CO-CREATION WITH ANIMALS

Tori Murphy I Project Chair: Roxi Thoren

INCLUSIVE LANDSCAPE DESIGN: CO-CREATION WITH

A N I M A L S

Tori Murphy
Project Chair: Roxi Thoren

APPROVAL

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Project Chair: ______________________________

Roxi Thoren

Committee: ______________________________

Chris Enright

ABSTRACT

Ecological restoration is a field that is constantly evolving as we learn more about how much we do not know about our surroundings. This research looks at the potential to co-create with native animals as a way to provide more suitable restoration designs at neglected sites. Co-creation, in this case, is where animal functions contribute to a design that is collaborative, functional and efficient. This research through design approach to ecological restoration is under explored in the field of landscape architecture. Literature provides limited guidance about creating with animal functions like browsing and grazing vegetation. This research develops an evaluative model for precedent analysis to determine a successful approach to co-creation, proposes a typology of animal functions in the Pacific Northwest with potential for co-creation and proposes a design framework that is tested with a case study in Eugene, OR. After determining the seed dispersal function was the most appropriate to address the landscape need of a ruderal meadow, the case study informed a process for phasing prototype perches beginning with an efficient trial phase. Based on animal feedback the next phase of prototypes is refined to have more potential for collaboration. These prototypes must be implemented at the at the right time of year to function for the desired outcome. The arrangement of the design intervention will encourage an intended pattern by animal input at the landscape scale. This method will provide cost effective, suitable and non-human imposed outcomes for neglected sites and an opportunity for people to care about animals and their needs.

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CHAPTER 1
BACKGROUND

INTRODUCTION

This research aims to provide a method for designers to initiate ecological restoration through collaboration with animals. As a result, animal needs will be more equally addressed in designed spaces. In co-creation with animals, both the designer and animal are contributing to the design and evolution of a place. This strategy is more complicated than creating *for* animals, instead it is about creating *with* animals--and there is a big difference. When creating for animal habitat, designers make their best attempt to provide landscape form and structure to meet animal needs, based on research, literature review, or their own or collaborator expertise. On the other hand, facilitating animal involvement leaves the end design open to change based on the animal's contributions. This may result in more suitable designs for plants and animals because they are creating for themselves based on co-evolutionary processes and forms. The Army Corps of Engineers has recently been working on ways to engineer with nature, such as using plants for bank stabilization instead of riprap and using wetlands to reduce flood risk instead of barriers. They begin to look at the potential to 'engineer' with animals, but this topic can be explored further (Bridges, et al. 2018).

Co-creation with animals may provide an approach for ecological restoration, returning "the structure and functions of nature to areas where they have been removed by past land use disturbances," especially on neglected sites and with projects where there are minimal resources and an abundance of time (Society 2004, 3). The resulting animal-centric designs may be more efficient because the animals are already providing these services and they are able to interact with the environment in a more precise manner than human construction. These designs may also be more functional for native species because the species themselves are creating the space. Human imposed designs for animals may not provide the complexity necessary because we do not fully understand their needs.

Is it possible to co-create with all animals? How can we co-create with animals to improve the ecological function of a site? How do we get animals to show up and do the work? Using precedent analysis as a foundation and a case study of site-specific prototype designs in the Pacific Northwest as a test, this research proposes an overview framework for designing with animals. This research also provides a typology of animal functions suited for co-creation in the Pacific Northwest that can be applied to the design process framework which can be adapted for local ecological restoration. The framework guides the designer to develop site-specific interventions based on their specific design goals, the landscape need, and animal functions available in a given location. The framework is tested through a case study on a site comparable to a vacant lot on the University of Oregon campus in Eugene, Oregon. Specifically, iterations of prototype perch designs are developed to encourage seed dispersal by birds to initiate revegetation of native habitat of the neglected site.

Methodology

The research uses a three-phase methodology, with consideration given to the timing of local species activity to deploy design prototypes in the spring. First, in order to define and evaluate success, I used precedent analysis to propose an evaluative model for this project's goals. Second, from a typological analysis of an existing species-environment-relations database, I developed a curated list of animal functions and species that could be used as design collaborators in the Pacific Northwest. Finally, I proposed a design framework that I tested with a research-through-design process of prototyping.

Project Goals

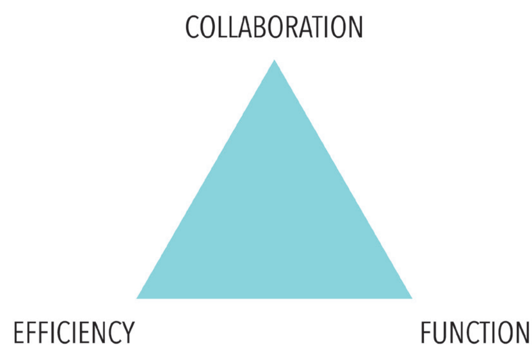
This project focuses on co-creation aimed towards ecological restoration and proposes a set of evaluative criteria to determine success. In this project, successful co-creation interventions are derived from definitions of successful ecological restoration and must be collaborative, functional and efficient (Wortley et al. 2013). This definition of success is specific to the restoration goals of this research; co-creation with animals for any other purpose would require different evaluative criteria. For example, criteria such as aesthetics may be more important for co-creation with animals as an art-based environmental communication project.

1. The design must be a collaboration between animal and designer. Does the animal show up? Does the animal add or subtract elements or alter flows of materials, wind or water? Collaborating with animals results in unique designs because the animals are adding an element of unpredictable texture, form, and color that cannot be replicated by a human intervention.

2. The design must produce increased function. Is the design intervention encouraging the desired outcome of ecological restoration? Animals that create their own environment will provide for their own needs and will subsequently provide opportunities for the survival of other species. These functions may indirectly improve the human environment and can provide us with benefits such as shade, food and clean water.

3. The design must be efficient. Is the design intervention cost effective, low maintenance, time sensitive and self-sufficient? Does it use time as a resource for installation and implementation? Is the design built less expensively and with less disturbance than a construction project? Efficiency will ensure that these methods can compete with human-centered interventions.

Defining Success
Successful co-creation interventions are derived from definitions of successful ecological restoration and must be collaborative, functional and efficient



SIGNIFICANCE

Animal needs are typically less of a priority than human needs when considering future land use change. An animal's ecosystem services are difficult to measure and therefore not perceived as important enough to prevent development of critical habitat. Ecosystem services are processes that plant and animal communities offer to human communities, usually at no cost (Daily 1997). Little or no financial wealth is generated by preserving land in native habitat conditions while substantial financial wealth can be made by developing land. As a result, animals are pushed out of urban areas because habitat is not a priority for economic development. Most animals have been impacted by human pressures that cause habitat loss or habitat fragmentation. Designers have the opportunity to shape possibilities for human-animal interactions and influence land owners to value animals. However, Jennifer Wolch claims, the effort is not there, that designers and developers "do not reflect desires to enrich interactions between people and animals through design (Wolch 1996, 43)." Designers are pressured to develop for clients which perpetuates tension between human and animal spaces.

Animal functions can provide services that are lacking in urban areas. Degraded land will not recover to historical conditions without intervention because of things like invasive species and contamination. "Even when habitats are well prepared and species choices carefully made, successful restoration can be delayed or prevented by local environmental change (Robinson 1993, 272)." Involving animals in the intervention can provide maintenance processes that are missing from human interventions. Animal created spaces can create biodiversity in plants and animals that provide otherwise costly services such as organic waste disposal, soil formation, biological nitrogen fixation, crop and livestock genetics, biological pest control, plant pollination, and pharmaceuticals (Pimentel 1997).

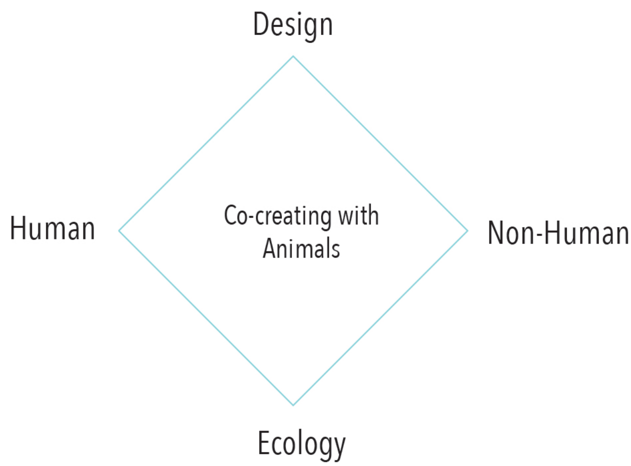
Bringing animal functions into urbanized areas will make nature more accessible in human spaces which may relieve cognitive stresses. "The radical exclusion of most animals from everyday urban life may disrupt development of human consciousness and identity and prevent the emergence of interspecific webs of friendship and concern (Wolch 1996, 37)." Animals are awe-inspiring creatures that give us insight to design, communication, behavior and instincts. Additionally, studies in eco-philosophy attribute positive development of human consciousness and identity to the relationship with wild animals (Naess 1993, 406). Activities like bird watching and wildlife expeditions make people aware of greater ecological processes and our impact on them. Working with animals will make their presence more visible creating opportunities for the public to care about them and their needs. People will become aware of the benefits of co-created green spaces which will contribute to improved healing, focus, and mood (Tang 2017).

Changing the way we think about sharing spaces may help to improve them to be generally more inclusive. Animals have intrinsic rights to these spaces and need urban refuges. Underserved populations have intrinsic rights to the benefits provided by animal interactions. Public spaces can be improved for demographics "who are denied the experience of animal kinship and otherness so vital to their well-being (Wolch 1996, 47)." Animals are an underserved population that experience the violence that is pervasive in the human world of "white supremacy, colonialism, patriarchy, heterosexism, and ableism (Davis 2015, 7)." Equity becomes an issue of including all organisms in designing public spaces.

This project asserts that the human quality of life can be improved through co-creation but does not evaluate this for proposed site interventions. This research will have the most impact on neglected sites, which is often privately owned, and for stakeholders who care to be inclusive of animals. "Cities with more than 250,000 inhabitants generally have between 12.5-15% vacant land by area at any given time (Anderson and Minor 2017, 146)." Co-creation in neglected areas like vacant lots will activate the spaces and increase positivity and community engagement (Anderson and Minor 2017). This research addresses how to accommodate for ecological restoration with a growing demand on resources and time for development. This research provides a design process for people and animals to engage with one another in a way that is not disruptive.

RESEARCH THROUGH DESIGN

The research-through-design approach to co-create with animals is a speculative exploration of animal functions to generate new knowledge. In this case, the designer is learning more about animal agency based on each response to iterative prompts to perform a prescribed action. The iterative methods of design allow the designer to responsibly incorporate the animal's actions. Sandra Lenzholzer outlines four approaches to research-through-designing: 1) Positivist: based on the natural sciences and relating to physical questions of environment, technologies, and function; 2) constructivist: focusing on cultural values, experiential qualities, and human beliefs; 3) advocacy/participatory: aimed at provoking change in sociopolitical contexts; 4) and pragmatic: which synthesizes elements from the preceding approaches (Lenzholzer et al. 2013). This research is a positivist research-through-design approach based on changes in the physical environment to improve ecological function through animal engagement.



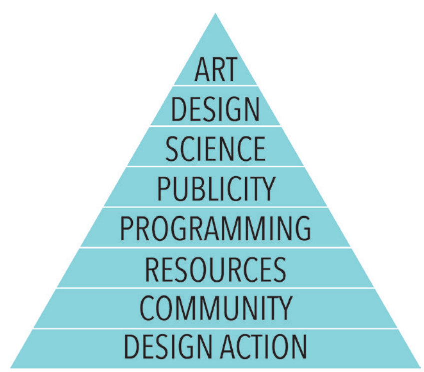
Framing the Research
Co-creation with animals is a combination of a design and ecological approach and human and non-human influence

Co-creation with animals research is a combination of a design and ecological approach; and human and non-human influence. Ecological research informs the design and the design, in turn, is generating new ecological knowledge directly through animal input. This research results in thoughtful expression of both human and non-human where design engages with animals and the ecology engages with people. Mel Chin's approach to art in "Revival Field" is also a combination of design and ecological approach and human and non-human influence. "Revival Field" is an art work from 1991 on Pig's Eye Landfill in St. Paul, Minnesota where Chin set up an experiment to remove toxins from the soil with phytoremediating plants, which had never been done before on a superfund site (Finkelpearl and Acconci 2014). This approach is participatory research-through-design because he is looking at how the work can initiate a process for phytoremediation. The work does not exist in the experiment alone; Mel Chin paved the way for more of these experiments on superfund sites by convincing stakeholders to let him do the research.

Revival Field
Mel Chin 1991

When Mel Chin was asked “is it possible to call Revival Field a success even if it turns out that the scientific research is a dead end? He responds, ‘no, but it can be a successful model of cooperation between disciplines and a guide for navigation through legal, political and social worlds (Finkelpearl and Acconci 2014, 386).’” Similarly, I believe research-through-design is an important method to not only understand variables but also about understanding process. This research proposes a research-through-prototype-design method to test co-creation with animals. Feedback, as well as the lack of feedback, informs new phases of prototyping that will encourage animal functions. The process of prototyping contributes to new knowledge about animals and their functions but also about using prototyping as an appropriate mode of inquiry.

The new knowledge generated from the research-through-design method to co-create with animals will yield opportunities for science communication. David Buckley Borden’s pyramid explains his work as art, design and science that become opportunities for science communication through public engagement aiming to inspire design action. Successful work for him can be contextualized regionally, nationally and globally. For his work, success is whether the project creates opportunities for understanding, outreach, and further community-building (Ellison and Borden 2018).



Framework for Science Communication
David Buckley Borden

Science communication may not be appropriate for all co-creation projects depending on disturbance threats and sensitivity. Observation decks and interpretive signage can allow for these functions to be acknowledged and used for educational purposes. The design intervention may be science communication in themselves if they have an obvious relationship to the restoration outcome.

These co-created spaces should be celebrated by the community and will help this approach in ecological restoration gain momentum.

THEORY OF CO-CREATION

There is a large literature about the way humans regard animals but not much solution-based thinking about how this relationship can be improved through design. In the field of landscape architecture, based on publications in the past few years, there is a growing interest in designing with animals. In landscape architecture academia, there is research about how to co-create with animals expressed as art installations in the field (Thoren 2018). In the landscape architecture profession, there are considerations for being proactive about beaver activity in wetland designs (Viani 2019). The *Topos* publication in landscape architecture and urban design produced a review entitled Creatures and has literature about promoting animal life in urban cores (Dodington 2018), integrating animals in design by designating space (Beatley 2018), and the landscape impact of animals (Tautz 2018) (Malcon 2018). These topics all support the idea that animals can be integrated into design in thoughtful ways but no one is taking a step further and providing a method nor giving animals more agency in design.

Animal and human theories cover topics such as animal and human relations (Berger 2009), humans within the larger system of species (Maller 2018), the subordination of animals and animal awareness (Burghardt 1985). Owain Jones talks about the animal-human relationship as one of either domestication, observation or conflict. He talks about our spatial relationships which make us feel removed from the animal world. For this reason, progress and development are human-centered, perpetuating the subordination of animals and an unethical relationship. Because we have the ability, we put ourselves first. We debate about animal awareness, uncertain if they have the ability to learn or think. George John Romanes constructed a hierarchical framework in the late nineteenth century that ranks animal species with mental structures involved in the emotions, will and intellect at various infant human ages. Romanes created a foundation for thinking about animal awareness that has been improved upon as we learn more about species (Burghardt 1985). All of this prior research supports the position that we need to be mindful of our relationship with animals, create spaces for both humans and non-humans and, animals should have agency that humans have prevented. It is a challenge to integrate animals into human spaces because of their overall invisibility, changing relationships, our general misunderstandings and lack of ethics.

