day on hilltops or across open fields.

Marginated White- Males patrol all day through clearing or openings within shaded forests, often stopping to bask in sunny clearings.

Ochre Ringlet- Males patrol all day continuously weaving and dipping into tall grasses

Common Wood Nymph- Males patrol during the warm hours of early afternoon just above or often dipping into grasses. Often landing for periods of time before resuming their patrolling. When temperatures reach near 100, butterflies move into the shaded woodlands.

Monarch Butterfly- Males patrol all day in open corridors, open fields, flower patches and milkweed patches.

Western-Tailed Blue- Males patrol all day near the ground over hostplant vegetation in wetlands and stream sides.

Eastern-Tailed Blue- Males patrol all day over host plants but do often resemble a perching behavior as well.

Acmon Blue- Males patrol all day near their host plants along roadsides and open fields.

Fender's Blue- Males patrol all day in a very small area of their hostplants, not straying far from lupine patches.

Silvery Blue- Males patrol all day near vetch or legume patches across open meadows and woodland clearings.

Spring Azure- Males patrol all day atop taller shrubs which serve as hostplants and along river corridors and forest clearings.

Great Spangled Fritillary- Males patrol all day through forest clearings and meadow systems at about four feet off the ground over more sparsely vegetated ground.

Field Crescent- Males patrol all day just above vegetation within colonies through meadow systems where hostplants are numerous.

Pine White- Males patrol high in the canopy of evergreen trees all day, only coming down to the ground in the morning and late afternoon to feed on flowers.

Note: Butterfly patrolling behavior information was attained through the publications of James A. Scott and through the Montana Field Guide butterfly series (fieldguide.mt.gov/) and through my direct observation.

Puddling

Design Consideration Checklist

- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Recognize the Reproduction Need
- ✓ Consideration for Water depth
- ✓ Consideration of spatial configuration
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day
- ✓ Consideration for substrate type(s)

Puddling-

Where mate-finding territorial displays bring out the aggressive side of male butterflies, the opposite behavior is seen with these same species when it comes to puddling. Puddling is a butterfly behavior in which adult butterflies feed atop mud, rotting carrion or even animal dung (Sculley, 1996). It is not uncommon to happen upon concentrated areas of wet soil and find a dozen or more species sipping wet soil alongside each other (Tekulsky, 1985).

Puddling most often occurs in mid-day when the temperatures are high. During the warm months, male butterflies can be seen along streambanks, lake side shorelines, seeps, springs, mud puddles after a rain, or over-spray runoff from irrigation. Although the surface water is a vital source of hydration, it is the dissolved minerals such as sodium (salts) within the wet ground that the butterflies are after (Coetzer 2014). This source of nutrition from puddling cannot be provided by the rich carbohydrate diet of nectar. Although male butterflies gain hydration and nutrition from puddling, puddling can be largely looked at as a reproduction driven behavior. The sodium and amino acids found within the mineral deposits of the soils are paramount for sperm development and maturation (Coetzer, 2014). During mating the male transfers stored minerals from his puddling efforts into the female. These nutrients help in the survivability of the egg clutch (Boggs, 1991).

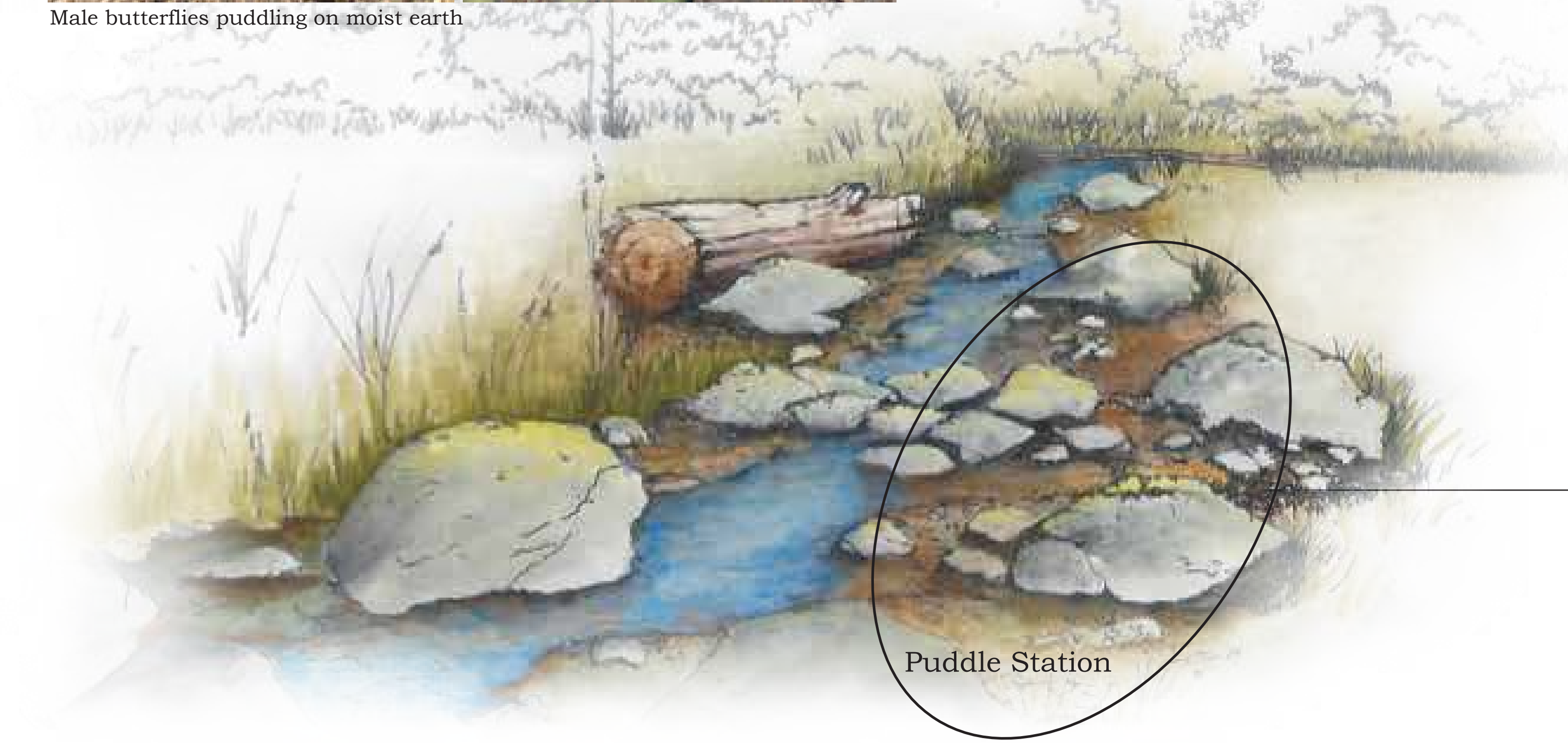
Some butterfly species rely on their vision to locate an adequate water source. Swallowtails, Sulphurs and Whites tend to be visually attracted to a puddles or wet patches of ground (Beck 1999). Smaller butterflies such as blues, use their sense of smell to locate a water source, rather than visual clues (Beck, 1999).

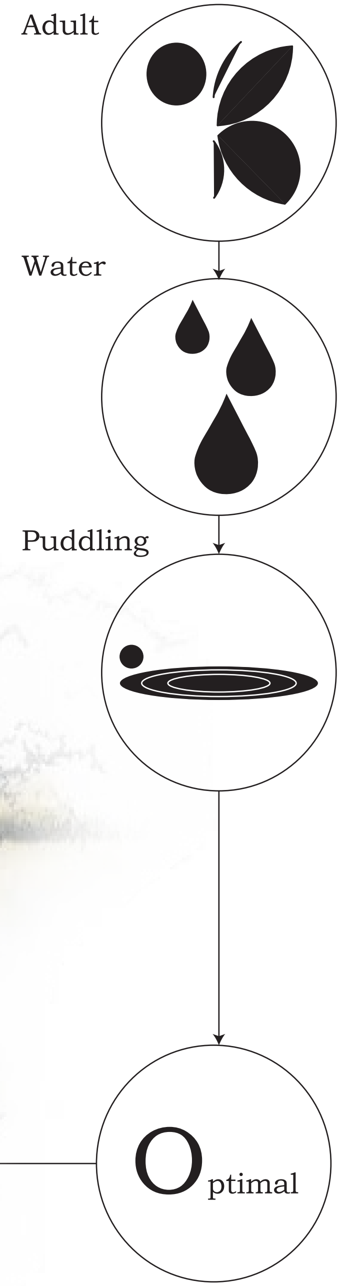
The behavior of puddling in nature translates to the building of a puddling station in the butterfly garden. Many homemade butterfly puddle station designs advocate for a puddle station to be made from a shallow bird bath sized saucer, filled with sand and a bit of manure to provide salts and proteins. This is a simple and inexpensive way to create a butterfly puddle station. In nature, wet patches of earth tend to be larger and occur in areas free from vegetation and debris; such as a creek wash, river bank, or seasonal seep running over exposed soil.

I assert that the size of your garden should drive the size of the puddle station. The area chosen should be free from vegetation, have exposed native soil, have a daily supply of fresh water and be located in an area that receives sun during the late morning through the afternoon hours and be protected from the wind. The water source can be from a natural occurring spring, stream, or seep. It can be sourced from an irrigation system, hand watered daily. The key is to keep the soil moist without letting water stand, as butterflies cannot wade or swim (Tekulsky 1985). Water depth and other requirements are discussed and illustrated on the following pages.

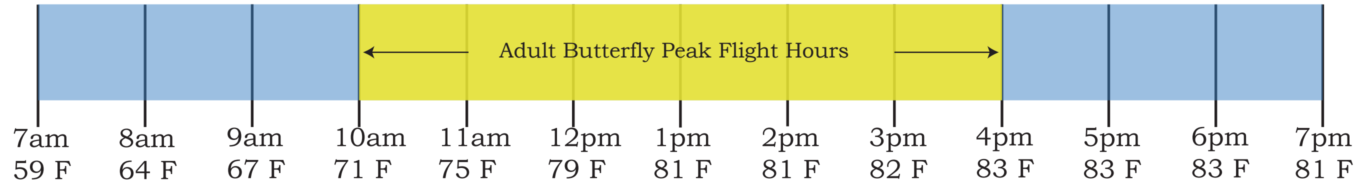
Butterflies seek moisture during the warm months along streambanks, lake-side shorelines, seeps, springs, mud puddles after a rain, or over-spray runoff from irrigation. The surface water is a vital source of hydration as well as dissolved minerals, such as sodium, which cannot be provided by the rich carbohydrate diet found in nectar. It is not uncommon to find large assemblages of butterflies and a dozen or more species sipping wet soil alongside each other (Tekulsky 1985).

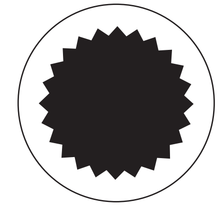
Male butterflies puddling on moist earth



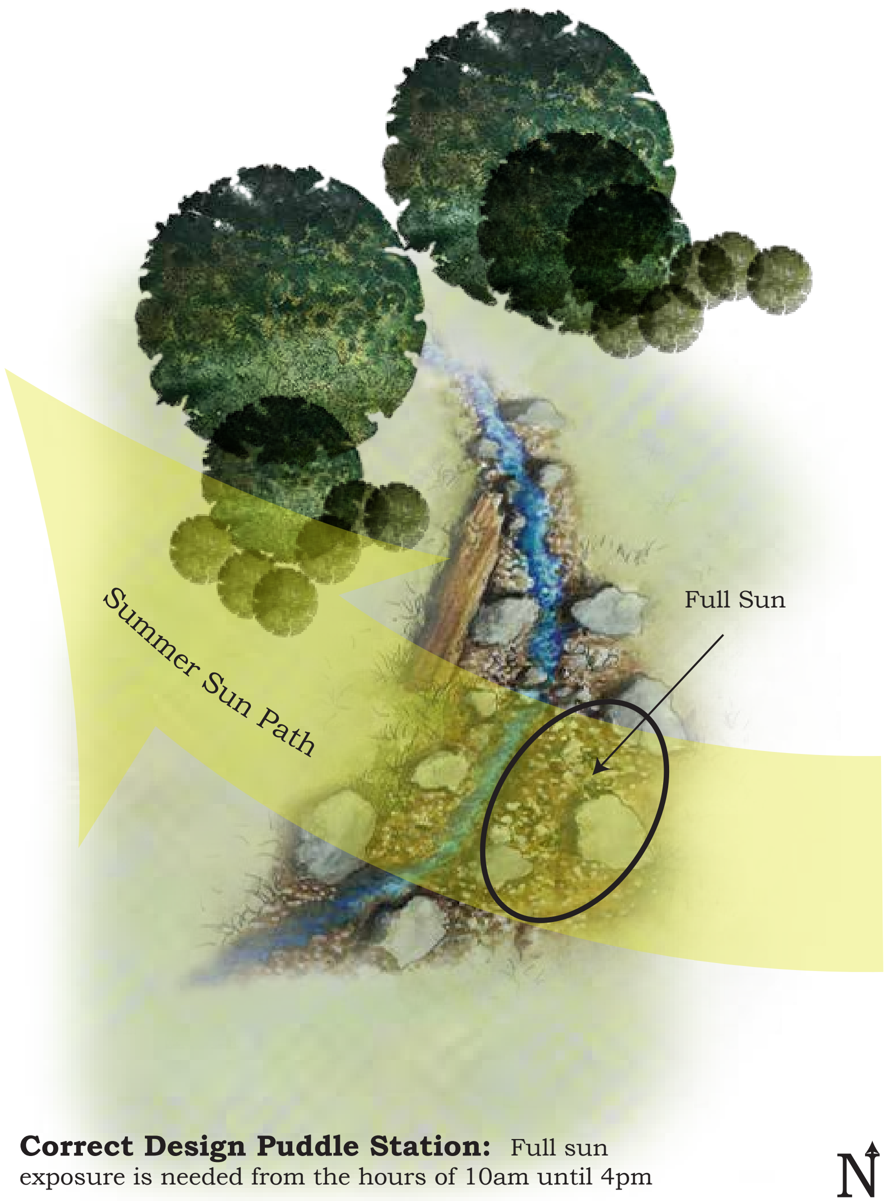


The Guidebook: Butterfly Puddling Sunlight Consideration

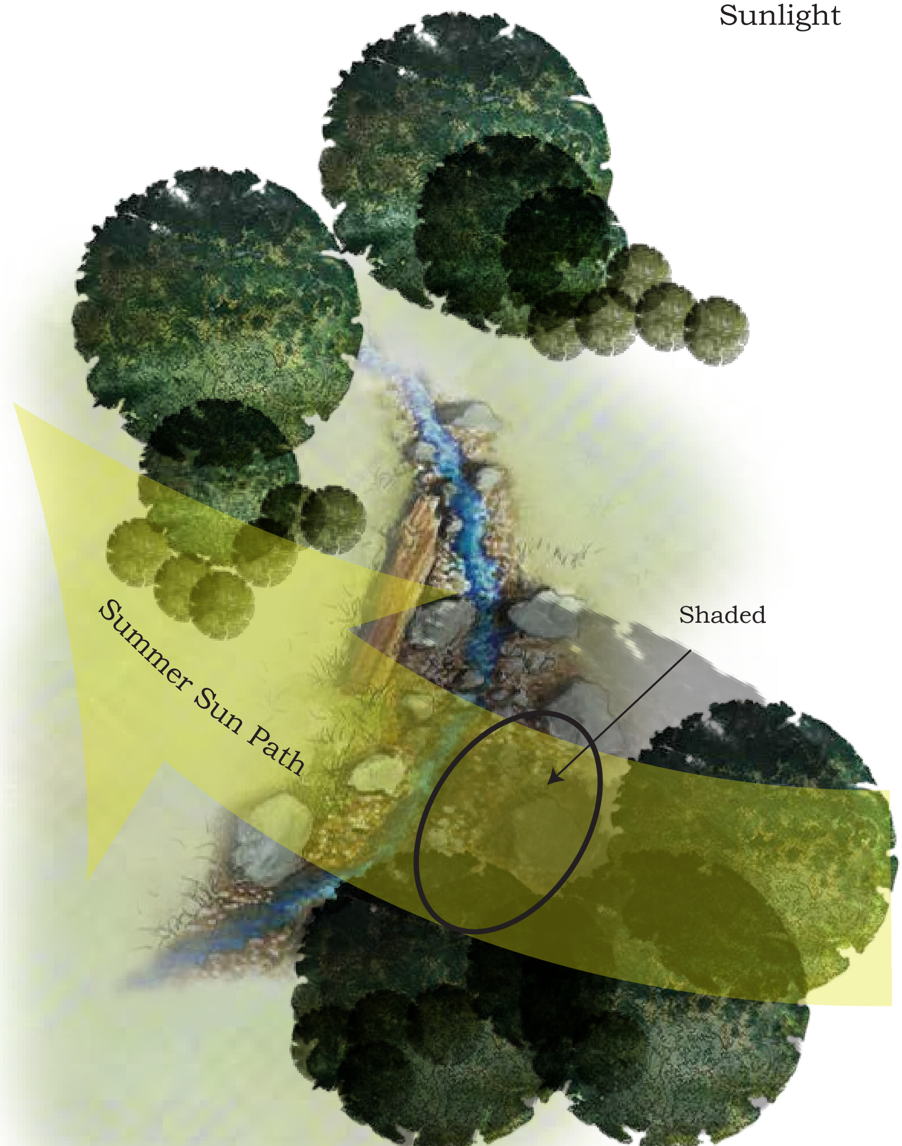




Sunlight



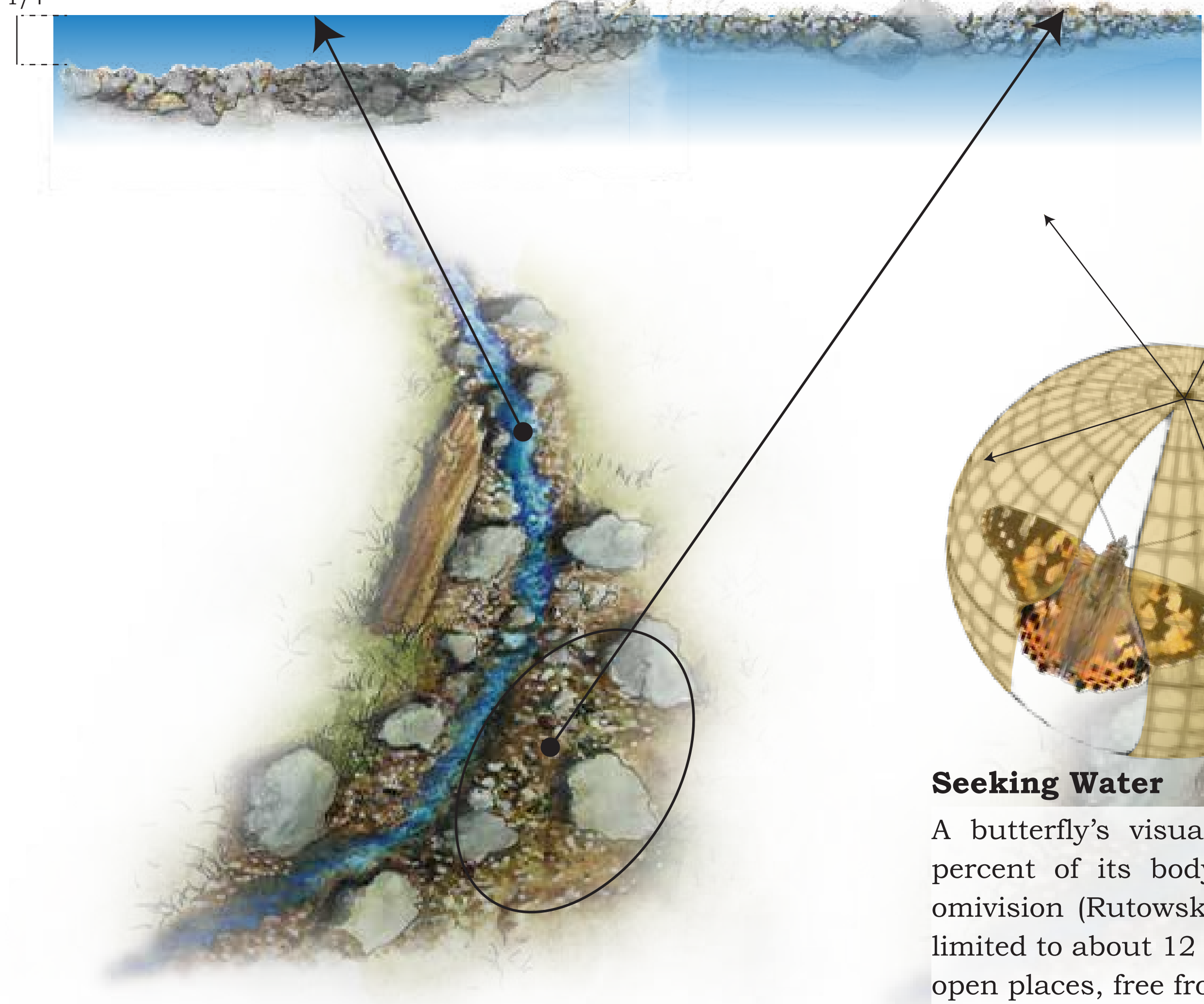
Correct Design Puddle Station: Full sun exposure is needed from the hours of 10am until 4pm



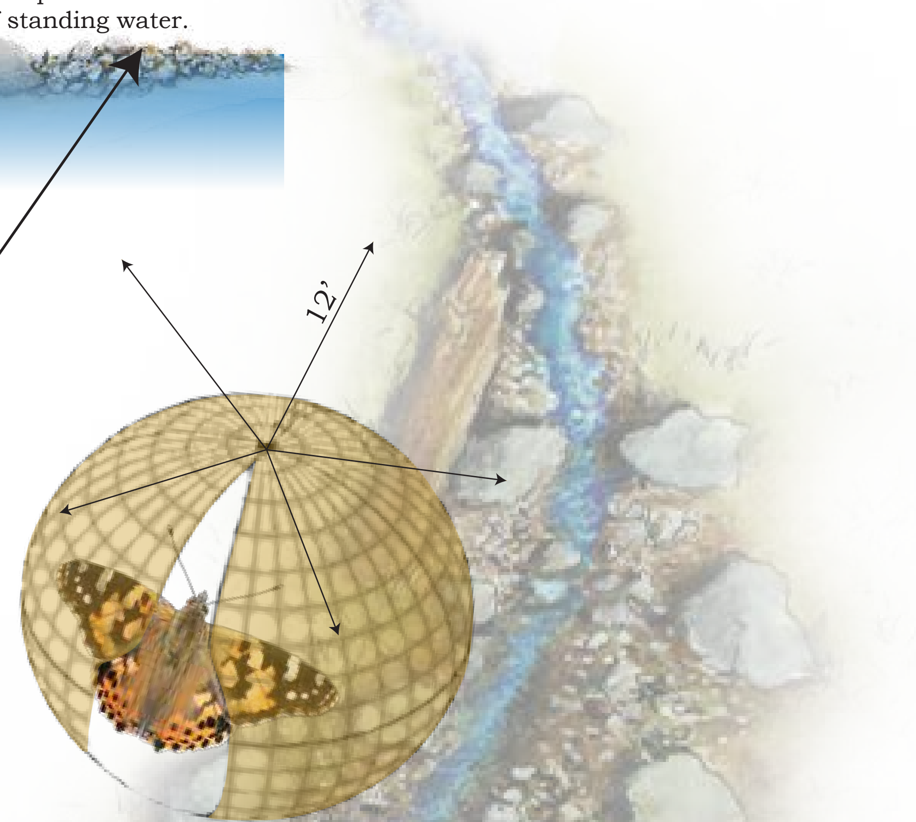
Incorrect Design Puddle Station: Full sun exposure is blocked from large trees casting shadows across the puddle station.

Thinking about water depth

Butterflies can't swim or wade into water, thus they avoid any standing water. Wet sand or moist earth instead of standing water is sufficient for puddling.



Male butterflies are especially fond on wet earth, as the sodium and amino acids found within the mineral deposits of the soils are paramount for sperm development and maturation. These nutrients are then transferred to the female during mating which helps in the survivability of the egg clutch. (Boggs, 1991), (Coetzer, 2014)



Seeking Water

A butterfly's visual field encompasses approximately 93 percent of its body. This gives the butterfly a sense of omivision (Rutowski 2002). However, their visual acuity is limited to about 12 feet. Thus, puddle stations need to be in open places, free from vegetation and obstructions.

BEHAVIORS

Basking

Design Consideration Checklist

- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Consider individual species needs
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day

Basking-

Basking is behavior used by both sexes of adult butterflies for thermoregulation (Clench 1966). Because butterflies are heliothermic (gaining their body heat from direct sunlight energy), they cannot effectively regulate their body temperature (Kemp 2002). External heat sources from solar radiation makes up the majority of sourced heat which allows for mobility (Clench, 1966). Because butterflies have a finite window of activity to feed and reproduce, time is of the essence for attaining flight time to accomplish both goals.

Basking, like perching is a sedentary behavior in which butterflies open their wings towards the sunlight to capture as much solar radiation to warm their thoracic flight muscles (Kemp 2002). Most adult butterflies will seek specific microclimates to bask in. These microclimates are generally heat sinks where wind is reduced, and sunlight is at its highest. Body orientation is key, and most butterflies will position their bodies perpendicular to the sunlight with their wings acting as solar-like panels directing heat inward to the body (Kemp 2002). Other factors aide in the efficiency of solar collection such as dark pigmentation near the body.

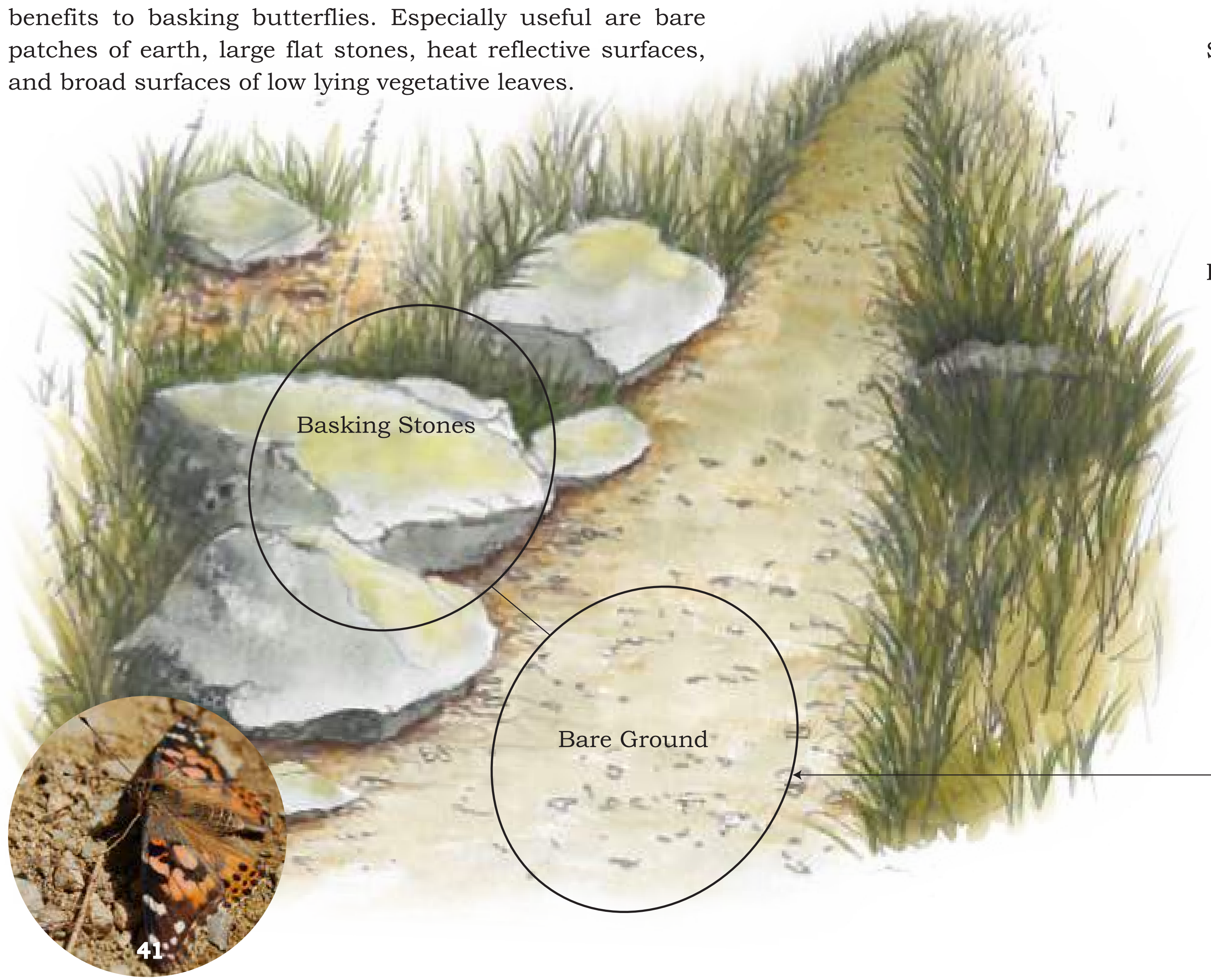
It is often difficult to distinguish perching behavior form basking behavior, as both resemble one another. However, in general, most butterflies whose primary activity at the moment is basking, will open their wings to near horizontal to gain more heat. Butterflies whose wings are closed across their backs are more likely engaged in perching behavior (Kemp 2002). Horizontal wing positioning is not universally adopted by all species. Many Sulphurs and Browns bask with their wings tightly folded over their back to expose the darkened bodies to direct sunlight. Some research indicates that basking may be related to perching as males optimize their ability to pursue potential mates if their body temperature remains at peak values for flight (Kemp 2002).

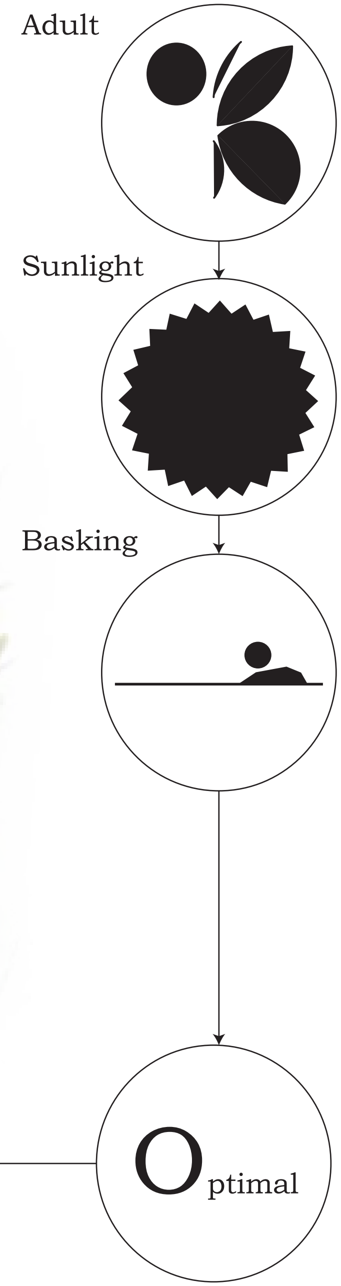
Basking is not exclusive to adult butterflies. Butterfly larvae have the same thermoregulation mechanisms as do adult butterflies. Caterpillars will bask in direct sunlight to increase their body temperatures (Weiss 1988). Caterpillars that have access to sunlight and protected warm environments develop quicker and pupate sooner, both of which are conducive form butterfly survivability (Weiss, 1988). Placing host plants in areas that receive full sun and protection from wind can help all stages of the butterfly lifecycle.

Butterflies will bask continuously throughout the day based on environmental factors such as the availability of sunlight and ambient temperatures. Arguably, one of the more important factors in designing a garden that promotes basking is creating microclimates that receive full sun and wind shelter in the early hours of the day. Butterflies lose body heat through the night as they roost. Creating gardens that receive full sun from sunrise and through the morning hours, will help butterflies attain heat they need for maintaining functional activity. Creating basking stations such as gravel pads and basking stones that are bathed in sunlight in the morning will help butterflies gain heat and begin their activities sooner.

The Guidebook: Butterfly Basking

Basking is universally performed by butterflies to acquire heat from solar radiation. Designing for basking is much like that of designing for perching. Many butterflies bask at the same levels of perching. Designing specifically for basking behavior should involve the provision of certain design strategies that provide the maximum heat gain benefits to basking butterflies. Especially useful are bare patches of earth, large flat stones, heat reflective surfaces, and broad surfaces of low lying vegetative leaves.

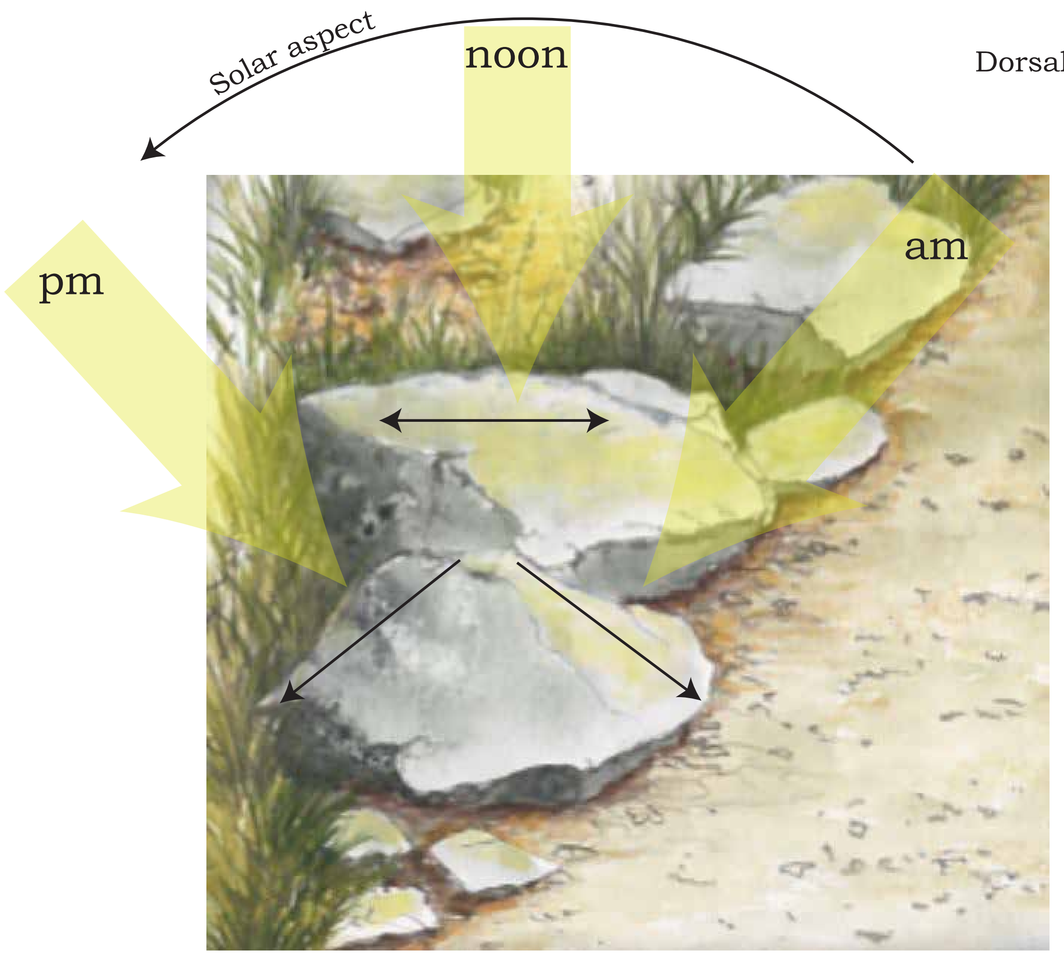




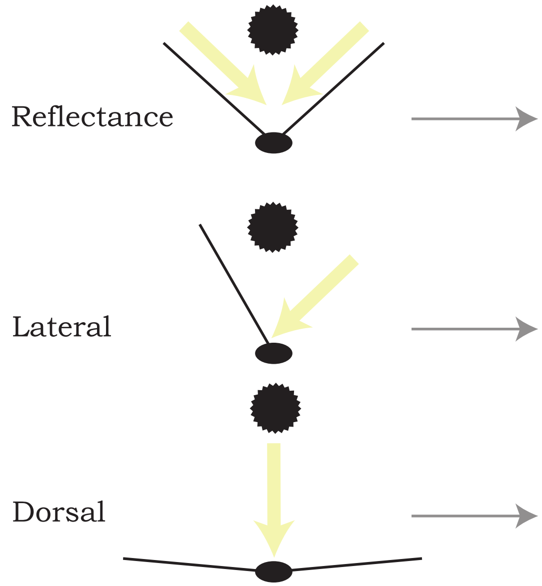
Basking stones are an excellent design feature to place in sunny locations within the garden. The stones absorb heat and provide a reflective surface that radiates heat back into the butterfly's body.

Most literature suggests placing stones in a sunny location that receives at least six hours of sun (Gardening Fact Sheet). Dark colored stones such as basalt absorb and thus retains heat longer than lighter colored stones, giving off heat at a higher rate.

Its not understood if angling a stone towards the sun is more effective. Most writings call for a flat surface. So experiment and see if angled stones work in your garden.