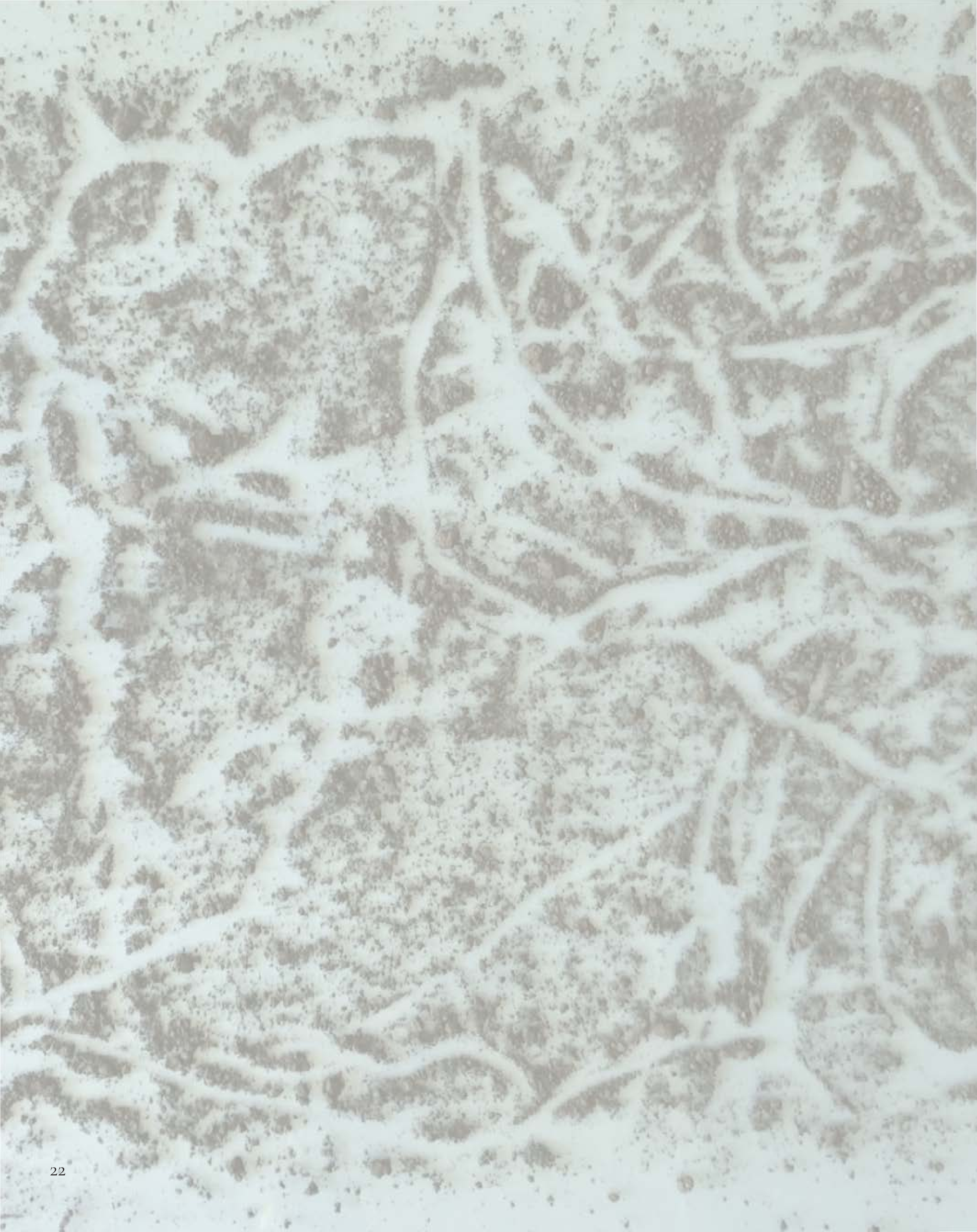
Animal invisibility diminishes their presence and consideration in human spaces. Their invisibility is a result of anthropocentrism. Animals flee to the periphery of developed areas to find suitable habitat and are not present in our everyday lives. Large animals stay out of urban areas because their habitat is fragmented. Wildlife images "carry with them numerous indications of their normal invisibility (Berger 2009, 16)." We consider ourselves lucky to catch a glimpse of a fox, coyote, bear or bird of prey.

A restored relationship with animals that can be productive calls for us to relinquish control in human spaces. Pressures like climate change and human population growth exacerbate human pressures on animal habitat and well-being. Our relationship to animals emerges from a long history of dominance, domestication and hunting as well as a mix of emotions from "reverence to revulsion and from fetish to fear (Jones 2000, 275)." In the Anthropocene, our relationship to animals has changed from thinking of animals as counterparts, to now, as nuisances. Jacques Derrida points out that humans evolved after most animals but assumed dominance over the non-human world. Furthermore, we gave ourselves the right to name other living beings and decide that they are different than us (Derrida 2002). Despite our close relation to animals, they are considered to oppose anthropocentric development because they often create conflict with human activity and damage to property. This relationship has potential to create mutually beneficial spaces. Catherine Johnston has proposed that, "animals might be active and more equal partners in the creation of space, place and history [which] gesture[s] towards the need for a dialogue between animal geography and actor network theory (Johnston 2008, 637)." Actor network theory suggests that everything exists within a network of constantly shifting relationships. A productive relationship with animals has the potential to provide solutions to degraded spaces with human imposed conditions.

Integrating animals in human spaces is difficult because we generally misunderstand them and their complexities. To design habitat, we are using our best judgement, yet, it is still a trial and error process. There are design possibilities with animals that have not been explored. There is a lot that we do not understand about how involving animals in design might be implemented into best management practices because it cannot be standardized.

A major challenge to integrate animals on a larger scale is that we have no obligation to include them in human spaces. There is no ethical geography for animals nor ethics that are specific to species. Jones writes that nature is often excluded from normative ethics and only occasionally included "based on religious, spiritual, emotional or even aesthetic grounds (Jones 2000, 275)." Animals are subject to a human hierarchy and often experience neglect comparable to that of underserved populations. Their needs and considerations are invisible and unaccounted. Equitable design must include the needs and agency of underserved populations, including animals, in public spaces.

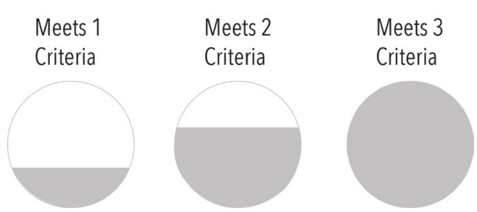
There have been some efforts to ameliorate our exclusion of animals. More-than-human theory studies and critiques normative practice that attempts to make urban areas healthy through designs that are human-centric and don't consider animal needs. The theory proposes that when designing, we need to rethink who urban environments are for in order to make them "healthy (Maller 2018)." Some people have also experimented with this thinking in animal-aided design (Hauk and Weisser 2018, 43), which plans the settlement of animals in both urban open spaces and built areas; multispecies studies (Dooreen et al. 2016) (Kirksey and Helmreich 2010), which analyzes how organisms shape and are shaped by political, economic and cultural forces; and biophilic design (Beatley 2016), which is the innate connection with and love for nature expressed in design. All three of these consider designing for animals because they should be included in meta-species thinking. "To think of ourselves as biological organisms first, as one type among the worlds of other critters, allows for more open and curious relations to the other beings with whom we co-compose the world (Davis 2015, 13)." Co-creation takes the design process a step further to involve animals in the design process to truly 'co-compose' spaces.



CHAPTER 2
RESEARCH

PRECEDENT ANALYSIS

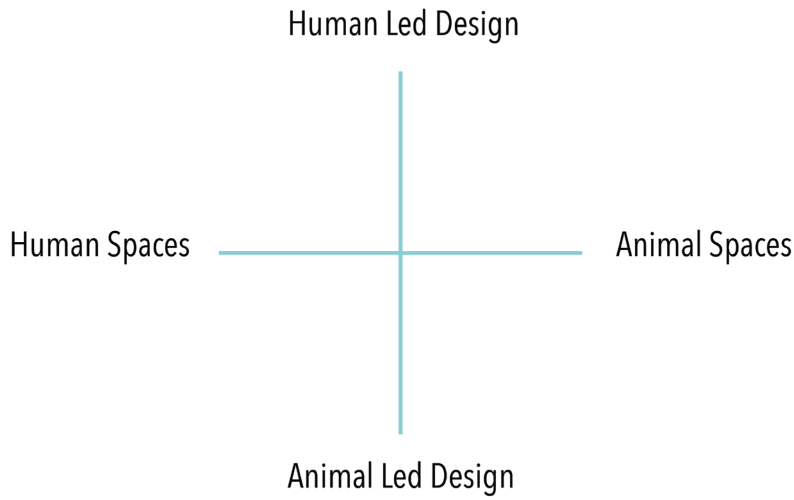
Through an ecological lens, this research analyzes precedents of co-creation to determine their success. This is not to say the precedents are not successful on their own terms, they are just successful for different goals. A designer with co-creation goals other than ecological restoration, must determine their criteria for success then perform a precedent analysis to guide their research. For the purposes of this research, co-creation is successful if it is collaborative, functional and efficient. The result might be different, even with the same precedents, for a different set of goals and success criteria. The full circles indicate a successful design. Successful precedents analyzed with this framework inform the co-creation process developed in this research.



Gauging Success
The precedents that meet all three criteria for success, collaborative, functional and effecient, are gauged with a full circle. If they do not meet all three criteria the circle is partially full.

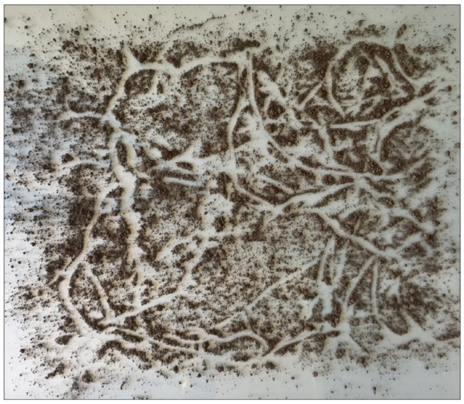
The precedents were also studied to understand which types of projects and project sites have been most successful. Co-creation can occur in animal or human spaces on a spectrum between human-led design and animal-led design. Animal space represents native habitat and human space represents developed areas. Human-led design is when a designer encourages an animal function or facilitates animal activity in a particular way. Animal-led design is when the designer is inspired by animal activity and building upon what an animal creates. This framework is used to determine trends in spaces and design approaches for successful precedents. For the following case study analysis, the circles gauging the success of the project will be positioned in the evaluative model.

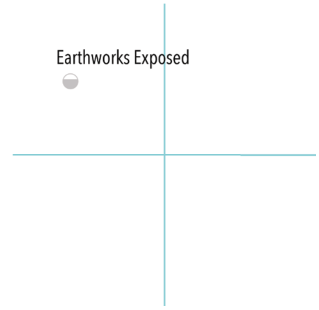
Evaluative Model
Projects that co-create with animals are either human led or animal led and in human spcae or animal space.



The following four precedents - Earthworks, 3 Newts: 120 Minutes, In Transition and the Chimney Swift viewing - are types of co-creation that ensure the animal's presence is visible and that people are engaged with the animal's functions, but there is not a primary focus on the ecological benefits of those functions for people. Three of the projects are student works from the University of Oregon's 2016 Overlook field school, in which students were asked to produce site-specific art installations that co-created over time with the animal as collaborator, monitoring animal activity (Thoren 2018, 27). The students used mapping and design methods to research the animal and made prototypes and installations to investigate the animal and our relationship with it (Thoren 2018, 27).

EARTHWORKS EXPOSED
Jaimie Willeke | Overlook Field School | 2016



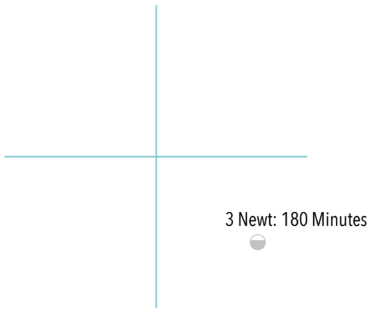


This project was focused on earthworms and intended to make earthworm activity more visible. Earthworm burrowing activity creates tunnels in the soil and the ingested organic matter creates surface casts that are rich in nutrients (Syers and Springett 1984). Earthworms redistribute organic matter, penetrate soil, transport ions, create root distribution, increase microbial activity and cycle nutrients, but these ecosystem services are invisible to, and unappreciated by, most people (Syers and Springett 1984). In this project, Willeke directed the worms' movement across a thin layer of soil on a 2 x 2 foot area on a glass plate so the patterns and networks of their subsurface tunnels could be exposed.

This is an example of human-led co-creation in human space where the designer collaborated with the earthworm by facilitating the burrowing function. Willeke was able to create conditions to make the function more visible to people. The design is not functional because the design intention was to create art with the animal not to improve ecological function. Willeke's methods were not expensive in time or money. This project is not an example of successful co-creation defined by this research because there is an emphasis on creating an artful representation of the tunnels to increase awareness rather than use the earthworm's ecological function for ecological restoration.

3 NEWTS: 120 MINUTES

Justin Kau | Overlook Field School | 2016

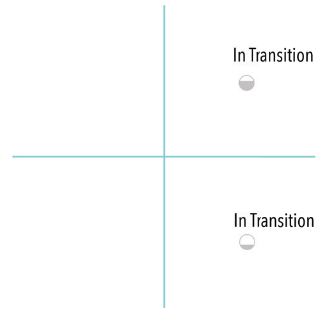


This project focused on the movement of 3 Eastern Newts when observed for 120 minutes. Eastern Newt are amphibians that "spend an entire life stage, the Red Eft, on a journey from water to water which lasts from three to five years. This life stage is marked by vibrant orange coloration (Fuller 2019)." The Red Efts are small, and typically emerge after rain events. This project makes the salamander activity more visible by tracing their paths in the forest with stone painted in the eft's striking orange. Kau studied newt traffic on a patch of ground, testing several prototypes for tracking their movement, including small newt backpacks with a spool of string that would thread a trail, but decided to observe, mark their path with flags, and trace the path with orange stone. The wall is made of flat shale stone about 6 inches off the ground and serpentines through a small patch of forest for about 10-15 feet.

This is an example of animal-led co-creation in animal space where the Eastern Newt activity inspired the placement of the wall. Again, the design intention was to create art with the animal not to improve ecological function. Kau's methods did not cost a lot of time or money to produce so it is efficient. This project is not an example of successful co-creation defined by this research because there is an emphasis on making the Eastern Newts movement more visible rather than using the newt's ecological functions for ecological restoration.

IN TRANSITION.

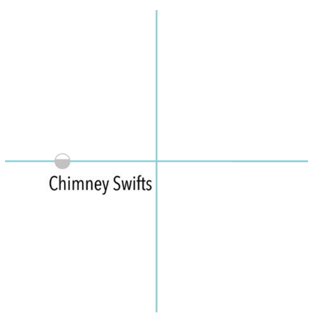
Jill Stone and Rachel Spencer | Overlook Field School | 2016



This project focuses on the deadly impacts of the Emerald Ash Borer on ash tree stands in Pennsylvania and the potential for seed dispersal by squirrels to replace trees. The project looks at dispersal patterns of animals both in negative impact and new growth potential. The emerald ash borer is an invasive beetle from Asia that is devouring the phloem in the bark of ash trees resulting in an epidemic (Poland and McCullough 2006). It was introduced in Michigan and is now disturbing ash forests all over the east coast before making its way west (Poland and McCullough 2006). “Around 70% of northeast Pennsylvania’s forests are made up of Ash trees. After the Ash Borer moves through, the canopy loss will allow for new species, no longer competing with the prolific Ash tree, to move in (Fuller 2016).” Stone and Spencer exposed the extensive impact of the emerald ash borer by tracing their trails in the tree phloem with red paint. They also installed squirrel feeders to facilitate replanting a more resilient forest by seed dispersal.

This is an example of both animal-led and human-led co-creation in animal space where the Emerald Ash Borer activity inspired the painting and the designed squirrel feeder encouraged seed dispersal by caching. The animal-led design component is collaborative, because it was inspired by the beetle activity and efficient because it did not cost a lot of time or money to produce, but, it is not functional because it does not use the emerald ash borer's function to improve ecological restoration. The human-led design component is efficient because manually replanting the forest would be time consuming, labor intensive and expensive, but, it is unclear whether it is collaborative or functional. Collaboration and function can be determined after monitoring the squirrels and if this design intervention encourages reforestation. This is not an example of successful co-creation defined by this research because it is only partially collaborative and it is not functional.

CHIMNEY SWIFTS.
University of Oregon

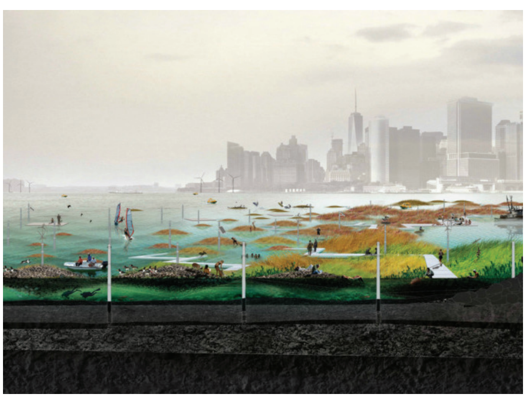


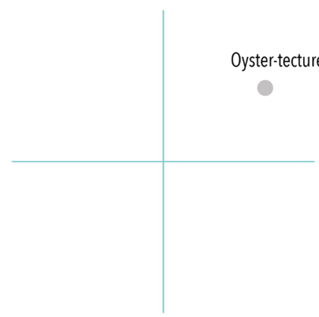
This example of co-creation is both an animal and human led co-creation of performative art. Vaux swifts put on a show in the early fall during their migration where thousands of birds do a choreographed routine before swooping into a chimney stack for the night. The common swift is adapted to an aerial lifestyle and spends its entire 10-month non-breeding time in the air (Hedenstrom et al. 2016). The birds have become a cultural spectacle for thousands of Oregonians who come to watch the event each year. As a result, chimneys around the state have been preserved to provide the opportunity for the swifts to return and continue the display. People, therefore, co-create this opportunity for the chimney swift event.

The chimney swift event is both animal and human led event in human space because the chimneys created the opportunity for the swifts to rest and the swifts inspired the preservation of chimneys to collaborate for the cultural spectacle. The chimney provides a functional resting place for swifts and the event has a cultural function for people, but, it does not result in ecological restoration, other than preserving habitat for the birds. Preserving chimneys was an efficient method to maintain the event and saved money and time compared to removing them. This project is not an example of successful co-creation defined by this research because there is an emphasis on making the Vaux Swifts movement more visible rather than using the swift's ecological functions for ecological restoration.

The next three case studies, Oyster-tecture, Fresh Kills Landfill and Analogue Beaver Dams demonstrate successful co-creation intended for ecological restoration in concept because they are collaborative, functional and efficient. The goals of these precedents align with the goals of this research – ecological restoration through animal action – and so provide more direct design suggestions for the next phase of this project, a site-specific design.

OYSTER-TECTURE.
Kate Orff | Scape | 2009

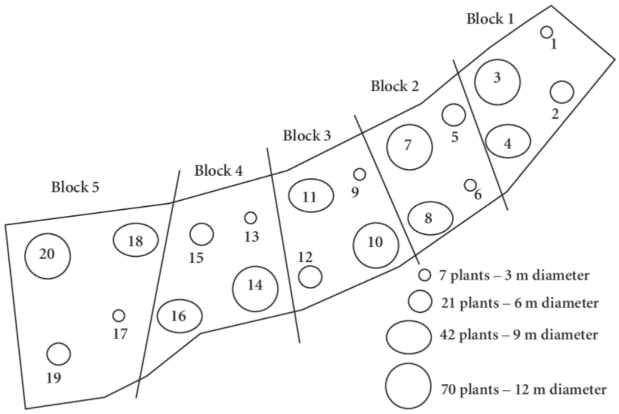


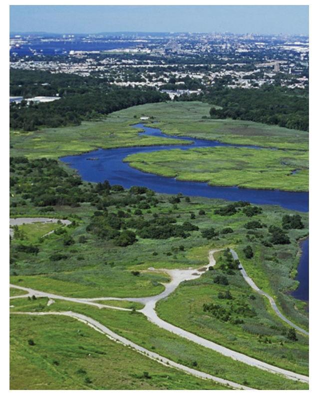


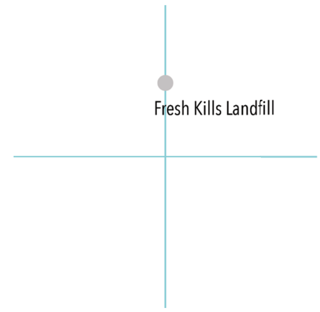
This project was produced as design research for New York Harbor commissioned by the Museum of Modern Art in 2009 for the Rising Currents exhibition. Orff's concept proposes a living reef composed of "fuzzy rope" that supports marine growth of oysters, mussels and eelgrass that helps with wave attenuation and filtering water. The oysters are farmed in the Gowanus Canal in floating aquaculture structures called FLUPSYS. The oysters are then transported to their human designed habitats in the Harbor. Oysters are filter feeders and trap food and other particles in their gills. One adult oyster can filter as much as 50 gallons of water a day (Chesapeake 2019). Oysters are an ecosystem engineer and help to shape the reefs for other species to use. "Oyster-tecture aims to improve habitat and water quality, restore biodiversity to tidal marshes and encourage new relationships between New Yorkers and their harbor (Scape 2009)." Oyster-tecture was designed to restore ecological function and the cultural heritage of oyster harvesting.

This is an example of human-led co-creation in a more neutral space that is closer to an animal space because it is oyster habitat but degraded by the surrounding urban area. The reef structures are a collaboration between designer and animal. The designer is creating a substrate for oyster propagation with the intention to encourage ecological function. The function has been determined through monitoring the oyster preference at the prototype scale. The next step will be to confirm that the design will encourage the desired outcome at the landscape scale. This method in concept is efficient, however, the human designed filter system would cost a lot of money and time to design and install.

FRESH KILLS LANDFILL
Steven Handel Rutgers University | 1993







Steven Handel, an ecologist from Rutgers University, proposed that seed dispersal by animals could help accelerate the spread of woody plants onto and across the site. There is not a lot written about this work other than Handel's own research documents. The Fresh Kills landfill was closed in 2001 after 53 years servicing New York. The Municipal Art Society, which is a civic group of urban planners and preservationists took the opportunity to create a park in 2003, and they are hoping to open the first phases in 2019 (Beck and Franklin 2015). To test his seed dispersal idea, Handel and his colleagues planted clusters of trees and shrubs in blocked off sections on the landfill mound. Handel's team used seed traps under the tall plantings to examine the seeds brought from surrounding areas by birds. These plantings were nuclei as the birds revegetated the plots outward from these areas with native seeds. Handel observed the site for years and found after five years that 95 percent of the seeds were bird dispersed (Robinson and Handel 1993, 271).

This is an example of human-led co-creation in a neutral space that is both human space and animal space because it is a landfill that is beginning to be restored. The revegetation effort is a collaboration where the designer is facilitating seed dispersal. This method is functional because it revegetated the landfill with native plants and produces a landscape that is suitable for bird foraging habitat because the birds themselves had chosen the food source and dispersed the seeds. This method resulted in a cost-effective solution to revegetation because manually replanting the site would be costly, labor intensive and time consuming.

ANALOGUE BEAVER DAMS

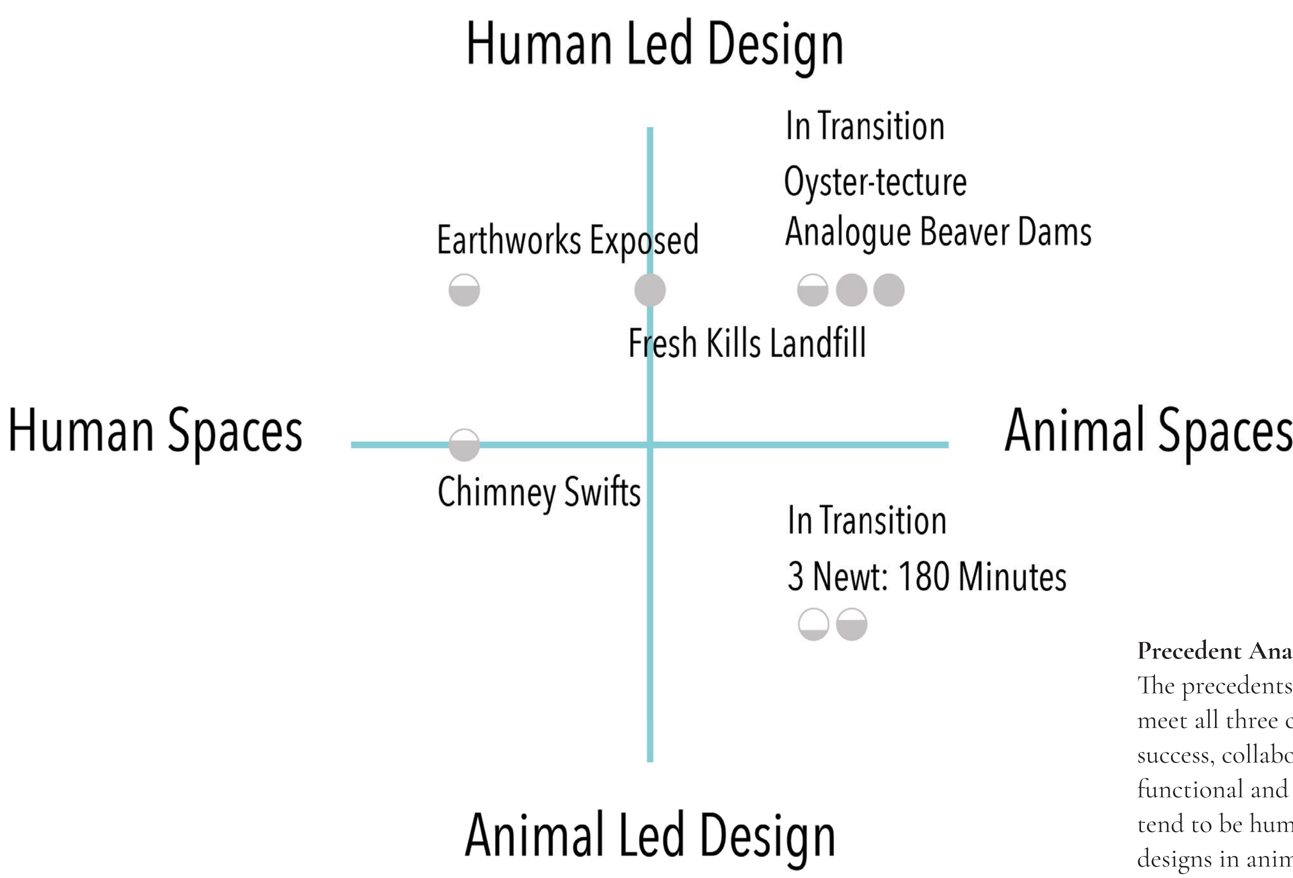
Analogue Beaver Dams

Restoration groups are making 'analog beaver dams,' or, beaver inspired stream interventions to begin the stream restoration process. Beavers are ecosystem engineers that create wetland habitats and maintain stream health by damming streams. Many other organisms depend on the beaver dams to slow the flow of water for organic matter, sediments, sand and gravel to build up. Once the analogue beaver dams create suitable beaver habitat, it is expected that the beavers return and continue the restoration process and maintenance of the stream (Pollock et al. 2014, 6).

This is an example of human-led co-creation in an animal space. The stream restoration is a collaboration between the designer and beavers through dam construction. The designer is creating a suitable habitat to encourage beaver activity. This co-creation is functional for ecological restoration. This method is efficient compared to a series of human interventions which would take a lot of time and labor to install and maintain, often in inaccessible areas where normative construction would be difficult.

Through this precedent analysis, it is evident that there is not a large pool of examples of co-creation with animals in ecological restoration. This does not mean that it is not possible or necessarily challenging. A research-through-design approach will make this kind of ecological restoration more accessible. The function of these successful projects could be monitored and refined further. Oyster-tecture, in particular, is a project that would be a large investment for the city of New York. There is not a lot of room for error if the oysters do not show up and do the work. The prototype designs helped to inform the design at a landscape scale, but what informs appropriate landscape scale quantity and form?

These precedent studies encourage more human and animal interaction in both animal and human spaces whether human-led or animal-led. Most of the precedents studied are human-led designs; this research could be explored further to understand what successful co-creation looks like when animal-led in either animal or human spaces. These last three examples: Oyster-tecture, Fresh Kills Landfill and Analogue Beaver Dams meet all three criteria for success within the parameters of this project. All are human-led designs and most are in animal spaces, which suggests that successful design is more likely to occur within these parameters, and will guide the design and prototype stages of this project.



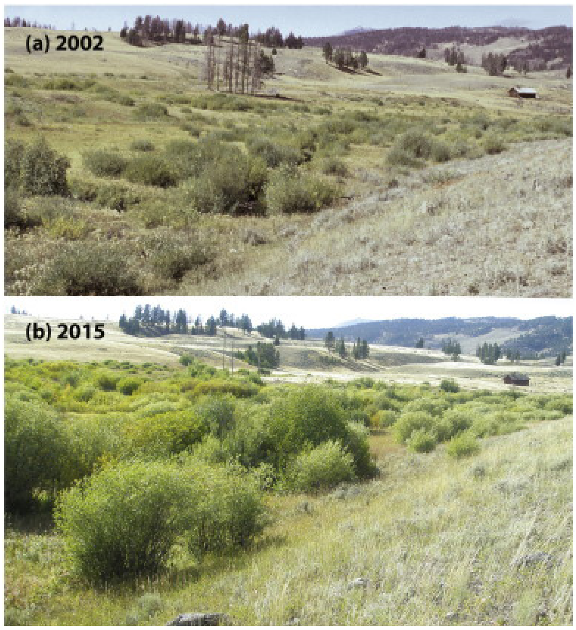
Precedent Analysis
The precedents that meet all three criteria for success, collaborative, functional and effecient, tend to be human-led designs in animal space.

TYPOLOGY OF ANIMAL FUNCTIONS

Co-creation with animals that influence the structure and function of the landscape may produce enhanced ecological restoration efforts. Animals influence structure and function on a variety of sites and at a variety of physical and temporal scales. What if designers were able to collaboratively harness these animal functions? The field of study called zoogeomorphology looks at animals as geomorphic agents, studying interactions like the roles of fish, amphibians and reptiles in aquatic environments or birds as agents of erosion and transportation of woody material (Butler 1995). Individual digging, trampling and compaction may not seem like a large influence, but in numbers and over time these actions can have a large effect. Animals do not have the opportunity to fully display their landscape influence in human spaces because of human pressures on their populations, habitat and functions.

Ecosystem engineers are important species because of how they shape their environments through their functions. Beavers are an example of ecosystem engineers who create wetlands and maintain stream health through damming. "Beavers do more to shape their landscape than any other mammal except human beings, and their ancestors were building dams ten million years ago (Outwater 1996, 20)." In tribes across North America, "legend has it that the beaver helped the Great Spirit build the land, make the seas, and fill both well with animals and people (Outwater 1996, 20)." Beaver populations were much greater before the European fur trade which depleted numbers from between 100 and 200 million in 1620 to nearly extinct along the east coast in the 1800s (Oregon 2019). Their numbers have recovered to 7 to 12 million now (Outwater 1996, 17). Their importance in shaping wetland habitat and maintaining river and stream health was only understood later, and restoration ecologists and engineers have been experimenting since the mid-twentieth century with reintroduction of beavers to effect large-scale ecological restoration.

Keystone species have a similar influence on their environments because their functions support the survival needs of many other species in their ecosystem. For example, when wolves were reintroduced into Yellowstone National Park, they reduced the elk herds that were heavily browsing the riparian vegetation which is important habitat to many other species. After thirteen years the riparian buffer was able to fully recover (Beschta and Ripple 2016). These ecosystem engineers and keystone species provide necessary functions for ecosystem creation and maintenance that can potentially be used in restoration efforts.



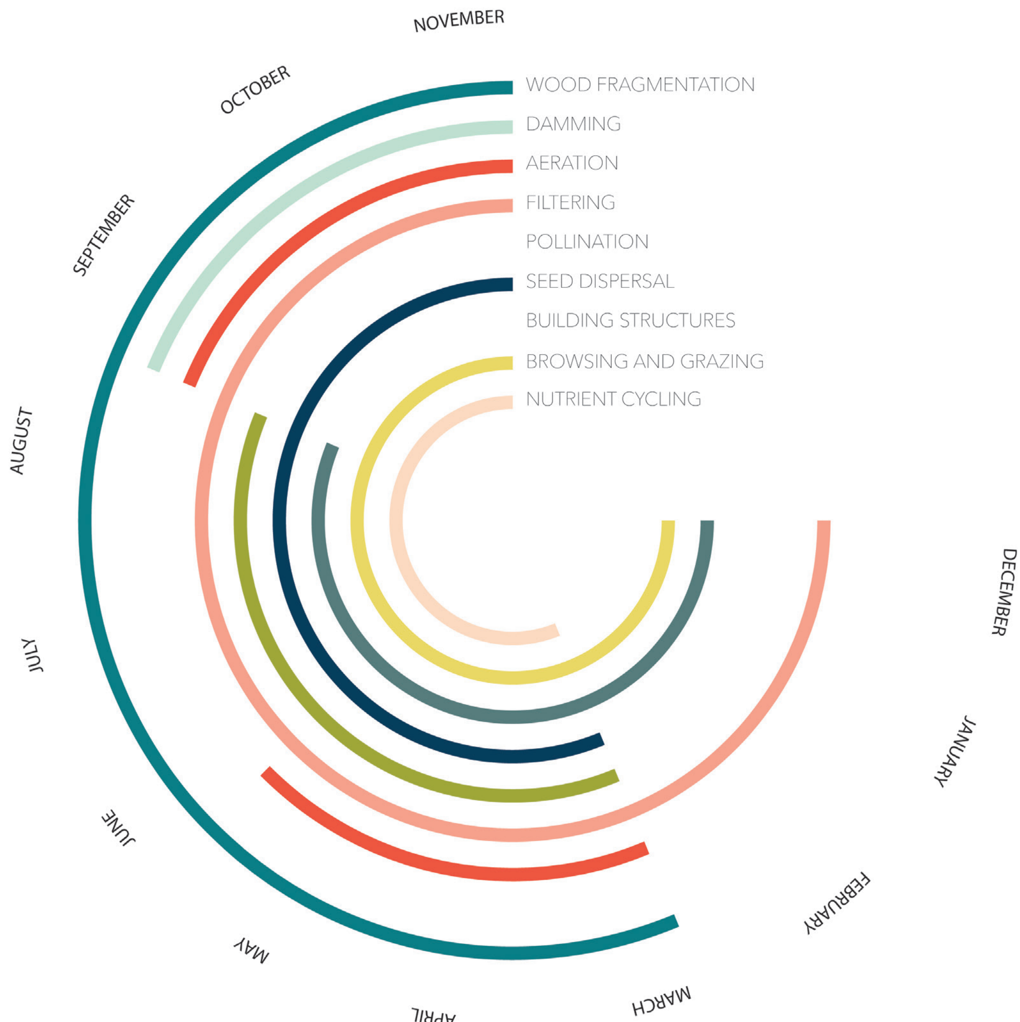
Reintroducing wolves into Yellowstone,
The top image is the riparian vegetation before introduction and the bottom image is 5 years after introduction when the vegetation has come back.