Common Butterfly Basking Postures



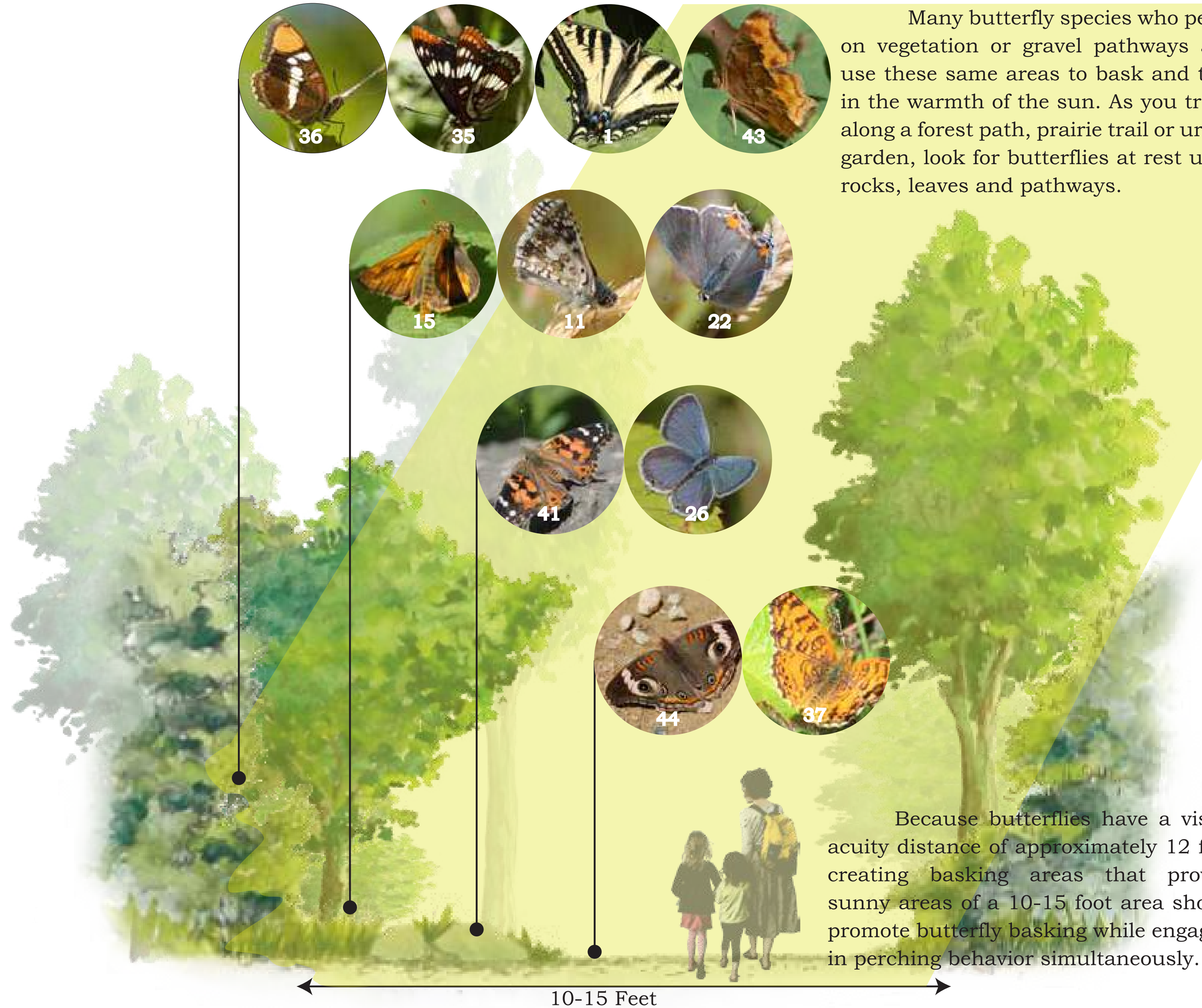
Adapted from Kemp & Krockenberger

Because butterflies are inactive at night and solar radiation is unavailable, butterflies lose body temperature as they rest (Wilson 2018). In the morning butterflies seek sunny patches to regain the heat lost from the evening roosting (Kemp 2002).

Placing basking stones, gravel pathways or patches of broad-leaf vegetation near roosting areas for early morning basking is a vital component to butterfly basking design consideration (Gardening Fact Sheet).

Different species display different basking postures to gain and retain body heat. Basking habitat also changes from species to species. Many species will bask at ground level during the early hours of the morning and then move into their respective daily habits of feeding, patrolling and perching, mixing basking into the daily routine to maintain body temperature (Kemp 2002).

Many butterfly species who perch on vegetation or gravel pathways also use these same areas to bask and take in the warmth of the sun. As you travel along a forest path, prairie trail or urban garden, look for butterflies at rest upon rocks, leaves and pathways.



Because butterflies have a visual acuity distance of approximately 12 feet, creating basking areas that provide sunny areas of a 10-15 foot area should promote butterfly basking while engaging in perching behavior simultaneously.

Final Thoughts

Through this design guidebook, the complex life histories of the butterfly life cycle, butterfly needs, and butterfly behaviors have been explored and categorized. Using these life histories, I devised a design framework to distill and simplify this complex information into a step by step process to better understand how to meet the survival requirements of butterflies.

By creating an icon language, butterfly life histories can be graphically converted into design element strategies. When each design element is investigated individually, the complexity of these life histories is simplified and the designing for butterfly friendly habitat space is better understood. Because visual representation is so important to creation of these butterfly habitat gardens, this guidebook relies heavily on the graphic representation of what these individual life history components may look like in the field.

I hope that this guidebook was an informative resource for designers seeking to build butterfly habitat gardens. I hope that the complex information was broken down into an easy to follow and easy to understand format. I hope that this guidebook will educate and inspire people to want to learn more about how to help urban butterflies thrive within our cities and neighborhoods. In short, I hope that there will always be butterflies within our gardens.

"We delight in the beauty of the butterfly, but rarely admit the changes it has gone through to achieve that beauty"

-Maya Angelou

4 The Design

4.1 Revisiting the Scope of the Project

The scope of this master's project was to create a step by step process that explores, defines, and identifies the survival requirements of urban butterflies. To accomplish this, I assert that the use of the butterfly life histories of butterfly the life cycle, butterfly needs, and butterfly behaviors, can give the designer a more comprehensive set of guidelines to meet butterfly survival requirements. For this project, the butterfly life history components are represented visually as iconographic design elements. These icon elements can be arranged within a design to create design solutions that promote butterfly survival.

One benefit to this process, is that it categorizes each butterfly life history component into an easy to understand conceptual framework for the designer to follow. Another benefit to this project, is the transferability of the process. This project's process framework is transferable because nearly all butterflies, no matter their location, the life histories remain largely universal. The strategies for meeting the survival requirements that address these life histories can be applied across place and scale. Thus, no matter where the proposed garden resides, be it Eugene Oregon or Portland, Maine, the step by step process should be applicable and provide benefits for local butterflies. Details in species of butterflies, habitat matrices and plant community palettes will change, but the process of this design program remain consitent.

Because this master's project used design as research as its research strategy, I needed to remain consistent to the overall research strategy of the research through designing approach. Thus, creating, sketching, and the generation of knowledge through a visual and graphic based language was a key consideration at all phases of my design process.

To demonstrate the ease and efficiency of the process, I built a conceptual butterfly habitat garden design based on an actual site within the city of Eugene, Oregon. Because this process was the emphasis of my master's project and not the design itself, no actual garden was built.

A Brief Description of the Site

The site that I chose to carry out this design process framework is Willagillespie Elementary School. The school resides in central Eugene, Oregon. The school property has 4.4 acres of potential butterfly garden habitat. Of that total acreage, I've chosen to design a .5 acre parcel of the property that historically was wet prairie habitat. Thus, the overall butterfly garden theme is based on a wet prairie habitat, with a butterfly and plant species palette that can be naturally found within the wet prairies of the Southern Willamette Valley.

The twenty 4J elementary schools of Eugene, Oregon

A Design Process:

"a sequence of problem-solving and creative steps used by the designer to develop an appropriate design solution, as an organizational framework"

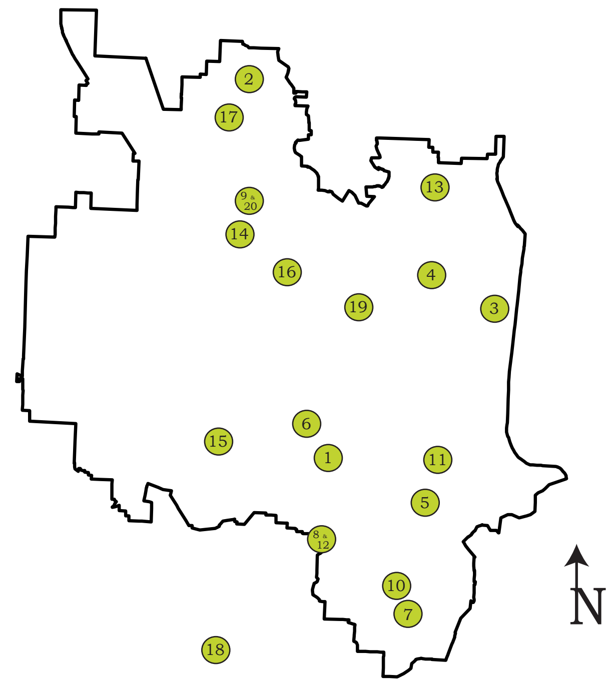
-Norman K Booth

My master's project centers around the process of creating a butterfly habitat garden based on butterfly life histories. A butterfly garden can be designed to occupy a myriad of locations from residential homes, to business storefronts, to rooftops, to city parks. There is no set size that a butterfly garden needs to adhere to and there is no set theme that the garden needs to carry forth. However, for the sense of scoping and narrowing, I based my butterfly habitat garden locations to be designed and carried out at the school grounds of the 4J elementary public-school system of Eugene, Oregon.

4.2 Site Selection

There are twenty elementary schools within the Eugene 4J public school system. These schools form a network across Eugene, spanning from Eugene's South Hills, to the far reaches of the northern section of Eugene's urban growth boundary. During the summer of 2017, I photo documented and cataloged each school, listing their features, their proximity to undeveloped spaces, the degree of urbanization surrounding them and evaluated their open spaces for potential butterfly habitat gardens.

At the end of the site visits, I determined that of the twenty schools analyzed, Willagillespie Elementary School, that resides in central Eugene, would make an excellent demonstration site for my butterfly habitat garden design.



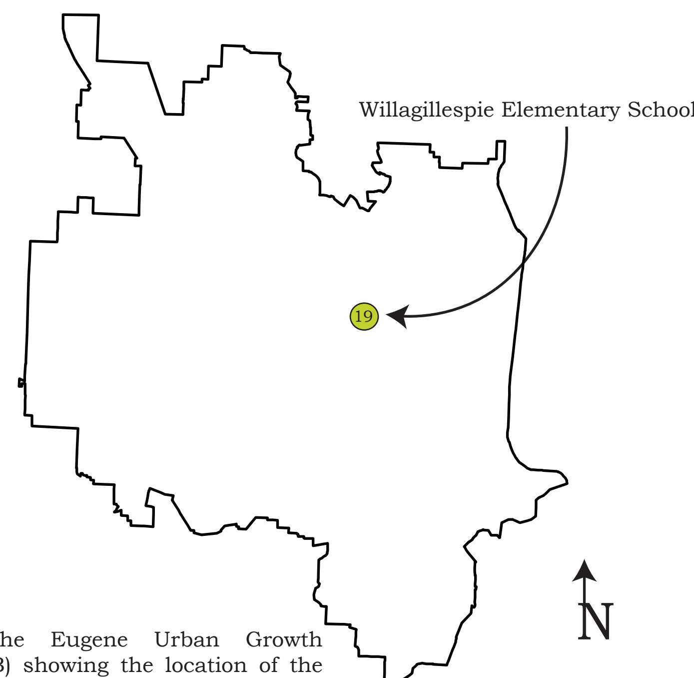


Figure 4.1 The Eugene Urban Growth Boundary (UGB) showing the location of the twenty 4J elementary schools.

Criteria for choosing Willagillespie Elementary School:

1. Habitat(s): The school resides upon both wet and upland prairie habitats and is less than a quarter mile from the north banks of the Willamette River and thus has a strong influence of riparian habitats. The school also lies directly southwest of Gillespie Butte, a five-acre remnant oak savanna that has a healthy stand of mature Oregon White Oaks. Thus, the potential for a greater diversity of butterfly species can be realized on this site.

2. Water: The school is next to year-round fresh water supply along the school's southern border, and has a fresh water source from the Gillespie Butte. This water supply slowly trickles through the edge of the school property, nearly year-round, along the school's northern border.

3. Stewardship: The school has a very active vegetable garden program and thus a culture that engages children to be connected to the space. Engaging children and creating ecological stewardship through scholastic butterfly gardens is a key to longevity and success for urban butterflies (Blair 2009).

4. Size: The School has over four acres of usable and diverse potential habitat along three of its four property boundaries. Literature states that gardens of greater than half an acre show more butterfly use and diversity (Mauro 2007).

5. The school has a fair amount of native landscape and native species on the property. There is a camas field on the northwest section of the school grounds, and an oak woodland upslope. The presence of native plant species growing on the property, are clear indicators that a native seedbank remains, making habitat gardening that more successful (Campbell 2004).

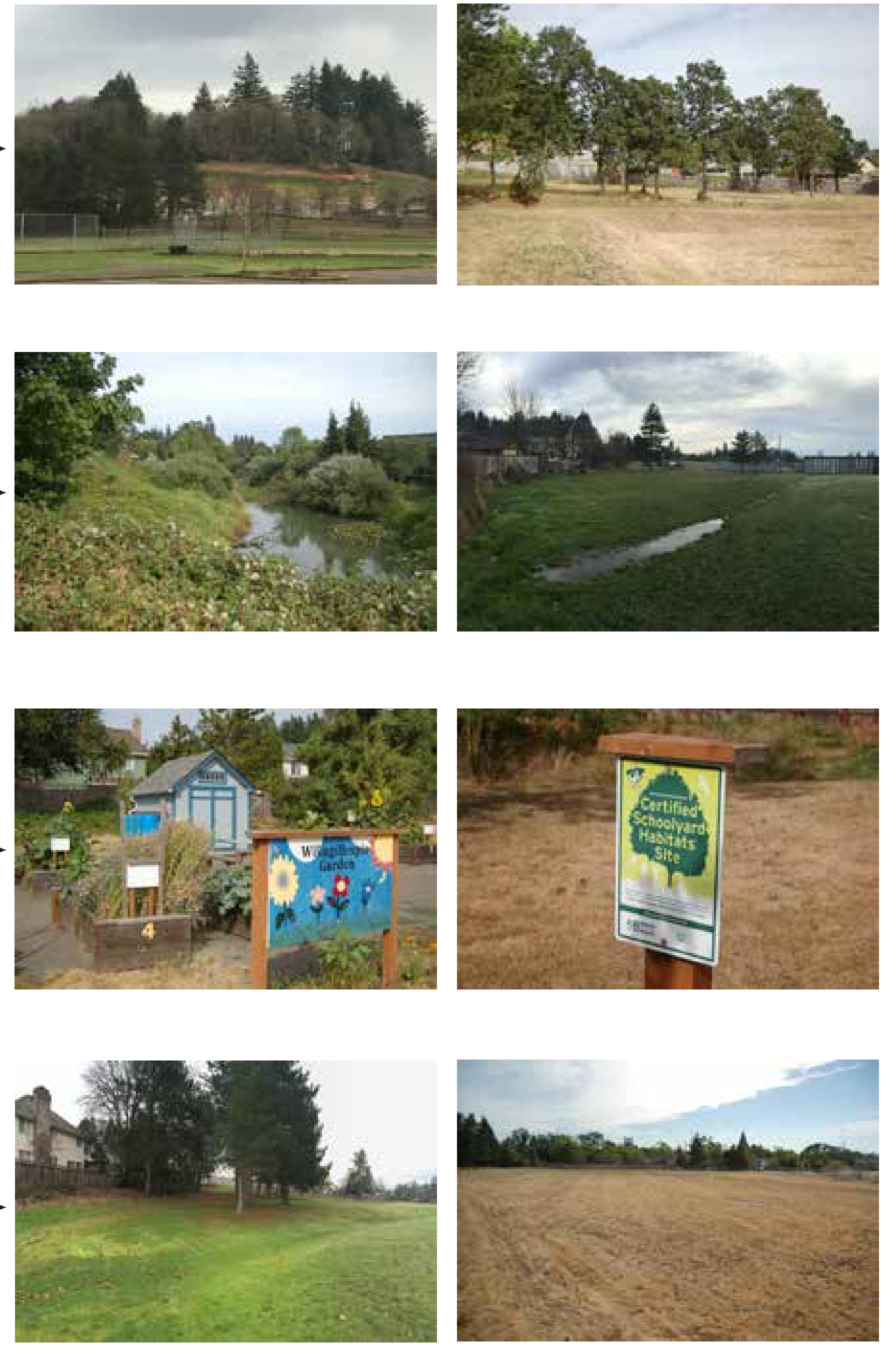


Figure 4.2 Site Analysis and Inventory

Current conditions at Willagillespie Elementary School

4.3 Site Analysis

Step 1 Inventory what you have

I inventoried the plants, existing features and buildings that were already in existence on the school grounds (Fig. 4.2). Compiling a site inventory gives you a workable baseline from which to start a design plan (Booth 2012). My next task was to survey and inventory what types of habitats were surrounding the site. It is important to determine if there are any wild spaces, streams, fields, forests, meadows, or more urban, industrial or agricultural features within close proximity to the garden space (Tekulsky 1985). Surrounding landscapes are vital sources for butterfly population movement. The more natural spaces surrounding your garden site, the more likely butterfly populations will expand into your garden (Mauro 2007).

Step 2 Mapping the school grounds

By accessing the City of Eugene tax lot data, I was able to determine the property lines, and map the site. I loaded in aerial images into AutoCAD and diagrammed the area; filling in parking areas, buildings, play areas, sports fields, lunch and recess areas, roads and pathways. I drew in existing trees, shrubs, planting beds. Through GIS contour data, I marked out any areas of changes in topography, like mounds or swales, to understand how water would flow across the site.

Step 3 Diagram current use zones

To determine use zones, I drew a rough bubble or boundary around the areas used for sporting, play, maintenance, parking, lunch and recess, and outdoor learning (school garden). I gave each zone its own color or unique hatch. These zones will help you analyze the open spaces that could be used as potential habitat areas (Booth 2012).

Step 4 The Plan or Program

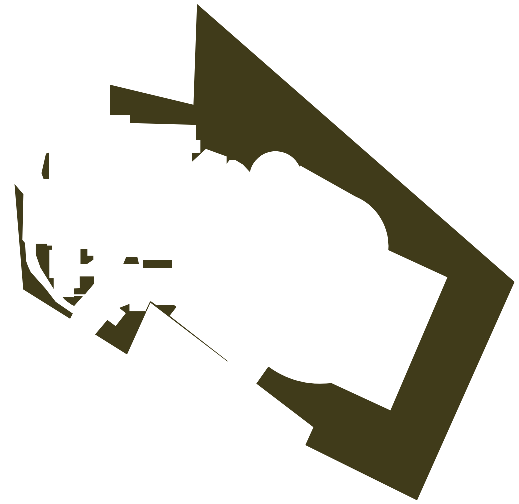
The plan or program is where the design solutions are incorporated, and a checklist of all design elements are compiled (Booth 2012). Select the appropriate habitat that your garden will represent. Perhaps there are going to be multiple habitats in your garden. Base these habitats garden selections on the pre-settlement vegetation communities that existed there. Was it upland prairie, was it once a woodland or savanna?

Remember, these are habitat friendly gardens, not restoration projects. These spaces do not have to follow strict guidelines or protocols that intensive restoration must prescribe. Think of these gardens as a representation or facsimile of native habitats. The key to the success of the butterfly garden doesn't rest in the integrity of restoration, what matters is the provision of design elements that facilitate butterfly life history requirements. What that looks like will vary from garden to garden. The butterflies will not know the difference, and if you follow the basic template of the habitat you are wanting to create, then the chances are likely that positive results will follow.

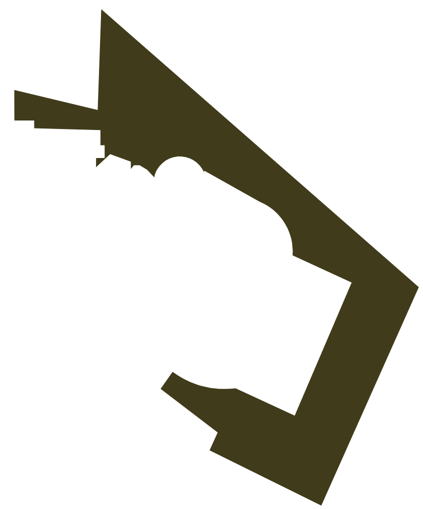
Mapping the site and taking an inventory allowed me to produce a map that divided the site into land use zones (Fig 4.3). This allowed me to better understand which sections of the school were suited for potential butterfly habitat garden spaces and which sections of the school were best suited for other activities. The map on the next page shows land that is dedicated open space. This open space is further broken down into potential butterfly garden habitat, shown here in dark green.

Figure 4.3 Use Zones

Current Green Spaces



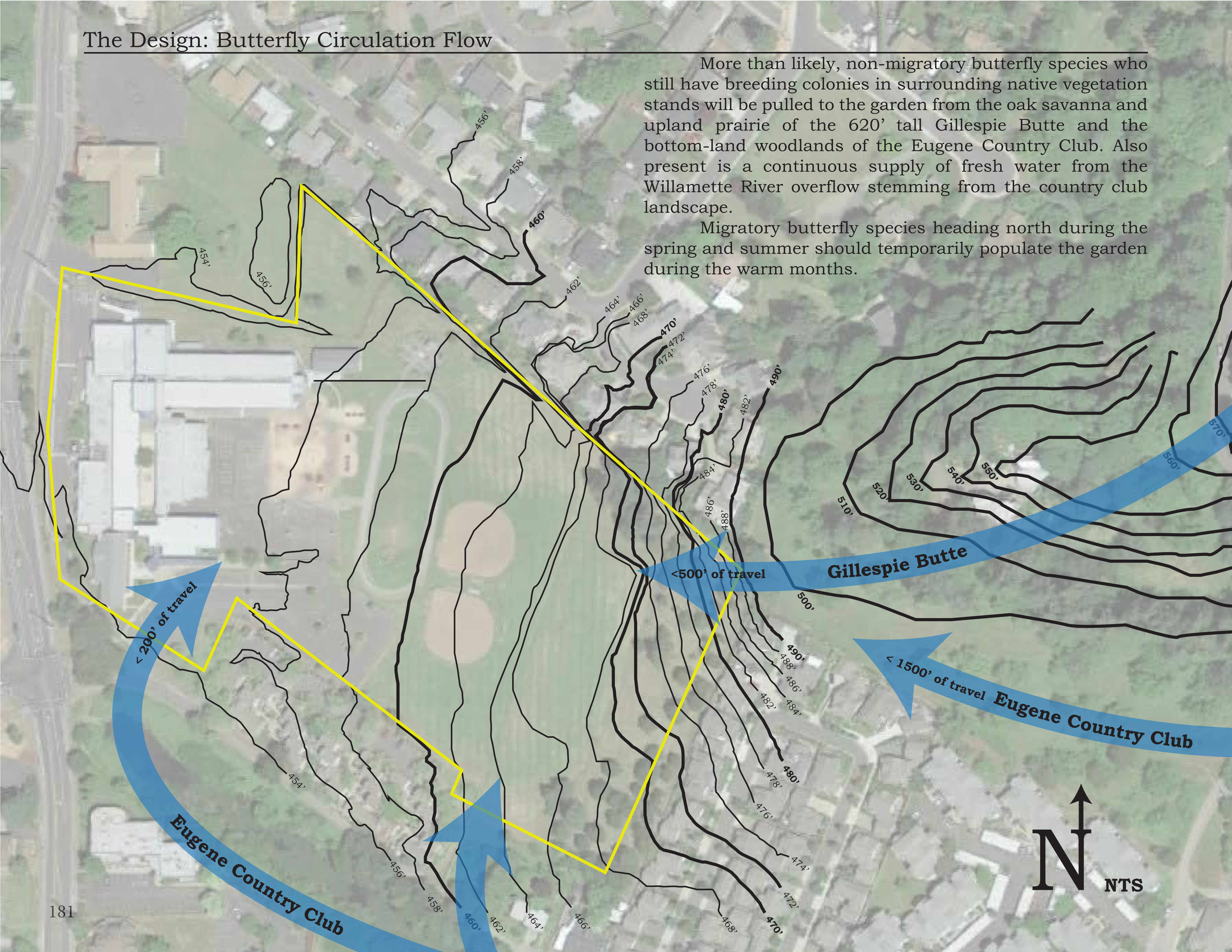
Potential Habitat

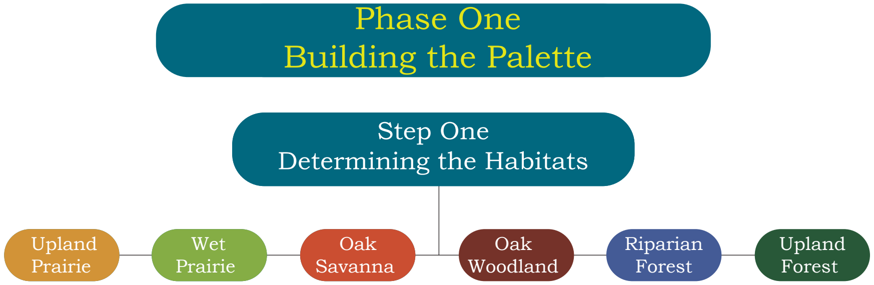


The Design: Butterfly Circulation Flow

More than likely, non-migratory butterfly species who still have breeding colonies in surrounding native vegetation stands will be pulled to the garden from the oak savanna and upland prairie of the 620' tall Gillespie Butte and the bottom-land woodlands of the Eugene Country Club. Also present is a continuous supply of fresh water from the Willamette River overflow stemming from the country club landscape.

Migratory butterfly species heading north during the spring and summer should temporarily populate the garden during the warm months.





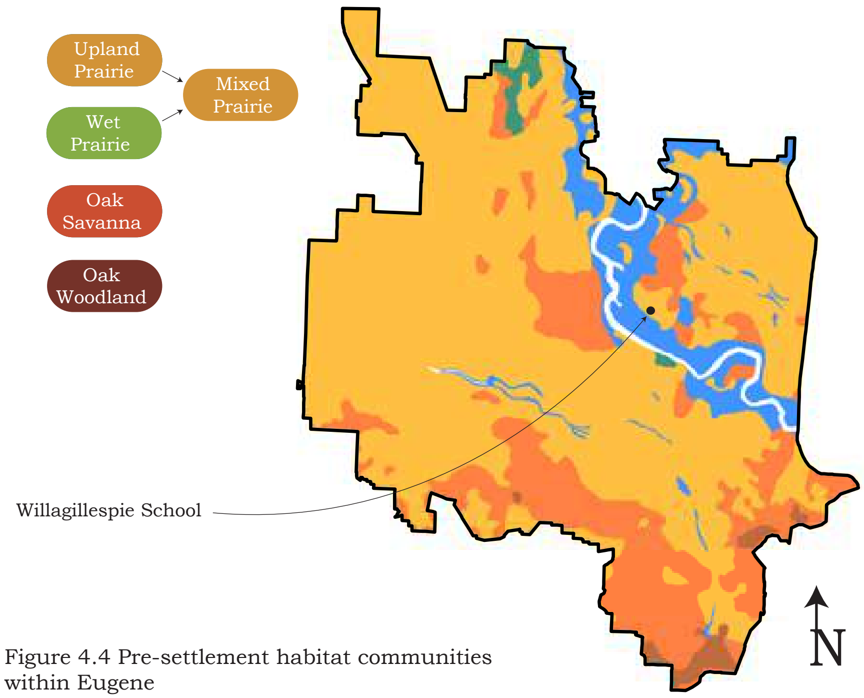


Figure 4.4 Pre-settlement habitat communities within Eugene

4.4 Applying the Design Process

Revisiting Phase One- The Building of the Palette

Once a site has been chosen and a site analysis has been performed, the butterfly habitat garden process can be employed. To do so, let's revisit Phase One of the process. The starting point, step one; determining the habitats.

Step One- Determining the Habitats

Determining the habitat or habitats that the garden will represent, should be based on the native plant communities that would have existed upon the site before the area was altered from the activities of white settlement. The motivation for creating biodiversity upon the site should drive habitat choice. (Tallamy 2007) Determining specific habitat themes should in no way prevent the designer from exercising creativity or originality. Nor should the efforts of bringing back a pristine habitat upon the site require intense restoration. Such a level of pure habitat restoration may not be practical or possible, since there is little record of what these pre-settlement landscapes looked like. There are very few representations of habitat within the Willamette valley that consist of a pure pre-settlement plant community, thus a comparison is not likely (Campbell 2004).

GIS data files of pre-settlement habitats and 4J elementary school locations were provided by Dr. Chris Enright of the University of Oregon. I built several maps showing the location of these habitats in relation to where the twenty 4J schools reside. Analysis of the Willagillespie Elementary School showed that school rested on what was once mixed wet and upland prairie, but also was near both riparian forest and savanna (Fig. 4.4). Upon my site visit, both upland and wet prairie habitats were still showing some remnant pieces on school grounds. There was also an oak woodland that had been planted in the past and was of considerable size, enough so to consider the potential for woodland butterfly species. Ground truthing did not support any evidence of riparian habitat near or on school grounds. Thus, I determined that the best habitat garden themes should target butterfly species of wet prairie, upland prairie, savanna, and woodland for this site (Fig. 4.5).

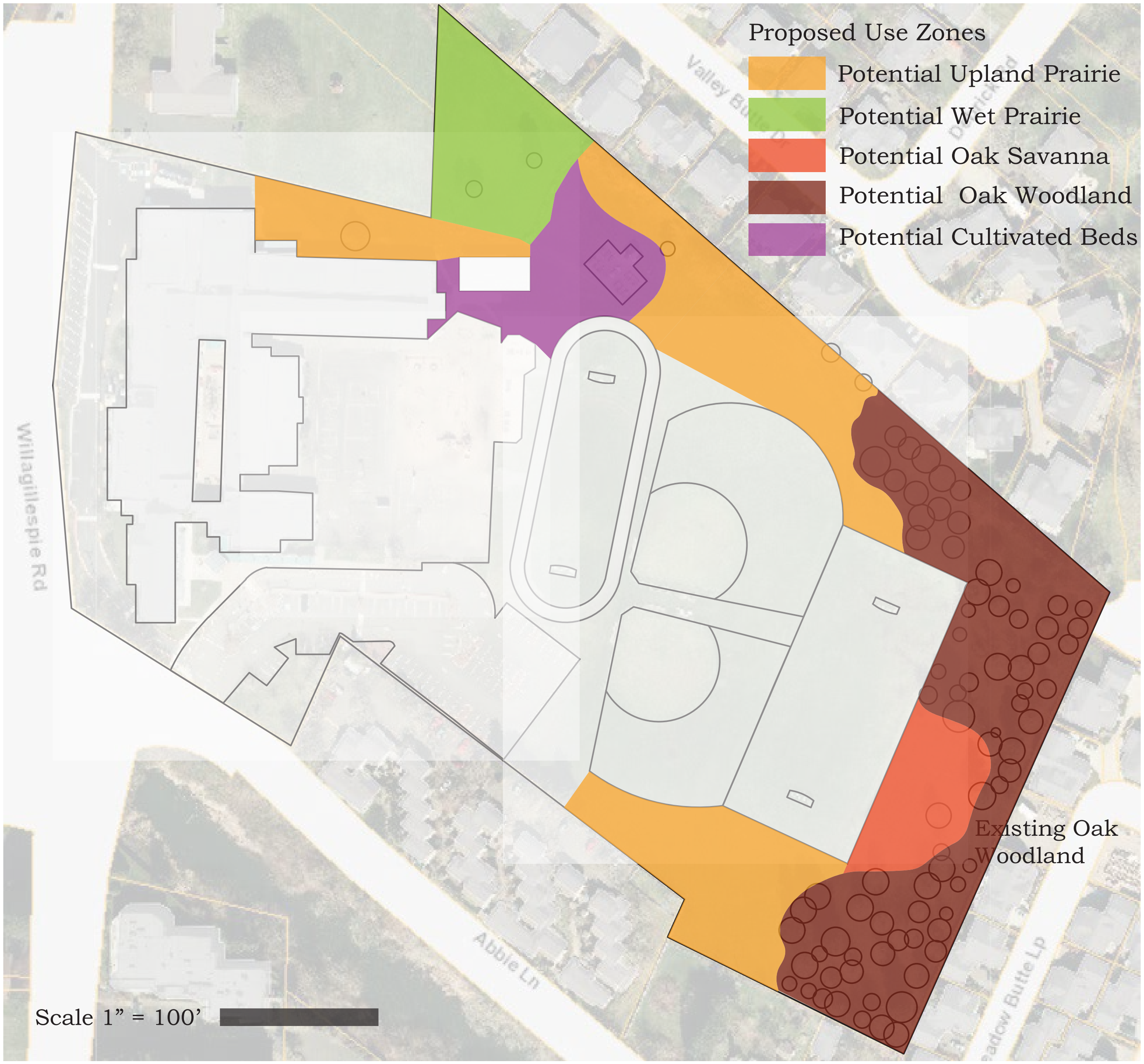
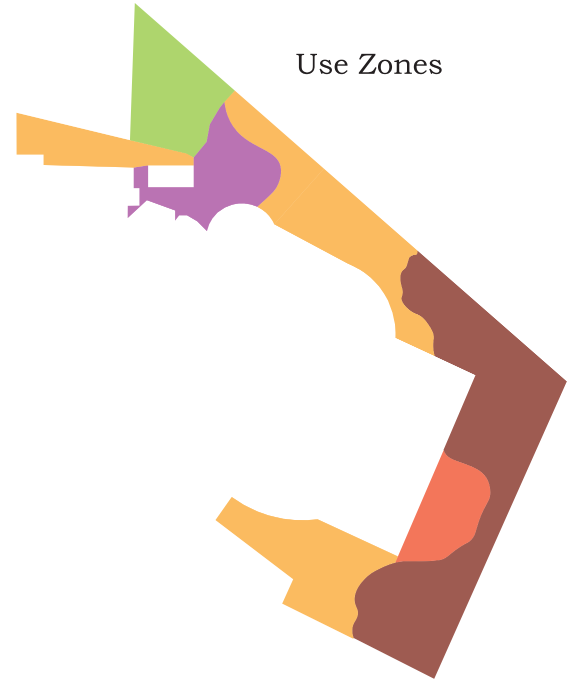
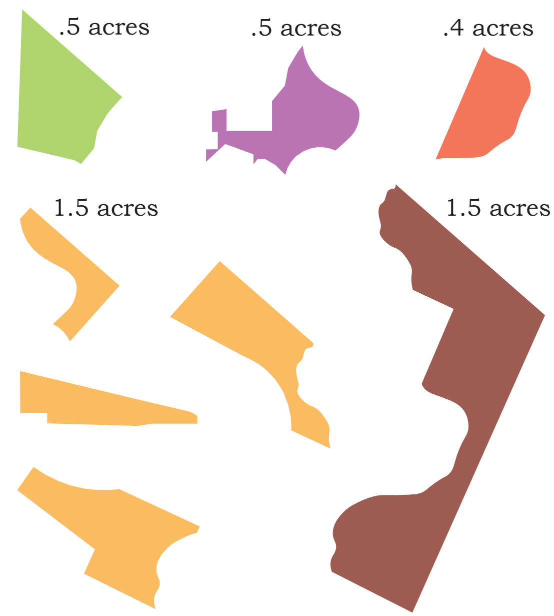
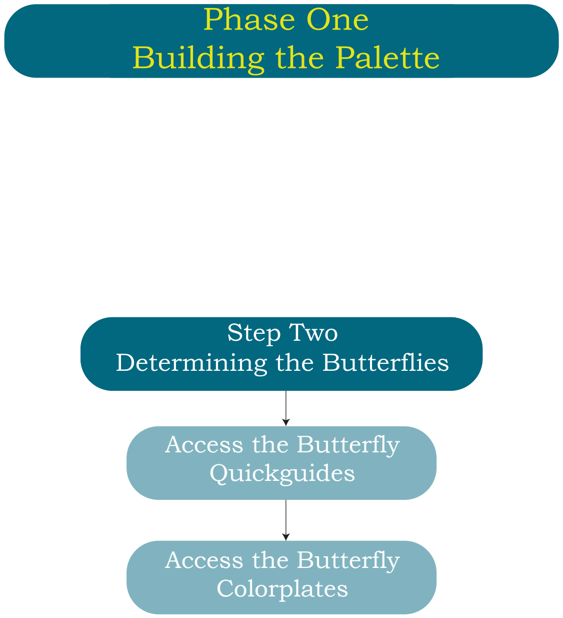


Figure 4.5 Proposed Habitat Zones



Zone Acreage Breakdown 4.4 acres





Step Two- Determining the Butterflies

Once you have determined the habitat(s) for the garden, select the butterfly species you hope to encourage to use the garden space. This can be accomplished by referencing the butterfly quickguide and color plates. Also, it is important to get out into the surrounding neighborhood and wild spaces to observe which species of butterflies are present. The species you find flying near the site, will likely be the species that will demonstrate the greatest success of butterfly use within the garden.

As mentioned previously, not all butterflies that occur within a certain area will occur in great number. The butterflies that are considered rare within an area, are generally poor candidates for effective butterfly gardening. Rare butterflies are even more unlikely to visit gardens within urban areas. Thus, it is recommended to garden for species that are likely to find, use and flourish in such spaces, these are the common butterfly species.

Of the 47 species found within the Eugene area, 20 of these appeared as common species. These common species were butterflies that could be found in the four potential habitats that the Willagillespie site could support. I compiled a list from the quickguide of each butterfly species that occurred within each habitat. I was left with four lists; wet prairie, upland prairie, savanna, and woodland. Because these are common butterfly species, many of the butterflies found within one habitat list will be found on another habitat list, thus it is clear that common species are common because they have a greater habitat range than perhaps rare species do.

These lists and the process that led to the making of these lists are shown on the following page. It is helpful to see where each species of butterfly naturally occurs within the specific habitats found within the Eugene area. Since Willagillespie Elementary School has four out of the six potential habitat types found within Eugene, potential butterfly diversity should be high. This visual cue helps take you into the next step of phase one, determining the hostplants (Table 4.1).