Animal activity may result in additive and subtractive co-creation. Additive co-creation is encouraging animal functions that produce results directly through animal mechanisms of digging, eating, transporting, etc. Reintroducing beavers to positively impact stream restoration through damming is an example of additive co-creation, as the desired outcome is the introduction of an animal and its activities. Subtractive co-creation results from the absence of an animal activity encouraged by a design intervention. This is the case with reintroducing wolves in Yellowstone, with the desired effect of reducing the activity of the elk. This research focuses on additive co-creation that will encourage animal and human interaction.

Bruce G. Marcot, a research wildlife biologist with the National Forest Service, produced the Species Environment Database for Pacific Northwest (PNW) native species of animals and plants that lists key ecosystem functions for each species (Marcot 2005). Building on Marcot's work, this project restructures and edits the database for use in design (Appendix A). The design database is sorted by animal functions, which were curated based on a typology of landscape effects and curated for their potential for human-led co-creation. Functions such as predator- prey relationships were edited out of the list, although as in the case at Yellowstone, these secondary effects could be important in subtractive co-creation.

This research identifies the following animal functions with co-creation potential: seed dispersal, building structures (nests, cavities), aerating soil, pollination, wood fragmentation, damming streams, filtering water, nutrient cycling and browsing and grazing vegetation. In the PNW species database, these animal functions are each composed of animal actors. Designers may use this species database to determine which animal functions and animal actors have potential to co-create at a given site. The type of design intervention is determined by the availability of these animal functions and animal actors.

To develop a design intervention, the designer must think about their desired outcome, the appropriate actors and the timing of the event. The designer must determine if they need to target a specialist species or generalist species in their design intervention to get their desired outcome. Although it is possible to encourage a function with individual species, like encouraging beavers to dam streams, in some cases, encouraging the function itself, like encouraging browsing and grazing by all undulate animals, rather than targeting individual species may allow for more flexibility in the animal actors. Another consideration to facilitate these functions is the timing and frequency throughout the year. Some functions are only happening during certain seasons when the animal actors are active. Many of these functions occur from spring into late summer and fall. Winter is a more inactive time for animal functions because many have migrated to other area, hibernate or are inhibited by snow and ice.



Temporal Analysis
Animal functions
throughout the year

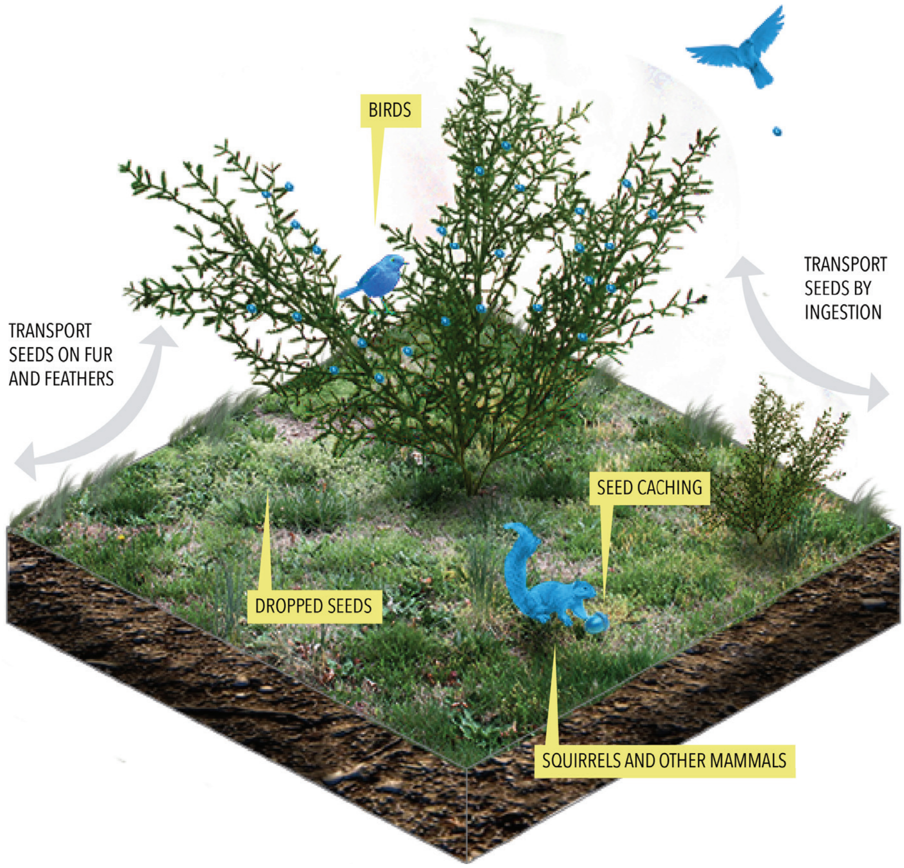
Animal Actors
Bird 85%
Mammal 15%

SEED DISPERSAL

Function: Seed dispersal can help with revegetating sites in an economic way, instead of planting trees or mechanically seeding a site. A variety of different species disperse seeds. Frugivores consume seeds and transport them to surrounding sites where they are deposited after digestion. Squirrels disperse seeds by collecting and burying them in a process called seed caching. Other species transport seeds that stick to their bodies or fur. Some seeds may be transported in unexpected ways like animals using vegetation for building structures. Some plant and animal species have co-evolved so that seeds are dispersed in a particular way and have characteristics that encourage a certain type of seed dispersal. For example, seeds that are dispersed by consumption are encased with fruit and seeds that are transported by fur are burred or sticky.

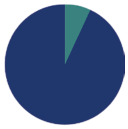
Co-creating Potential: Animals that disperse seeds will have a unique dispersal pattern, from hedgerows for digested seeds to a network for cached seeds. A human or machine seeded or planted plot may have a uniform dispersal pattern, while an animal dispersed plot may have a more complex pattern, and the animals may disperse seeds from adjacent sites that are not available or accessible for purchase. There has been a lot of research with perch design to attract birds to revegetate abandoned pastures (Athie and Dias 2016) (Zanini and Ganade 2005).

Design Intervention: research timing of plant seeding and bird migration, plant fruiting shrubs, provide perches to direct dispersal, provide native seed or nut feeders, provide nesting material, create opportunities for seed dispersal by fur, consider how location and frequency of interventions influences dispersal pattern



Seed Dispersal
Function diagram and species list

American Coot
American Crow
American Goldfinch
American Marten
American Pika
American Robin
American Wigeon
Band-Tailed Pigeon
Barrow's Goldeneye
Belding's Ground Squirrel
Black-Billed Magpie
Black-Capped Chickadee
Black-Crowned Night Heron
Black-Headed Grosbeak
Black-Throated Sparrow
Black Bear
Black Scoter
Blue-Winged Teal
Blue Grouse
Brant
Brewer's Sparrow
Bufflehead
Bushy-Tailed Woodrat
California Ground Squirrel
California Quail
Canvasback
Cascade Golden-Mantled Ground Squirrel
Cassin's Finch
Cattle Egret
Cedar Waxwing
Chukar
Cinnamon Teal
Clark's Grebe
Clark's Nutcracker
Cliff Chipmunk
Columbian Ground Squirrel
Columbian Mouse
Columbian Sharp-Tailed Grouse
Common Goldeneye
Common Loon
Common Merganser
Common Snipe
Deer Mouse
Douglas' Squirrel
Downy Woodpecker
Eared Grebe
Eastern Kingbird
Eurasian Wigeon
Fisher
Fox Sparrow
Gadwall
Gambel's Quail
Golden-Mantled Ground Squirrel
Gray Catbird
Gray Partridge
Great Blue Heron
Great Egret
Greater Sandhill Crane
Greater White-Fronted Goose
Green-Winged Teal
Grizzly Bear
Harris' Sparrow
Hooded Merganser
Horned Grebe
House Sparrow
Idaho Ground Squirrel
Killdeer
Lark Sparrow
Lazuli Bunting
Least Chipmunk
Lesser Goldfinch
Lesser Scaup
Lewis' Woodpecker
Lincoln's Sparrow
Long-Billed Curlew
Mallard
Marbled Godwit
Mountain Plover
Mountain Quail
Northern Bobwhite
Northern Flicker
Northern Flying Squirrel
Northern Mockingbird
Northern Oriole
Northern Pintail
Northern Shoveler
Pacific Loon
Parasitic Jeager
Pine Grosbeak
Pine Siskin
Pinyon Jay
Pinyon Mouse
Pronghorn
Red-Breasted Merganser
Red-Headed Woodpecker
Red-Necked Grebe
Red-Necked Phalarope
Red-Tailed Chipmunk
Red-Throated Loon
Red-Winged Blackbird
Red Crossbill
Redhead
Red Squirrel
Ring-Necked Duck
Ring-Necked Pheasant
Rose-Breasted Grosbeak
Ross' Goose
Ruddy Duck
Ruffed Grouse
Sage Sparrow
Sage Thrasher
Savannah Sparrow
Snow Goose
Snowy Egret
Song Sparrow
Sora
Southern Red-Backed Vole
Spotted Sandpiper
Steller's Jay
Swainson's Thrush
Three-Toed Woodpecker
Townsend's Ground Squirrel
Tundra Swan
Uinta Chipmunk
Uinta Ground Squirrel
Upland Sandpiper
Virginia Rail
Washington Ground Squirrel
Western Gray Squirrel
Western Grebe
Western Least Bittern
Western Red-Backed Vole
White-Crowned Sparrow
White-Faced Ibis
White-Headed Woodpecker
White-Tailed Antelope Squirrel
White-Tailed Ptarmigan
White-Winged Crossbill
Wild Turkey
Willet
Wilson's Phalarope
Wood Duck
Wyoming Ground Squirrel
Yellow-Breasted Chat
Yellow-Pine Chipmunk
Yellow Rail



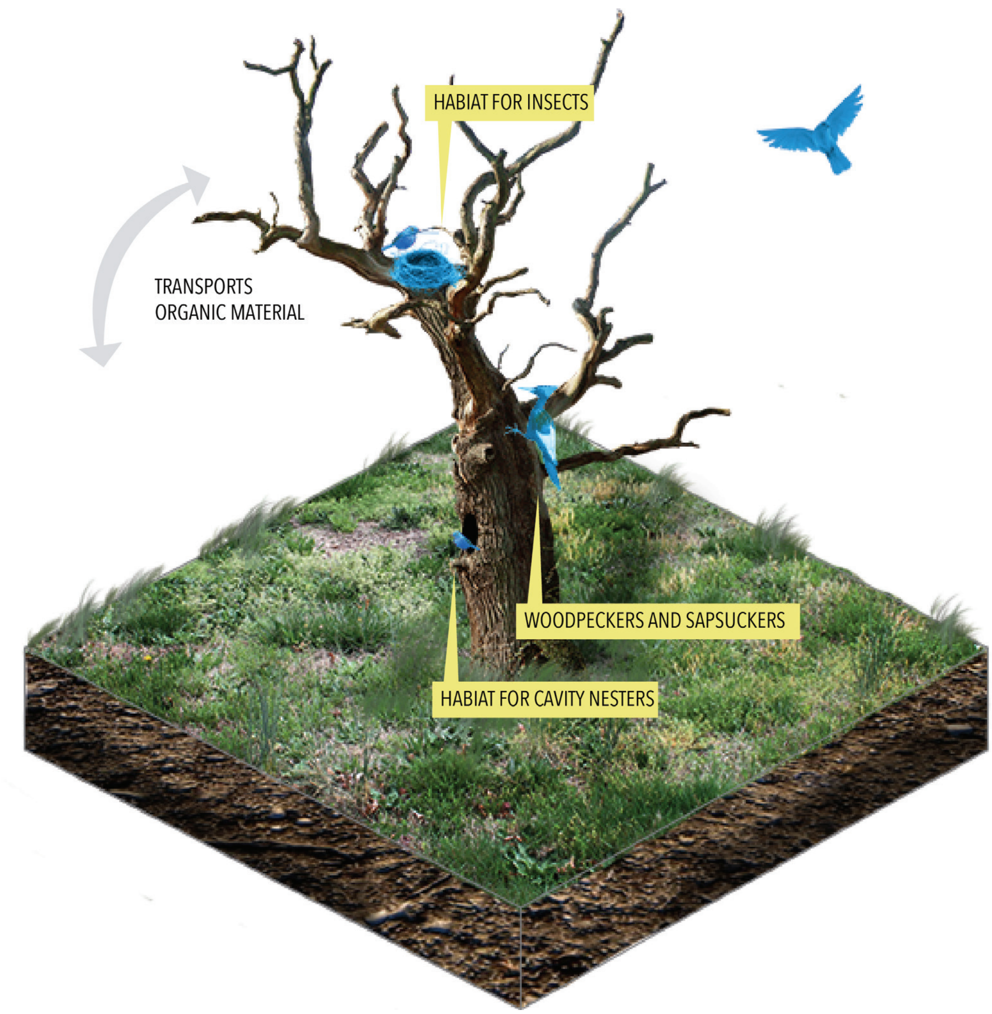
Animal Actors
Bird 7%
Mammal 93%

CAVITIES & STRUCTURES

Function: Creating cavities and structures provides habitat for birds, mammals and insects. These are not usually planned for in conventional designs but are an important type of habitat. Some species of birds, like woodpeckers and sapsuckers, create cavities in living and dead trees to access a food source. These cavities can support biodiversity, as they can provide access to a food source for other animals that cannot make their own cavities. The cavities are also often used as dwelling sites for secondary nesting birds and animals. Birds nest in a wide variety of habitats and use a variety of substrates such as the ground, a cliff, birdhouses, tree branches, bushes, vines, buildings, cavities and reeds (The Cornell Lab 2019). "The selection of a suitable nest site is determined by a combination of five main factors: the availability of food for both parents and offspring, the risk of predation, the presence and behavior of conspecifics, the availability of suitable nest material, and the presence of a suitable ambient climate for raising offspring (Mainwaring et al. 2014, 3918)." Nests are untidy, bulky structures of straw, plant stems, paper, string, cloth, and similar debris. Nests are lined with feathers, hairs, and other soft material (Link 2004, 160)." These cavities and structures create habitat for insects and smaller animals.

Co-creation Potential: The designer may be able to direct cavity and structure formations to provide habitat in a certain location on site. Cavities may be encouraged with dead or dying trees. The designer may also be able to change the quality of the nest structures based on the material provided. There has been some exploration with "nesting balls" in residential backyards to attract nesting birds by providing a hanging ball of twigs, hair, thread and cotton (Pennington 2016). Birds may be faster and more accessible actors than mammals to engage with to co-create structures and cavities.

Design Intervention: provide dead or dying trees, provide perches to direct cavity formation, create nesting platforms, provide nesting material, consider how the location of these interventions might influence bird watching opportunities.