The Design: Selecting the Butterfly Palette List

Select Common Butterfly Species

No. Eugene Butterfly Species	Common Status	Target Butterfly Species
1. Tiger Swallowtail	Common	1. Tiger Swallowtail
2. Anise Swallowtail	Uncommon	
3. Pale Swallowtail	Uncommon	
4. Clodius Parnassian	Uncommon	
5. Orange Sulphur	Common	5. Orange Sulphur
6. Cabbage White	Common	6. Cabbage White
7. Western White	Rare	
8. Marginated White	Rare	
9. Ochre Ringlet	Abundant	9. Ochre Ringlet
10. Common Wood Nymph	Abundant	10. Common Wood Nymph
11. Common Checkered Skipper	Common	11. Common Checkered Skipper
12. Arctic Skipper	Rare	
13. Silver-Spotted Skipper	Rare	
14. Propertinus Skipper	Fairly Common	14. Propertinus Skipper
15. Woodland Skipper	Abundant	15. Woodland Skipper
16. Sachem Skipper	Abundant	16. Sachem Skipper
17. Dun Skipper	Fairly Common	17. Dun Skipper
18. Sonora Skipper	Fairly Common	18. Sonora Skipper
19. Juba Skipper	Rare	
20. Monarch	Rare	
21. Great Copper	Rare	
22. Grey Hairstreak	Fairly Common	22. Grey Hairstreak
23. Cedar Hairstreak	Rare	
24. Hedgerow Hairstreak	Uncommon	
25. Western Tailed Blue	Rare	
26. Eastern Tailed Blue	Abundant	26. Eastern Tailed Blue
27. Acmon Blue	Rare	
28. Fender's Blue	Rare	
29. Silvery Blue	Fairly Common	29. Silvery Blue
30. Spring Azure	Common	30. Spring Azure
31. Variable Checkerspot	Uncommon	
32. Great Spangled Fritillary	Rare	
33. Mourning Cloak	Uncommon	
34. California Tortoiseshell	Irruptive	
35. Lorquin's Admiral	Fairly Common	35. Lorquin's Admiral
36. California Sister	Fairly Common	36. California Sister
37. Mylitta Crescent	Common	37. Mylitta Crescent
38. Field Crescent	Locally Common	38. Field Crescent
39. Red Admiral	Uncommon	
40. West Coast Lady	Rare	
41. Painted Lady	Fairly Common	41. Painted Lady
42. American Lady	Rare	
43. Satyr Comma	Uncommon	
44. Common Buckeye	Rare	

Butterfly Habitat Garden Habitats

Wet Prairie Species	Savanna Species
1. Tiger Swallowtail	1. Tiger Swallowtail
5. Orange Sulphur	5. Orange Sulphur
6. Cabbage White	6. Cabbage White
9. Ochre Ringlet	9. Ochre Ringlet
10. Common Wood Nymph	10. Common Wood Nymph
11. Common Checkered Skipper	11. Common Checkered Skipper
14. Propertinus Skipper	14. Propertinus Skipper
15. Woodland Skipper	15. Woodland Skipper
16. Sachem Skipper	16. Sachem Skipper
17. Dun Skipper	17. Dun Skipper
18. Sonora Skipper	18. Sonora Skipper
22. Grey Hairstreak	22. Grey Hairstreak
26. Eastern Tailed Blue	26. Eastern Tailed Blue
29. Silvery Blue	29. Silvery Blue
30. Spring Azure	30. Spring Azure
35. Lorquin's Admiral	35. Lorquin's Admiral
37. Mylitta Crescent	37. Mylitta Crescent
41. Painted Lady	41. Painted Lady

Upland Prairie Species	Woodland Species
1. Tiger Swallowtail	1. Tiger Swallowtail
5. Orange Sulphur	6. Cabbage White
6. Cabbage White	9. Ochre Ringlet
9. Ochre Ringlet	10. Common Wood Nymph
10. Common Wood Nymph	11. Common Checkered Skipper
11. Common Checkered Skipper	14. Propertinus Skipper
14. Propertinus Skipper	15. Woodland Skipper
15. Woodland Skipper	16. Sachem Skipper
16. Sachem Skipper	17. Dun Skipper
17. Dun Skipper	18. Sonora Skipper
18. Sonora Skipper	22. Grey Hairstreak
22. Grey Hairstreak	26. Eastern Tailed Blue
26. Eastern Tailed Blue	29. Silvery Blue
29. Silvery Blue	30. Spring Azure
30. Spring Azure	35. Lorquin's Admiral
35. Lorquin's Admiral	36. California Sister
37. Mylitta Crescent	37. Mylitta Crescent
41. Painted Lady	41. Painted Lady

Table 4.1 Butterfly Selection Process

The Design: Plant Selection List

These species also use these hostplants

Plate Number / Hostplant Species	Target Butterflies	Layer	Non-Target Butterflies
1. Oregon White Oak	(14, 22, 36)	Tree Layer	
2. Pacific Dogwood	(30)		
5. Red Alder	(1, 35)		(3, 33)
6. Western Serviceberry	(35)		(3)
7. Scouler's Willow	(1, 35)		(33, 43)
8. California Black Cottonwood	(1, 35)		(33)
9. Oregon Ash	(1)		(1)
10. Bigleaf Maple	(1)		(33)
11. Vine Maple	(1)		
12. Pacific Madrone	(30)		
14. Ponderosa Pine	(22)		(46)
18. Pacific Ninebark	(30)	Shrub Layer	
19. Blue Elderberry	(30)		
20. Western Spirea	(30)		
21. Mountain Balm	(30)		(24, 34, 45)
22. Oceanspray	(30, 35)		(3, 33)
23. Deerbrush	(30)		(3, 24, 34)
24. Red Twig Dogwood	(30)		
28. Evergreen Huckleberry	(30)		
29. Spanish Clover	(5, 26, 27, 29)	Ground Layer Forbs	
30. Meadow Birdsfoot Trefoil	(22, 26, 27, 29)		
31. Big Deervetch	(22, 29)		(13, 25)
32. Springbank Clover	(5, 22, 26)		
33. Kincaid's Lupine	(29)		(28)
34. Bigleaf Lupine	(22, 29)		
36. Stinging Nettle	(41)		(39, 40, 43)
37. Showy Milkweed	(20)		
38. Narrowleaf Milkweed	(20)		
41. Rosy Checkermallow	(11, 22, 41)		(40)
42. Henderson's Checkermallow	(11, 22, 41)		(40)
43. Cusick's Checkermallow	(11, 22, 41)		(40)
45. Cluster Thistle	(37, 41)		
52. Garden Crucifers	(6)		
53. Douglas Aster	(38)		
55. Pacific Aster	(38)		
59. Foothill Sedge	(9, 17)	Ground Layer Grasses	
60. Dense Sedge	(9, 17)		
61. Roemer's Fescue	(9, 10, 18)		
62. Red Fescue	(9, 10, 16, 18)		
63. California Fescue	(9, 10, 18)		
64. Alaska brome	(9)		(12, 19)
65. Kentucky Bluegrass	(9, 10, 16, 18)		
66. Pine Bluegrass	(9, 10, 18)		
67. Poverty Oatgrass	(10, 15)		
68. California Oatgrass	(10, 15)		
69. Lemmon's Needlegrass	(9)		(19)
70. Tufted Hairgrass	(9)		(19)
71. Blue Wildrye	(15)		
72. Slender Wheatgrass	(15)		

Table 4.2 Selecting Hostplants

Step Three
Determining the Hostplants
↓
Access the Hostplant Quickguides
↓
Access the Hostplant Colorplates

Step Three- Determining the Hostplants

The hostplants you select will attract the butterfly species that you wish the garden to support. These hostplants are the food source for the caterpillars. Without a hostplant component, butterflies will never set up residency within the space. Because the hostplants are also the structural components of the garden, chose plants that fulfill the life cycle of the butterfly and act as landscape features, such as shade trees, wind breaks, massings and backdrops. The selection process is displayed in Table 4.2.

Step Four
Determining the Nectar Sources
↓
Access the Nectar Source Quickguides
↓
Access the Nectar Source Colorplates

Step Four-Determining the Nectar Source Plants

Chose nectaring plants that are typical of the habitat that you are designing, but also select nectar plants that are proven valuable nectar sources even if they may not be completely associated with that habitat.

Table 4.3 depicts the end result of selecting the proper plant palettes based on the habitat type for which the garden will be designed for.

The Design: Habitat Planting Palettes

Woodland Plant Species

Hostplants

1. Oregon White Oak	2. Pacific Dogwood	5. Red Alder
6. Western Serviceberry	10. Bigleaf Maple	11. Vine Maple
12. Pacific Madrone	14. Ponderosa Pine	
18. Pacific Ninebark	21. Mountain Balm	22. Oceanspray
23. Deerbrush	24. Red Twig Dogwood	28. Evergreen Huckleberry
29. Spanish Clover	30. Birdsfoot Trefoil	31. Big Deervetch
34. Bigleaf Lupine	36. Stinging Nettle	37. Showy Milkweed
38. Narrowleaf Milkweed	41. Rosy Checkermallow	42. Henderson's C. mallow
43. Cusick's C. mallow	45. Cluster Thistle	53. Douglas Aster
61. Roemer's Fescue	62. Red Fescue	63. California Fescue
64. Alaska brome	65. Kentucky Bluegrass	66. Pine Bluegrass
67. Poverty Oatgrass	69. Lemmon's Needlegrass	71. Blue Wildrye
72. Slender Wheatgrass		

Nectar Sources

1. Common Madia	2. Mule's ears	3. Douglas Aster
4. Western Goldenrod	5. Yarrow	7. Pearly Everlasting
11. Oregon Geranium	15. Wood's Strawberry	17. Lanceleaf Selfheal
21. Halls's Aster	24. Tiger Lily	25. Lewis's Mock-orange
30. Red Columbine	38. Pacific Bleedingheart	41. Oregon Iris

Upland Prairie Plant Species

Hostplants

1. Oregon White Oak	6. Western Serviceberry	7. Scouler's Willow
21. Mountain Balm	22. Oceanspray	
29. Spanish Clover	33. Kincaid's Lupine	34. Bigleaf Lupine
36. Stinging Nettle	37. Showy Milkweed	38. Narrowleaf Milkweed
41. Rosy Checkermallow	42. Henderson's C. mallow	43. Cusick's C. mallow
45. Cluster Thistle	53. Douglas Aster	55. Pacific Aster
59. Foothill Sedge	61. Roemer's Fescue	62. Red Fescue
63. California Fescue	64. Alaska brome	
65. Kentucky Bluegrass	66. Pine Bluegrass	67. Poverty Oatgrass
68. California Oatgrass	69. Lemmon's Needlegrass	71. Blue Wildrye
72. Slender Wheatgrass		

Nectar Sources

1. Common Madia	9. Indian Hemp	3. Douglas Aster
4. Western Goldenrod	5. Yarrow	7. Pearly Everlasting
18. Rosy Plectritis	19. Bluehead Gilia	17. Lanceleaf Selfheal
8. Wooly Sunflower	22. Fernleaf Biscuitroot	29. California Poppy
31. Slender Cinquefoil	33. Willamette Daisy	35. Deltoid Balsamroot

Table 4.3 Final plant palette selections for site.

Savanna Plant Species

Hostplants

1. Oregon White Oak	12. Pacific Madrone	14. Ponderosa Pine
18. Pacific Ninebark	21. Mountain Balm	22. Oceanspray
29. Spanish Clover	33. Kincaid's Lupine	34. Bigleaf Lupine
36. Stinging Nettle	37. Showy Milkweed	38. Narrowleaf Milkweed
41. Rosy Checkermallow	42. Henderson's C. mallow	43. Cusick's C. mallow
45. Cluster Thistle	53. Douglas Aster	55. Pacific Aster
59. Foothill Sedge	60. Dense Sedge	61. Roemer's Fescue
62. Red Fescue	63. California Fescue	64. Alaska brome
66. Pine Bluegrass	67. Poverty Oatgrass	68. California Oatgrass
69. Lemmon's Needlegrass	71. Blue Wildrye	72. Slender Wheatgrass

Nectar Sources

1. Common Madia	2. Mule's ears	3. Douglas Aster
4. Western Goldenrod	5. Yarrow	7. Pearly Everlasting
11. Willamette Gumweed	9. Indian Hemp	17. Lanceleaf Selfheal
21. Halls's Aster	16. Rosy Plectritis	19. Bluehead Gilia
31. Slender cinquefoil	32. Congested Snake lily	33. Willamette Daisy

Wet Prairie Plant Species

Hostplants

5. Red Alder	6. Western Serviceberry	7. Scouler's Willow
8. Black Cottonwood	9. Oregon Ash	
18. Pacific Ninebark	20. Western Spirea	24. Red Twig Dogwood
29. Spanish Clover	30. Birdsfoot Trefoil	31. Big Deervetch
32. Springbank Clover	33. Kincaid's Lupine	34. Bigleaf Lupine
36. Stinging Nettle	37. Showy Milkweed	38. Narrowleaf Milkweed
41. Rosy Checkermallow	42. Henderson's C. mallow	43. Cusick's C. mallow
45. Cluster Thistle	53. Douglas Aster	55. Pacific Aster
59. Foothill Sedge	60. Dense Sedge	62. Red Fescue
64. Alaska brome	65. Kentucky Bluegrass	66. Pine Bluegrass
67. Poverty Oatgrass	68. California Oatgrass	70. Tufted Hairgrass
71. Blue Wildrye	72. Slender Wheatgrass	

Nectar Sources

1. Common Madia	2. Mule's ears	3. Douglas Aster
4. Western Goldenrod	5. Yarrow	7. Pearly Everlasting
9. Indian Hemp	23. Camas	17. Lanceleaf Selfheal
21. Halls's Aster	6. Willamette Gumweed	31. Slender Cinquefoil
36. Sneezeweed	39. Lovage	41. Oregon Iris

Urban Cultivated Nectar Bed Palette

1. English Lavender	2. Purple Cone Flower	3. Tall Verbena
4. Sneezeweed	6. Common Lilac	7. New England Aster
8. Fleabane	9. Butterfly Weed	11. Garden Thyme
14. Pincushion Flower	15. Goldenrod 'cultivars'	16. California Lilac
22. Mints	27. Bluebeard	31. Zinnia

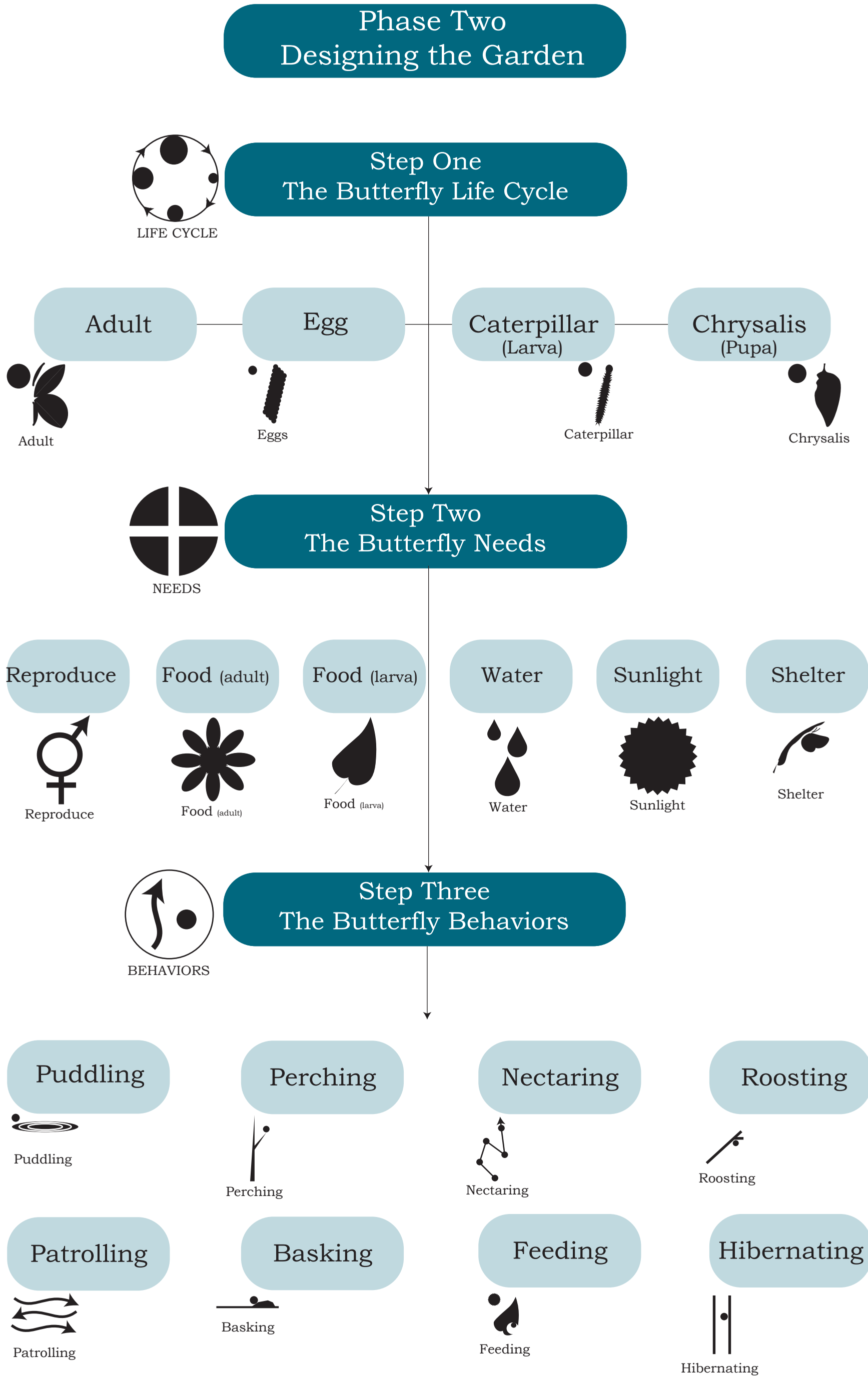


Figure 4.6 Design Process Phase Two Revisited

Revisiting Phase Two- The Designing of the Garden

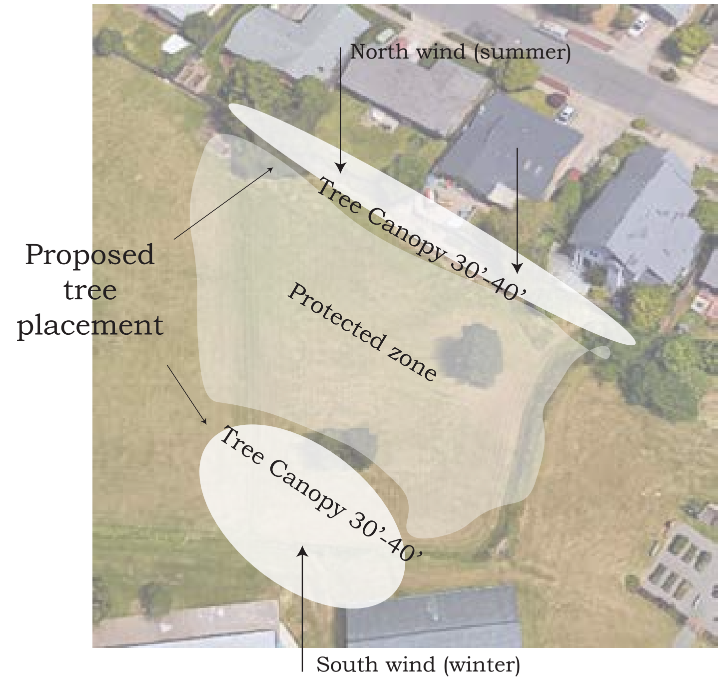
For this next step in the process framework, its best to think of this process as a series of hierarchy-based design decisions. The process begins with the butterfly life cycle, proceeds to the butterfly needs and ends with the butterfly behaviors. The reason it's best to think in a hierarchal manner, is because the butterfly needs are directly influenced by the individual stages the butterfly life cycle, and the butterfly behaviors are directly influenced by the butterfly needs.

Figure 4.6 pairs the icons (design elements) with each specific butterfly life history. The icons are important because they not only help the designer understand which specific life history that they are designing for, but they keep a clear understanding of what step the design is at within the design process. Thus, they act as an identifier of the design intent and help as a wayfinding tool.

As I progress through the design, I begin with the intent to make design decisions based on the adult butterfly and the caterpillar stages of the life cycle. This was my choice to simplify this design process at the Willagillespie school site. To meet the life history requirements of the butterfly life cycle, I address the overarching needs of sunlight, shelter, water, food and reproduction. Each page in the design example is a step by step process, in how I went about addressing these butterfly needs. Once I addressed the needs, I address the butterfly behaviors in the same step by step process. Because my project is representing a design process and not a design, I will only show an example of creating the butterfly garden for the wet prairie butterfly habitat garden on the site, even though there are four potential habitat type gardens upon the property.

Sun Analysis

Wind Analysis

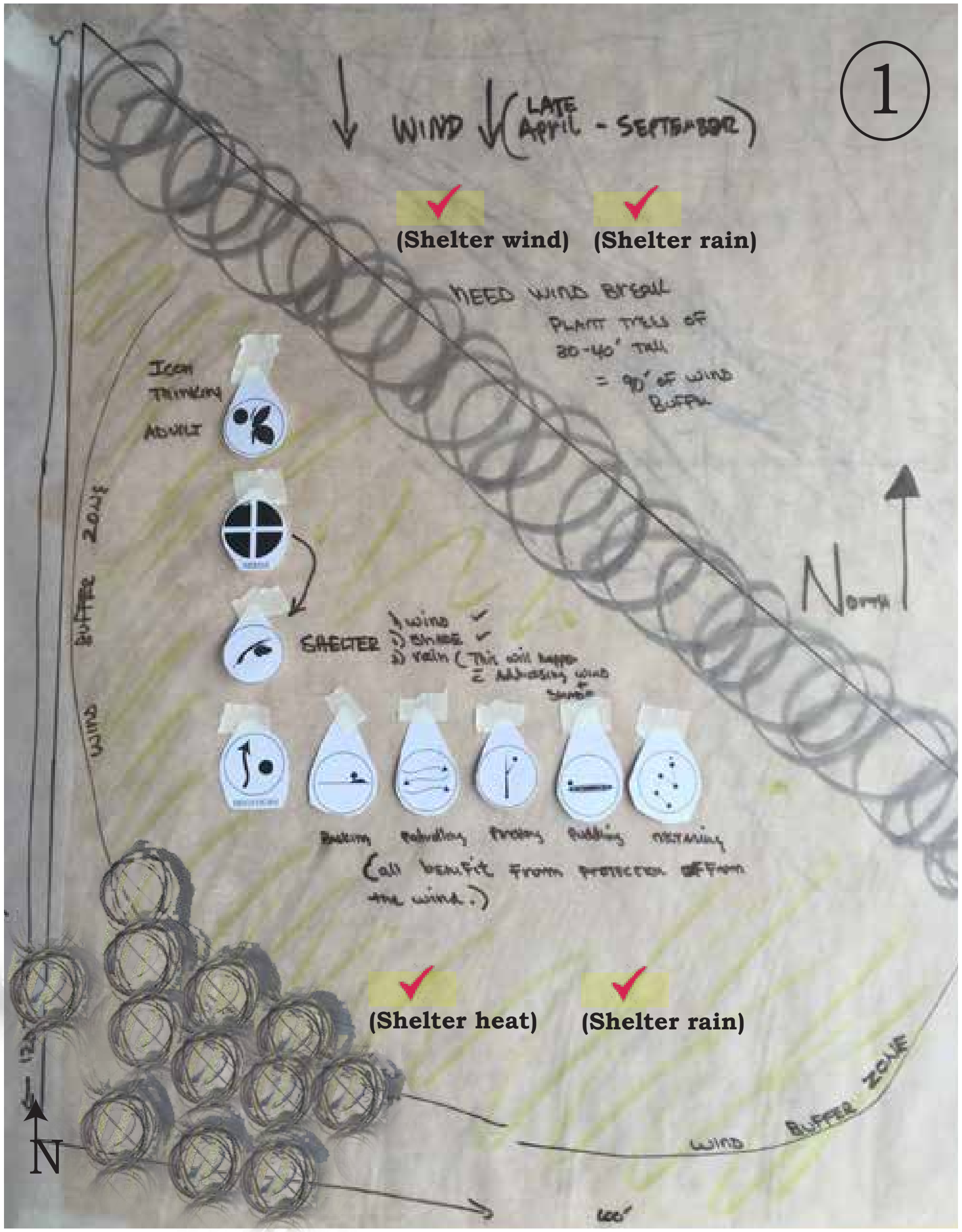


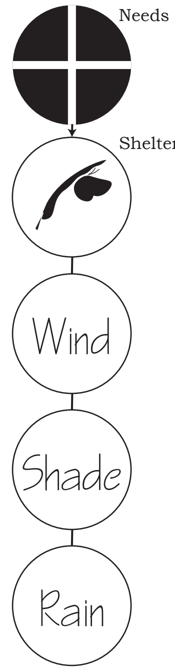
Shade Analysis

Water Analysis

Example

Need- Shelter- Wind-Heat-Rain Process Work Flow





Shelter

Design Consideration Checklist

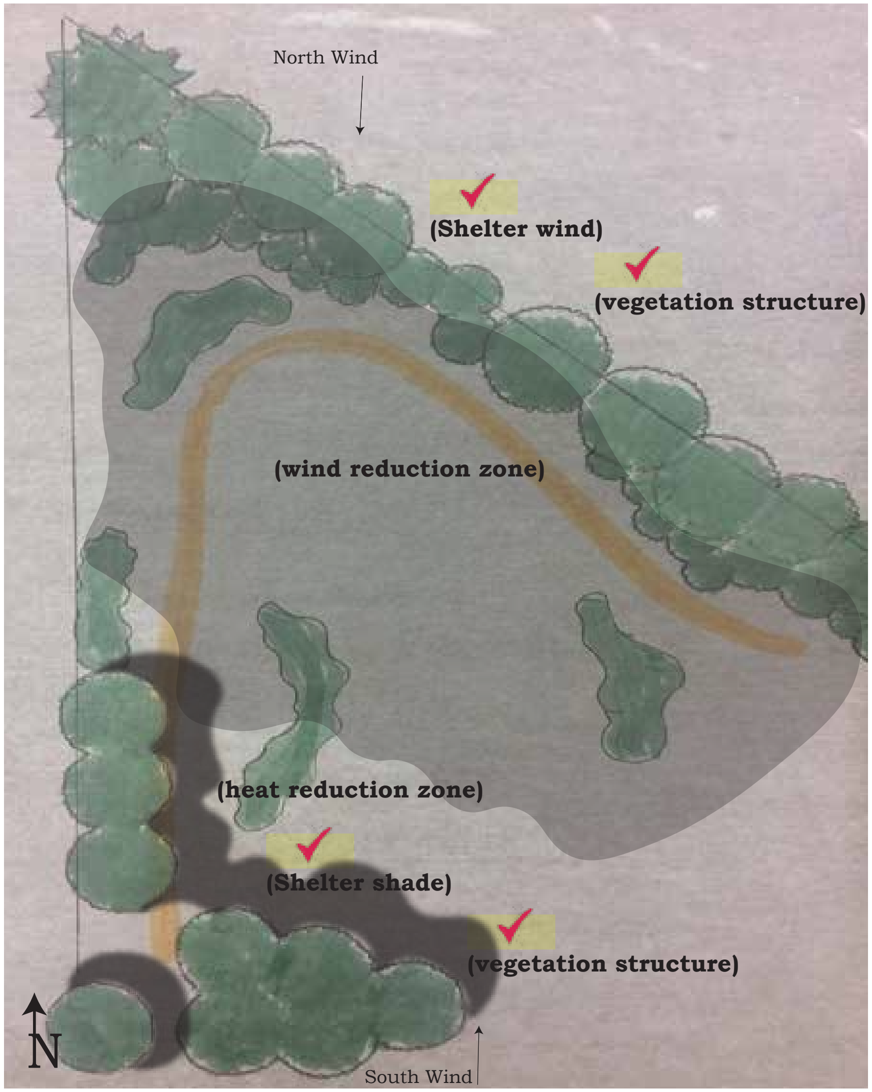
- ✓ Consideration for Wind Protection
- ✓ Consideration for Rain Protection
- ✓ Consideration for Heat Protection
- ✓ Consider spatial vegetation layering

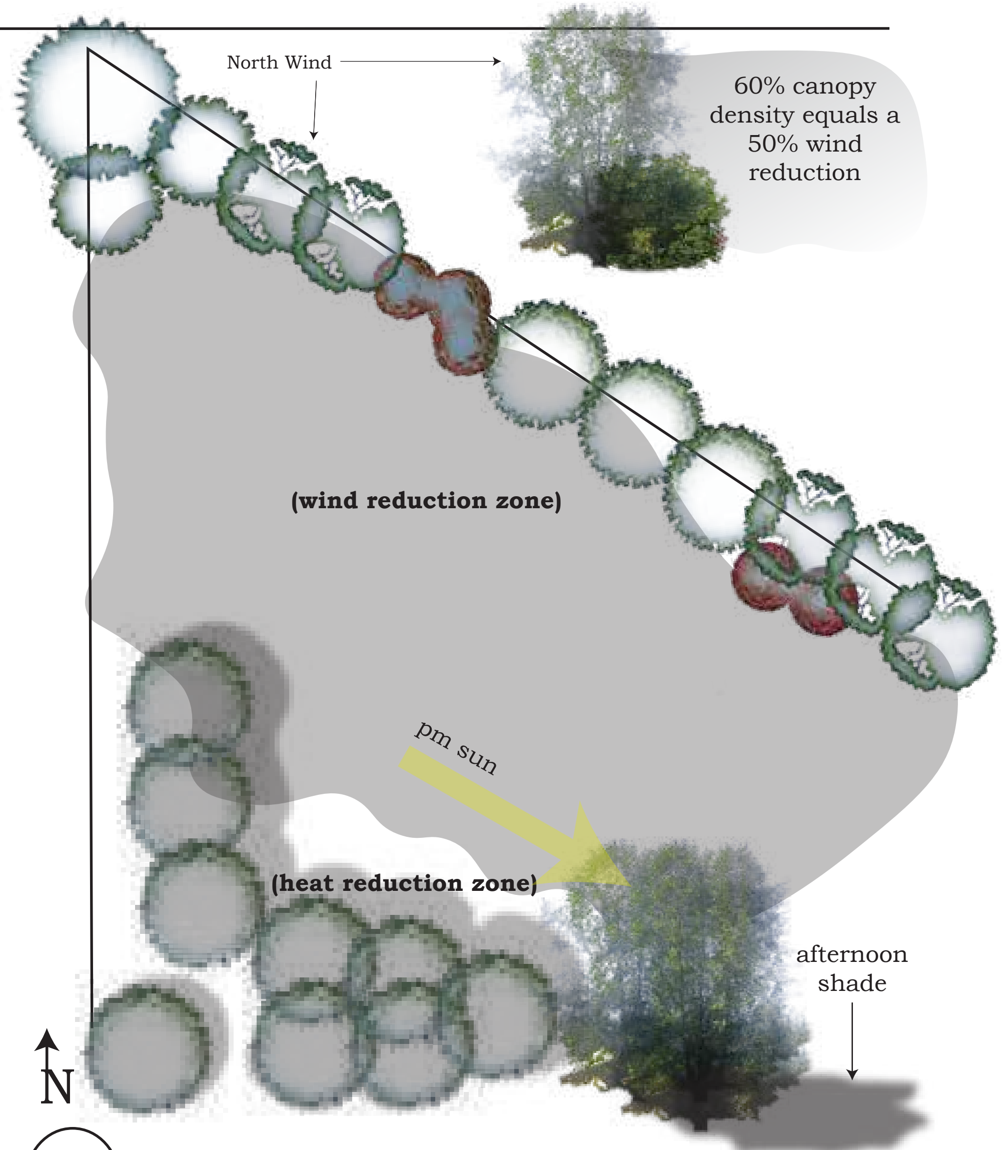
1 Step One

Sketch out the garden and roughly place vegetative massing of appropriate size and shape that will help buffer the garden from wind. In Eugene, the strongest winds come out of the north during butterfly flight season, thus a massing on the north border of the garden is appropriate.

Because this is a wet prairie design, the tree canopy cover should be roughly 5% of the total occupied space. However, prairie butterflies still seek shade to cool off their body temperatures during peak heat hours of the day. Place a tree massing on the southwest side of the garden to cast shade to provide a “cooling off ”section for butterflies to seek refuge.

Shelter from rain will automatically be accomplished by placing various layers of vegetation in the garden, especially with the planting of trees.





2 Step Two

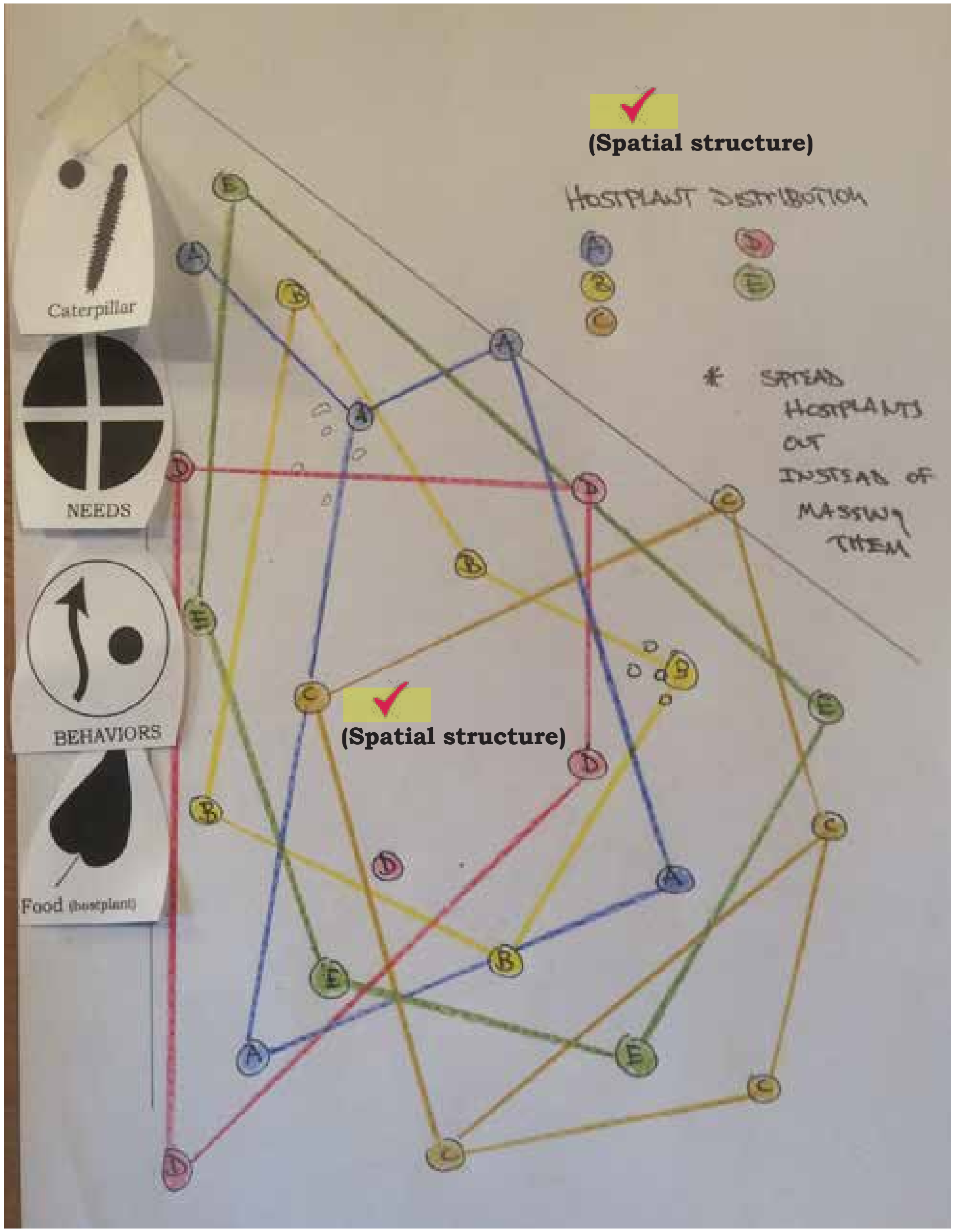
Structure the vegetation massings in a more specific arrangement and visualize the protection zones that will be derived from this positioning. Tree massings can provide all three of the needs of wind, heat, and rain protection. However, not all three protection requirements will be met by planting massing in the same place. Address each need separately.

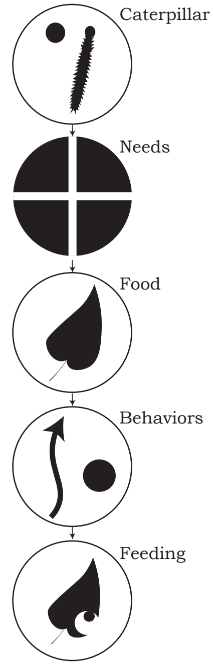
3 Step Three

Refine the vegetation structure, based on species specific parameters. For wind protection, a canopy of 60% density will reduce the wind velocity on the leeward side (the garden space) by 50%. The linear distance achieved for this 50% reduction zone is directly related to the height of the buffer. For shade, direct the shadows towards the center of the garden during the warmest time of the day.

Example

Need-Food-Hostplants Process Work Flow





Food (Hostplants)

Design Consideration Checklist

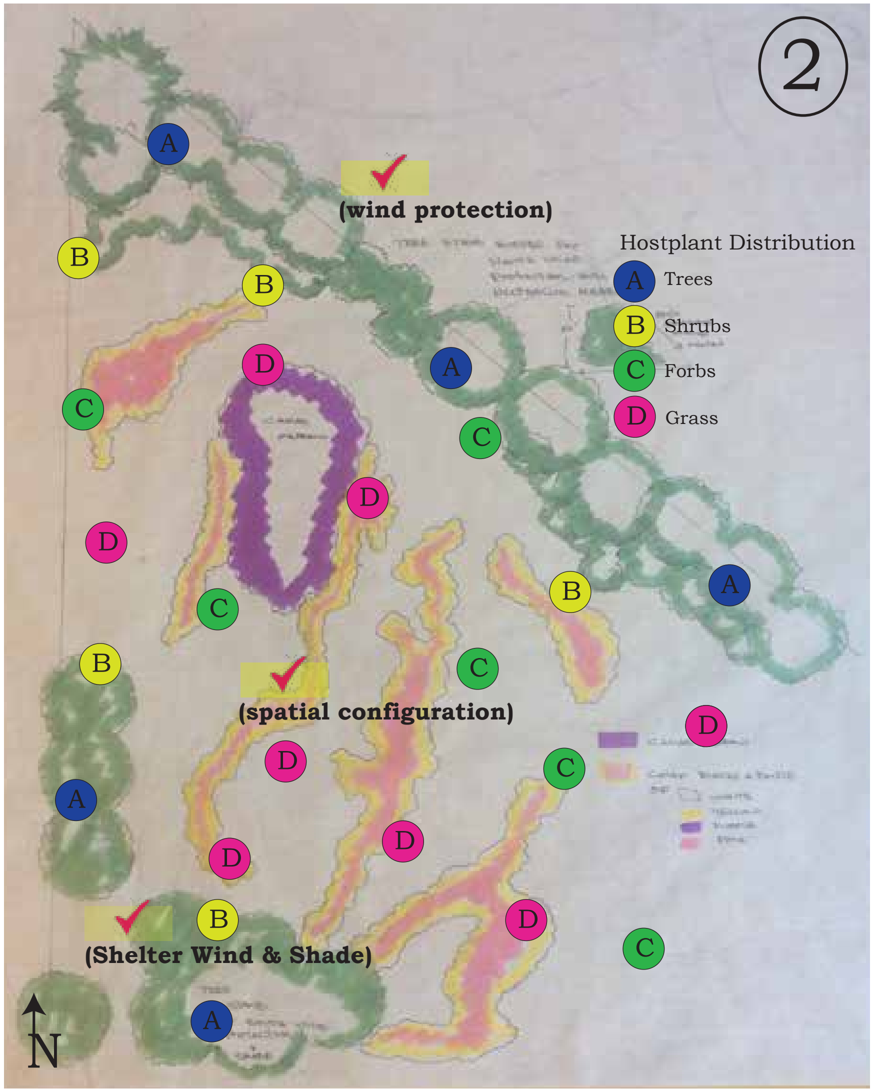
- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Configuration of spatial structure
- ✓ Consideration for hostplant species

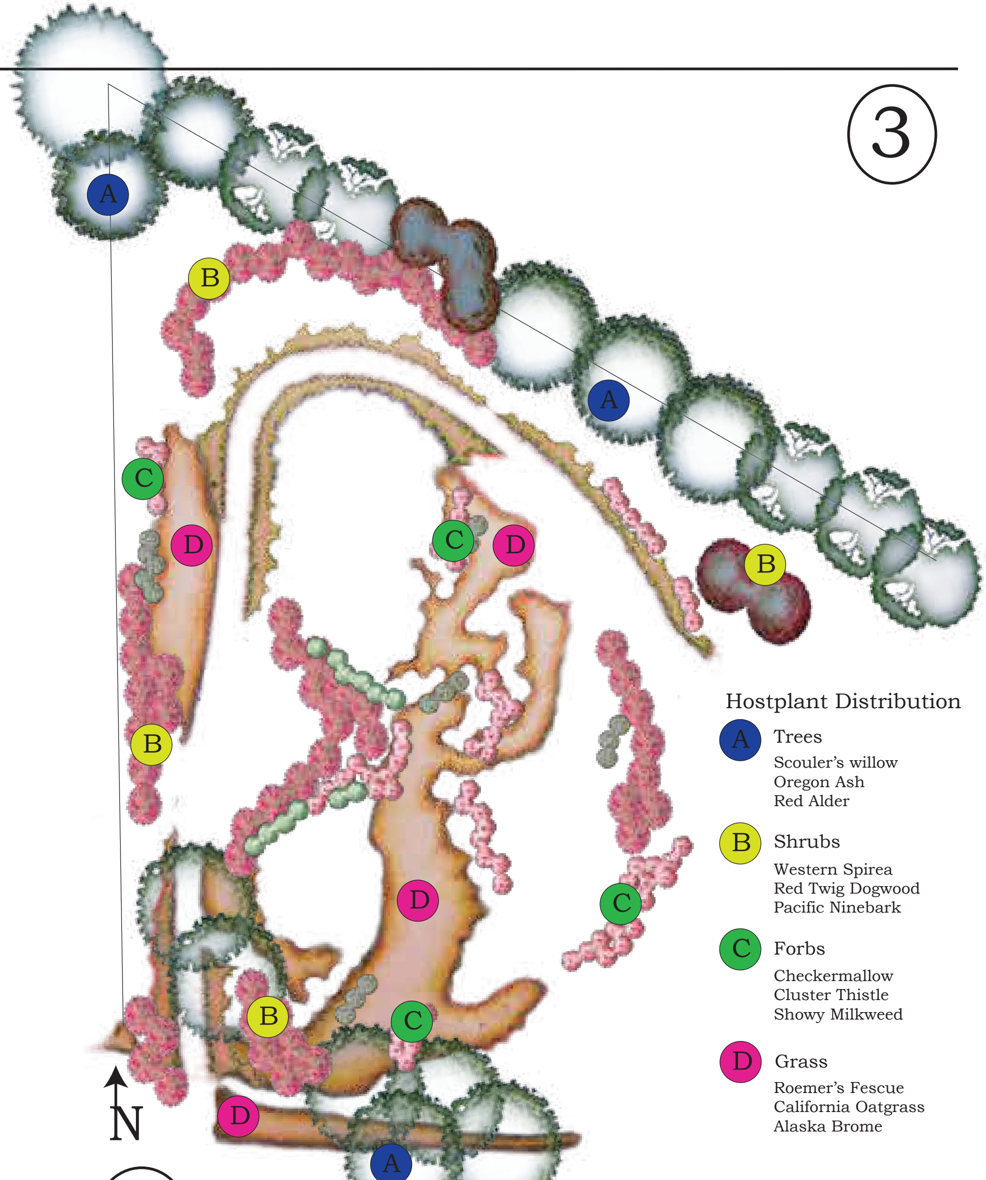
1 Step One

With the initial sketch, you can rough out some basic concepts of how hostplants should be evenly disbursed throughout the garden. Choose generalized conceptual color codes to get an idea of how these different hostplant species may be spatially placed in relation to one another.

Don't worry about species and specifics at this point, just lay down a rough idea of where these hostplants will be placed as per the general color code themes.

Evenly spread out hostplants throughout the garden so that female butterflies will distribute eggs across a greater spatial distance. This accomplishes two distinct goals; 1) it keeps butterfly caterpillars from being clustered in one area and being located easily by predators 2)Female butterflies may lay a greater amount of eggs in one garden space.





② Step Two

Refine the color codes to specific groups of hostplants. Don't worry about the species yet. The structuring of these hostplants serve multiple design functions such as shade, windbreaks, borders, massings and backdrops.

Distribute hostplants evenly throughout the garden space. Keep in mind that hostplants serve various functions for garden design, such as wind buffers and shade.

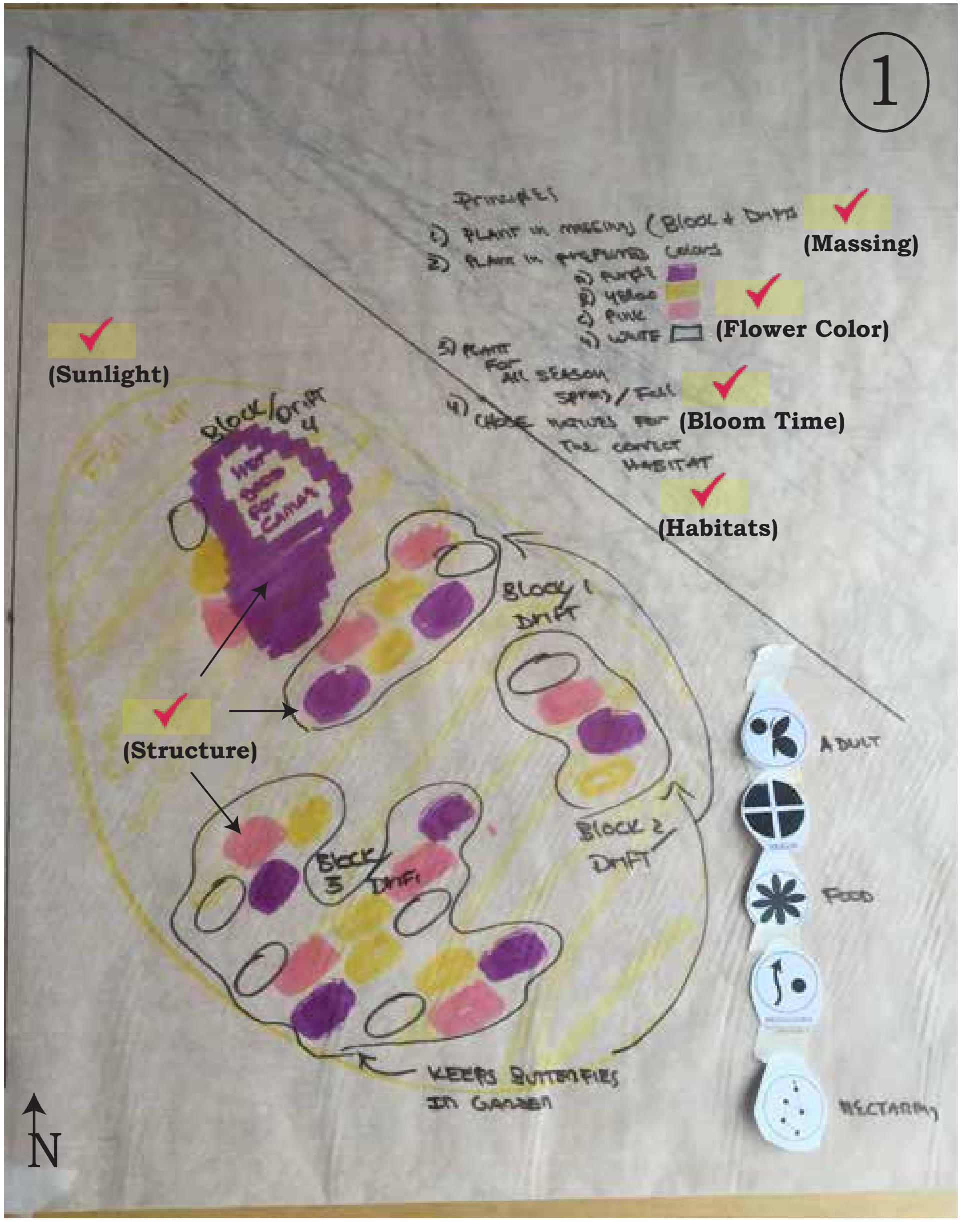
③ Step Three

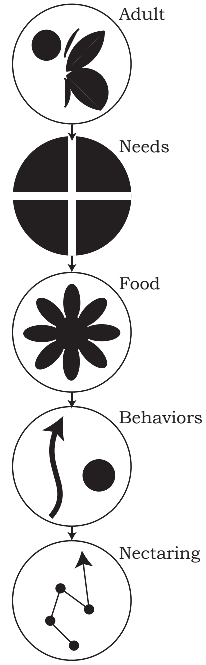
Because the plant palette has already been predetermined at this point, getting species specific about hostplants allows the designer to place hostplants into diverse roles of both food sources and other structural functions.

Get specific with hostplant species and the placement within the garden space. You may want some in drifts, and some in blocks. Design for ample plantings of hostplants.

Example

Need-Food/**Behavior**-Nectaring Process Work Flow





Nectaring

Design Consideration Checklist

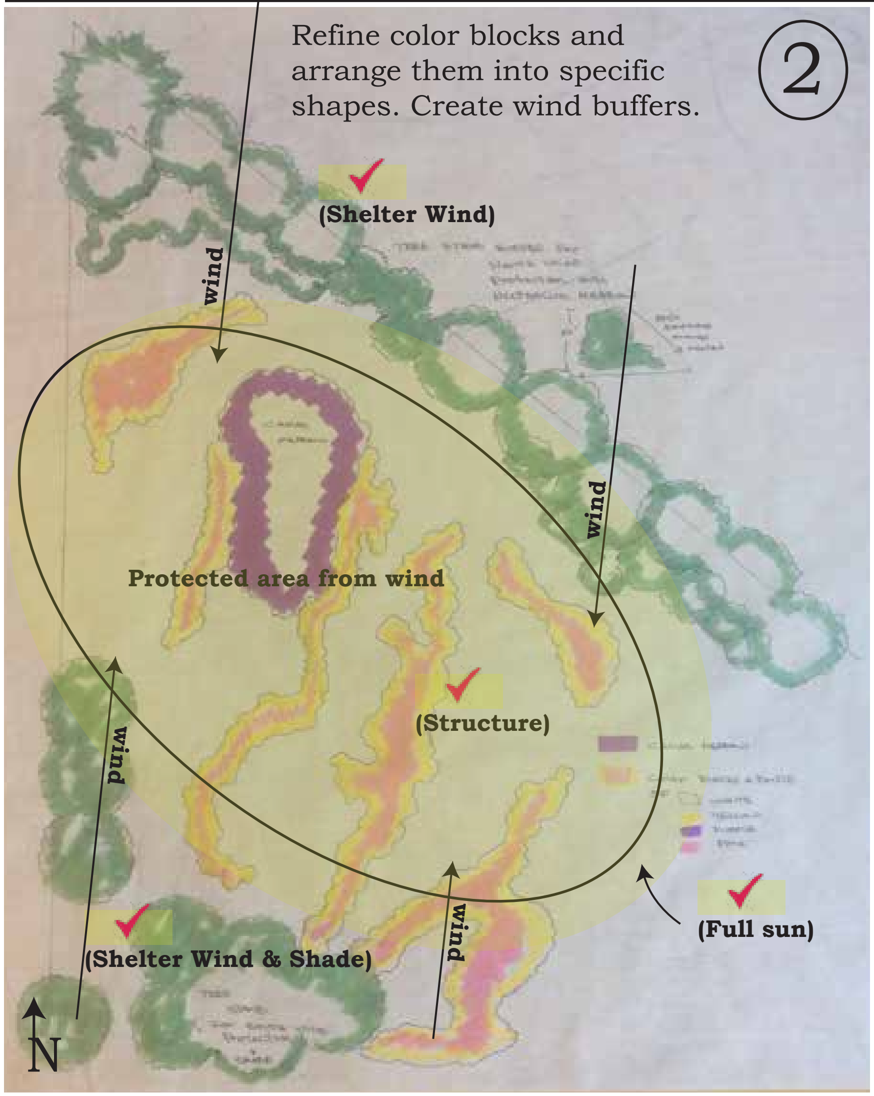
- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Consideration for flower species
- ✓ Consideration for flower massing
- ✓ Consideration for flower color
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day
- ✓ Consideration of Habitats
- ✓ Consideration of bloom time

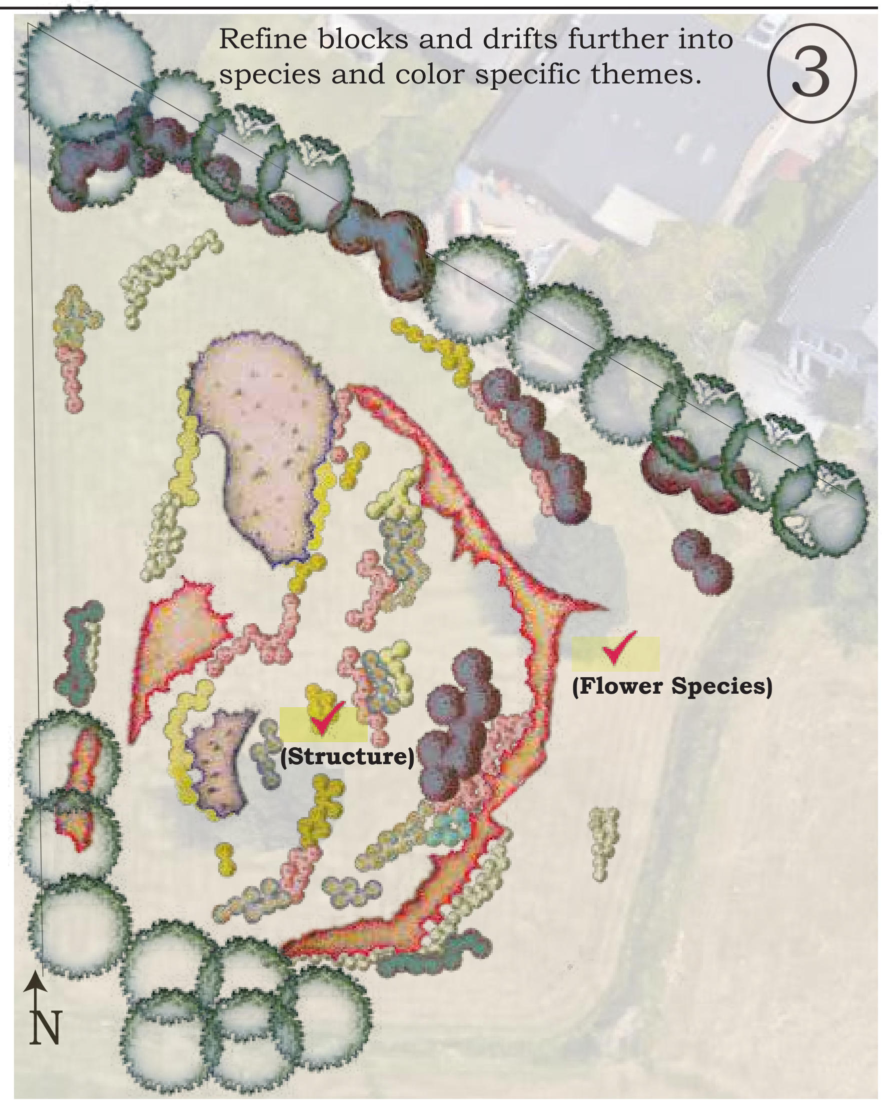
1 Step One

With the initial sketch, you can rough out some basic concepts of addressing both the need for adult butterfly food (flowers) and the behavior of nectaring with a very simple diagram.

Once you know the basic area that the garden will occupy and you know the pathway for direct sunlight, place flowering plant color blocks and drifts in a generalized area to get a sense of spatial arrangement and distribution through the garden.

Don't worry about species and specifics at this point, just lay down a rough idea of where these nectar sources will be placed and their general color themes. Rough out the four main colors that drive butterfly flower visitation; purple, yellow, white, and pink. Plant species are determined later.





② Step Two

Here, color blocks and drifts are arranged into more specific shapes, still keeping it non-specific.

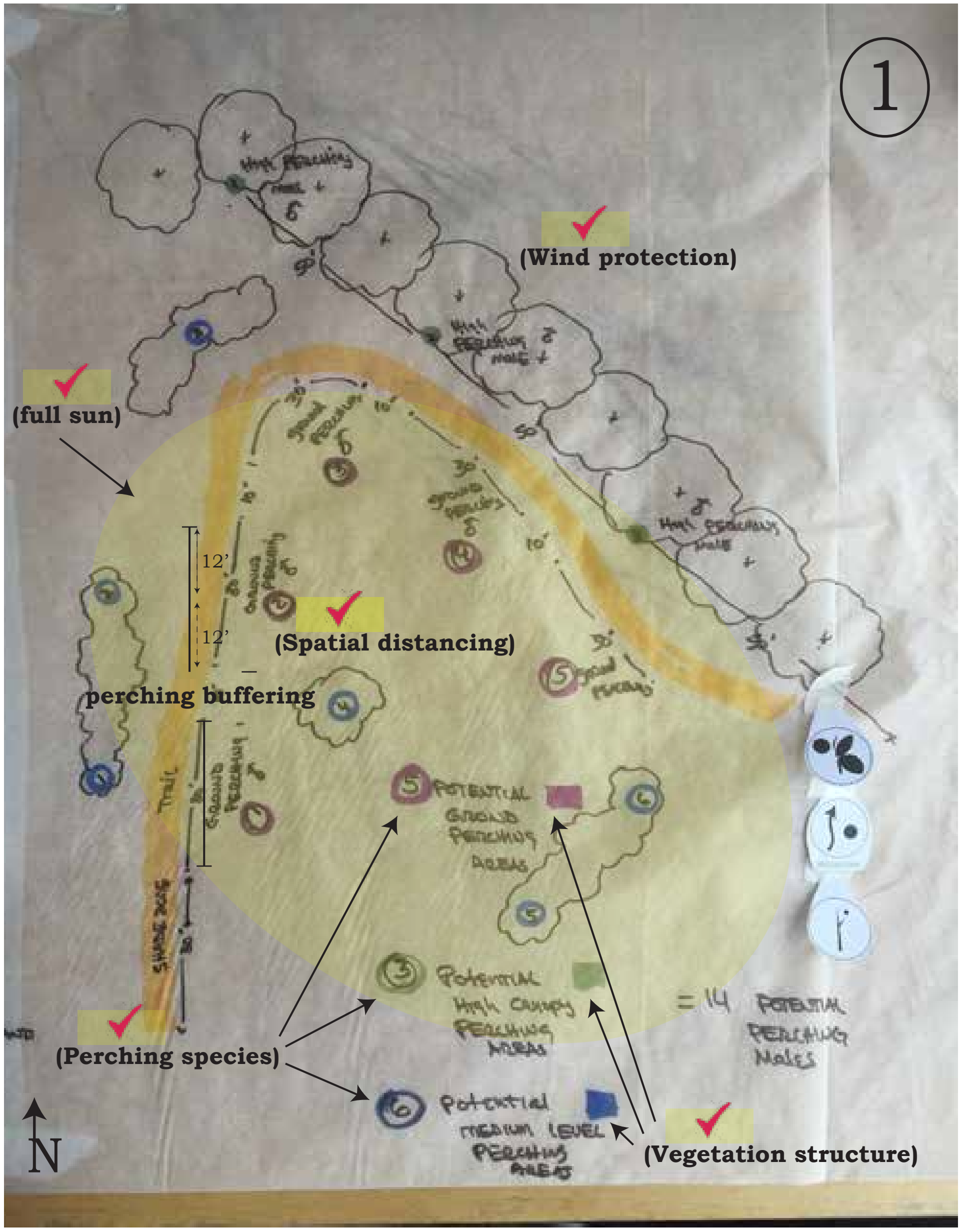
Shelter from wind and heat is added to block winds that come from the two most prevalent directions of the North and South. Keeping the center of the garden protected from winds promotes adult butterfly food foraging behavior.

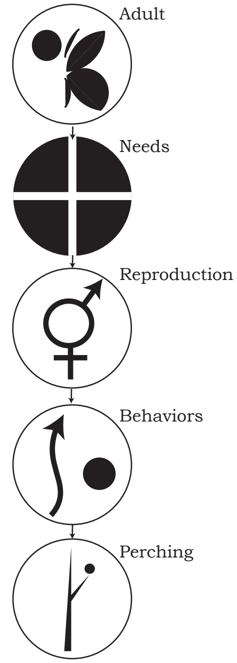
③ Step Three

Because the plant palette has already been predetermined at this point, the getting specific flowering plant species, color arrangement, bloom time, planting layout and quantity of plants can occur. Placement of color blocks and drifts and the shaping them in ways that create large obvious color massings, that will be easily seen by adult butterflies, will encourage adult butterflies to remain in the garden.

Example

Behavior- Perching Process Work Flow





Perching

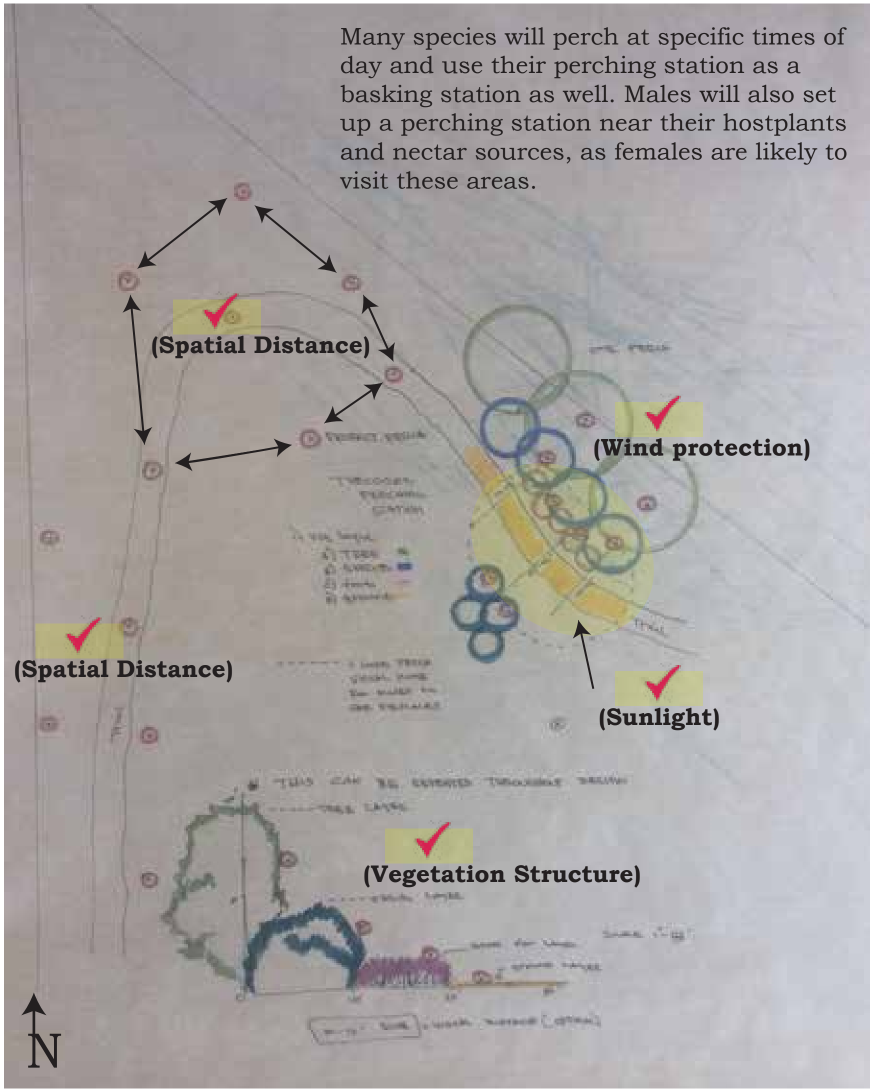
Design Consideration Checklist

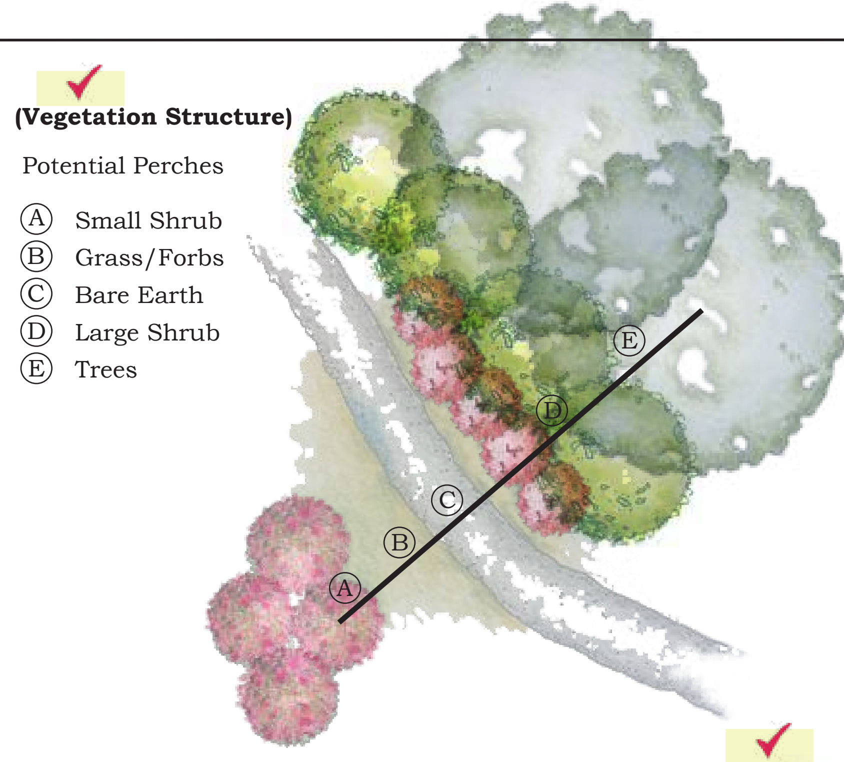
- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Combine with Reproduction Need
- ✓ Consider spatial distancing
- ✓ Consideration of perching species
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day

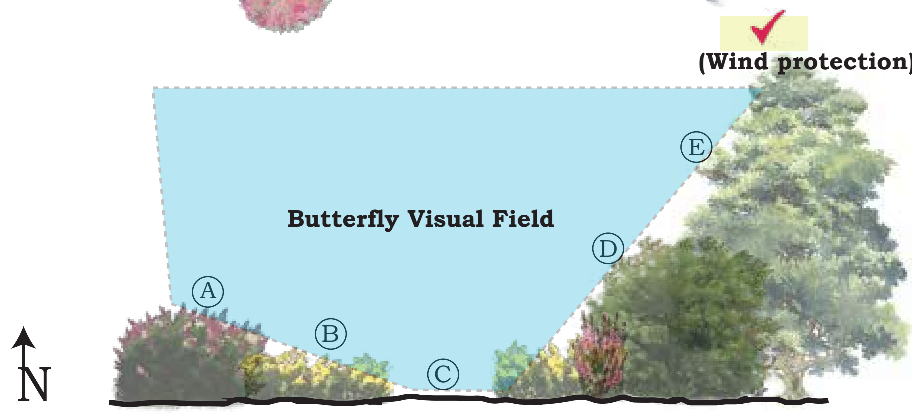
1 Step One

When designing for perching, the first consideration, is to realize that different butterfly species will perch at different height levels. Some species will perch on a bare earth surface, some will perch at around 2 to 3 feet off the ground and some will perch on taller shrubs and even up into the tree canopy. Creating vegetation layers will encourage perching to occur for the various species.

The second consideration is to realize that perching is a mate finding behavior and is exclusive to males. These male butterflies will defend a territory surrounding their perch. Spacing perching stations far enough apart from the next station will encourage more male butterflies to occupy the garden. Butterfly visual acuity is generally 10-12’, thus perching stations should be placed no closer than this distance to avoid rival male butterflies from competing for the same perching stations.







2 Step Two

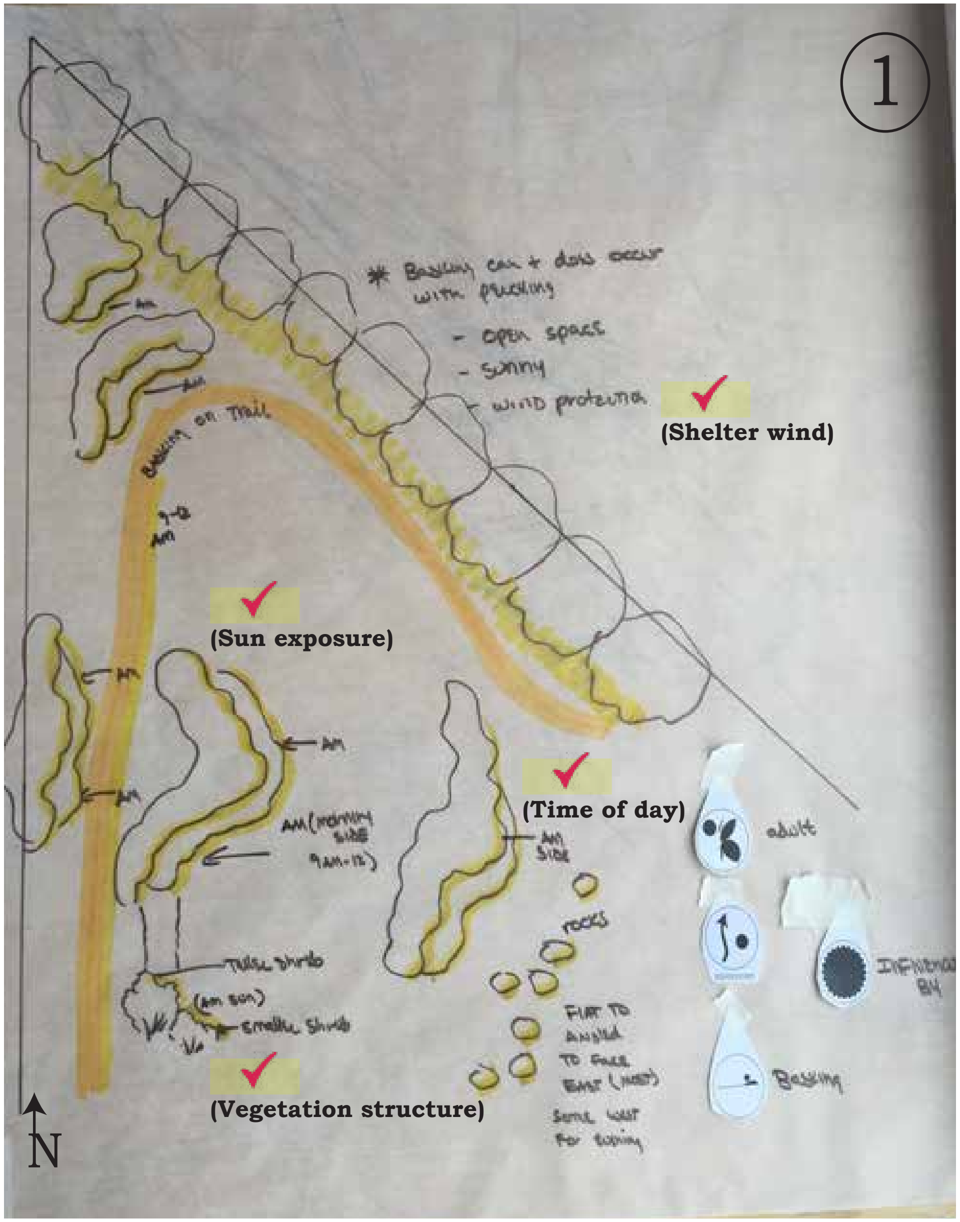
Pay close attention to spatial distances between perching stations. Because male butterflies will occupy a single perch and defend that territory, purposefully arranged vegetation and designed perching stations should have ample room. Create stations 20 to 30 feet apart from the last perching stations to help reduce competition between rival males.

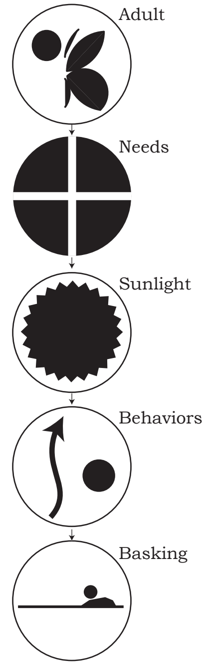
3 Step Three

Structure vegetation based on tallest plants to the back and shortest to the path. The pathway should be considered a perching station in its own right for ground perching species. The forb and grass layers, shrub layer, and tree layer will all be used as potential perching stations for various butterfly species. The key is to create an open visual field of view for males, unobstructed and free of vegetation.

Example

Behavior-Basking Process Work Flow





Basking

Design Consideration Checklist

- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Consider individual species needs
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day

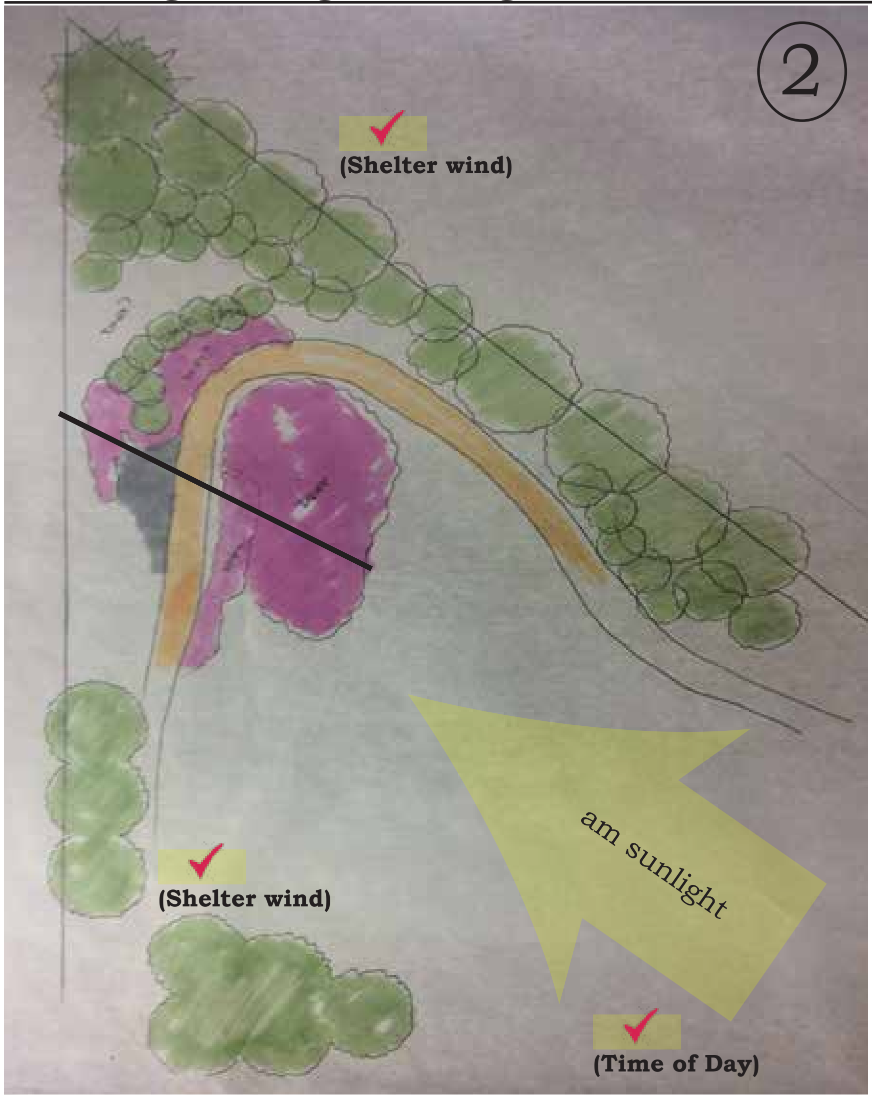
1 Step One

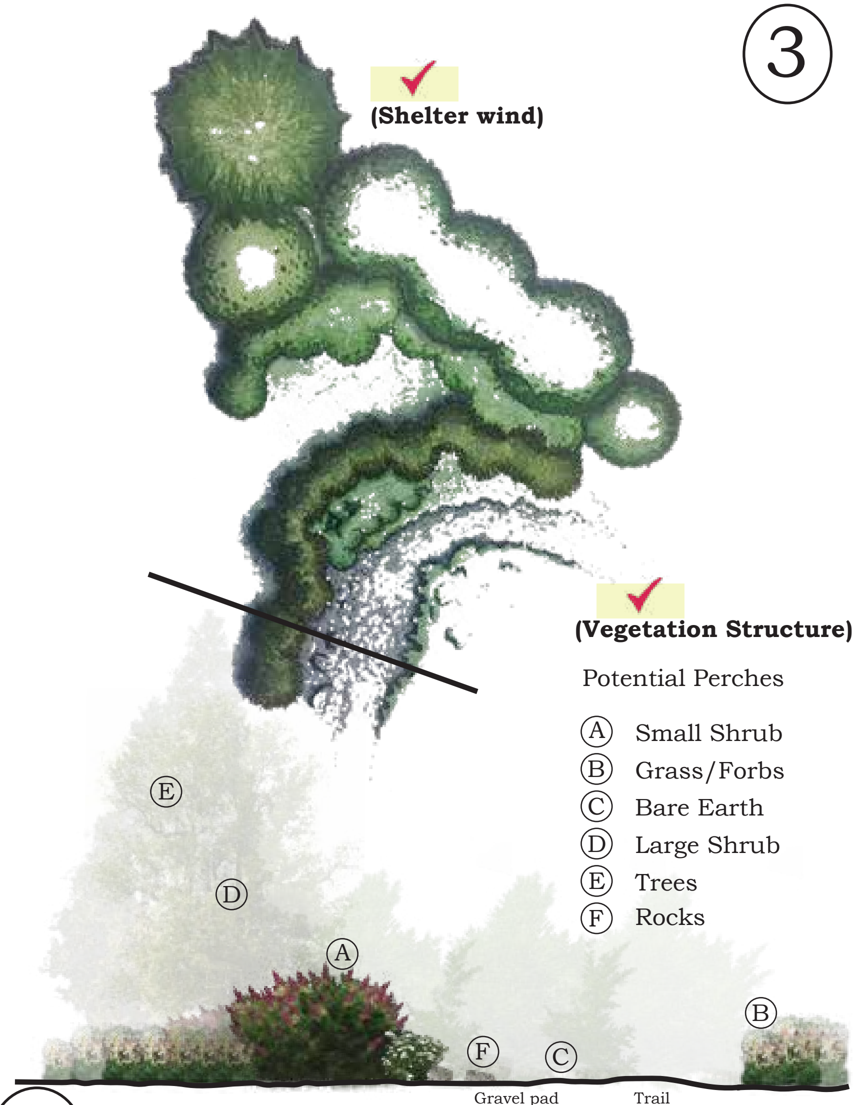
Basking is a behavior, in which adult butterflies collect warmth from the sun, to raise their body temperature so they can remain active (flight, feeding and mating).