Cavities and Structures
Function diagram and species list

American bittern
American coot
American crow
Black-backed woodpecker
Black-billed magpie
Black-capped chickadee
Boreal chickadee
Cooper's hawk
Desert woodrat
Dusky-footed woodrat
Golden eagle
Hairy woodpecker
Lewis' woodpecker
Mountain chickadee
Northern flicker
Northern goshawk
Osprey
Pileated woodpecker
Plain titmouse
Pygmy nuthatch
Red-breasted nuthatch
Red-headed woodpecker
Red-naped sapsucker
Red-tailed hawk
Swainson's hawk
White-breasted nuthatch
White-headed woodpecker
Williamson's sapsucker

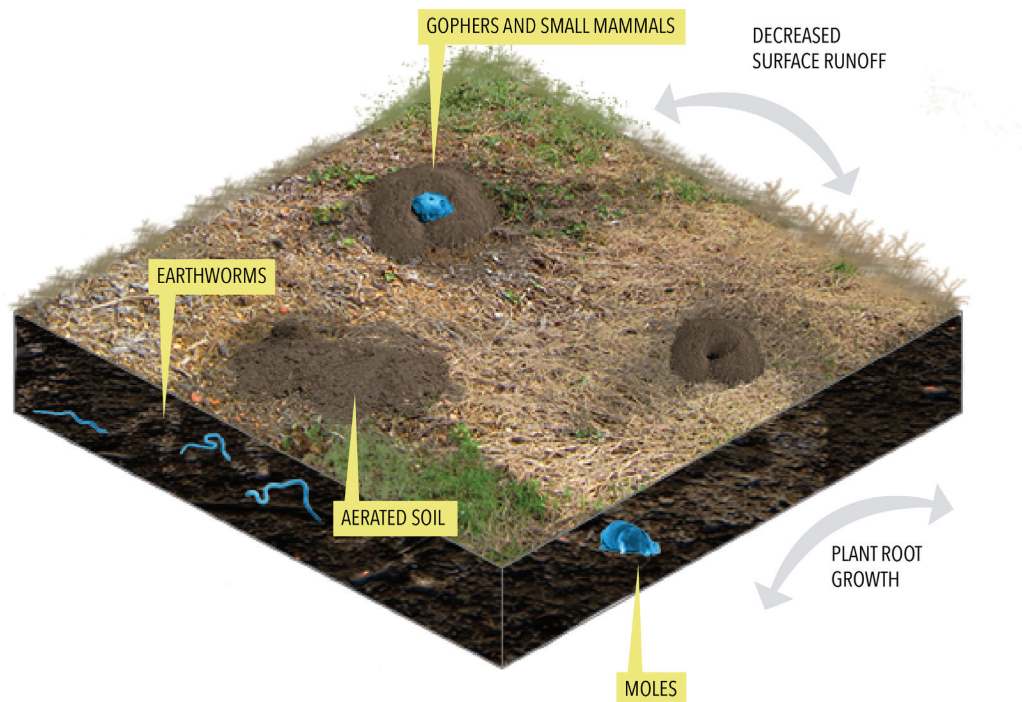
Animal Actors
Insect 27%
Bird 2%
Mammal 68%
Amphibian 4%

AERATION

Function: For strong plant growth, soil needs to have a mixture of water, organic matter, minerals and air. Aeration reduces compaction in the soil so roots can have more space to grow. Aeration happens when animals dig, burrow or tunnel in soil but many lawns are mechanically aerated. In the process of digging tunnels underground, animals loosen soil which provides more suitable soil conditions for plant root growth and decreases surface runoff. Soil from underground gets pushed up to the surface and creates bare earth and an opportunity for new growth. Earthworms usually burrow to 3 feet or more, unless the soil is saturated or very hard. The number of earthworms in the soil can be up to over a million per acre (Sustainable 2012). Larger animals burrow in the soil and often times are considered a nuisance in crops and residential yards but they also help conduct water away from the surface during downpours and thus decrease erosion (Sustainable 2012). Aeration is important on compacted or otherwise degraded sites where the soil's capacity for water absorption or plant growth has been compromised.

Co-creation Potential: Human aeration is mechanized and removes uniform cores of soil. Animal aeration is deeper in the soil, creates a network of tunnels and also mixes the soil. Earthworms may be a more welcome animal than amphibians or mammals on public sites, and they have a wide range of benefits like soil redistribution, soil penetrability, ion transport, root distribution, microbial activity and nutrient cycling in casts (Syers and Springett 1984). "Earthworms are present in most soils but their production and activity may require stimulation by using appropriate management practices, e.g. liming, direct drilling, return of organic matter, and more careful use of pesticides (Syers and Springett 1984, 102)." Larger animals could be engaged in vacant lots and neglected sites so they will not be a nuisance.

Design Intervention: Determine areas in the site that have compacted soil, create a soil substrate that will encourage worm activity, use barriers to direct animal tunnels for new plant growth, plant desired species in newly aerated soil



Aeration
Function diagram and species list

American Badger
American Barkworm
Bank Swallow
Belding's Ground Squirrel
Botta's Pocket Gopher
Broad-Footed Mole
Broad-Footed Mole
Brushprairie Pocket Gopher
California Ground Squirrel
California Kangaroo Rat
Cascade Golden-Mantled Ground Squirrel
Cascade Golden-Mantled Ground Squirrel
Cliff Chipmunk
Coast Mole
Coast Mole
Columbian Ground Squirrel
Common Gray Fox
Dark Kangaroo Mouse
Earthworm (Allolobophora chloratica)
Earthworm (Allolobophora trapezoides)
Earthworm (Allolobophora tuberculata)
Earthworm (Allolobophora turgida)
Earthworm (Aporrectodea tuberculata)
Earthworm (Argilophilus hammodi)
Earthworm (Dendrobaena rubida)
Earthworm (Drilochaera chenowithensis)
Earthworm (Eisenis rosea)
Earthworm (Lumbricus rubellus)
Earthworm (Lumbricus terrestris)
Earthworm (Octalasion tyrataeum)
Giant Palouse Earthworm
Golden-Mantled Ground Squirrel
Golden-Mantled Ground Squirrel
Great Basin Pocket Mouse
Idaho Ground Squirrel
Least Chipmunk
Little Pocket Mouse
Mink
Mountain Beaver
Northern Pocket Gopher
Ord's Kangaroo Rat
Pacific Jumping Mouse
Pygmy Rabbit
Red-Tailed Chipmunk
Red Fox
Sagebrush Vole
Shrew-Mole
Squaretail Worm
Striped Skunk
Townsend's Ground Squirrel
Townsend's Pocket Gopher
Uinta Chipmunk
Uinta Ground Squirrel
Washington Ground Squirrel
Washington Ground Squirrel
Water Vole
Western Jumping Mouse
Western Pocket Gopher
Western Toad
White-Tailed Antelope Squirrel
White Salmon Pocket Gopher
Woodhouse's Toad
Wyoming Ground Squirrel
Yellow-Pine Chipmunk

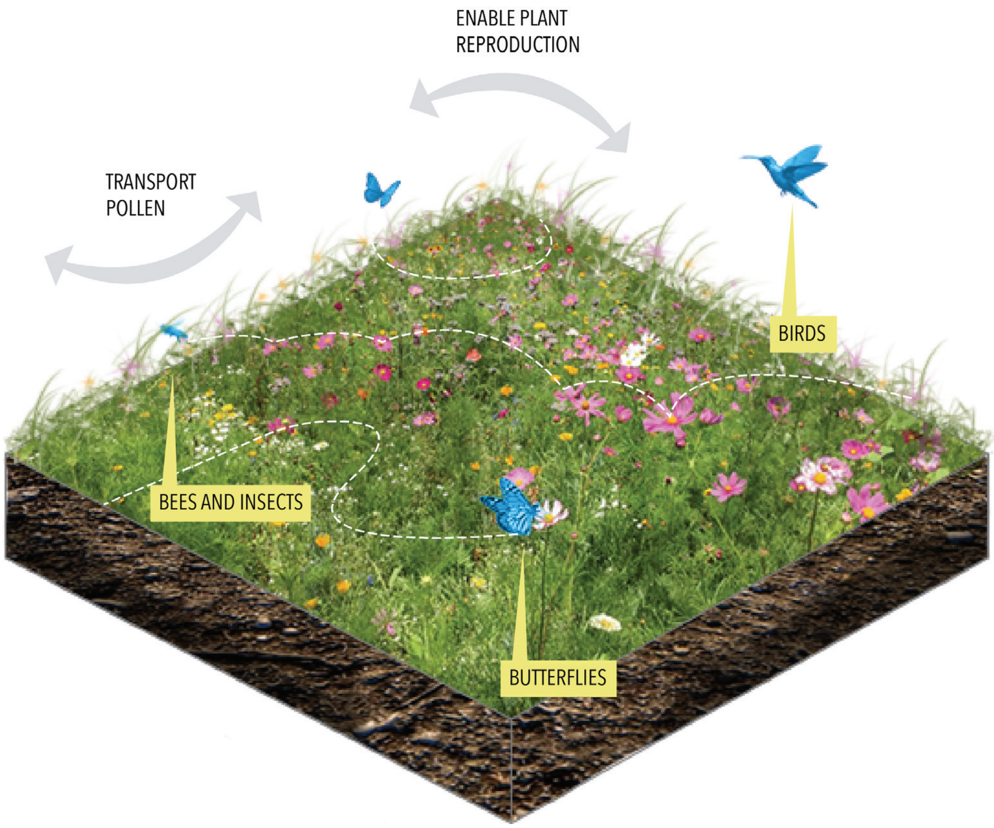
Animal Actors
Insect 92%
Bird 8%

POLLINATION

Function: Pollination is necessary for plant reproduction. Many species of insects, birds and bats use nectar as a food source and will transport pollen from flower to flower. “Pollination is the process of moving pollen from one flower to another of the same species, which produces fertile seeds. Almost all flowering plants need to be pollinated. Some plants are pollinated by wind or water, and some are even self-pollinating (Reel and Seiler n.d.).” The economic value of insect pollination worldwide has been estimated at $217 billion (Reel and Seiler n.d.).

Co-creation Potential: Designers can create bee and insect houses that attract these pollinators to the garden. Bees, in particular, “prefer blue, purple, and yellow flowers, and sweet fragrances. They see ultraviolet colors – found on the flowers such as buttercups and black-eyed susans (Reel and Seiler n.d.).” The designer can also plant native flowers that need pollination and attract pollinators (Reel and Seiler n.d.). These are the plants that will be pollinated and reproduced in the garden. Pollinators produce seeds and fruits by enabling plant reproduction.

Design Intervention: Consider the site context and provide pollinator corridors or habitat stepping stones, consider the location of these gardens for observation, plant native flowers that are dependent on pollination, provide other habitat needs like refuge and water



Pollination
Function diagram and species list

Agile Long Horned Bee
Akali Bee
Anna's Hummingbird
Bee (Andrena angustitarsata)
Bee (Andrena cupreotincta)
Bee (Atoposmia abjecta)
Bee (Bombus balteatus)
Bee (Chelostoma cockerelli)
Bee (Heriades carinatus)
Bee (Hesperapis kavella)
Bee (Heterosarus subdilatipes)
Bee (Hylaeus lunicraterius)
Bee (Lasioglossum egregium)
Bee (Megachile umatillensis)
Bee (Melissodes rivalis)
Bee (Nomadopsis barri)
Bee (Nomadopsis scitula)
Bee (Osmia tristella)
Bee (Perdita barri)
Bee (Perdita crassihirta)
Bee (Perdita salicis euxantha)
Bee (Perdita salicis sublaeta)
Bee (Perdita similis pascoensis)
Bee (Perdita wyomingensis sculleni)
Bee (Perdita wyomingensis wyomingensis)
Bee (Proteriades n. sp. near plagiostoma)
Bee (Proteriades orthognathus)
Bee (Synhalonia acerba)
Bee (Synhalonia douglasiana)
Bee (Synhalonia frater)
Bee (Synhalonia frater lata)
Black-Chinned Hummingbird
Blister Beetle
Broad-Tailed Hummingbird
Bumblebee
Calliope Hummingbird
Carpenter Bee
Leaf Cutter Bee
Leaf Cutter Bee
Leaf Cutter Bee
Leaf Cutter Bee
Leaf Cutter Bee
Leaf Cutter Bee
Leaf Cutter Bee
Mason Bee
Mason Bee
Mason Bee
Mason Bee
Mason Bee
Mason Bee
Mason Bee
Mason Bee
Miner Bee
Miner Bee
Miner Bee
Mining Bee
Mining Bee
Mining Bee
Mining Bee
Northern Oriole
Oil Collecting Bee
Polyester Bee
Polyester Bee
Rufous Hummingbird
Sweat Bee
Sweat Bee
Sweat Bee
Western Yellow Jacket
White Shouldered Bumblebee

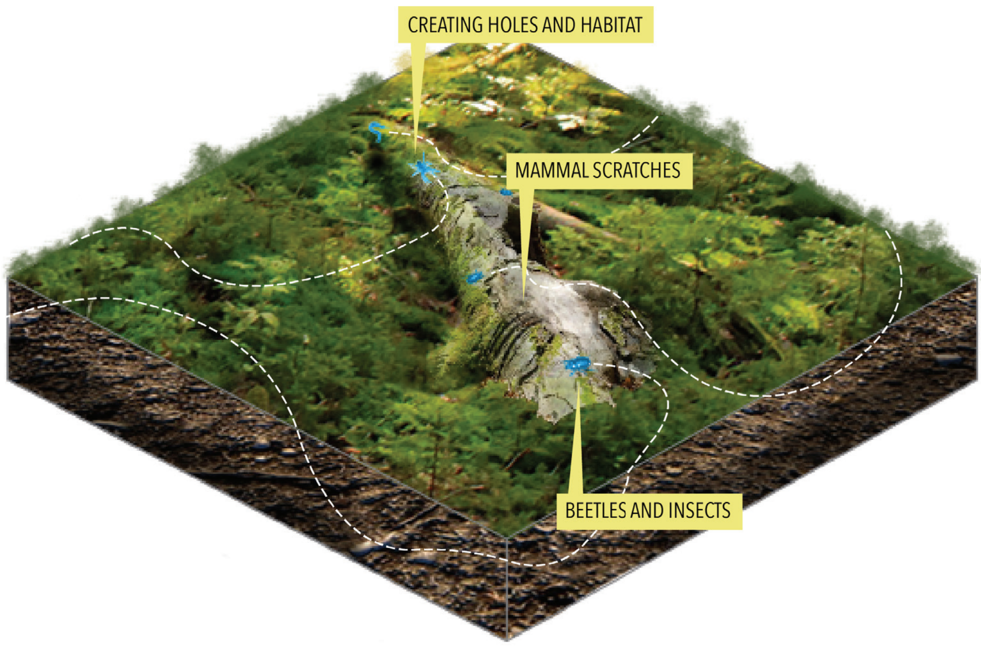
Animal Actors
Insect 64%
Bird 18%
Mammal 18%

WOOD FRAGMENTATION

Function: For ecological restoration, organic matter is an important source of nutrients that comes from decomposing organisms. Wood does not decompose on its own, there are processes happening to help break down the wood. Animals help this decomposition process in their hunt for food or opportunities for dwelling. Wood fragmentation happens in both live and dead trees but is an essential process in creating suitable habitat for other insects and animals. Wood fragmentation can assist clean-up on storm-damaged sites and improve soils on sites with poor or compromised soils.

Co-creation Potential: Fragmented wood and debris can be a sculptural process. The texture and form of a tree may be transformed based on animal collaboration. Co-creating with wood-fragmenting animals will provide organic matter for soil as well as eating and dwelling opportunities for other animals.

Design Intervention: Create dead and dying trees, provide perches to direct wood fragmentation on standing trees, place tree limbs on the ground to improve soil



Wood Fragmentation
Function diagram and species list

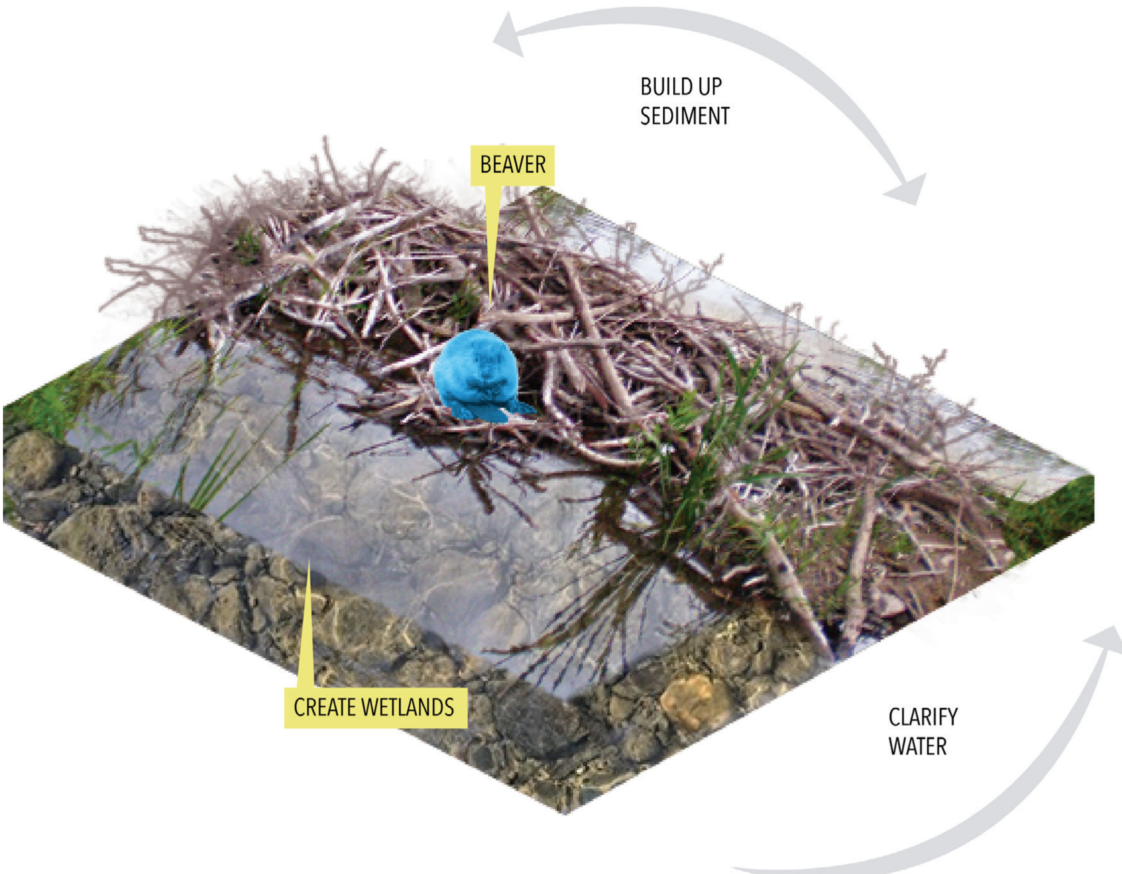
Balsam Woolly Adelgids
Black Bear
Carpenter Ant
Douglas Fir Beetle
Fir Engraver Beetle
Grizzly Bear
Mountain Pine Beetle
Pileated Woodpecker
Rubber Boa
Spruce Beetle
Western Pine Beetle

DAMMING

Function: Beavers dam streams to provide deep water for them to build their lodges. These dams create wetland ecosystems which help to clarify water, build up sediment, reduce rain event flooding and prevent erosion (Outwater 1996). Beavers are a keystone species because many animals depend on these dams for their own survival. Beavers eat trees and also use them in the construction of their dams. The tree species vary based on availability; cottonwoods, birch, willows, poplars, and especially aspen are the preferred tree types (Butler 1995). Beavers shape the composition of riparian forests because they are selectively harvesting trees. They will dig canals and build slides to transport wood from surrounding wooded areas. They drag the logs into position on the dam and use stones and mud for mortar. They maintain their dams continuously every night. In wide streams, they build a concave dam into the flow of the water (Outwater 1996). There are four types of beaver dams: overflow dams where there is stream flow overtopping, gap-flow dams where the water is funneling through gaps in the dam crest, underflow dams where water moves through the weakened bottom structure, throughflow dams where water seeps throughout the entire dam structure (Butler 1995).