The first step in designing basking stations within the garden space, is to identify areas in the space that will receive direct sunlight from sunrise through the early part of the day.

Wind that blows across the garden can create a wind chill effect and drop the butterfly’s body temperature below active flight temperatures. Creating a microclimate of warm air, through the use of a wind barrier such as a stand of mixed height vegetation, is an excellent way to reduce chilling wind surrounding the basking stations.

Structure vegetation so that taller plants planted in the back won’t create shaded areas across the ground and shorter vegetation layers during sunrise and in the morning hours.





2 Step Two

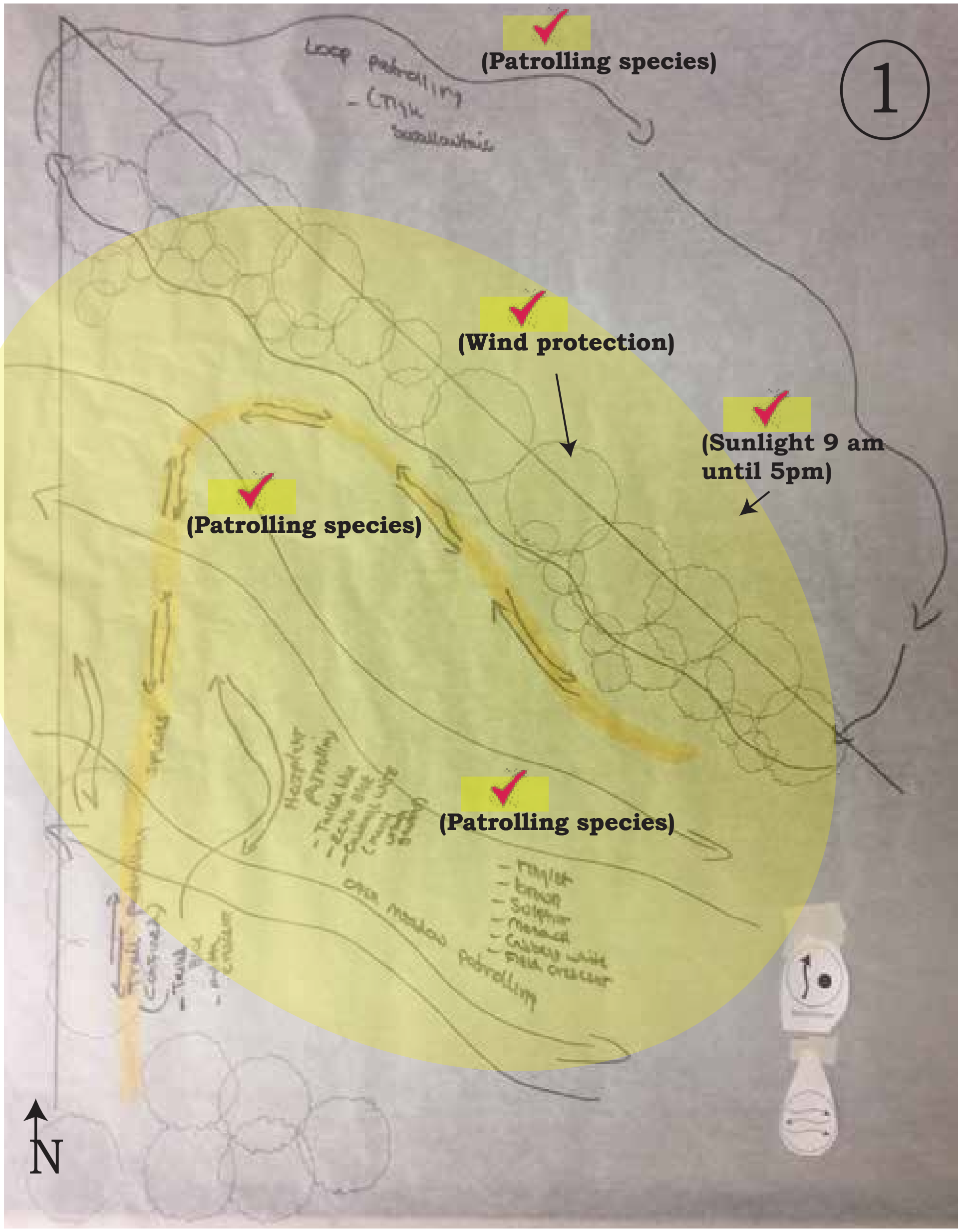
Step two of designing the basking station is where you can get more specific with the arrangement of plant structure, creation of pathways, gravel beds, forb/grass layers, shrub layers and tree layers.
You don't need to be plant species specific at this point, just a general concept of where plants will be placed.

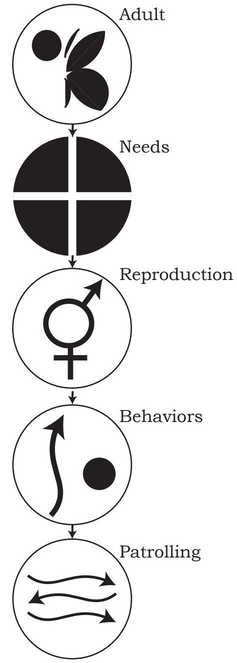
3 Step Three

Get specific with plant layer species and placement, measure out the distance of the gravel pad and the placement of the pathway. Add basking stones in the gravel pad area for butterflies. Draw out the refined ideas for a final rendering on the design plan. Look at specific butterfly species and their specific basking tendencies.

Example

Behavior- Patrolling Process Work Flow





Patrolling

Design Consideration Checklist

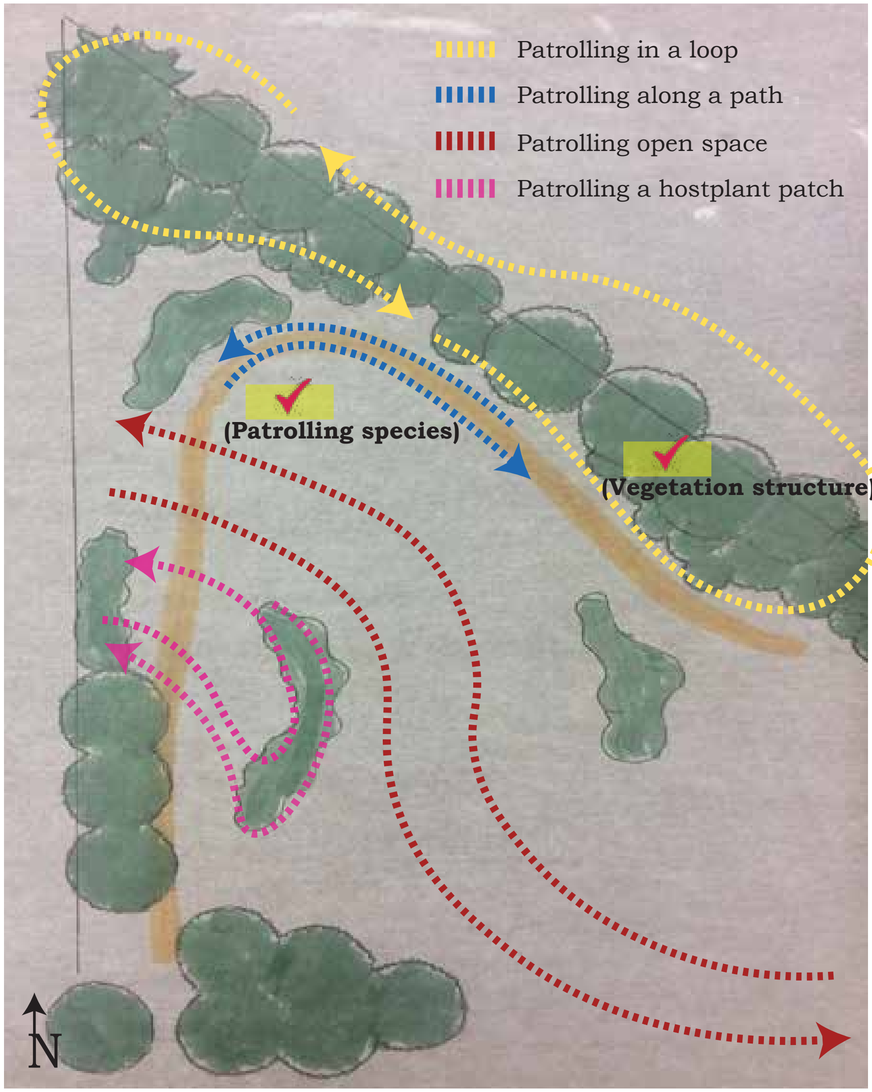
- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Combine with Reproduction Need
- ✓ Consider Hostplant association
- ✓ Consideration of patrolling species
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day

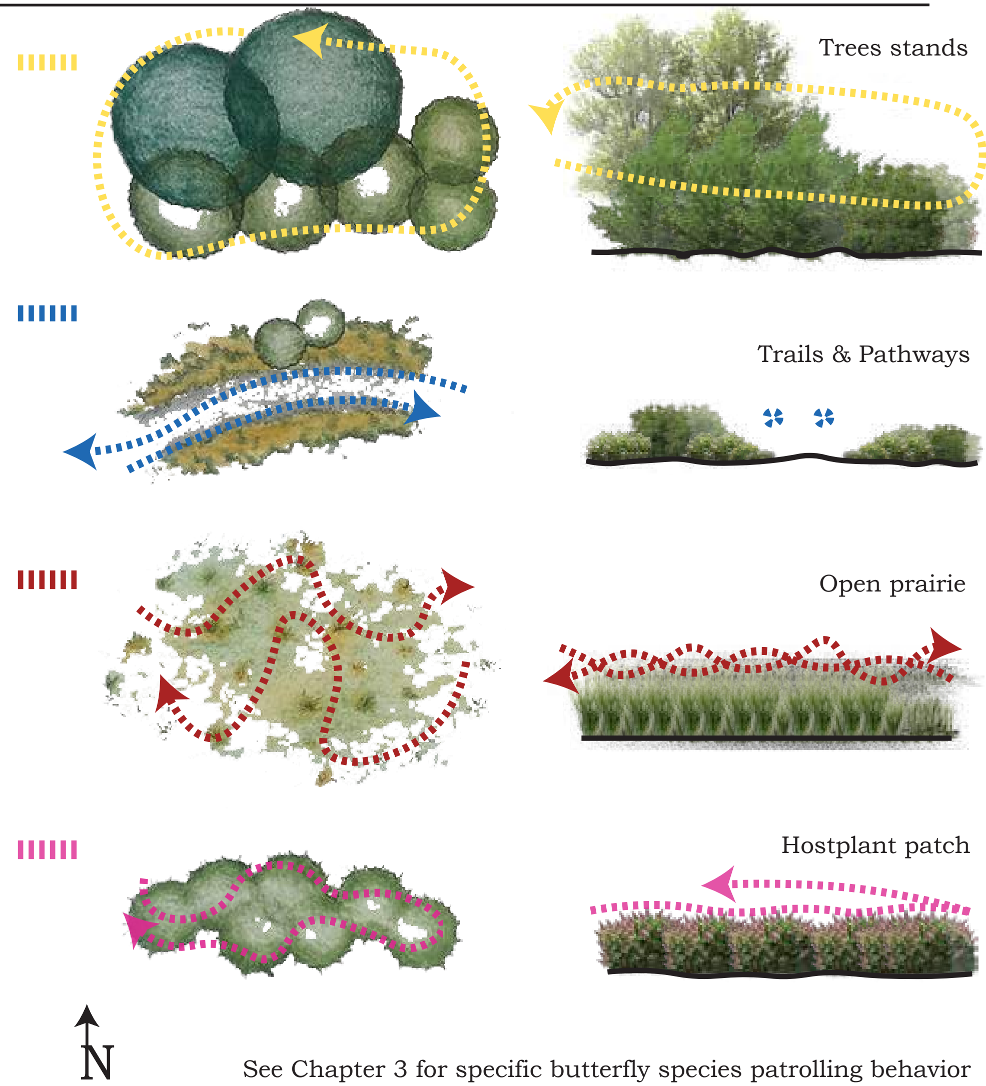
1 Step One

Sketch out vegetation for windbreaks and shade patches. These windbreaks, shade tree and shrub vegetative patches will create visual guides for species that prefer to patrol around and through tree stands. The windbreaks will create a warmer area for butterflies to move about the garden when temperatures are lower.

Leave plenty of open prairie grasses and mixed flowers for both male and female butterflies to navigate and explore. This habitat will encourage open prairie patrolling species. Create a wide trail for ground hugging patrolling species to navigate in open areas.

All areas of the garden should be filled with full sun from 9am until 5pm. Keep shaded areas along the sides rather than crossing through the middle of the garden space.





See Chapter 3 for specific butterfly species patrolling behavior

2 Step Two

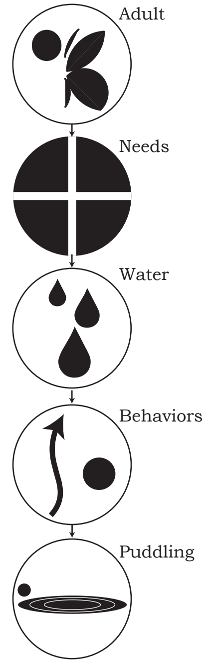
Get specific about vegetation types and structure that would promote the different patrolling species behaviors. Some species will patrol open prairie grasses, ducking in or flying atop. Some species will patrol open trails and pathways. Some species will fly in a loop-like pattern, others will patrol above hostplant patches. Get specific about patterns.

3 Step Three

Refine structure of vegetation types, based on butterfly patrolling behavior. The concept is to create an optimal structure for vegetation placement within the garden. Visualize what an open prairie might look like, what a stand of trees and shrubs would look like, what a trail system would look like and what hostplant patches look like. Create areas to provide the opportunities for patrolling butterflies.

Example

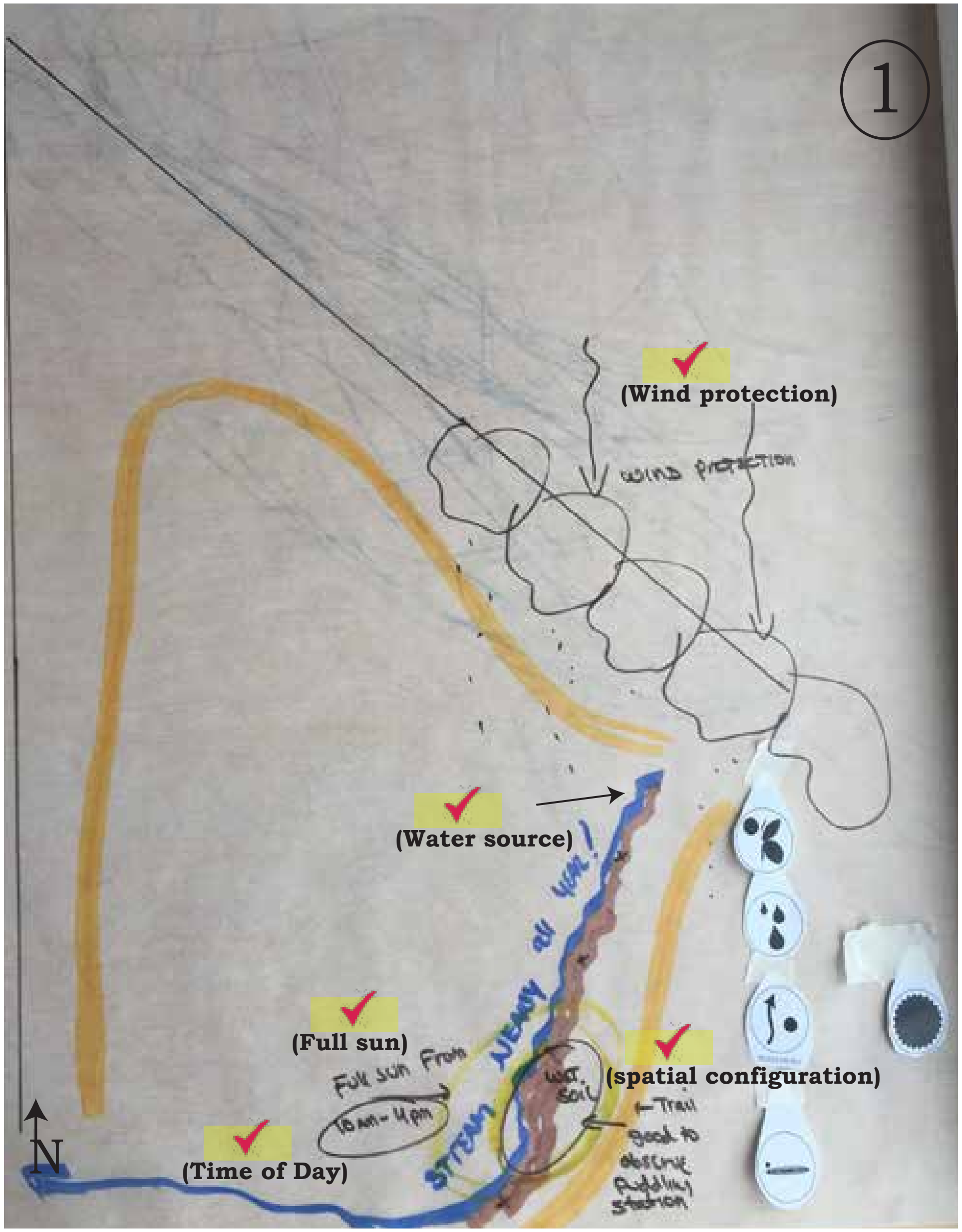
Behavior- Puddling Process Work Flow



Puddling

Design Consideration Checklist

- ✓ Combine with Sunlight Need
- ✓ Consideration for Wind Protection
- ✓ Consideration for Water depth
- ✓ Consideration of spatial configuration
- ✓ Consideration of vegetation structure
- ✓ Consideration for time of day
- ✓ Consideration for water source

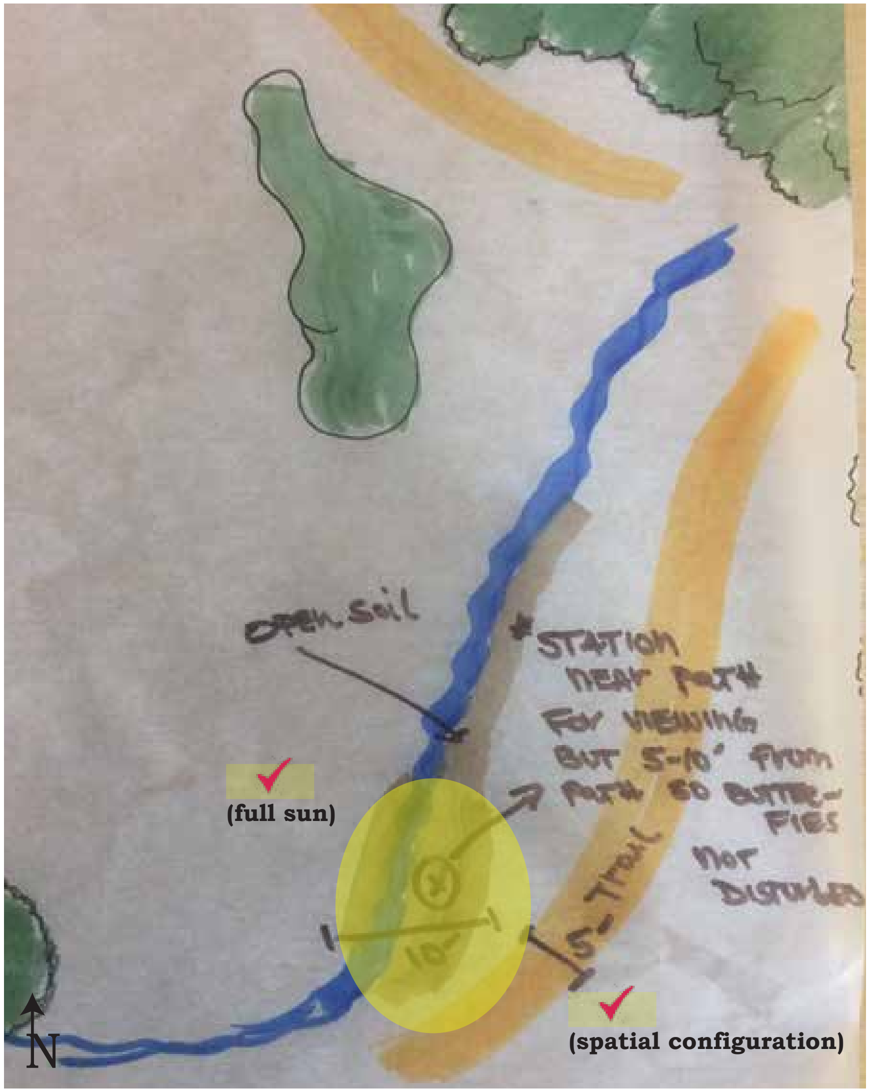


1 Step One

Sketch out the garden and roughly place the puddle station where it will receive full sun during the warmest time of the day (10 am to 4 pm is perfect). Sketch in a rough idea for where tall vegetation (trees and shrubs) will provide shelter from wind without creating shade across the puddle station.

Consider where the puddle station will receive water. If the water is from a natural source such as a spring or stream, then place the station next to this area. Make sure the area will receive a fresh supply of water through the hottest and driest months.

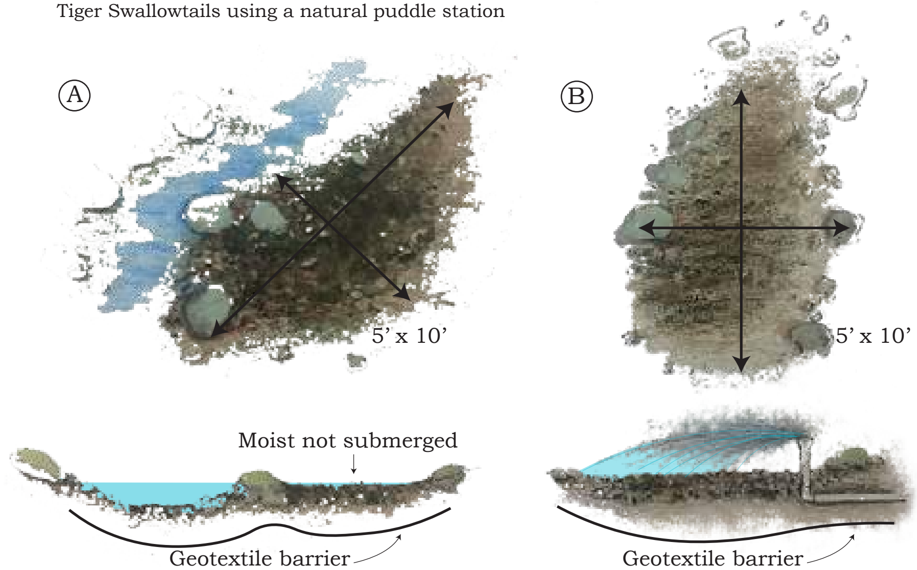
Place the station where the wet soil will be free from vegetation. Shrubs and grasses that block access to the station should be removed and bare earth and gravel should be exposed.




Tiger Swallowtails using a natural puddle station

Puddle Station Considerations

1. Moist soil
2. Free of vegetation
3. Full sun (10am-4pm)
4. Daily supply of water
5. Ample size 5-10 feet
(my assertion)



Ⓐ Pudding station (natural water source) Ⓑ Pudding station (irrigated)

2 Step Two

Besides the obvious benefit of water for the survival of the butterflies, is the consideration of the human component that will enjoy watching these butterflies. The most optimal placement would be along side of a trail where people can easily access the space to watch the butterflies.

3 Step Three

Refine the design of the puddle station. There really is no optimal size for a puddle station. Many backyard butterfly puddle stations are no larger than a sixteen inch wide saucer. However, I assert that creating a puddle station of between five and ten feet across, that is free of vegetation will be easier for butterflies to find. For puddle station specifics, see puddling behavior in chapter 3.

4.5 A Wet Prairie Design

So far, I have demonstrated my step by step design process from first, the guidebook, and then again during the design process section of this, the design chapter. From this point forward, the principles of the design process framework are applied to a more specific set of design decisions. The result is a more comprehensive and illustrative produced design. However, even though the design is more detailed, the process that was demonstrated earlier, remains the same.

The total area of potential habitat that occupies Willagillespie Elementary School is approximately 4.4 acres. Of this, 1.5 acres can be considered potential woodland habitat, 1.5 acres can be considered for upland prairie, .4 acres as potential savanna habitat and .5 acres is occupied with a school garden and potential for an urban flower garden or cultivated bed. The remaining .5 acres resides along the northwest section of the property. The topography is flat, and the soils are generally inundated or saturated from water that drains off from the other upslope sections of land on the property, making it perfect for a wet prairie butterfly habitat garden design. There is a near year-round water source that drains off Gillespie Butte, supporting an existing camas field.

My design concept for this space is to create a naturalistic wet prairie design of mixed forbs, sedges, and grasses. For wind protection, a mixed canopy of deciduous wetland trees will be planted along the north property line to block the north winds during spring and summer, and a small grove of native ash trees will be planted along the south perimeter of the space to create shade during the warmer months. All plants featured in the design are confirmed hostplants. However, as previously mentioned, these plants also perform other landscape design functions.

In addition to the targeting of common butterfly species, two rare butterfly species will be considered for the design. The two “rare” butterfly species that I hope to entice to the garden, are the Monarch Butterfly, by creating a Monarch waystation, and the colony driven Field Crescentspot butterfly by planting plenty of their hostplants, native asters. Neither one of these species are geographically rare, but within Eugene, certain constraints within habitat dynamics keeps these species from being universally common. For the Monarch butterfly, the Willamette Valley is its upper territory for summer distribution. For the Field Crescentspot butterfly, their colonial habit keeps them confined to meadows that support large populations of their hostplant, the asters.

This butterfly and native plant palette constitutes the phase one section of the design and the arrangement of the icon driven design elements, to meet the butterfly life histories, will constitute phase two of the design portion of this process.

Context Map

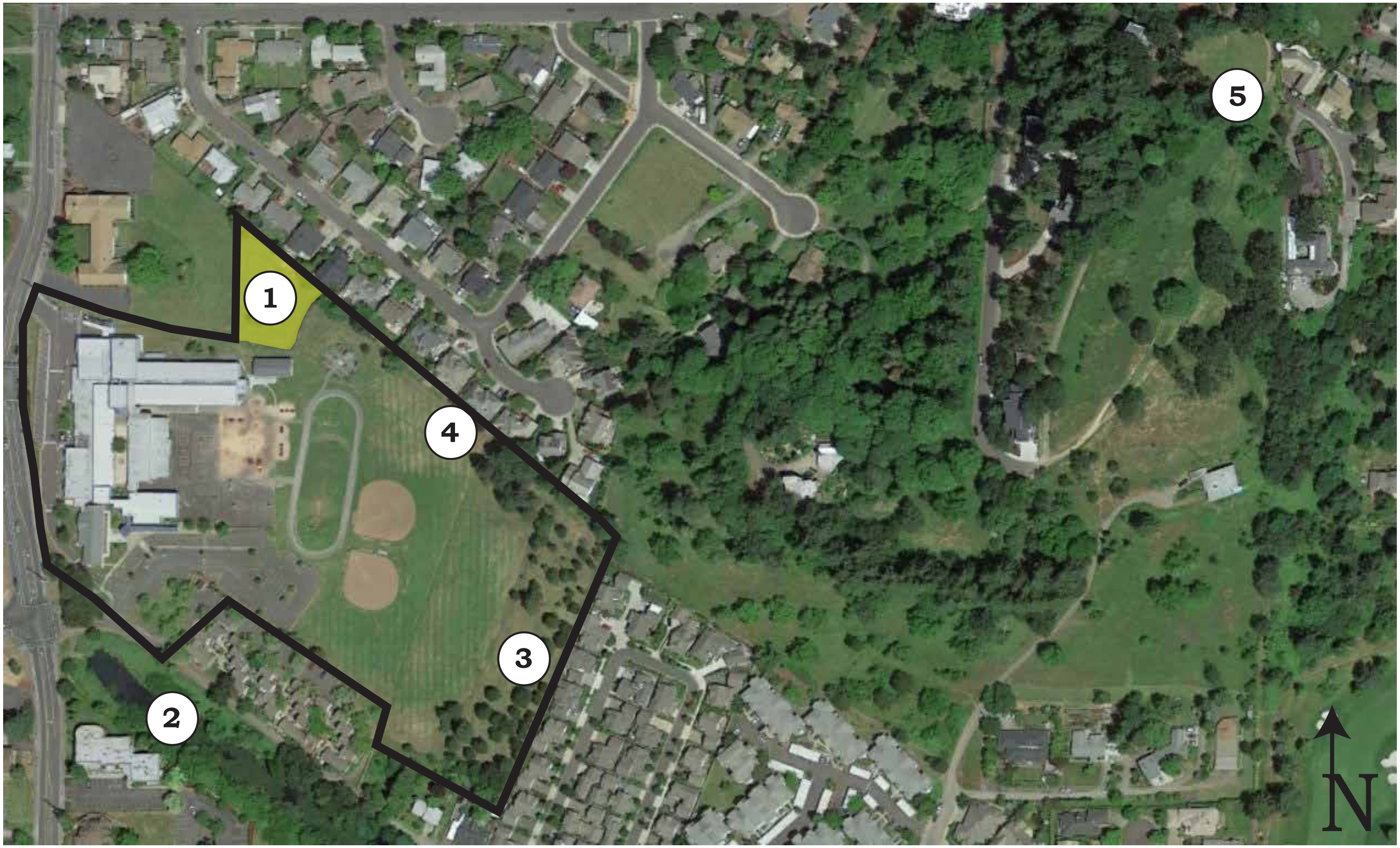
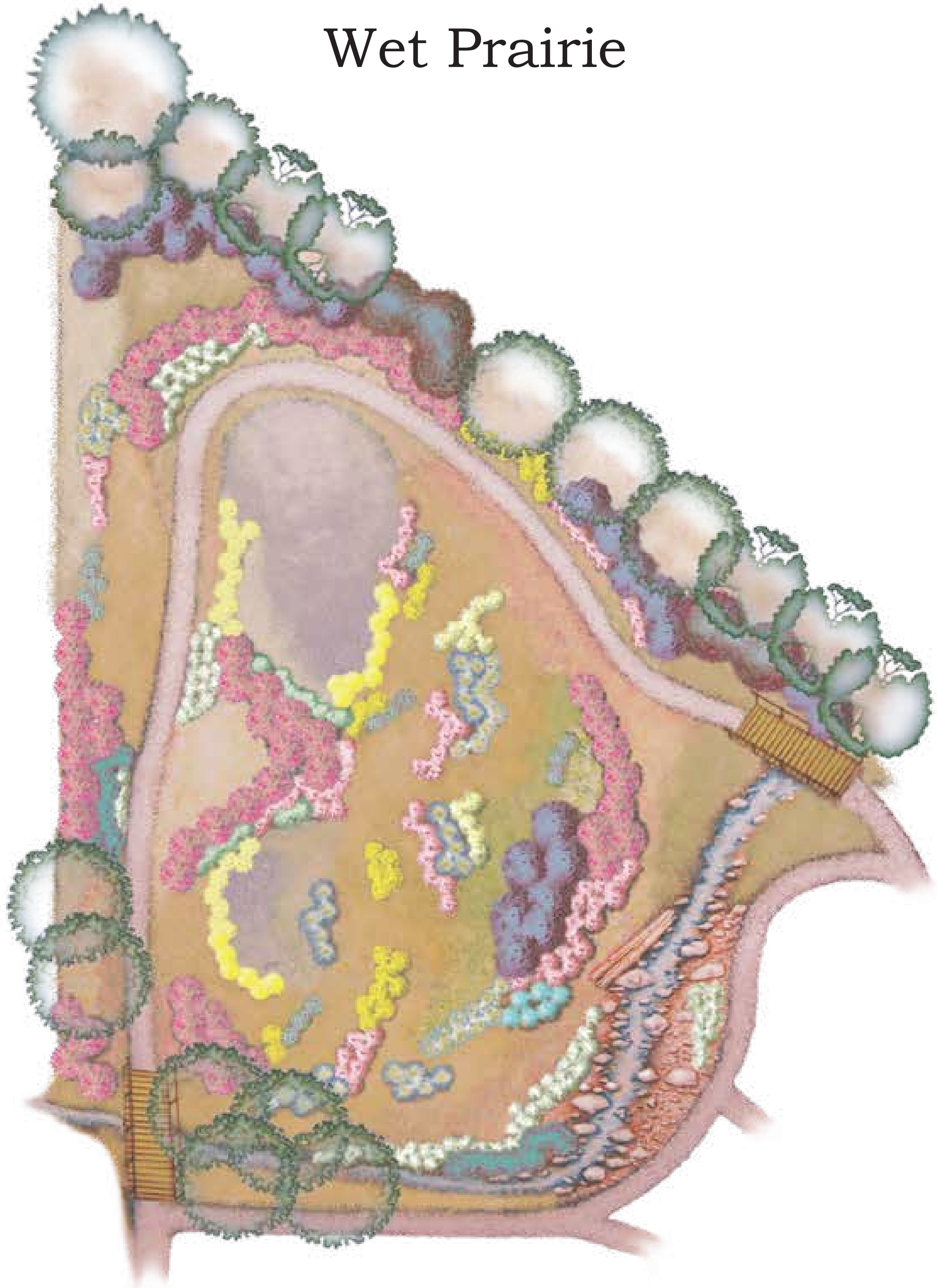
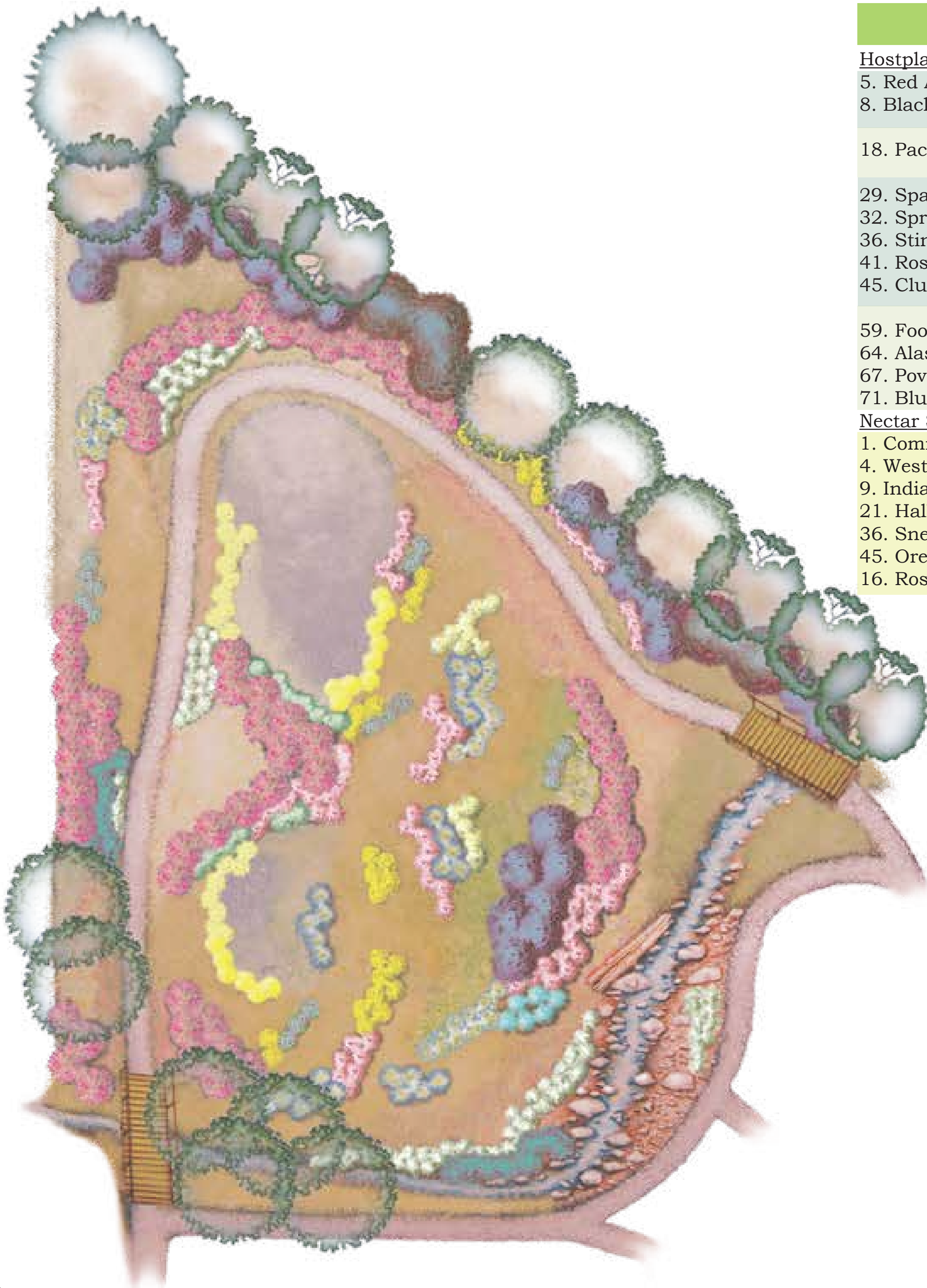


Figure 4.7 Context Map

1. Proposed Wet Prairie Butterfly Habitat Garden
2. Year round water source
3. Existing oak woodland
4. Possible site for upland prairie habitat
5. Gillespie Butte (Possible source for butterflies)

Wet Prairie





Wet Prairie Plant Species

Hostplants

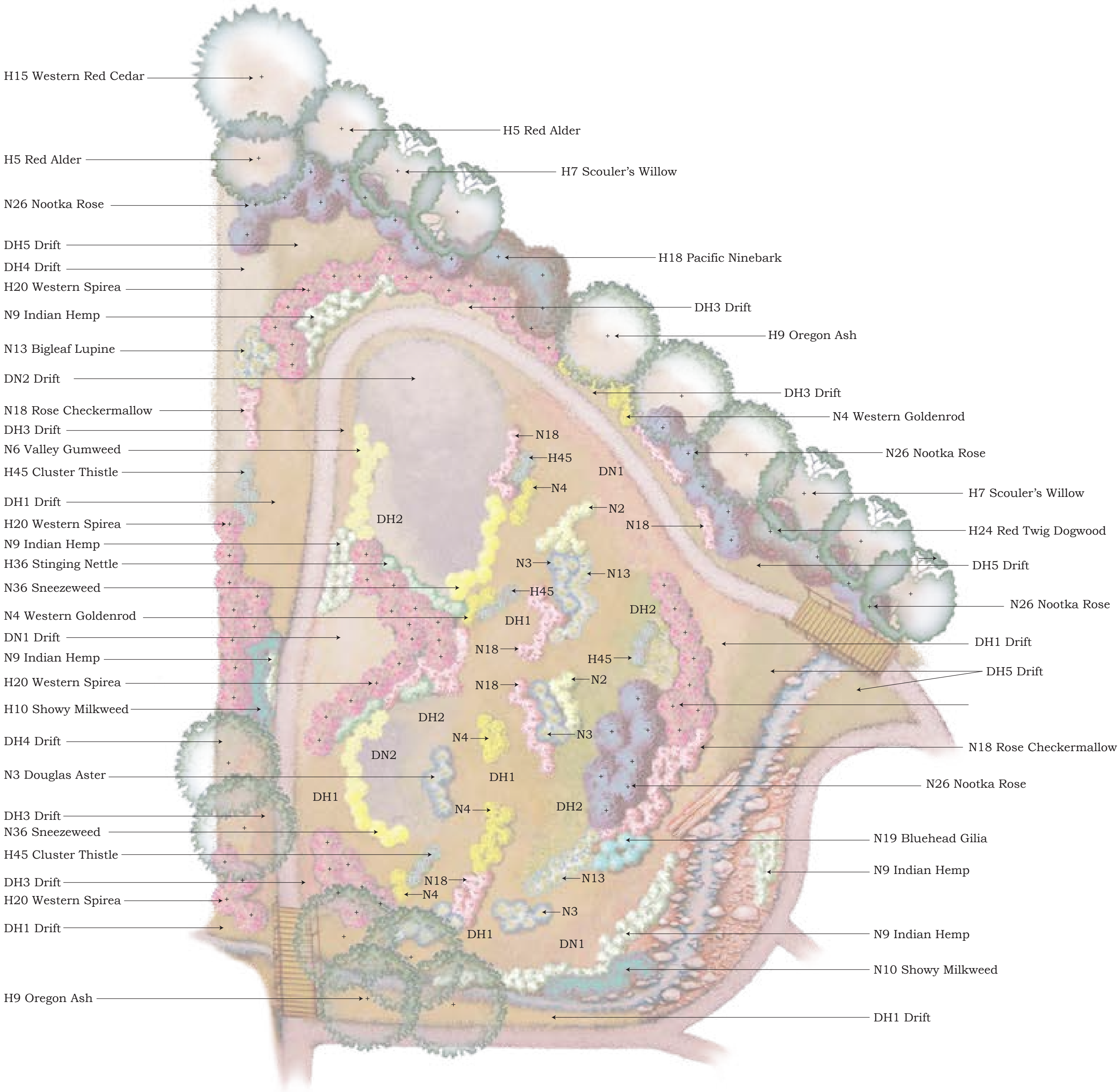
5. Red Alder	6. Western Serviceberry	7. Scouler's Willow
8. Black Cottonwood	9. Oregon Ash	
18. Pacific Ninebark	20. Western Spirea	24. Red Twig Dogwood
29. Spanish Clover	30. Birdsfoot Trefoil	31. Big Deervetch
32. Springbank Clover	33. Kincaid's Lupine	34. Bigleaf Lupine
36. Stinging Nettle	37. Showy Milkweed	38. Narrowleaf Milkweed
41. Rosy Checkermallow	42. Henderson's C. mallow	43. Cusick's C. mallow
45. Cluster Thistle	53. Douglas Aster	55. Pacific Aster
59. Foothill Sedge	60. Dense Sedge	62. Red Fescue
64. Alaska brome	65. Kentucky Bluegrass	66. Pine Bluegrass
67. Poverty Oatgrass	68. California Oatgrass	70. Tufted Hairgrass
71. Blue Wildrye	72. Slender Wheatgrass	

Nectar Sources

1. Common Madia	2. Mule's ears	3. Douglas Aster
4. Western Goldenrod	5. Yarrow	7. Pearly Everlasting
9. Indian Hemp	23. Camas	17. Lanceleaf Selfheal
21. Hall's Aster	6. Willamette Gumweed	31. Slender Cinquefoil
36. Sneezeweed	39. Lovage	41. Oregon Iris
45. Oregon Saxifrage	46. Popcorn flower	47. Seep Monkeyflower
16. Rosy Plectritis	39 Lovage	32. Congested Snake lily

Wet Prairie Butterfly Species

1. Tiger Swallowtail
5. Orange Sulphur
6. Cabbage White
9. Ochre Ringlet
10. Common Wood Nymph
11. Common Checkered Skipper
14. Propertinus Skipper
15. Woodland Skipper
16. Sachem Skipper
17. Dun Skipper
18. Sonora Skipper
22. Grey Hairstreak
26. Eastern Tailed Blue
29. Silvery Blue
30. Spring Azure
35. Lorquin's Admiral
37. Mylitta Crescent
41. Painted Lady



Nectar Drifts

<u>DN1 Nectar Drift 1</u>
<u>(Camas Meadow Drift)</u>
N1 Common Madia
N5 Yarrow
N7 Pearly Everlasting
N17 Lanceleaf Selfheal
N41 Oregon Iris
N32 Congested Snake lily

<u>DN1 Nectar Drift 2</u>
<u>(Mixed Forbs Drift)</u>
N23 Camas Bulb
N45 Oregon Saxifrage
N46 Popcorn Flower
N47 Seep Monkeyflower
N16 Rosy Plectritis
N39 Lovage
N31 Slender Cinquefoil
L6 Rush

Hostplant Drifts

<u>DH1</u>
H63 California Fescue
H67 Poverty Oatgrass
H68 California Oatgrass
H55 Pacific Aster

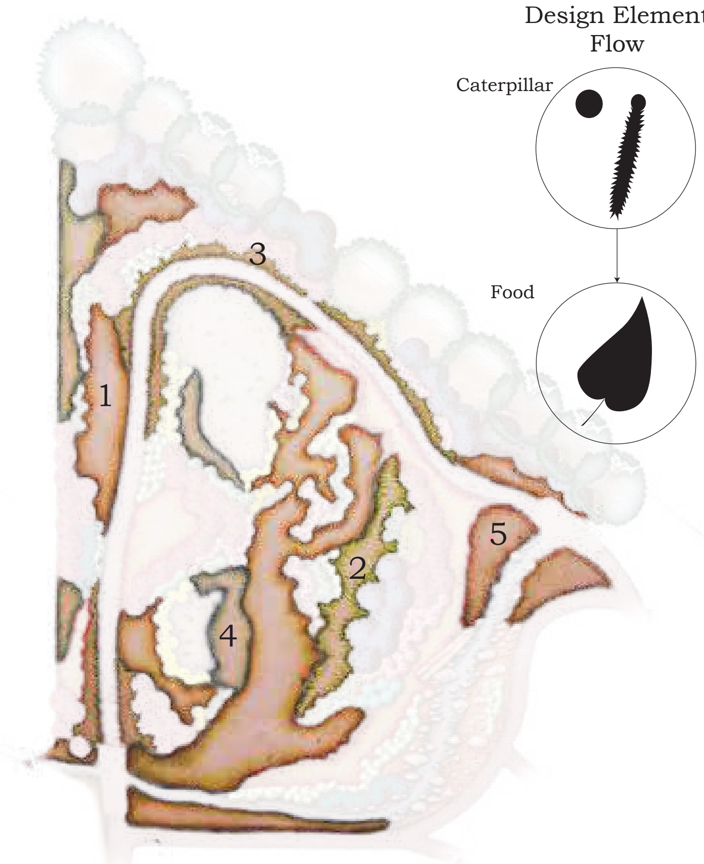
<u>DH2</u>
H63 California Fescue
H30 Birdsfoot Trefoil
H31 Big Deervetch

<u>DH3</u>
H29 Spanish Clover
H32 Springbank Clover

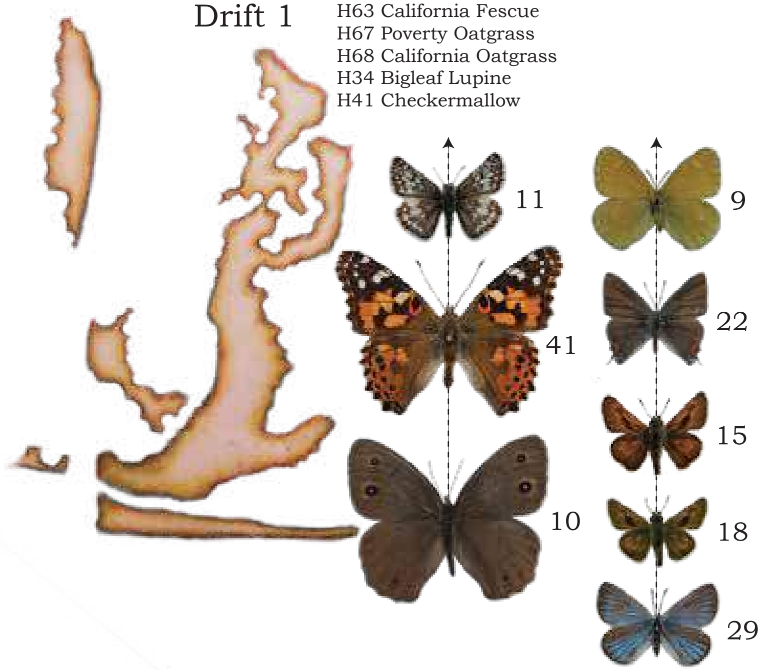
<u>DH4</u>
H70 Tufted Hairgrass
H41 Rose Checkermallow

<u>DH5</u>
H59 Foothill Sedge
H60 Dense Sedge

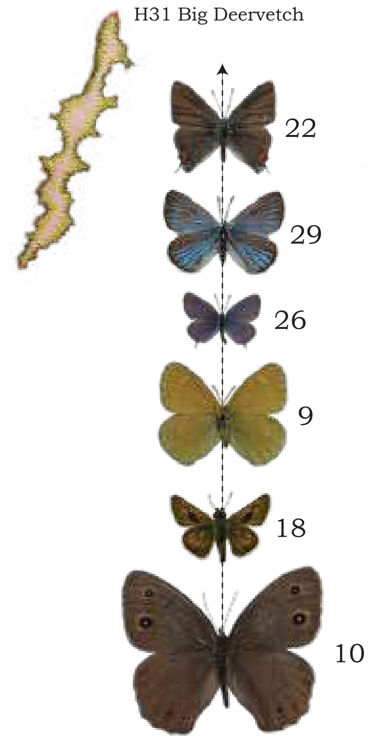
The Design: Hostplant Drift Plantings



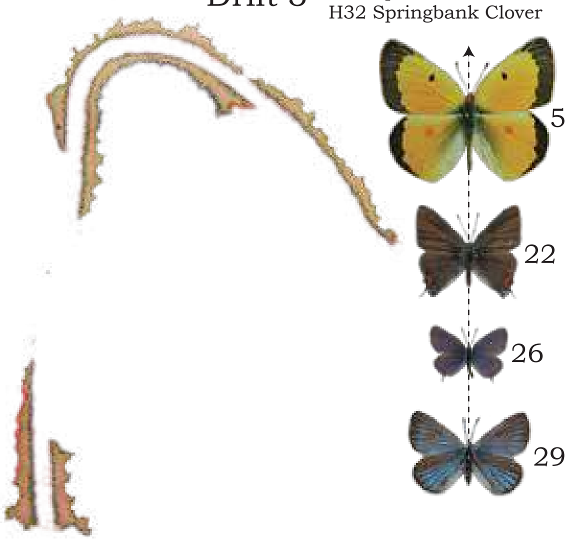
Drift 1
H63 California Fescue
H67 Poverty Oatgrass
H68 California Oatgrass
H34 Bigleaf Lupine
H41 Checkermallow



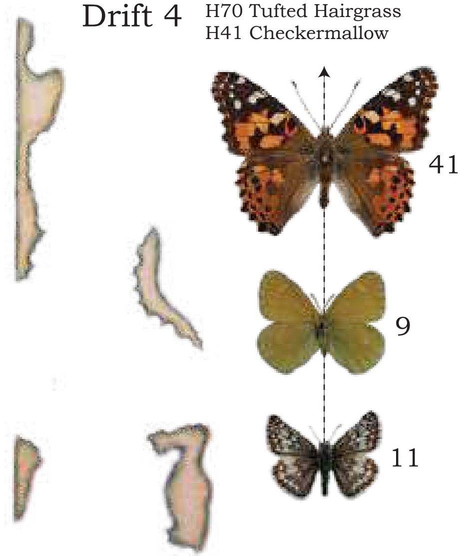
Drift 2
H63 California Fescue
H30 Birdsfoot Trefoil
H31 Big Deervetch



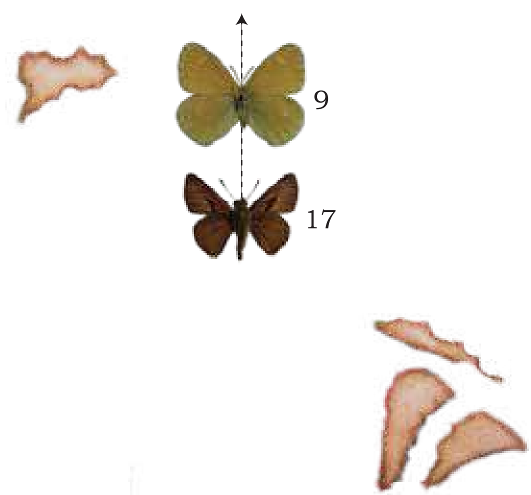
Drift 3
H29 Spanish Clover
H32 Springbank Clover



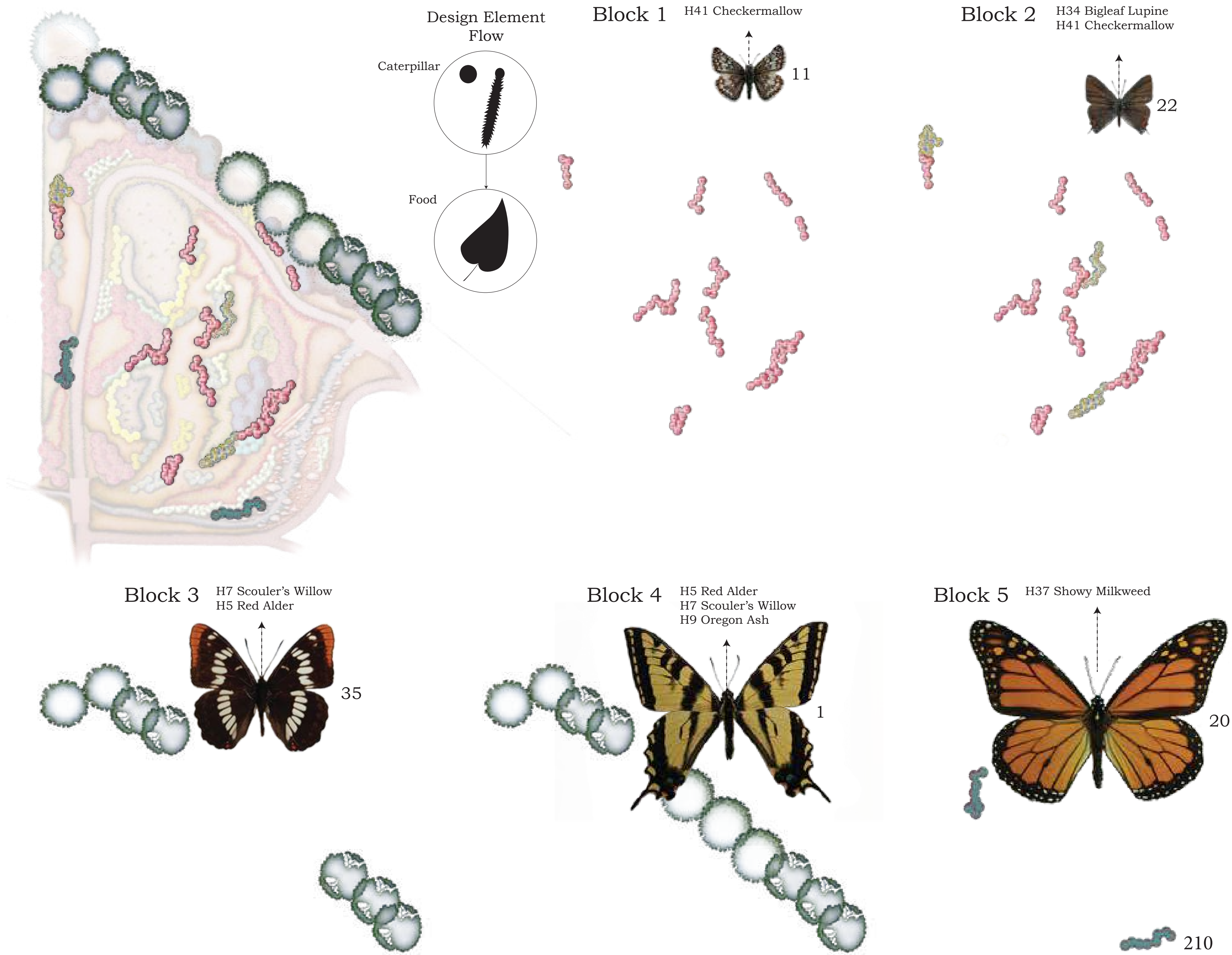
Drift 4
H70 Tufted Hairgrass
H41 Checkermallow



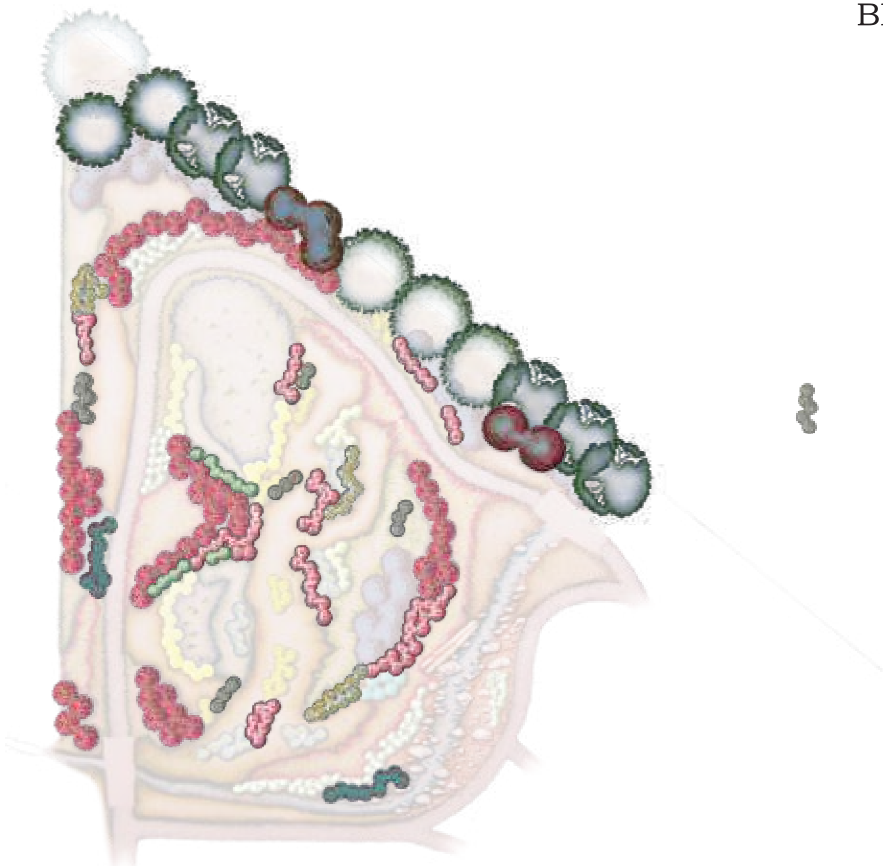
Drift 5
H59 Foothill Sedge
H60 Dense Sedge



The Design: Hostplant Block Plantings

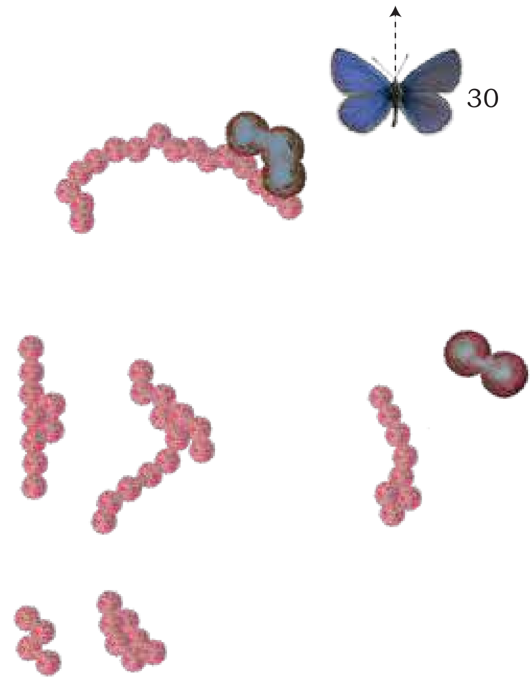


The Design: Hostplant Block Plantings

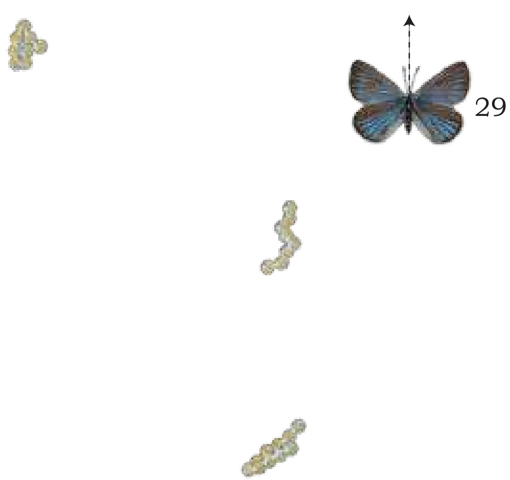


Block 6 H45 Cluster Thistle

Block 7 H18 Pacific Ninebark
H24 Red Twig Dogwood
H20 Western Spirea

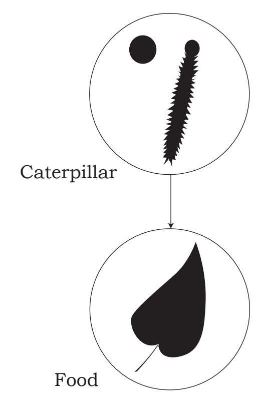


Block 8 H34 Bigleaf Lupine

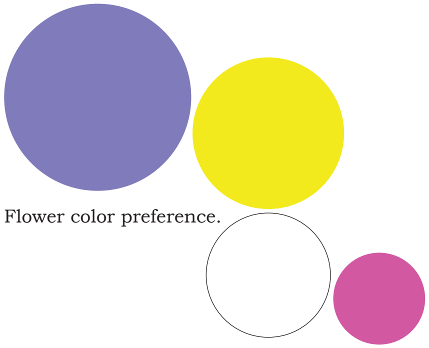


Block 9 H36 Stinging Nettle
H41 Checkermallow
H45 Cluster Thistle

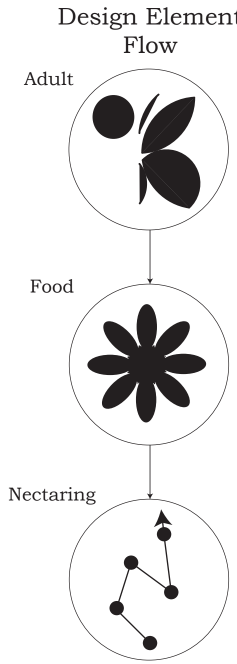
Design Element
Flow

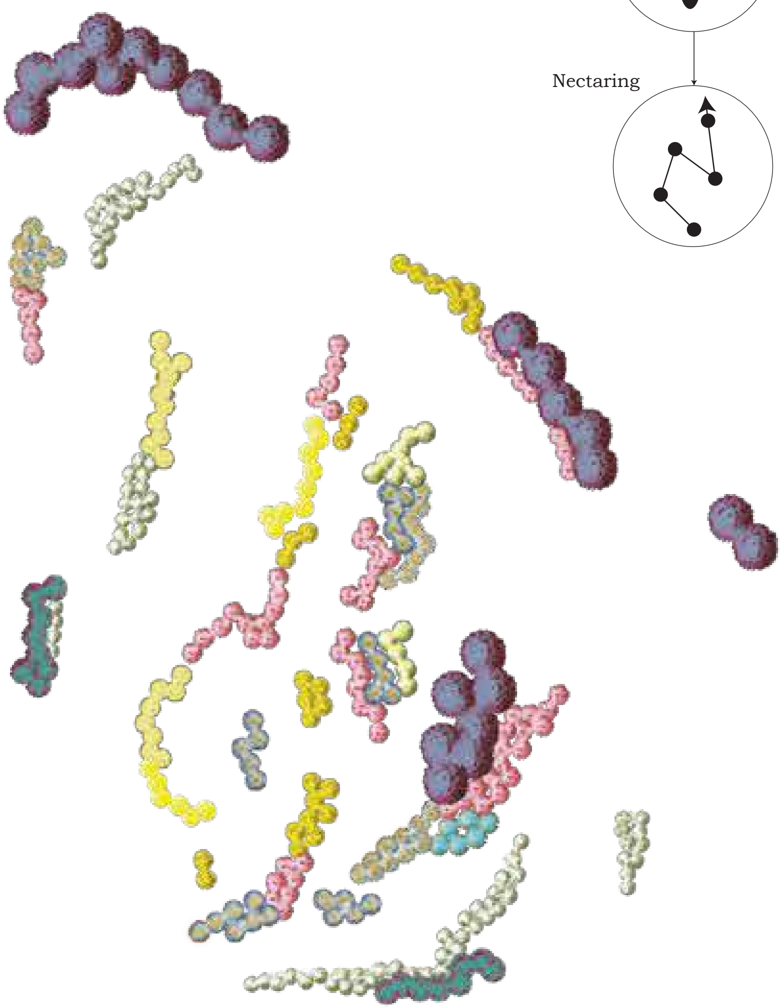


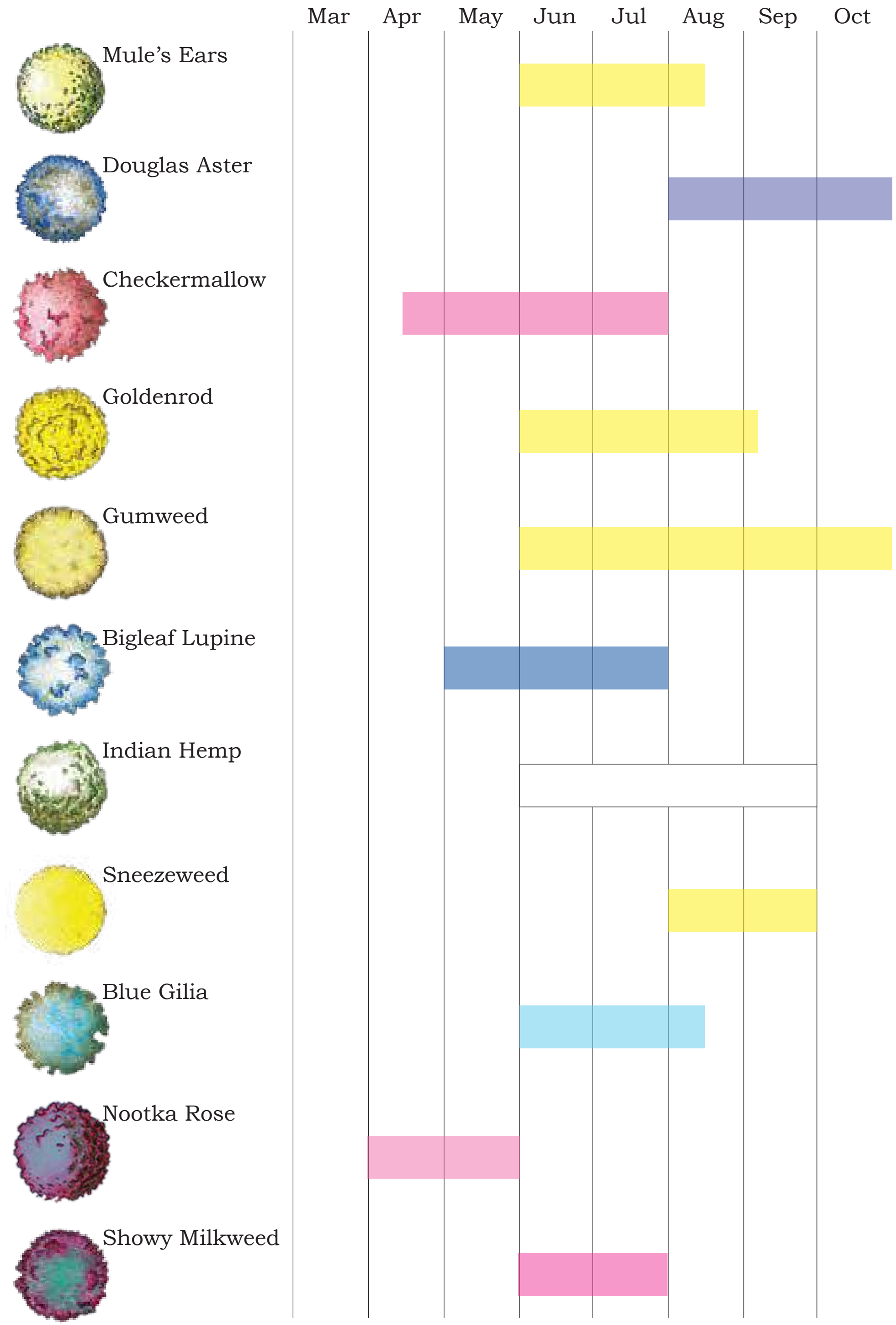
The Design: Color Block Plantings



Flower color preference.

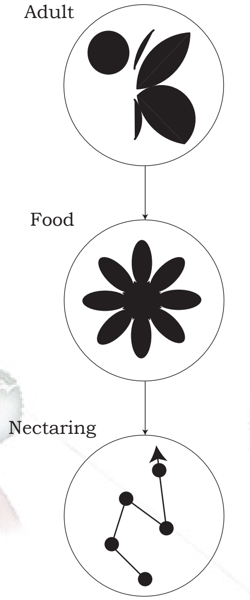




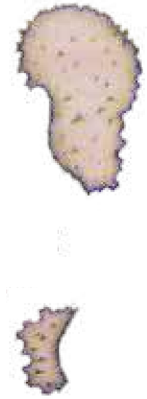


The Design: Nectar Drift Planting

Design Element Flow



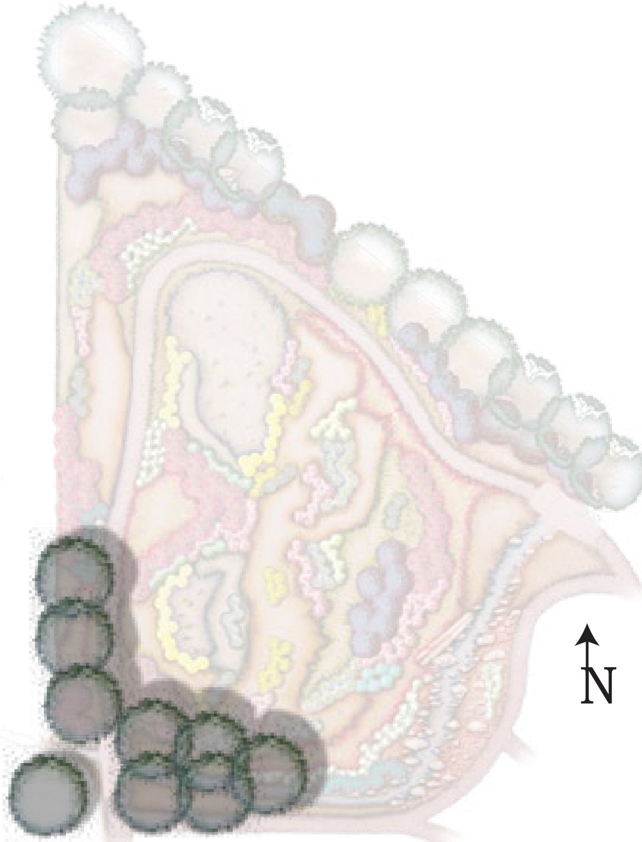
Drift 2



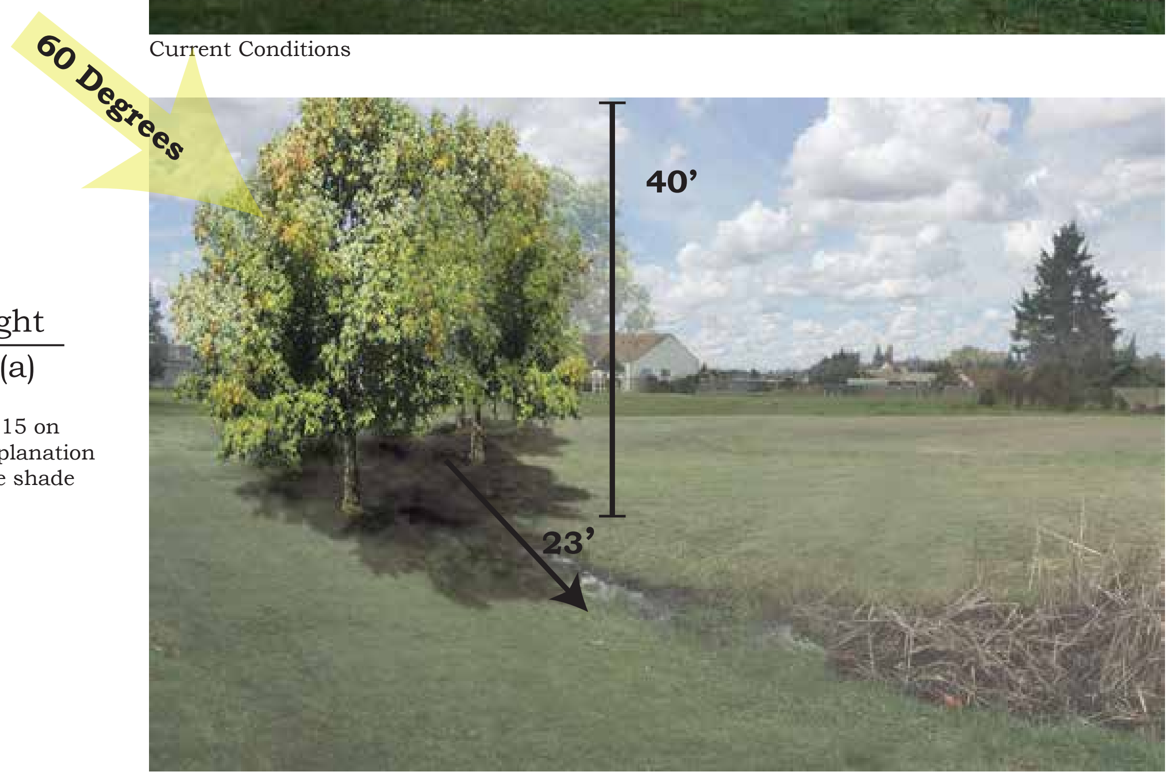
<u>DN1 Nectar Drift 2</u>
<u>(Mixed Forbs Drift)</u>
N23 Camas Bulb
N45 Oregon Saxifrage
N46 Popcorn Flower
N47 Seep Monkeyflower
N16 Rosy Plectritis
N39 Lovage
N31 Slender Cinquefoil
L6 Rush

Drift 1

<u>DN1 Nectar Drift 1</u>
<u>(Camas Meadow Drift)</u>
N1 Common Madia
N5 Yarrow
N7 Pearly Everlasting
N17 Lanceleaf Selfheal
N41 Oregon Iris
N32 Congested Snake lily

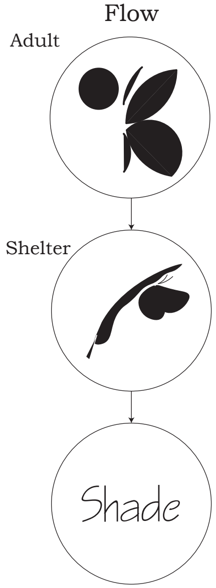


Current Conditions



Calculating sun angle helps determine tree placement and shadow.