Co-creation Potential: A beaver dam creates much more stream and wetland complexity than humans can provide. A low intensity and low-cost intervention from humans can provide suitable conditions for beavers to do the work and maintenance of a site.

Design Intervention: Analogue beaver dams, plant trees that beavers prefer, use almond extract on trees or leave fresh poplar branches and apples to encourage beavers to harvest in a certain area (Beavers n.d.)



Damming
Function diagram

FILTER

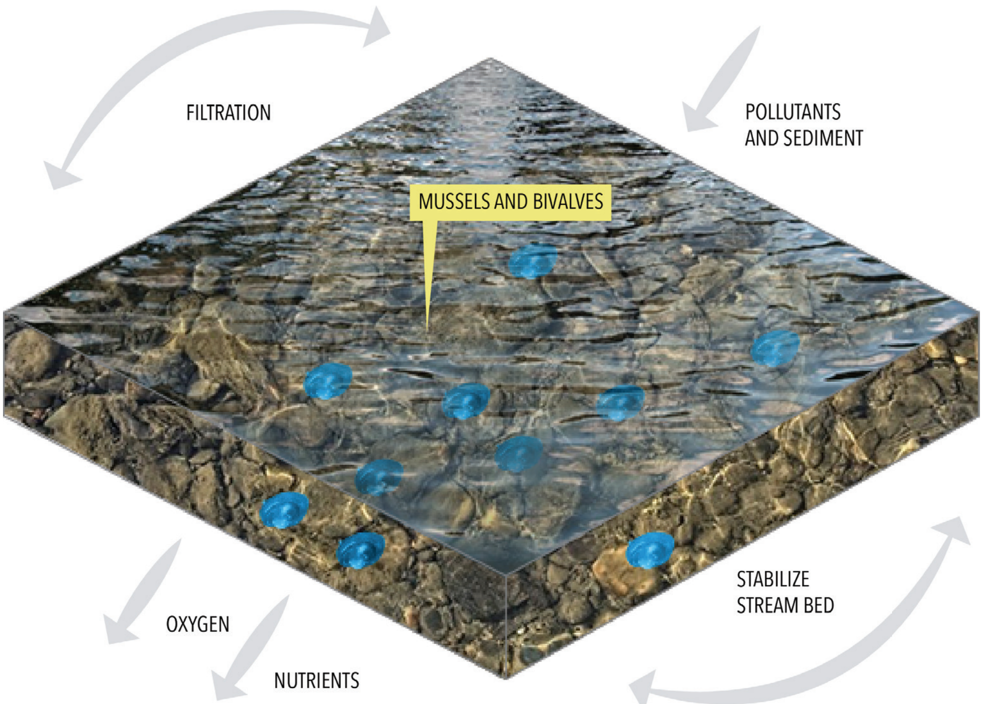
Species: Bivalves (Dethier 2006)

Function: Bivalves provide filtering services, deposit nutrients and sequester carbon (Patterson 2018). Bivalves like mussels and oysters are extremely efficient filter feeders. Mussels begin in a parasitic larvae stage where they need a host to complete metamorphosis to the juvenile stage. By parasitizing a mobile host, like freshwater fish, the larvae can be protected and distributed to new areas with sand and cobble substrate. Large mussel beds are capable of filtering the entire volume of water passing over the bed at any given time. They also transfer organic material in the water into nutrients for the river bed which support macroinvertebrates and fish. Mussel nutrients can alter algae composition, decrease blue green algae and increase water quality. The burrowing behavior can increase water and oxygen penetration through the sediment, as well as release nutrients from sediments and stabilize river substrates. Dead shells are used as source of calcium. Mussels need suitable substrate conditions, presence of suitable fish hosts, food availability, and water quantity and quality (Patterson 2018).

Oysters live in brackish and saltwater bays, estuaries, and tidal creeks. They are often farmed for food and pearls. Oysters begin as free-swimming spats that anchor to a surface like rocks where they stay. They reproduce and anchor to other oysters and develop a reef-like structure (National 2018). These reef structures provide habitat for other marine organisms, provide barriers to storms and prevent erosion (Habitat 2019). An oyster feeds by filtering algae from the water and can filter up to 50 gallons of water per day (Habitat 2019).

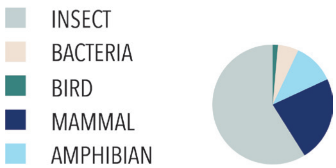
Co-creation Potential: Mussels may be difficult to engage with before the juvenile phase because of the parasitic host requirements. The designer may be able to develop optimal substrates for mussel or oyster propagation. The reef structures made by oysters may be encouraged for improved habitat or storm surge protection.

Design Intervention: creating suitable substrates for propagation



Butter Clam
California Floater
Cockle
Geoduck
Horse Clam
Littleneck Clam
Olympia Oyster
Oregon Floater
Western Floater
Western Pearlshell
Western Ridged Mussel
Winged Floater
Yukon Floater

Filtering
Function diagram and species list



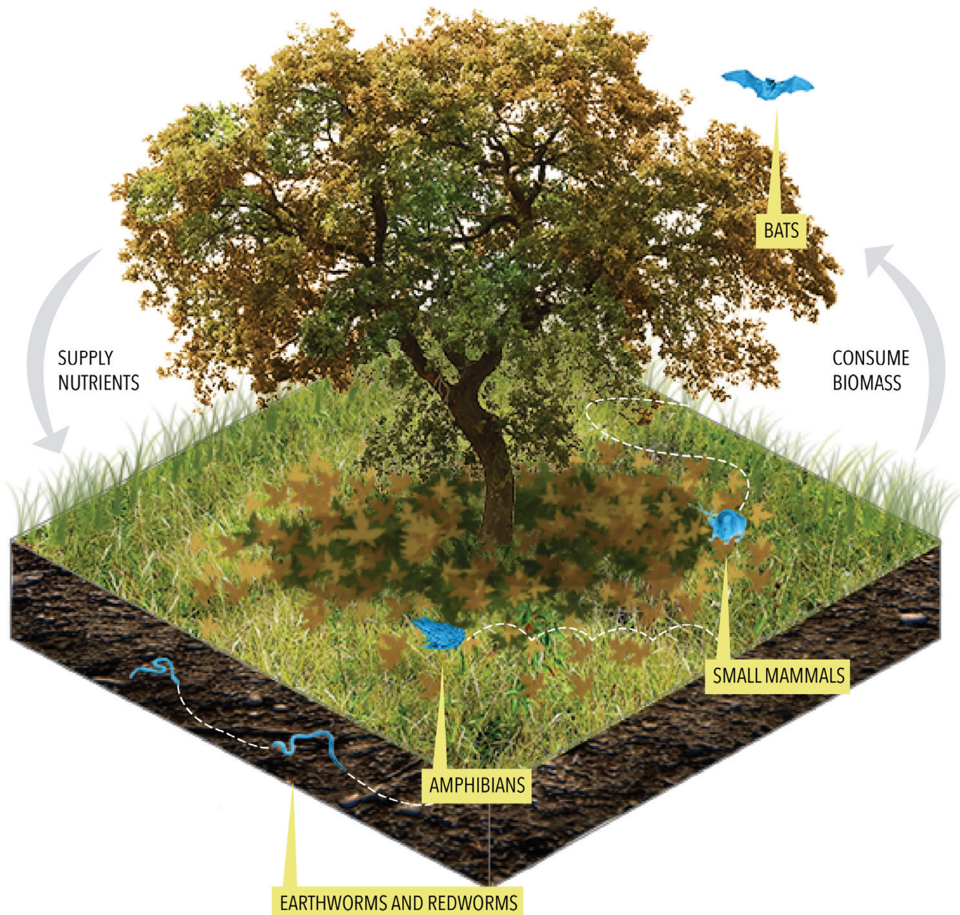
Animal Actors
Insect 59%
Bacteria 6%
Bird 2%
Mammal 23%
Amphibian 11%

NUTRIENT CYCLING

Function: Every species contributes to nutrient cycling by consuming resources. Some species make nutrients available to other plants and animal species by excreting nutrients not incorporated in biomass (Neiminen 2008). Nutrients like phosphorus, potassium, calcium, iron and nitrogen are important for ecosystem growth. Encouraging plant and animal nutrient cycling could minimize or eliminate the use of synthetic fertilizers to support plant communities.

Co-creation Potential: It will be difficult to engage bacteria in co-creation because of their microscopic size. The most useful nutrient cyclers will produce more and richer content like mammals and birds. People normally use fertilizers to assist in the growth of their crops and run the risk of excess nutrients leeching into water supplies causing algae blooms.

Design Intervention: Place organic matter in places to provide habitat and a food source for animals, do not remove grass clippings or dropped vegetation, build bat boxes over a nutrient poor soil area, create moist environments for amphibian habitat, consider locations of intervention to create planting rich areas



Nutrient Cycling
Function diagram and species list

Agile Long Horned Bee
Akali Bee
American Barkworm
American Pika
Anise Swallowtail
Bacteria
Bacteria
Balsam Woolly Adelgids
Bee (Andrena angustitarsata)
Bee (Andrena cupreotincta)
Bee (Hesperapis kavella)
Bee (Heterosarus subdilatipes)
Bee (Lasioglossum egregium)
Bee (Melissodes rivalis)
Bee (Nomadopsis barri)
Bee (Nomadopsis scitula)
Bee (Perdita barri)
Bee (Perdita crassihirta)
Bee (Perdita salicis euxantha)
Bee (Perdita salicis sublaeta)
Bee (Perdita similis pascoensis)
Bee (Perdita wyomingensis sculleni)
Bee (Perdita wyomingensis wyomingensis)
Bee (Synhalonia acerba)
Bee (Synhalonia douglasiana)
Bee (Synhalonia frater)
Bee (Synhalonia frater lata)
Beneficial Bacteria
Big Brown Bat
Brazilian Free-Tailed Bat
Bumblebee
Bushy-Tailed Woodrat
California Myotis
Canada Goose
Cascades Frog
Common Muskrat
Common Raven
Competitive Bacteria
Competitive Bacteria
Cottonwood Leaf Beetle
Desert Woodrat
Douglas-Fir Tussock Moth
Douglas Fir Beetle
Dusky-Footed Woodrat
Earthworm
Earthworm
Earthworm (Allolobophora chloratica)
Earthworm (Allolobophora trapezoides)
Earthworm (Allolobophora tuberculata)
Earthworm (Allolobophora turgida)
Earthworm (Aporrectodea tuberculata)
Earthworm (Dendrobaena rubida)
Earthworm (Eisenis rosea)
Earthworm (Lumbricus rubellus)
Earthworm (Lumbricus terrestris)
Earthworm (Octalasion tyrataeum)
Ensatina
Fir Engraver Beetle
Fringed Myotis
Giant Palouse Earthworm
Hera Buckmoth
Hoary Bat
Hoary Marmot
Idaho Giant Salamander
Larch Sawfly
Large Aspen Tortrix
Leaf Cutter Bee
Little Brown Myotis
Long-Legged Myotis
Long-Toed Salamander
Miner Bee
Miner Bee
Mining Bee
Mining Bee
Mining Bee
Mining Bee
Moth
Mountain Pine Beetle
Mourningcloak Butterfly
Northern Leopard Frog
Northwestern Salamander
Oil Collecting Bee
Pacific Chorus Frog
Pale Western Big-Eared Bat
Pallid Bat
Pandora Moth
Pelidne Sulphur
Pine Butterfly
Pine Sawfly Spp.
Polyester Bee
Polyester Bee
Protozoa
Riding's Satyr
Rotifers
Rough-Skin Newt
Saprophytic Fungi
Silver-Haired Bat
Spotted Bat
Spotted Frog
Spruce Beetle
Spurred Wave Moth
Squaretail Worm
Sweat Bee
Sweat Bee
Miner Bee
Thatch Ant
Tiger Salamander
Vashti Sphinx
Western Chorus Frog
Western Pine Beetle
Western Pipistrelle
Western Small-Footed Myotis
Western Spruce Budworm
Western Toad
Wood Frog
Woodhouse's Toad
Yellow-Bellied Marmot
Yuma Myotis

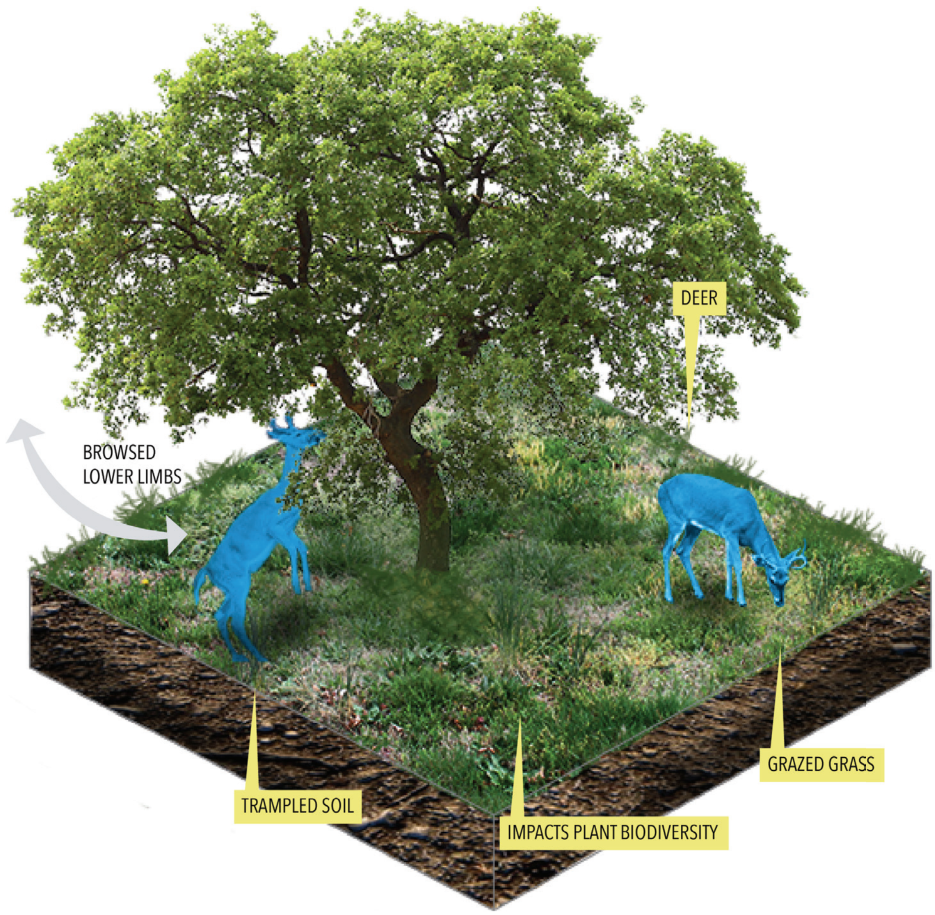
Animal Actors
Insect 60%
Bird 14%
Mammal 26%

BROWSING & GRAZING

Function: Mammals, birds and insects can shape plant communities through browsing, grazing and defoliating vegetation. Many species of plants and animals depend on this function to maintain open landscape types. Herbivores reduce vegetation biomass and disturb the soil by trampling. Wild undulates, 'or hooved animals', browsing and grazing activity impacts plant growth and succession dynamics (Tschope et al. 2011). Ungulates seem to be particularly suitable for preventing tree encroachment because of their fraying and bark stripping behavior compared to domesticated animals that heavily graze (Tschope et al. 2011). Browsing and grazing may impact biodiversity differently in various environments. "For example, grazing may increase plant diversity in more productive habitats, but may have no effects or decrease plant diversity in less productive habitats (Tschope et al. 2011, 201)."