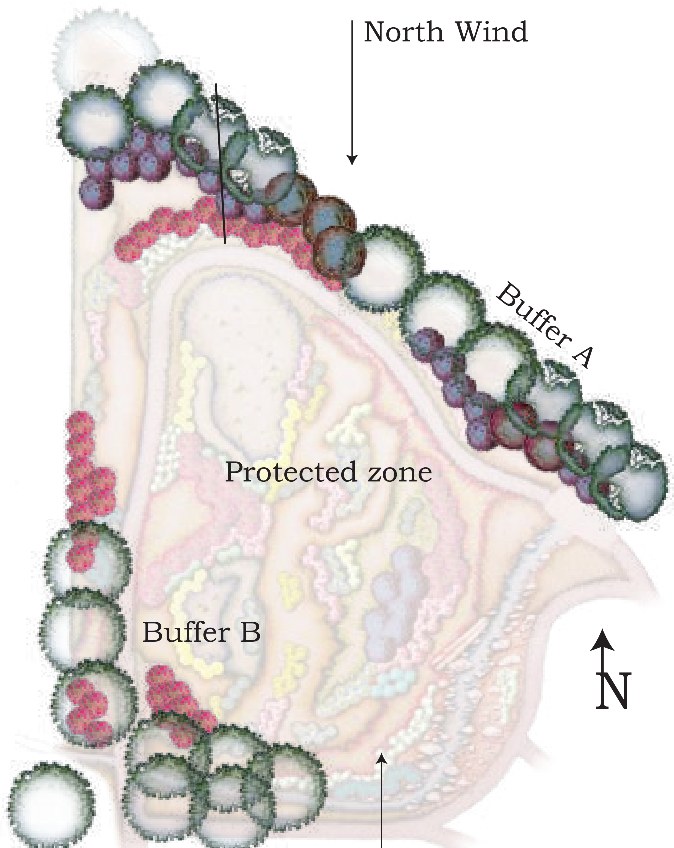
Design Element
Flow



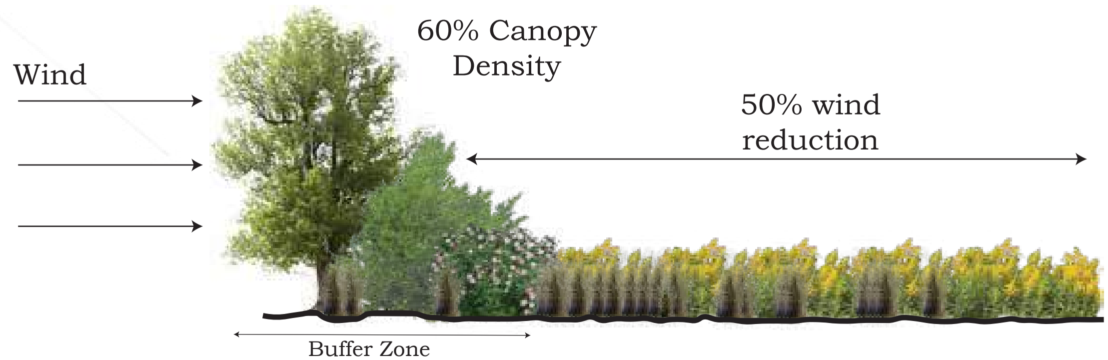
$$L = \frac{\text{height}}{\tan(a)}$$

Note: See Figure 3.15 on page 150 for an explanation on how to calculate shade coverage.

The Design: The Need for Wind Shelter

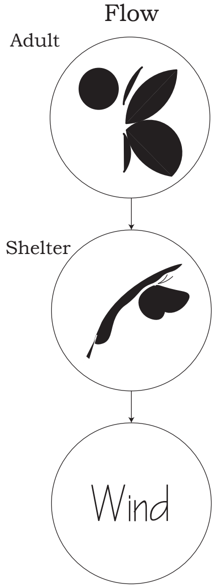


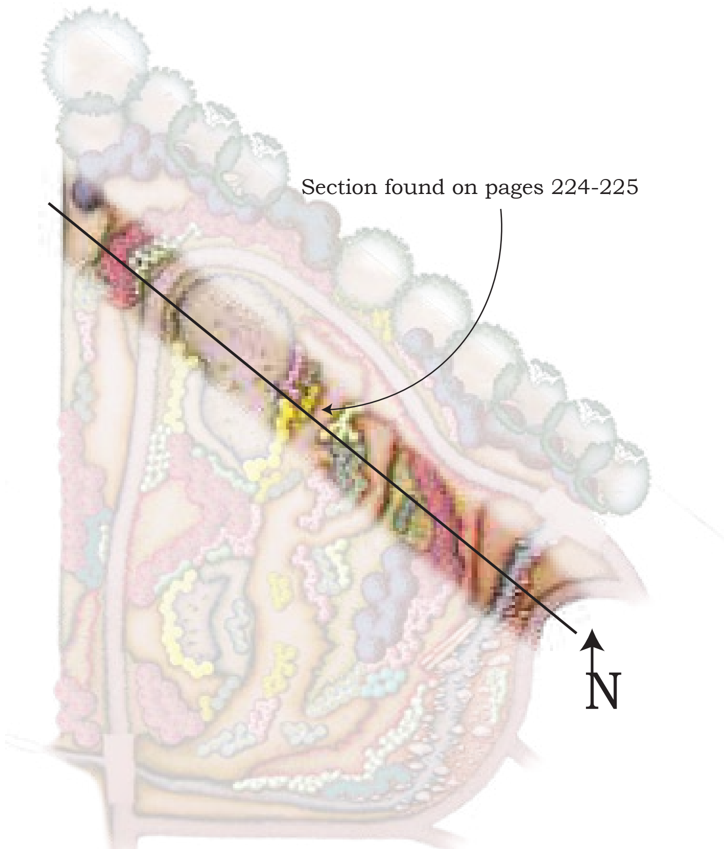
Current Conditions



Buffer A: Calmer Conditions

Design Element Flow

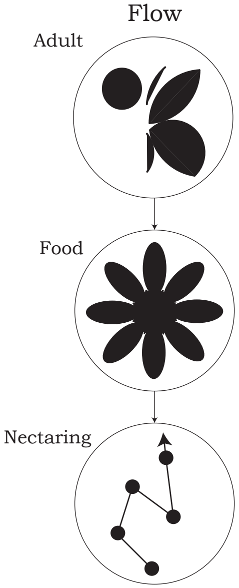




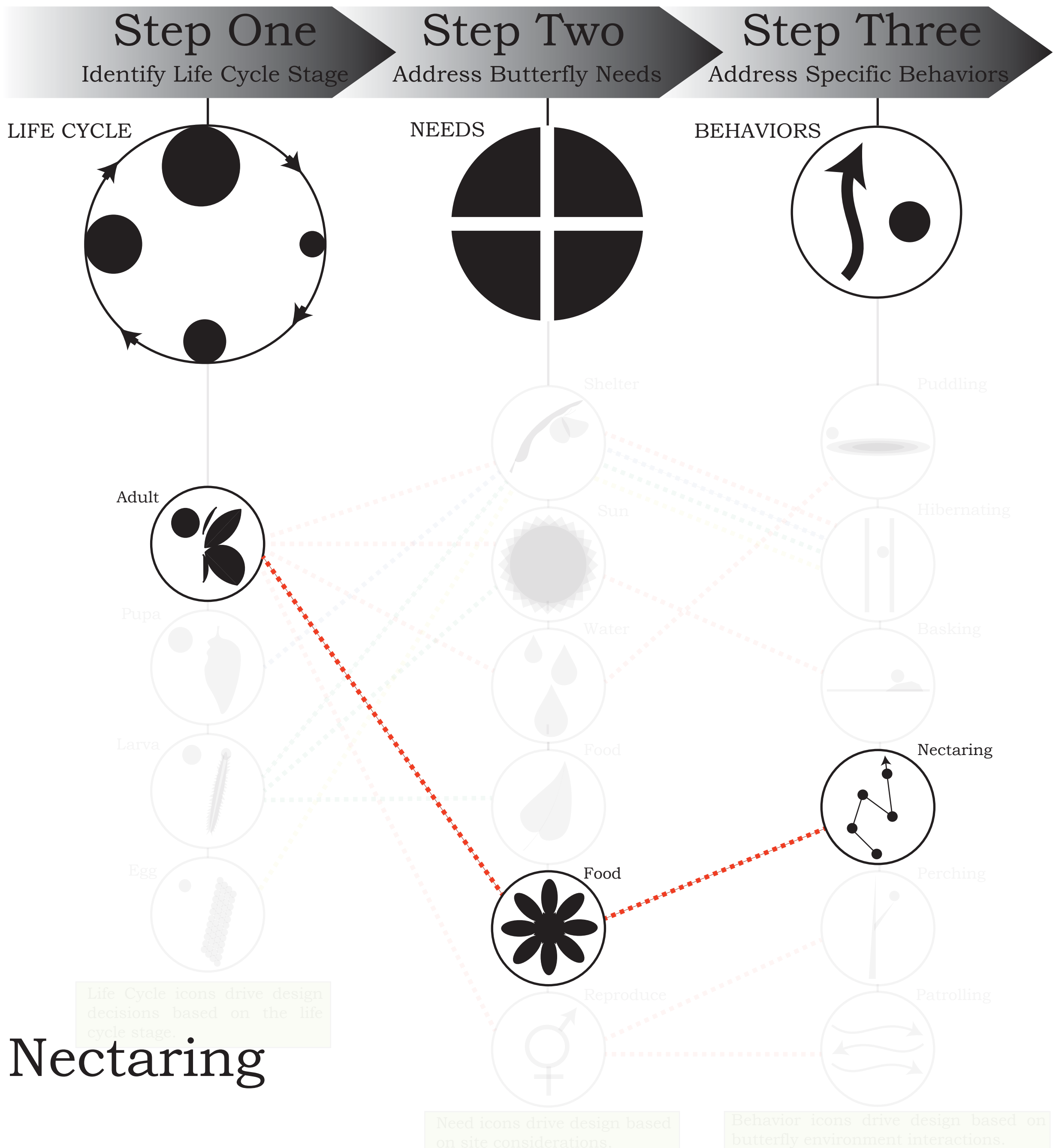
Current conditions

Color block and drift plantings

Design Element Flow

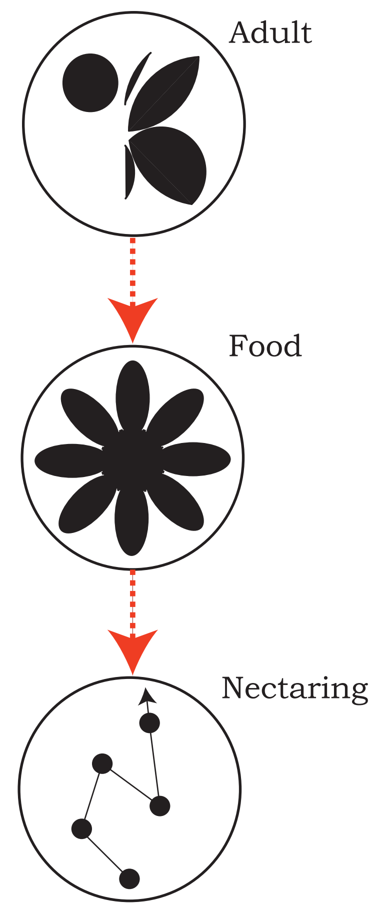


Designing for Butterfly Life Histories



Nectaring

The Flow Process




Color Selections
Stagger Bloom Season
Massings Blocks/Drifts

Drift
Tufted Hairgrass

Drift
Sedges

Hostplant
Western spirea

Nectar block
Indian Hemp

Drift
Sedges

Nectar block
Indian Hemp

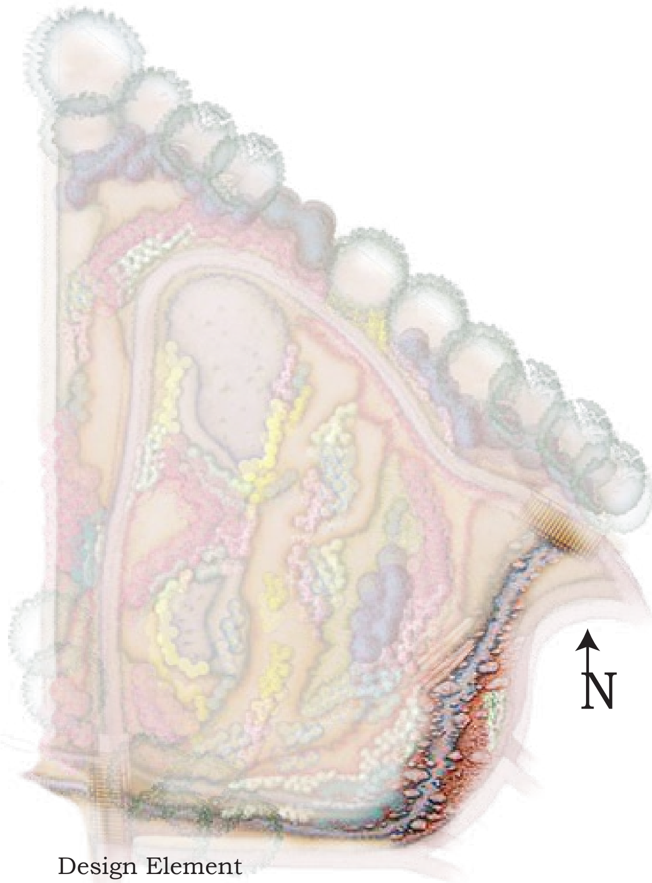
Drift
Camas meadow

Nectar Block
Checkermallow/
Goldenrod

Drift
Tufted Hairgrass

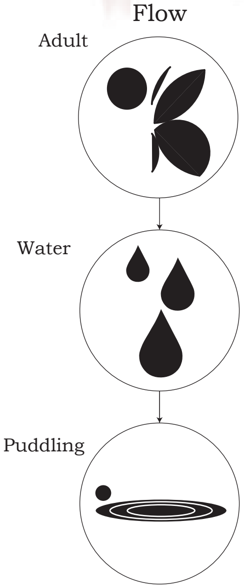

N3
N2
N13
H67
H30
H31
H63
F32
F16
F17
F45
H61
H66
F1
H59
H60
N9
H37
F4
E2
E3
Drift
Mixed prairie grass
Drift
Vetches
Hostplant
Western Spirea
Drift
Mixed nectar forbs
Drift
Mixed sedges
Drift
Mixed sedges
Nectar Block
Indian Hemp
Monarch Waystation
Milkweed/Flowers

The Design: The Puddle Station

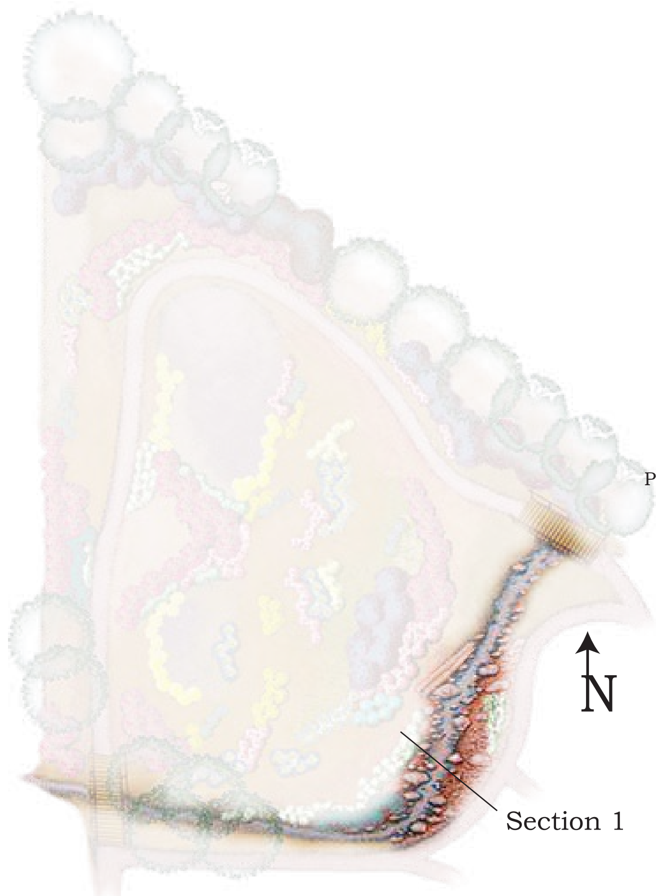


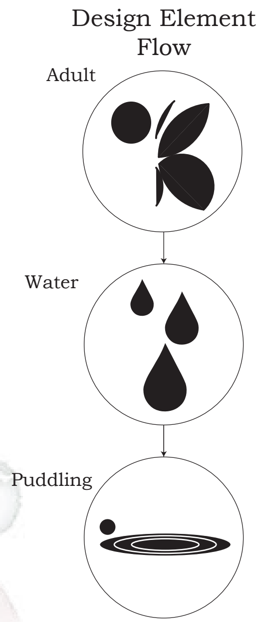

Current Conditions

Design Element Flow

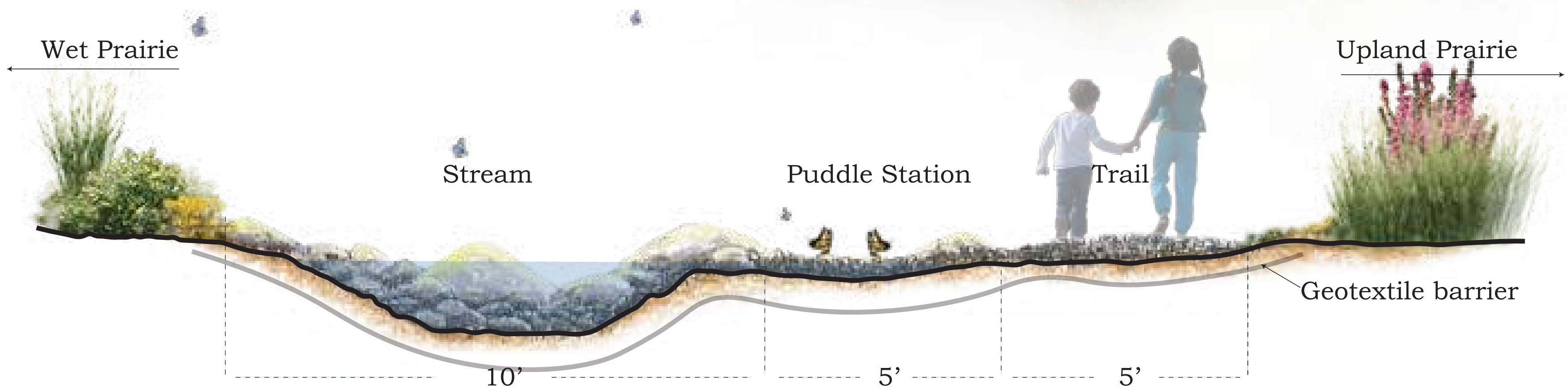



Puddle Station with trail


Section 1
N

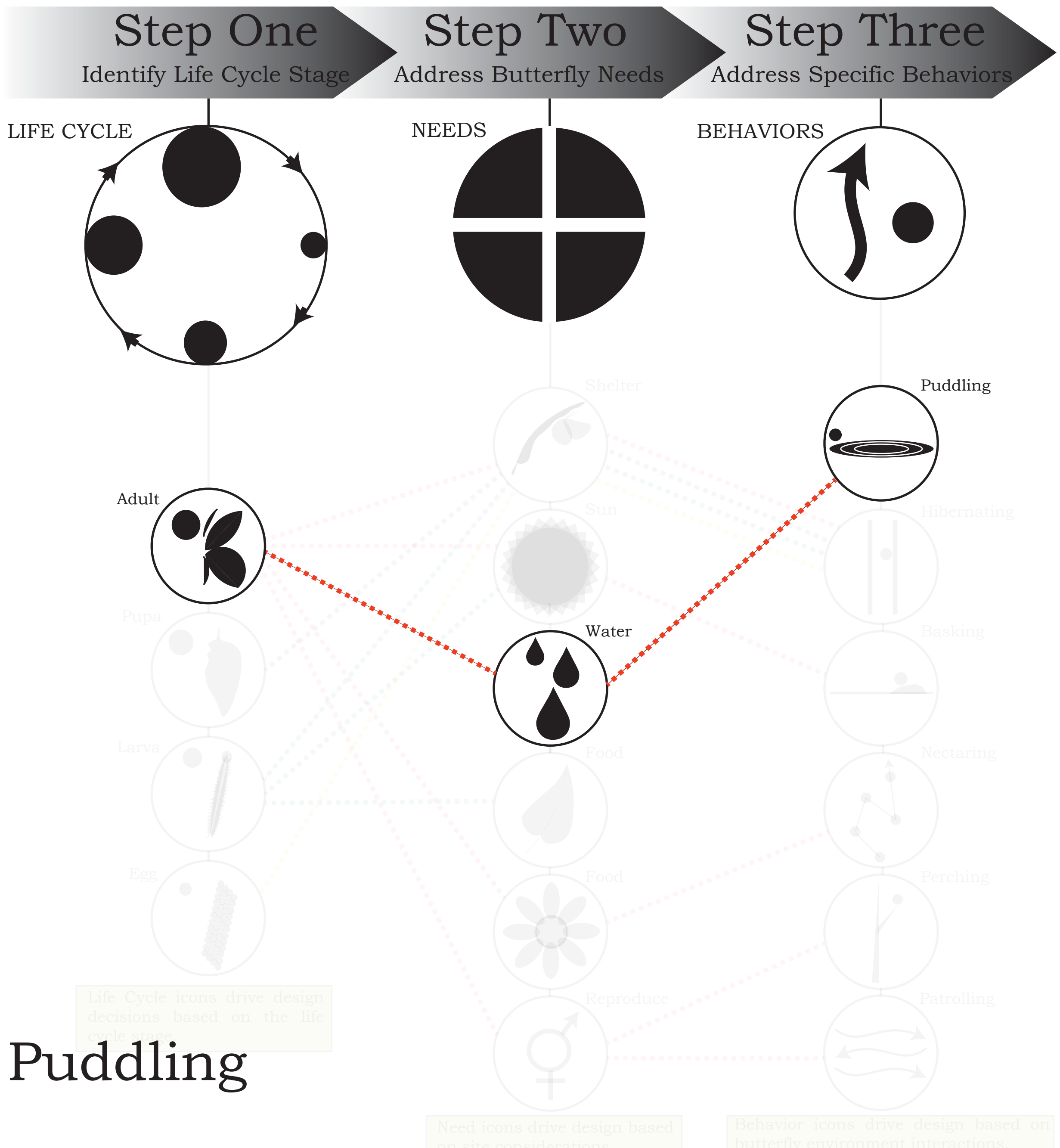

Design Element
Flow
Adult
Water
Puddling

Section 1

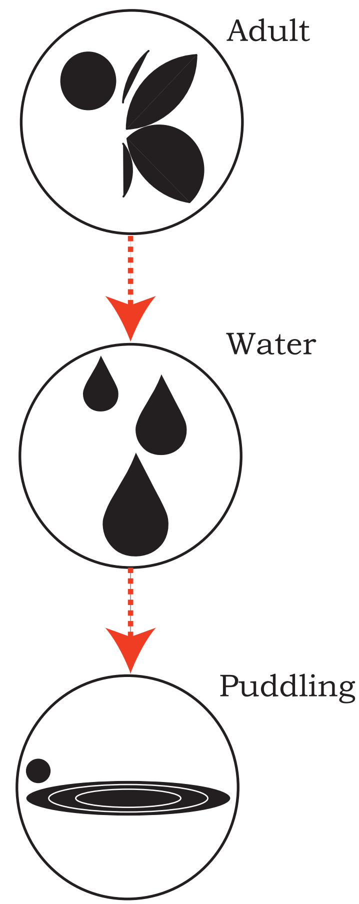

Wet Prairie
Upland Prairie
Stream
Puddle Station
Trail
Geotextile barrier
10’
5’
5’

The Design: Puddling Icon Flow Process

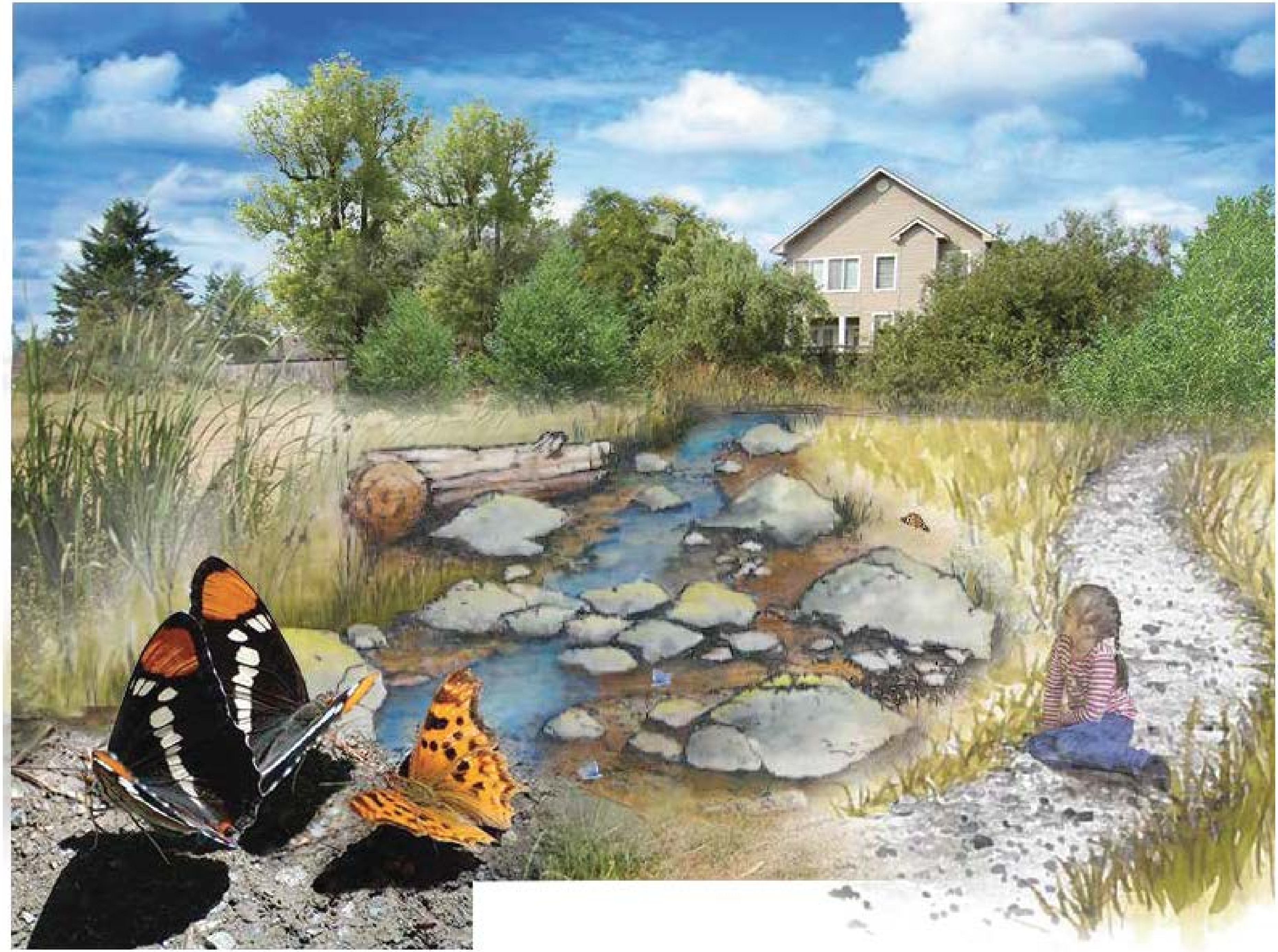
Designing for Butterfly Life Histories



The Flow Process

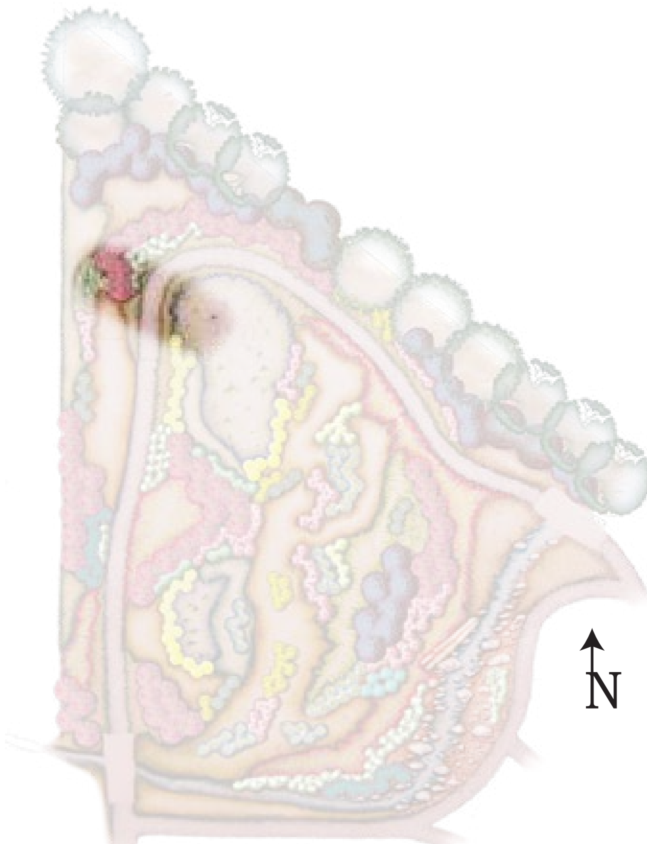


Puddling



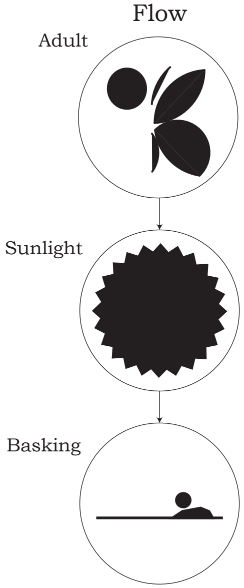

Open Space
Water Source
Puddle Station Moist Soil
Open Space

The Design: The Basking Station

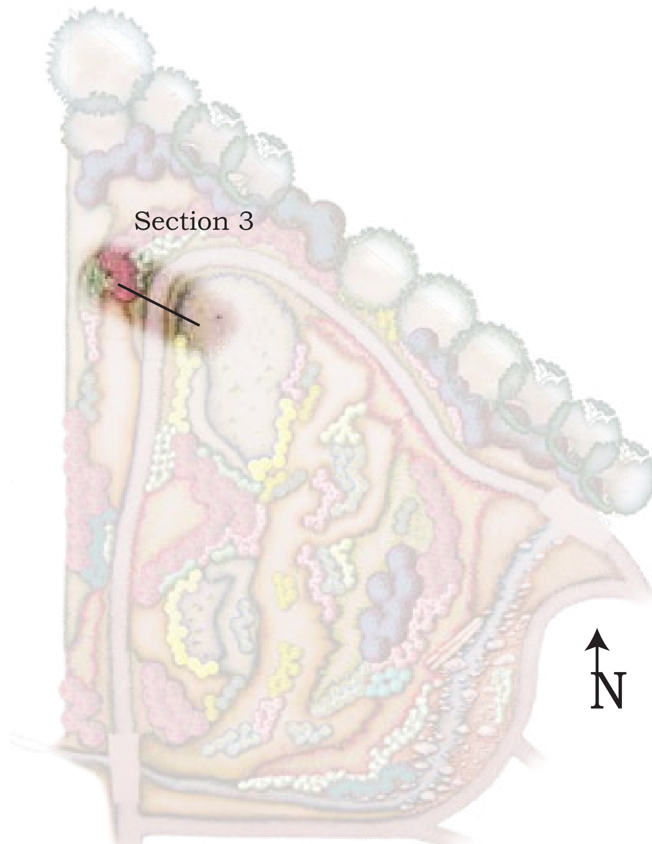


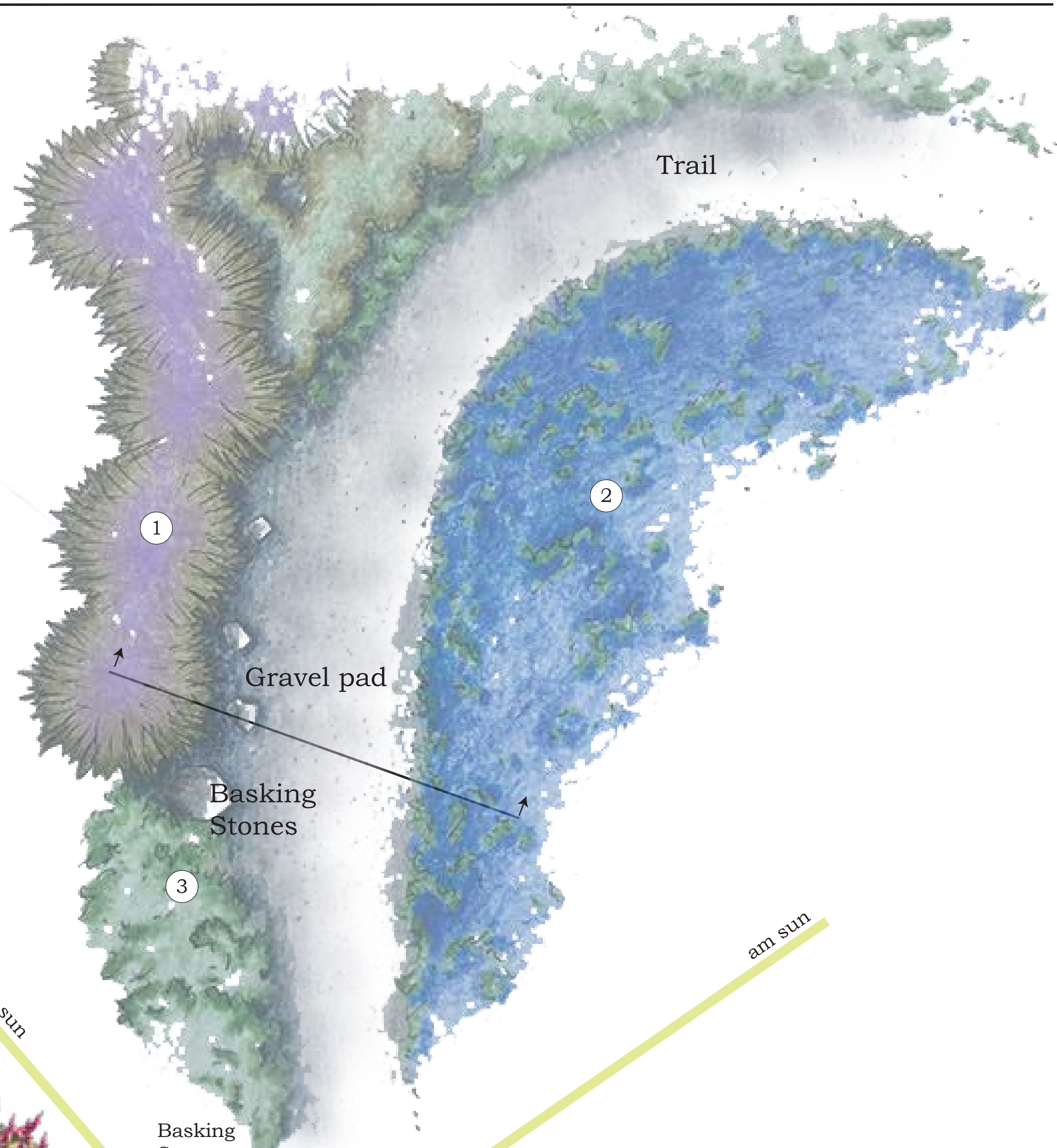
Current Conditions

Design Element Flow

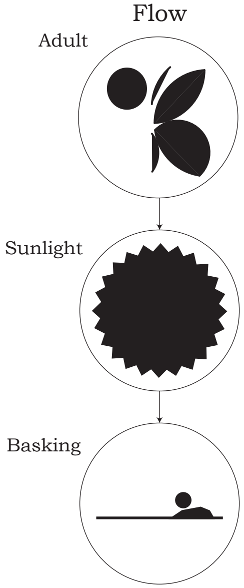


Basking Station



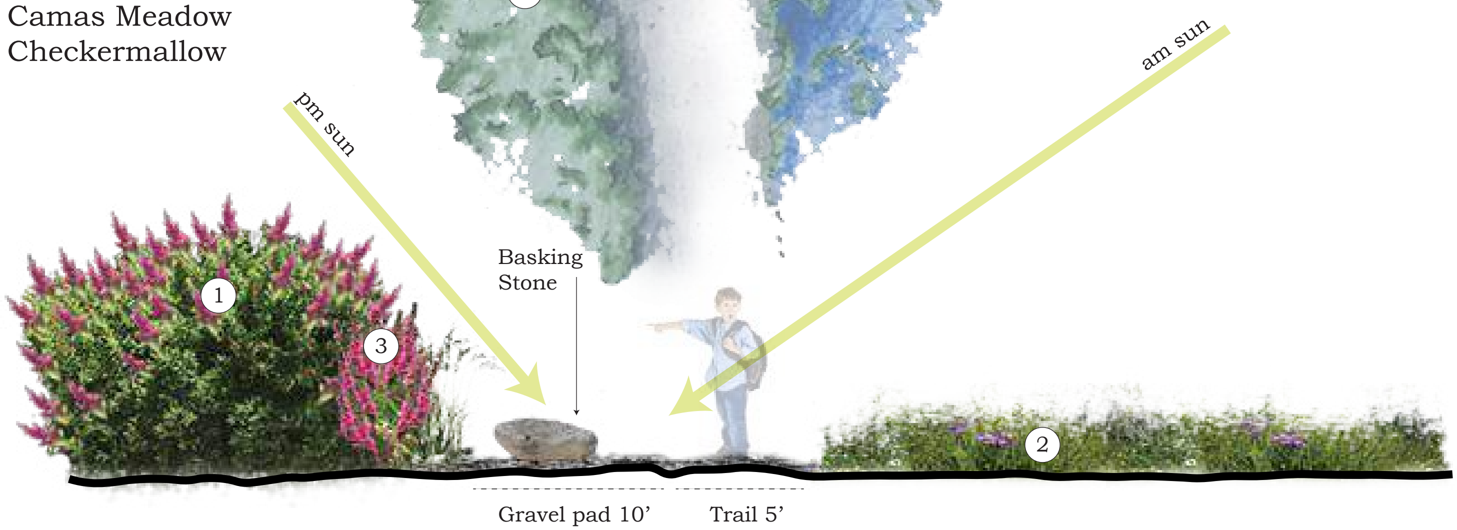


Design Element Flow

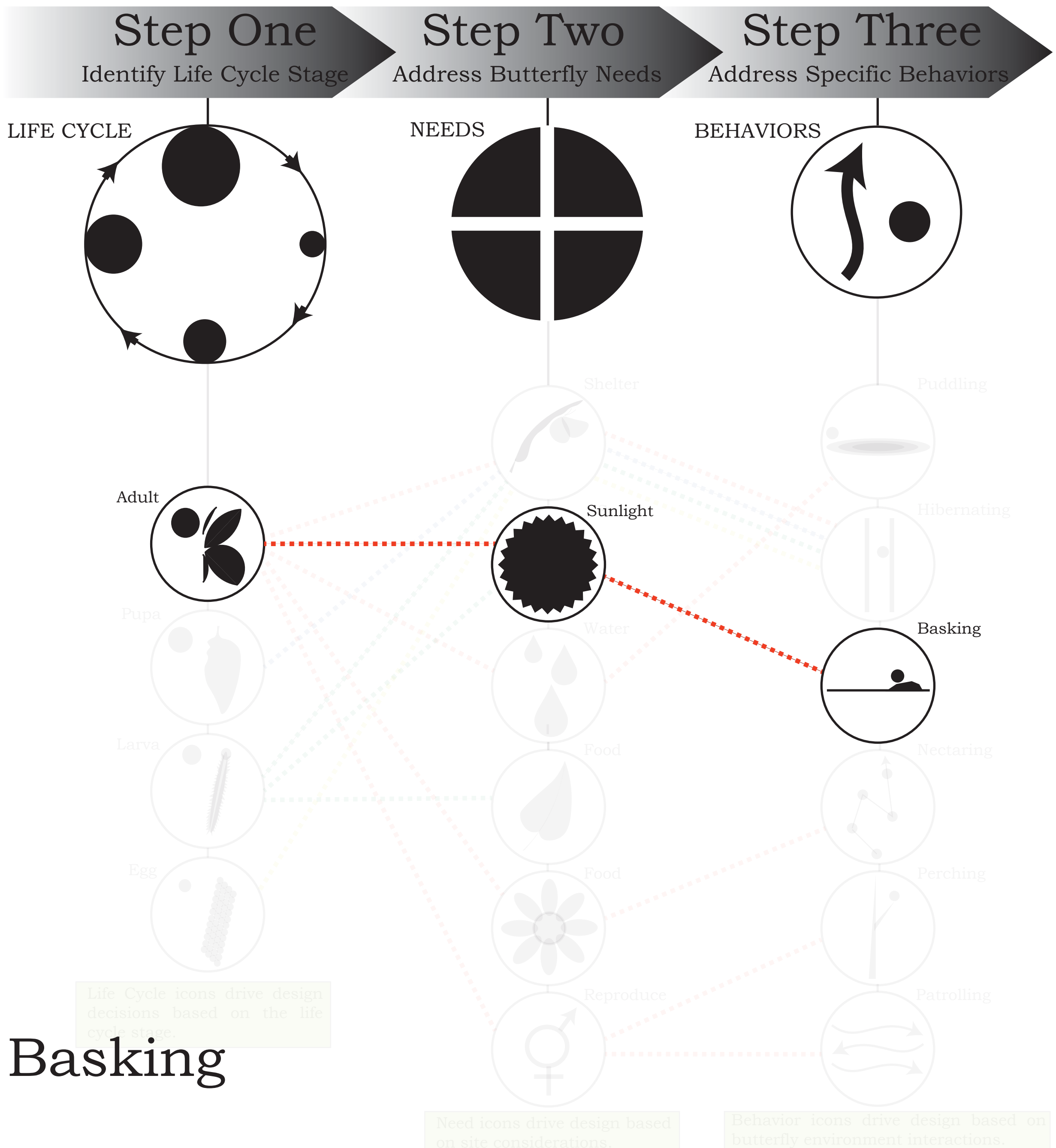


Section 3

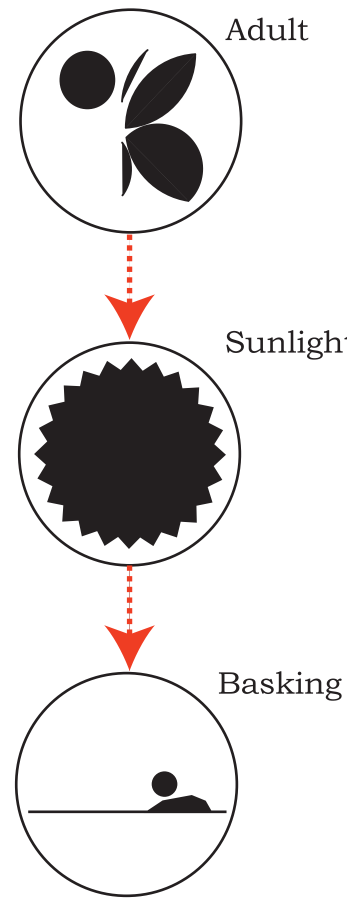
① Western Spirea
② Camas Meadow
③ Checkermallow



Designing for Butterfly Life Histories

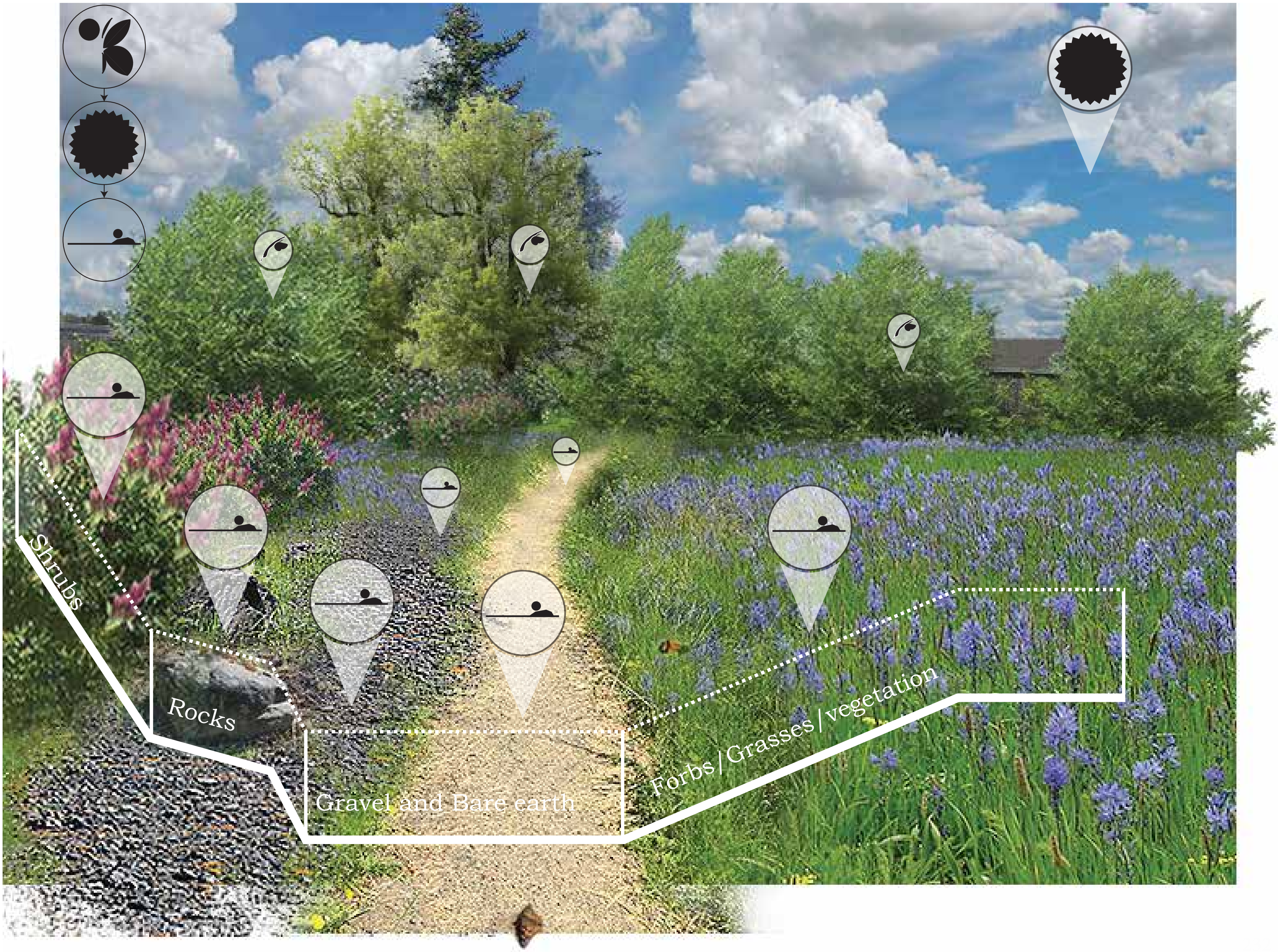


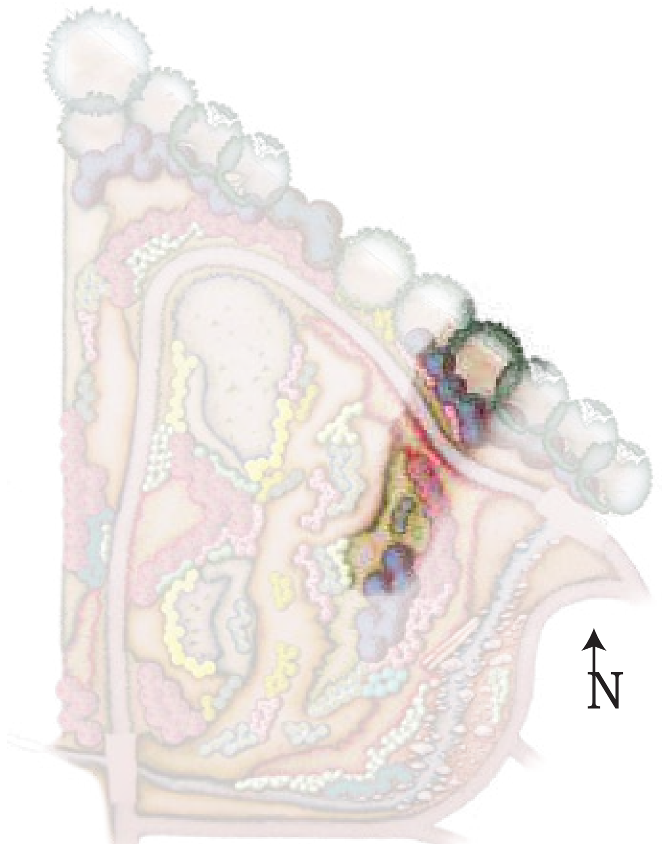
The Flow Process



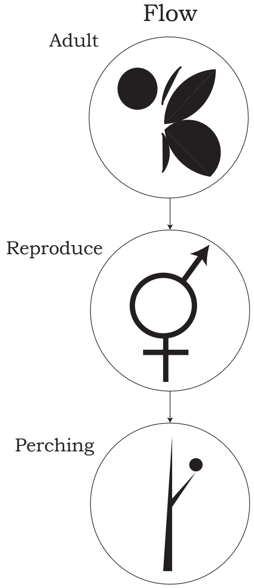
Basking

The Design: Basking Station Annotated

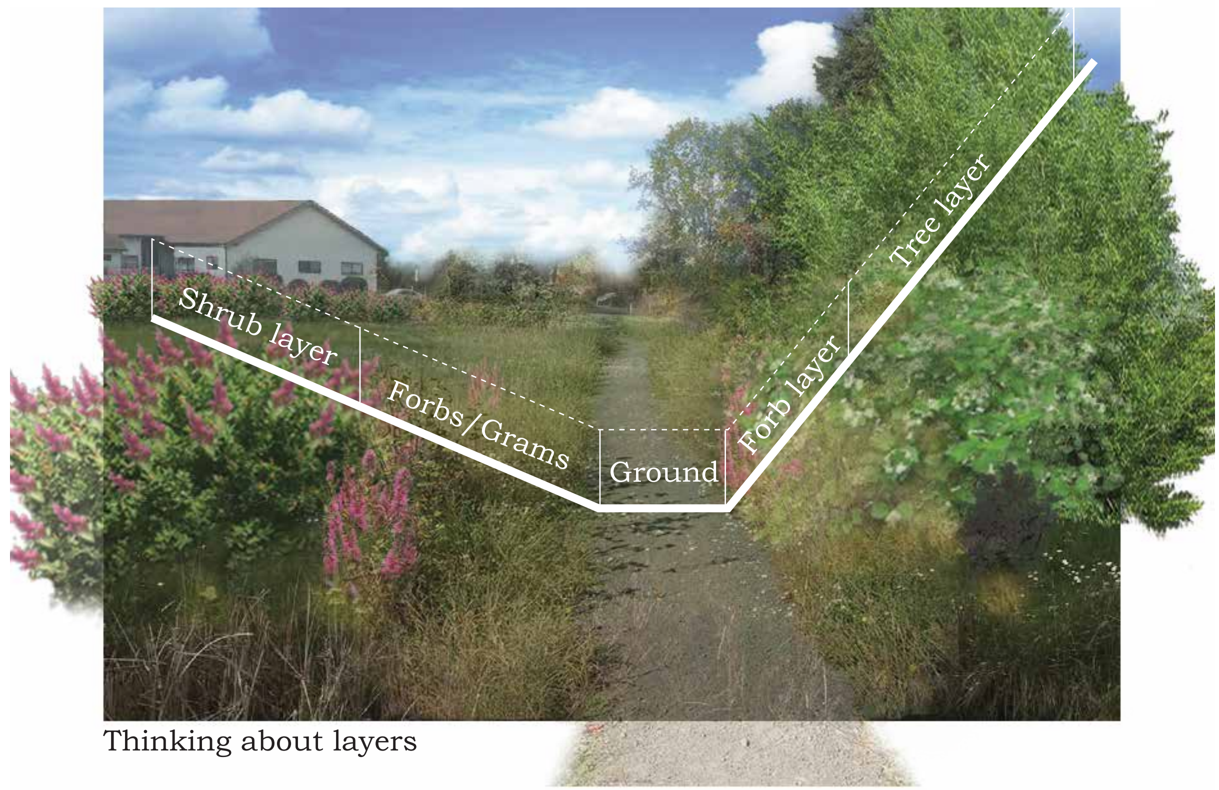




Design Element Flow

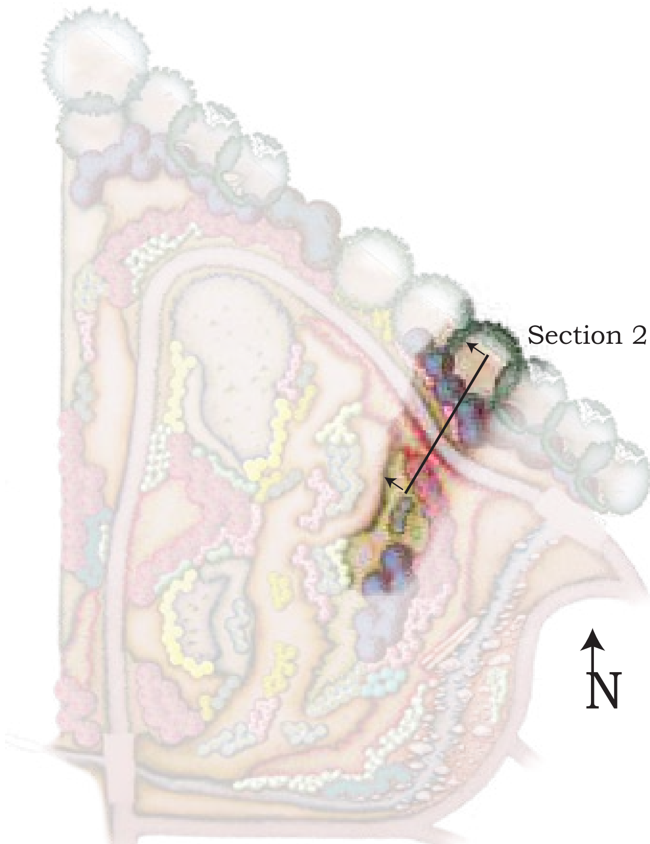


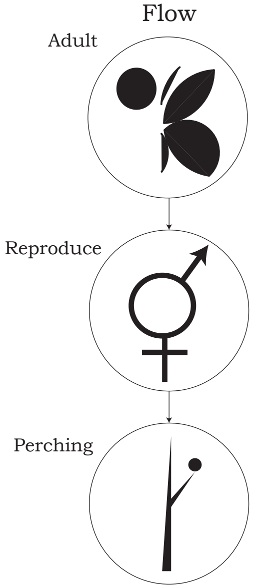
Current Conditions



Thinking about layers

The Design: The Perching Station Section

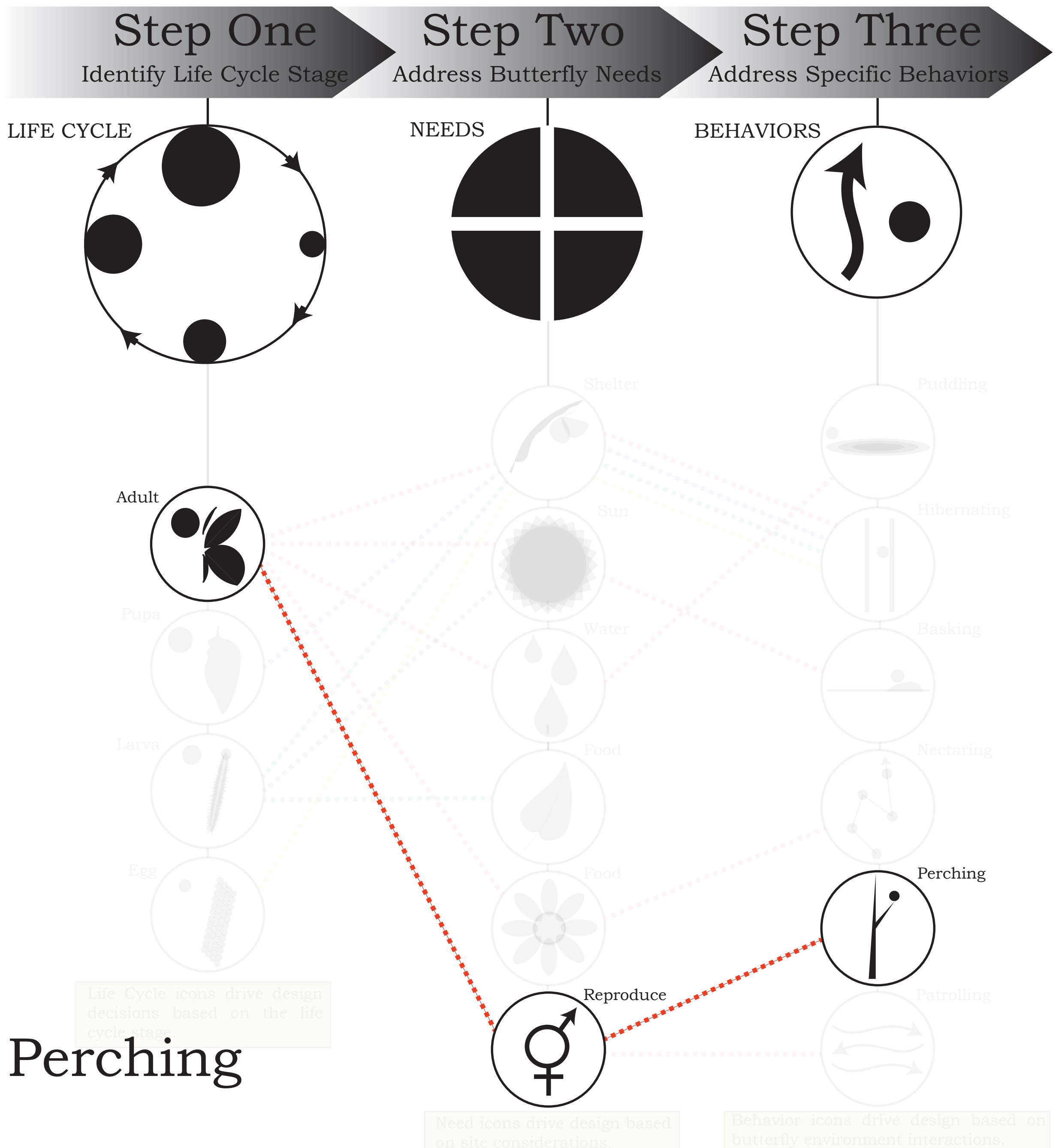




Section 2

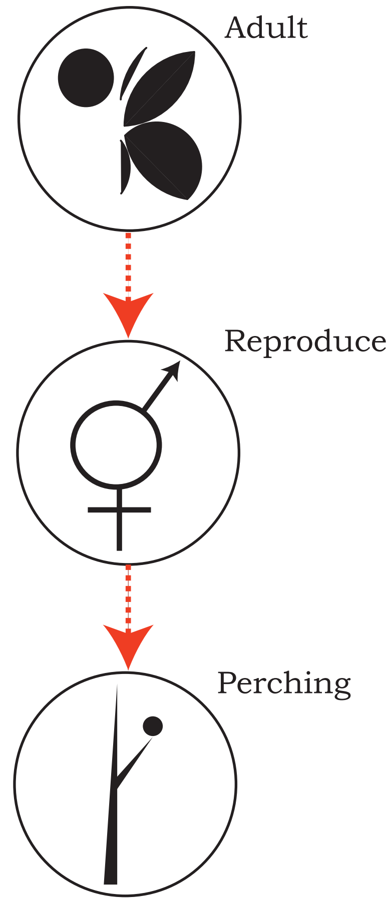
1. Western Spirea
2. Checkermallow
3. Indian Hemp
4. Nootka Rose
5. Pacific Ninebark
6. Scouler's Willow
7. Oregon Ash

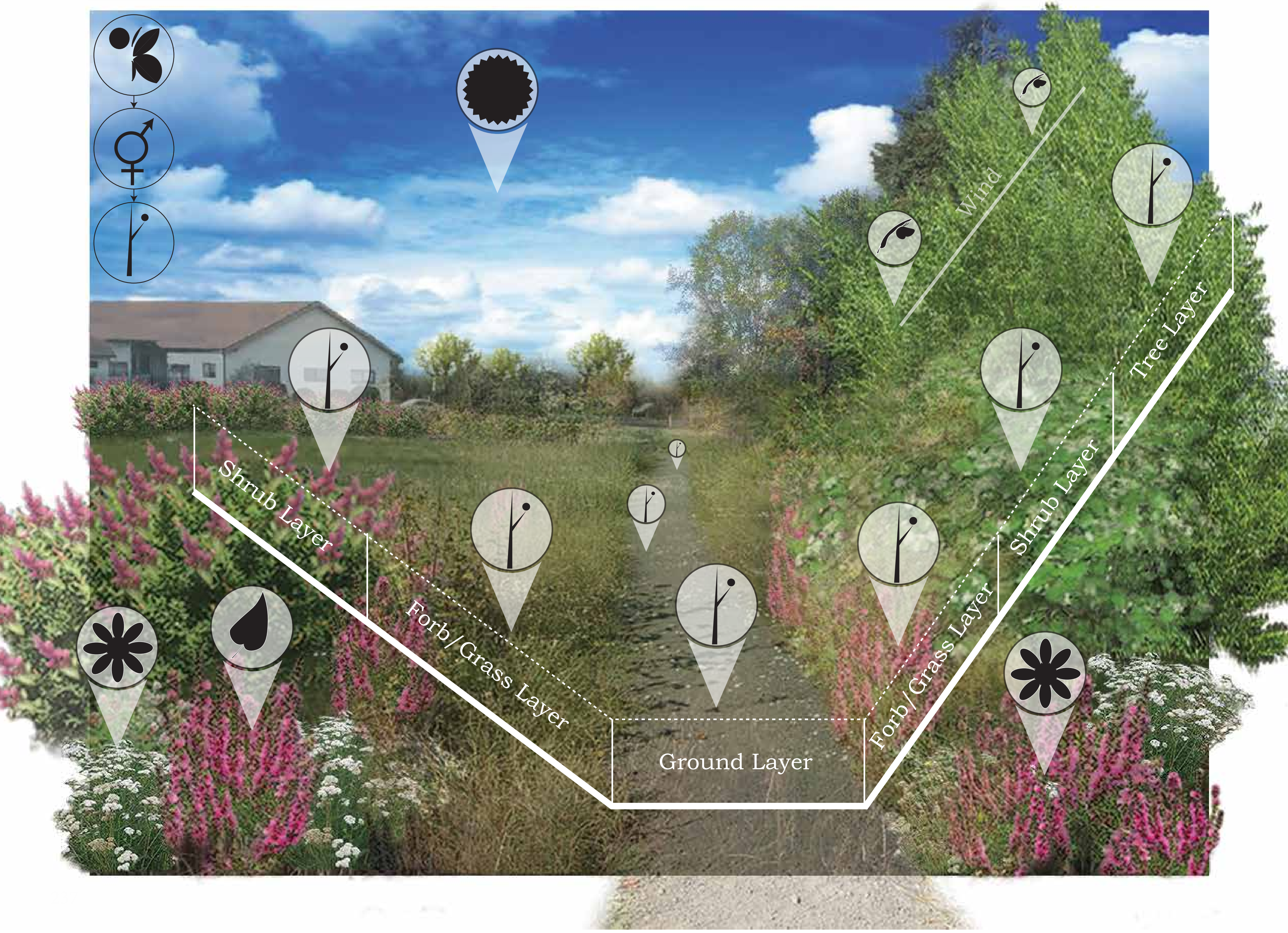
Designing for Butterfly Life Histories



Perching

The Flow Process




Wind
Tree Layer
Shrub Layer
Shrub Layer
Forb/Grass Layer
Forb/Grass Layer
Ground Layer

" Happiness is a butterfly, which when pursued, is always just beyond your grasp, but which, if you will sit down quietly, may alight upon you"

-Nathaniel Hawthorne

5 Conclusion

5.1 Discussion

The purpose of this master's research project was to create a process for the designing of butterfly habitat gardens that focus on butterfly life histories of the butterfly life cycle, butterfly needs, and butterfly behaviors. The intent was to generate a guidebook, that design professionals and landscape architect students could use to understand and design meaningful and functional habitat gardens for butterflies. The overall hope that comes from understanding the needs and behaviors of butterflies is to ensure the survival of these beautiful animals.

The project focuses entirely on the habitats, species of butterflies and plants found within Eugene, Oregon. However, the process is ultimately transferable through concept and can be effectively adapted across place and scale. Thus, this project's process can be equally adapted in any city across the nation. What will change are the specifics of habitats, butterfly species and plants to a given location, but the process remains consistent.

This master's research project utilized a pragmatic approach, using both research for design and research through designing strategies to demonstrate how a design as research project can be implemented to convey information through design and graphic representation. The result was both informative to me and my hope, the viewer, of how to create a butterfly habitat garden design process that is both equally functional and beautiful.

I used the research for design component to generate what I needed to know to form a base for the project. Through this strategy I used literature review, classification and direct observation to gather information about habitat, the butterflies and the plants of Eugene. The result was a series of detailed image-based color plates that described each habitat, butterfly, hostplant and nectar source necessary for successful butterfly survival and a quickguide system that matched specific species to specific habitats.

I used the research through designing strategy to create and generate new image-base design implementations based on the butterfly life histories. Here, the creation of a graphic language and imagery generated new knowledge on how to convey meaningful design principles. I followed the writings of both Deming and Swaffield as well as Sandra Lenzholzer's research through designing demonstrative strategies to formulate a strategy for my own project. The result was a series of graphic icons called design elements, which represent the specific life cycle stage of the butterfly, the butterfly needs, and the butterfly behaviors. The design element icons allow the designer to follow a step by step methodological process to understand a set of complex series of butterfly survival requirements.

5.2 Lessons Learned

The complexity of creating a methodological process for the designing of butterfly habitat gardens was a significant challenge, both in the gathering of information and in the presentation of it. Gathering the information necessary to create a comprehensive program that addressed the specific criteria which met the survival needs of butterflies, required months of study, months of observation, and months of organizing the enormous amount of data. It was clear that in order gain an understanding of what data were vital to this project's goal of designing for butterfly survival requirements, the need to concentrate on butterfly life histories was key. The life histories of the butterfly life cycle, the basic butterfly needs, and the basic butterfly behaviors would form the core of the creation of this research project.

Literature

Within the field of landscape architecture and the life sciences, there was a lack of published work on the "process" of designing butterfly habitat gardens. Because of this deficiency, the project naturally drifted to addressing this gap. There are a vast number of informational guides and books on butterflies as well as a large number of homeowner guides to basic butterfly garden principles, but what I found lacking was a body of knowledge that specifically walked a reader through the process of the designing of butterfly habitat gardens.

Most published design work concentrated on finished products and little to the process on how the garden design process transpired or what principles drove the projects. This frustration became a blessing in disguise, as the deficiencies of published process, became the core of my project and this gap that I found, became the focus for my efforts.

Spatial Considerations

This project aimed to take butterfly life histories and generate spatial designs from those life histories, the transfer from scientific information to design concept. Most of the life history information published within the scientific community focuses on butterfly life history, needs and behavior and little design considerations. The difficulty of translating needs and behaviors into spatially generated design features, meant having to interpret scientific findings into design components. This resulted in assertions that my design process would in fact elicit favorable conditions that would fulfill butterfly life histories.

There is still much that needs to be learned from the scientific community regarding spatial considerations for butterfly habitat gardening. The science and design components have yet to come together to generate a large amount of knowledge based on butterfly life histories. I see my project as a start to a conversation to a deeper level of thinking regarding spatial considerations to butterfly habitat gardening.

For example, a butterfly puddle station is a designed element within a garden to fulfill the need for water for adult butterflies. Most scientific data on the study of butterfly puddling as a behavior, focuses on the need for adult male butterflies to attain dissolved minerals for reproductive fitness. There is very little written, within the scientific community or the design community, on the spatial configuration of size, placement and external factors which enhance the puddling behavior within a built garden space. This piecing together of known requirements of butterfly survival, allowed me to construct hypothesized designs based on puddling facts. However, more research needs to be carried out and tested for these assertions to become more concrete.

The biggest lesson learned, aside from how to conduct a research-based master's project, was how difficult the creation of a guidebook can be. Translating the information learned into understanding it for myself and then disseminating this information in a clear and concise manner to someone who has little to no knowledge of my thought process was a challenge.

Butterfly life histories are quite complex and arguably not fully understood. My attempt to present this information into a simplified program was to create a step by step design process. Breaking complex information into easy to follow, easy to understand directions was a priority for this project, especially when provided within a guidebook format.

5.3 Limitations

Proof

One of the biggest limitations of this project is knowing whether any of this process will yield the intended results. The butterfly gardening principles and the science behind the life histories gathered is accurate and organized into a logical framework, but in the end, butterflies are wild animals and subject to many external factors that this design framework cannot address. Decreasing habitat, pesticide use, climate change, shrinking butterfly populations, habitat fragmentation and habitat degradation are all factors outside of this project's scope, but are real threats to butterfly gardening success.

Adequate Precedent Studies

One of the more difficult obstacles that I encountered during the early stages of structuring my masters project was finding precedent studies of built butterfly gardens and process design work that addressed the designing of such habitat spaces. I had no template to follow, thus the limitation here, at least for me , was a lack of work to base my assertions on. My assertions had to come from rigorous examination of scientific journal review and not design.

Inexperience

Structuring the project was a real challenge because of a lack of experience on how to create a design guidebook. I consulted many master's projects that had created various design guide formats and gleaned a lot of valuable information. Written books on butterfly gardening, habitat gardening and field guides were my road maps. The lack of published design process work proved the most challenging. But in the end my project had to be structured in a way that took the reader from an introductory level and help them navigate through a procedural design process. No easy task.

Gaps in Research

In the study of butterflies, scientific data is immense and given enough effort, information on butterfly life histories can yield design programming that can aide in butterfly survival. The lack of published design process work missing component to design research within the academic community of landscape architecture. At the very least, my project attempts to address this deficiency.

Clarity

The ability to create a clear graphic language through the use of an iconographic language remained a challenge. I spent a considerable amount of time dedicated to the creation of an icon based language to help the reader follow the design process in an efficient and clear manner. This was met with mixed results. Some people who reviewed my work found the icons easy to use and easy to follow, some people found them confusing and were lost in the method in how to use them. In the end, I remain confident that the creation of the iconographic language is worthy of presentation. Again, this is a learning process not just for the reader, but for myself.

5.4 Transparency

In the beginning of this master's project, I set out to find a series of design precedents that would demonstrate design concepts and provide me with a road map to the designing of butterfly gardens. Having not found many precedent studies of worth, I was set a task to find the answers on how to create a butterfly design process through my own discoveries.

This master's project, though very much rooted in science-based facts and principles, was largely generated by my own imagination on how to construct a butterfly habitat garden design process. Throughout this document I have made assertions to spatial layout and design configurations. When I have done so, I have stated that "I assert". These assertions to appropriate design are intended to reflect my best guess based on learned facts. Whether these assertions are indeed worthy of design investment remains unknown. My hope is these assertions can at the very least, trigger a discussion on butterfly habitat garden design.

I cherry picked from field guide formats and looked at ways landscape designers presented imagery and then looked for ways to improve the way my images were presented. I can not say whether the document I have produced is any better, any more complete, or any more user friendly than the works that have come before mine. But I can say that the information complied was done in the most thoughtful way I could imagine.

How much of my personal bias towards butterfly gardening went into this project? Admittedly I came into this project with some knowledge of butterfly ecology. My brother studies these animals and I have learned some important things about butterflies growing up. The information provided concerning the life histories of butterflies of Eugene, Oregon is an accurate accumulation of data driven knowledge. The presentation and the creation of this guidebook required me to make certain assertions and fill in certain gaps of knowledge, thus some of my creative license did factor into this process.

Will this butterfly habitat garden process work?

The project focuses on creating a butterfly habitat garden design process. The framework is a logical step by step process based on scientific research and applied in the best manner to design principles that I saw fit. In theory the results should yield benefits for butterflies within urban spaces. But will it work? Honestly, I do not know. The theory is sound but untested. Funding for creating large butterfly gardens may be a limiting factor for applicability for large scale butterfly habitat gardens. The feasibility for cost and maintenance may exceed the patience and attention to care for these spaces.

Because butterflies are flighted animals and tend to move at will through their environment, the ability to control which species will in fact find and then ultimately populate the garden is subject to chance. Although the provisions of the best-case scenarios have been spelled out within the design process, there is still a large degree of chance involved. Because this is a design process and not a design, the degree of testability falls outside of this master's project construct. The need to construct and then study the results of such a process driven design is a necessary next step of implementing these design principles to determine efficacy.

5.5 What's Next

I'd love to move this master's project into mainstream publication and rework some of the ways in which the information is presented. One of the main goals that could not be addressed in this master's project was the engagement of the Eugene school system. I would love to start a dialog with these institutions and create a network of school-based butterfly habitat gardens. I remain confident that part of the success of wild spaces within urban environments and wild environments in general is the engagement of our youth and the creation of stewardship within our communities. This engagement with wild spaces not only will ensure the survival of the creatures that depend on these spaces, but the benefits to the people who share these environments will be significant as well.

Another goal of mine is to create this guidebook to engage a more general audience. The guidebook is speaking directly to design professionals and landscape architect students alike. But admittedly the bulk of butterfly habitat gardening will have to be generated from the efforts of homeowners.

I, of course would like to be able to test this process upon an actual site within the city of Eugene and place a long-term monitoring system to measure and report of specific design prescriptions as stated within the process framework.

5.6 Final thoughts

I chose butterfly gardening as a master's project because I have a vested interest in butterfly habitat garden design as a profession. Butterfly populations are in a global decline. As urbanization continues to expand and agricultural processes proceed, natural and native tracts of land which serve as habitat disappear. Educating people to the importance of creating vestiges of habitat for butterflies carries the benefit of butterfly survival, but these habitat gardens can serve a benefit to the people who visit and learn from these designed spaces as well.

It was important for me to create a guidebook, to be a tool for other people who may not have a sophisticated knowledge of butterflies and not know how to design for butterfly survival. Although butterfly life histories are complex, I made every effort I could to condense the information into a simple step by step process to make these survival requirements easy to understand and easy to design for.

Butterflies are vital to my happiness, and I suspect to the happiness of many people who I share this planet with. I remain confident that if people were more aware of the problems that butterflies are facing for their survival, they would be motivated to do something to help these beautiful animals remain successful in carving out their place within these shared environments. I also remain confident that providing a guidebook that spells out how to understand the butterfly survival requirements and then shows the reader how to create these spaces will transcend into successful butterfly habitat gardens.

In short, I hope that our gardens will always be filled with butterflies.

Butterfly Photo Credits

Photo 3.1 Bill Bouton
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