Co-creation Potential: To create open landscapes people mow, use fire, cut down trees, graze with domestic animals. Browsing and grazing may create patterns that are unexpected and could not be recreated with human intervention. Domestic animals do not usually consume woody plants and would not be as effective in controlling tree succession (Tschope et al. 2011). Some researchers in Germany are looking into ways to manage open habitats with wild ungulate browsing and grazing (Tschope et al. 2011). They may browse and graze only on species they prefer to eat. "Wild ungulate browsing is a useful tool to inhibit encroachment of woody vegetation and to conserve a species-rich, open landscape (Tschope et al. 2011, 200)."

Design Intervention: Rotating cells for grazing, direct browsing and grazing with fencing or netting, consider location of intervention and height of accessible vegetation to create framed views



Browsing and Grazing
Function diagram and species list

American Bison
Anise Swallowtail
Balsam Woolly Adelgids
Black-Tailed Deer
Black-Tailed Jackrabbit
Blue Grouse
Brant
Canada Goose
Clodius Parnassian
Common Muskrat
Cottonwood Leaf Beetle
Douglas-Fir Tussock Moth
Douglas Fir Beetle
Eastern Cottontail
Fall Cankerworm
Fir Engraver Beetle
Forest Tent Caterpillar
Gall-Forming Sawflies
Giant Sulphur
Gossamer Winged Butterfly
Greater White-Fronted Goose
Hera Buckmoth
Larch Casebearer
Larch Sawfly
Large Aspen Tortrix
Lodgepole Needle Miner
Mardon Skipper
Meadow Vole
Montane Vole
Moose
Moth
Mountain Goat
Mountain Pine Beetle
Mourningcloak Butterfly
Mule Deer
Pandora Moth
Pelidne Sulphur
Pine Butterfly
Pine Sawfly Spp.
Potholes Meadow Vole
Riding's Satyr
Rocky Mountain Bighorn Sheep
Rocky Mountain Elk
Ross' Goose
Sage Grouse
Small Checkered Skipper
Snow Goose
Spruce Beetle
Spruce Grouse
Spurred Wave Moth
Vashti Sphinx
Viceroy
Western Pine Beetle
Western Pine Shoot Borer
Western Spruce Budworm
White-Tailed Deer
White-Tailed Jackrabbit
Yuma Skipper

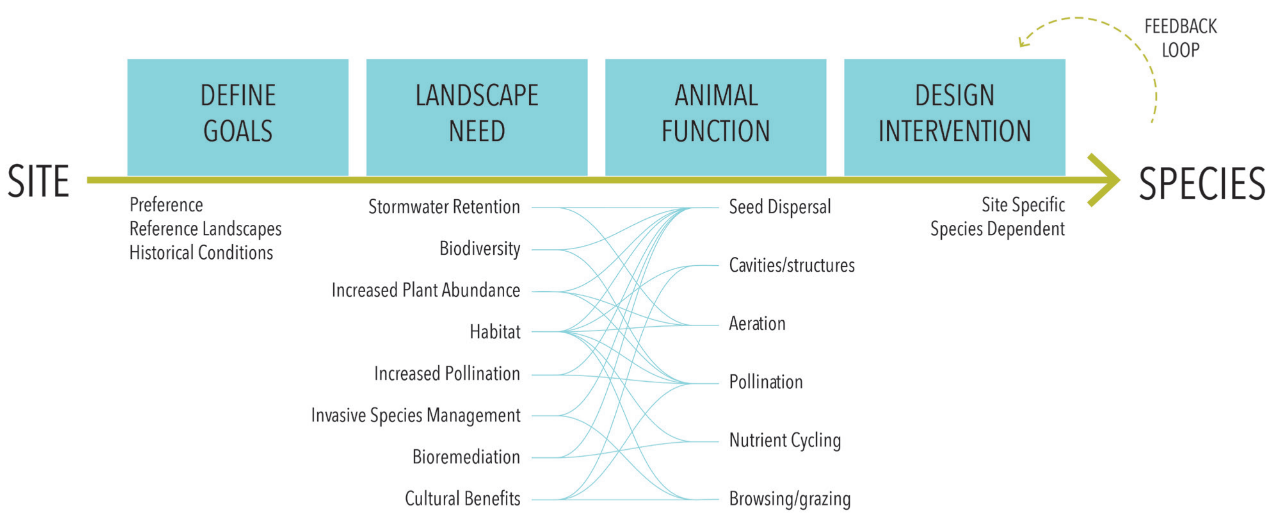
CO-CREATION FRAMEWORK

This project proposes a co-creation design framework that connects the typology of animal functions to landscape design goals, problems, and opportunities that are specific to a particular site. A designer will have desired outcomes and landscape needs for the site based on historical conditions, reference landscapes or preference. Using the animal function typology, the designer can identify animal functions available on site that may address the landscape need. Selecting the most appropriate animal functions will depend on several functional, temporal, and aesthetic constraints. Ecological goals will limit which actions are most viable on a site. The time of year will influence the animal functions available and the animal actors for those functions due to seasonal flux in populations and activity. The landowner or designer will have a desired formal outcome that will influence whether some animal activities are appropriate.

Once the designer has chosen the animal functions that are best suited to the site needs and goals, they must research the conditions that will encourage that function. This includes surveying the site for the animal actors present on site and understanding the research available defining the conditions that are suitable for that function and how they influence a design, including an animal's preference for texture, height, color, temperature or other design considerations. In general, species have basic needs in order to thrive: food, shelter, escape, refuge, loafing, nesting, roosting, sun, shade, water, and territory (Lyle 1999). These considerations can be applied to generalist species or to specialist species needs.

The designer must research the temporal aspect of the function with regards to the desired outcome. For seed dispersal and native plant revegetation, some very important questions need to be considered: When are native plants going to seed or produce fruit? When are invasive plants going to seed or produce fruit? What birds are resident or migratory in the area? The timing of species active season and timing of the variables of the function will influence the design.

Design interventions will encourage an available function with an intended animal group. The designer may have a desired outcome with an intended route, and yet the species may contribute in unexpected ways, providing a feedback loop of information. The prototypes evolve through phases as the animals and the site respond to the design intervention. Animals may be more encouraged by one prototype over another for reasons the designer cannot predict providing feedback for another phase of prototypes. These iterative prototype designs are a method of learning suitable interventions for a particular site. The site itself may have landscape features like slope, aspect, topography and vegetation that will have an impact on the design intervention. The designer must refine the prototype until it successfully encourages the desired function.



Framework Diagram
Define goals and determine landscape need of a site to encourage animal functions with design interventions which are improved by a feedback loop

CHAPTER 3
APPLICATION

EUGENE, OREGON CASE STUDY

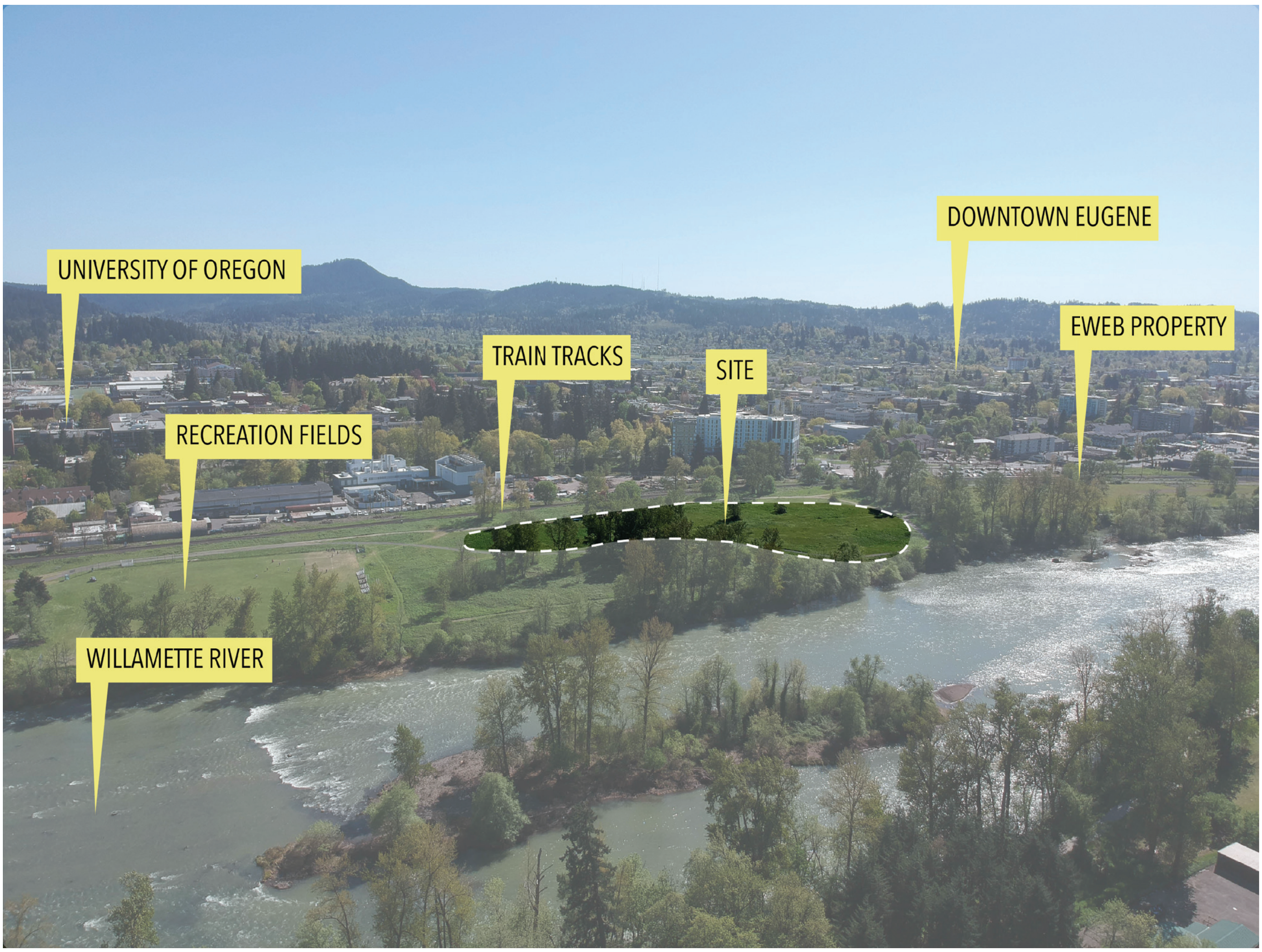
To test and refine the design framework, this research studies the landscape needs of vacant lots and the animal functions that can address them. Vacant lots are ideal case study sites, as they are typically neglected sites where the property owner may have minimal resources, time or incentive to invest in improving the function of the site, and so a low-cost, longer time frame ecological restoration collaboration with animals could be desirable. Using a ruderal meadow site on the University of Oregon campus that is representative of a vacant lot, I tested the iterative prototyping process by producing phases of perch designs to encourage seed dispersal by birds.

I determined the success of the prototype designs by observing whether they were collaborative, functional and effective. Collaboration is observed and monitored to determine if the animal is contributing to the design. Function is graphically recorded with sticky paper underneath the prototype as a modified seed trap. The seed dispersal process is mapped on the paper. Effectiveness is recorded by the amount of time and money spent to produce the prototype. These prototypes and observations will inform applications at a landscape scale.

Seed Dispersal Mapping
Sticky paper graphically records function

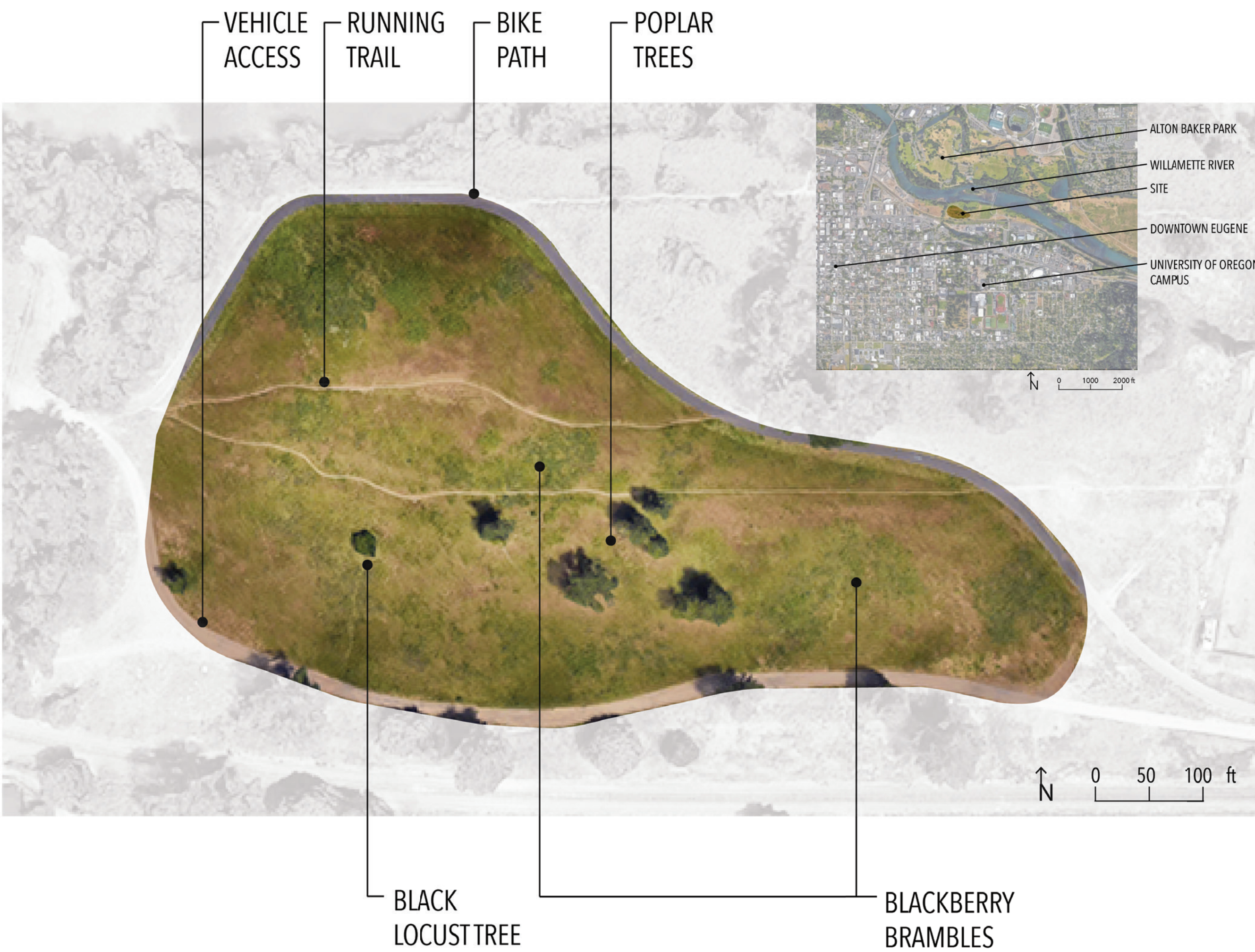
Site Context and Analysis

The study site is on the University of Oregon campus on the north end. It is south of the Willamette river, north of the Southern-Pacific Railroad tracks, east of a paved parking lot owned by Eugene Water and Electric Board (EWEB) and west of physical education and recreation fields.



Site Context
This photo is the view south from the north side of the Willamette River.

The site is bordered on two sides: one by a popular bike path and the other by a dirt road that provides vehicle access. The only maintenance of the site is mowing every few weeks in the spring. There are invasive species like Himalayan blackberry and Queen Anne's Lace throughout the field, and the site would be overrun with blackberries if the maintenance crew did not mow. The trees are mostly poplars, with a group of small black locust trees on the west side of the field. There are slight topographic undulations, but the site is mostly flat.



Site Context
The site is south of the Willamette River and North of the train tracks on the University of Oregon campus

There are many birds such as geese, ducks, song birds and pheasants as well as feral cats. This area is being considered for significant development by the University. Cameron McCarthy, a landscape architecture firm, hired Mason, Bruce & Girard, a natural resource consulting firm, to do an ecological assessment of this riparian area to plan for the north campus expansion (Mason 2017). The report from 2017 included a list of animals that were observed on this site in July.

Common Name	Scientific Name	Type
Common muskrat	*Ondatra zibethicus*	Mammal
Coyote	*Canis latrans*	Mammal
Raccoon	*Procyon lotor*	Mammal
Western gray squirrel	*Sciurus griseus*	Mammal
American crow	*Corvus brachyrhynchos*	Bird
American robin	*Turdus migratorius*	Bird
Barn swallow	*Hirundo Rustica*	Bird
Belted kingfisher	*Ceryle alcyon*	Bird
Black-capped chickadee	*Poecile atrcapilla*	Bird
Bushtit	*Psaltriparus minimus*	Bird
Canada goose	*Branta canadensis*	Bird
Dark-eyed junco	*Junco hyemalis*	Bird
European starling	*Sturnus vulgaris*	Bird
Great blue heron	*Ardea herodias*	Bird
Great egret	*Ardea alba*	Bird
Killdeer	*Charadrius vociferus*	Bird
Mallard	*Anas platyrhynchos*	Bird
Osprey	*Pandion hallaetus*	Bird
Rock dove	*Columba livia*	Bird
Scrub jay	*Aphelocoma californica*	Bird
Song sparrow	*Melospiza melodia*	Bird
Spotted towhee	*Pipilo maculatus*	Bird
Turkey vulture	*Cathartes aura*	Bird
Western hybrid gull	*Larus glaucescens x Larus occidentalis*	Bird
Pacific treefrog	*Hyla regilla*	Amphibian

Observations
These are the species observed on sit in July from the Mason, Bruce & Grirard report

The most abundant species observed are birds followed by mammals and amphibians. The report also mentioned that the site was historically used for agriculture then became a site for sand and gravel mining by Eugene Sand and Gravel Company. Throughout the years, the area has been filled in with dirt where it used to be an active floodplain. Even though the site does not reflect its historical riparian bottomland condition because of land use changes and invasive species, the existing conditions provide habitat that supports a wide range of native species associated with riparian areas. It has become an important area for wildlife migration due to the developed urban areas around it (Mason 2017).

Determining a Landscape Need

Vacant lots have numerous potential benefits that are ecological, social and economic. Some well-known landscape needs of vacant lots are stormwater retention, increased biodiversity, increased plant abundance, improved habitat structure, increased pollination, invasive species management, bioremediation and cultural benefits like recreation, spiritual attachment and aesthetic value (Anderson 2017). Vacant lots can benefit from co-creation with animals because design interventions may be implemented with minimal resources, using time as a resource. Co-creating with animals is not the easiest way to disperse specific plant types but can assist with increasing biodiversity of species that have co-evolved and are likely to be successful on a site.

At the University of Oregon site, landscape ecologist and faculty member Bart Johnson studied the adjacent property owned by EWEB and recommended upper bank habitat as the most suitable for this area, a recommendation that holds true for this study site. It is recommended that this area provide a patch of riparian habitat along the river and provide connectivity with riparian habitat across the river. For this area, Johnson advises to remove invasive vegetation and plant native and adapted small trees and shrubs for birds and pollinators (Johnson et al. 2010). The following list is his recommended vegetation structure for upper bank habitat including tree species, shrubs, forbs, ferns, grasses and sedges.

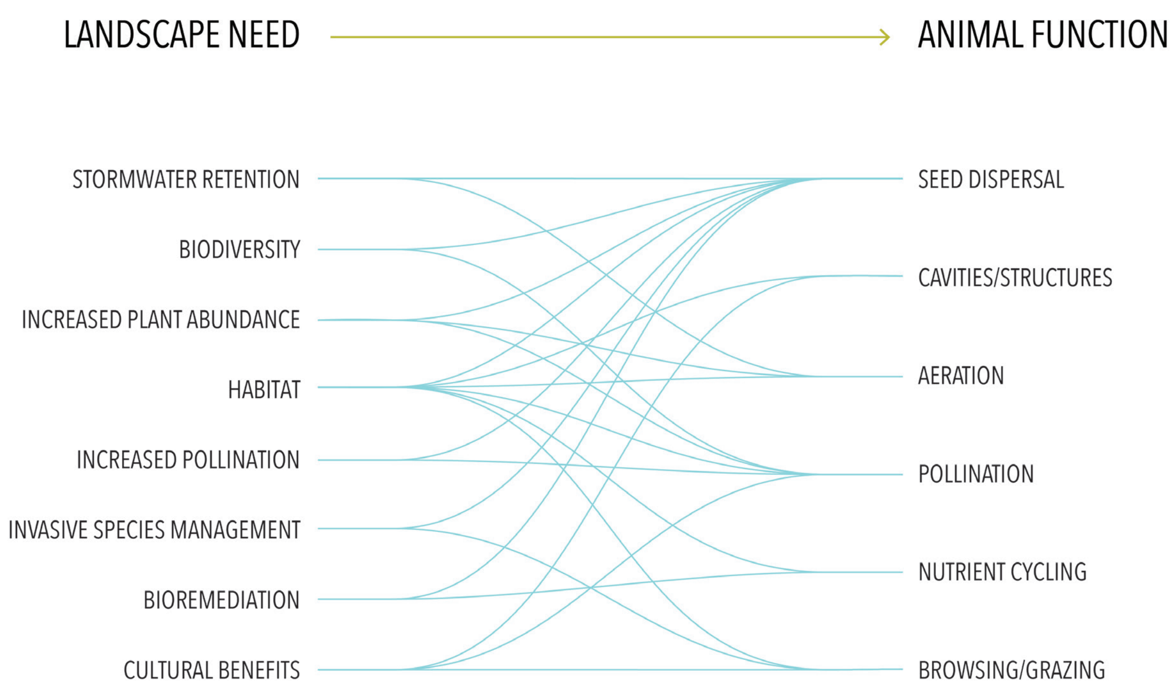
Recommendations
These are suitable "upperbank" plant species recommended for the site

<u>Tree species could include:</u>
Acer macrophyllum
Arbutus menziesii
Fraxinus latifolia
Quercus garryana
Quercus kelloggii

<u>Shrub and small tree species could include:</u>
Acer circinatum
Amelanchier alnifolia
Aruncus dioicus
Baccharis pilularis
Berberis aquifolium
Ceanothus sanguineus
Ceanothus velutinus
Corylus cornuta var. *californica*
Holodiscus discolor
Lonicera involucrata
Oemleria cerasiformis
Philadelphus lewisii
Prunus emarginata var. *mollis*
Prunus virginiana var. *demissa*
Rhamnus purshiana
Ribes sanguineum
Rubus parviflorus
Salix scoulerina
Sambucus racemosa
Symphoricarpos albus var. *laevigatus*
Viburnum ellipticum

<u>Forb and Fern species could include:</u>
Aquilegia formosa
Artemesia douglasiana
Asclepias speciosa
Clarkia amoena
Clarkia purpurea var. *purpurea*
Claytonia sibirica
Collinsia grandiflora
Collomia grandiflora
Delphinium menziesii
Delphinium trolliifolium
Dicentra formosa
Erysimum capitatum var. *capitatum*
Eschscholzia californica
Fragaria vesca var. *bracteata*
Fragaria virginiana var. *platypetela*
Geranium oreganum
Gilia capitata
Heracleum lanatum
Heuchera micrantha
Hydrophyllum tenuipes
Iris tenax
Lomatium dissectum
Lomatium nudicaule
Lomatium utriculatum
Lupinus rivularis
Mertensia platyphylla
Plectritis congesta
Polystichum munitum

Given the revegetation needs for this vacant site and the desired species that Johnson identified, seed dispersal has the potential to address the highest number of landscape needs and was selected as the preferred animal action to test through prototype design.



Landscape Need
Seed dispersal may address the landsacpe needs present on a site that is comparable to a vacant lot

Animal Function Research

To develop a seed dispersal design intervention, the designer must determine the animal actors and explore any prior research related to the function by that animal actor. In the study area report, the most abundant wildlife species observed were birds, which correlates well with the seed dispersal function. The Pacific Northwest species database attributes seed dispersal primarily to birds; about 80% of the regional species who perform this function are birds with the remaining species primarily mammals who might not be desirable on this urban site. To assist with revegetating the site, I hypothesized that bird perches would attract a variety of birds, who would deposit seeds around the perches, similar to Steve Handel's observations at the Fresh Kills landfill.

There is a paucity of data on the needs and constraints for prototyping seed dispersal perches for birds in the Pacific Northwest. Two experiments in Brazil provided some basic parameters and informed the prototype design. These parameters provide an opportunity to begin the research-through-design, iteratively adjusting the perches based on feedback from the animals.

Porto Ferreira State Park, Southeastern Brazil, 2016

(Athie and Dias 2016)
Experiment: This research site was a 10.75 Ha abandoned pasture 150m away from the savanna and 230m away from forest edges. Researchers created a natural perch, a simple artificial perch made from bamboo (3m tall with a crossbar) and an elaborate artificial perch made out of eucalyptus (7m tall and three crossbars), and provided controls for each. The perches were observed for one year, and traps were emptied every twenty days.

Findings: The number of bird dispersed seeds deposited was proportional to the number of structures for perching. Natural perches provide more resources like fruit, insects, and shelter which resulted in more seed deposition.

Araucaria Forest, Brazil, 2005

(Zanini and Ganade 2005)
Experiment: 2 Ha abandoned field where the natural establishment of seeds and seedlings of woody species with the presence and absence of perches was monitored every month over a twelve-month period. The edge of the nearest native forest is located about 50m from the study site. Perches were built using poles 2m in height and 16 cm in diameter. On the top of each pole, two crossed bars 50 cm in length and 14 cm in diameter were fixed. Although the use of real trees would probably be a more effective option to attract seed dispersers and implement forest restoration, artificial perches were used because trees could modify soil nutrient contents and light availability.

Findings: Seed abundance and species richness were significantly greater in places with perches than in control plots. Perches were more effective in January, when fruit production in the nearby forest increased; and it is bird reproductive season. Perches were less effective by the end of winter when fruit production in the forest was very low and bird diversity was smaller due to the lack of migratory species. Last, the greater structural complexity of perches could have been more effective in attracting seed dispersers.

According to this research, perches are successful in encouraging seed dispersal by birds. The perches need to be at a distance (50-150m) from the forested edge; they need to be structurally complex or provide a number of perching options; they need to be high enough for the birds to feel safe; natural material seems to be more effective; and they need to be implemented when the native plants are fruiting and seeding.

Temporal Analysis of Functions

Now that perches as the design intervention has been established, it is necessary to understand the timing of the variables in the seed dispersal function in Eugene, OR, such as seeding and fruiting native plants and migration of seed dispersing birds. After analysis of the timing of these variables, it seems, the late summer and fall have the greatest potential to encourage seed dispersal. Ideally, this perch prototype research could be implemented for a longer period of time, as in the research examples who observed for a full year, however, this project is constrained to two weeks in the spring. This prototyping will test the process of prototyping, the feasibility of seed dispersal by birds in Eugene, Oregon and perches as the appropriate design intervention. During the spring, there are not many native plants that are seeding but there are plenty of seed dispersing birds in the area.

Temporal Analysis
Legend colors represent colors of berry, seed or bird

SEEDING PLANTS

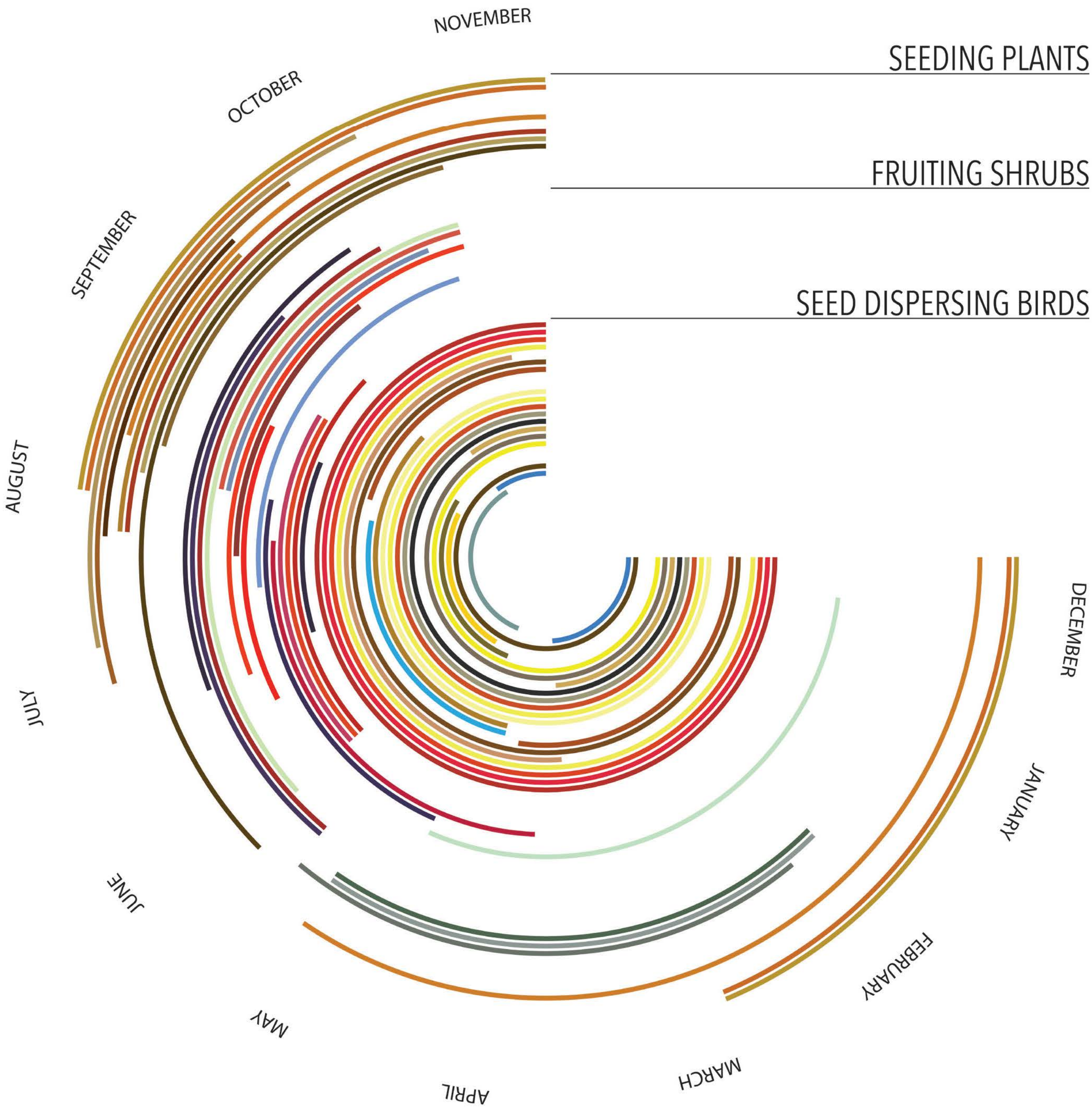
- RED ALDER
- WHITE ALDER
- OREGON ASH
- CATTAILS
- CHINKAPIN
- DOUGLAS-FIR
- HAZELNUT
- PACIFIC MADRONE
- BIGLEAF MAPLE
- CALIFORNIA BLACK OAK
- OREGON WHITE OAK
- SHORT-STYLED THISTLE,
- MOUNTAIN THISTLE
- EDIBLE THISTLE

FRUITING SHRUBS

- TRAILING BLACKBERRY
- BLUE RASPBERRY
- CASCARA
- PACIFIC CRABAPPLE
- PACIFIC DOGWOOD
- BLUE ELDERBERRY
- RED ELDERBERRY
- SUKSDORF'S HAWTHORN
- RED HUCKLEBERRY
- OAK MISTLETOE
- TALL OREGONGRAPE
- OSOBERRY
- SALMONBERRY
- PACIFIC SERVICEBERRY
- BROADPETAL STRAWBERRY
- WOODS STRAWBERRY
- BLACK TWINBERRY

SEED DISPERSING BIRDS

- NORTHERN FLICKER
- DOWNY WOODPECKER
- RED-WINGED BLACKBIRD
- CEDAR WAXWING
- SAVANNAH SPARROW
- HOUSE SPARROW
- FOX SPARROW
- LAZULI BUNTING
- BLACK-HEADED GROSBEAK
- PINE SISKIN
- LESSER GOLDFINCH
- AMERICAN ROBIN
- BLACK-CAPPED CHICKADEE
- AMERICAN CROW
- LINCOLN'S SPARROW
- WHITE-CROWNED SPARROW
- AMERICAN GOLDFINCH
- SWAINSON'S THRUSH
- YELLOW-BREASTED CHAT
- SONG SPARROW
- STELLER'S JAY
- BAND-TAILED PIGEON

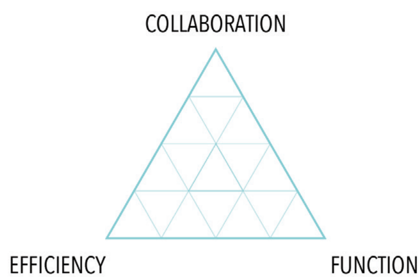


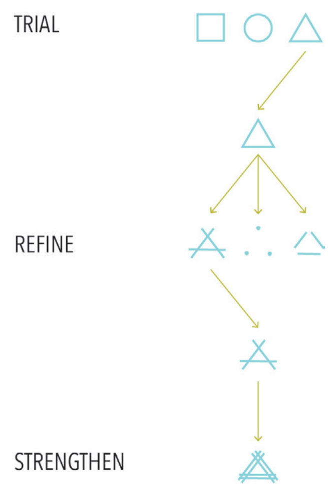
Temporal Analysis
Native plants that produce fruit and seeds for birds (Newhouse 2004). Seed dispersing birds from the PNW species database that are present in Eugene (Birding n.d.).

Design Intervention Development

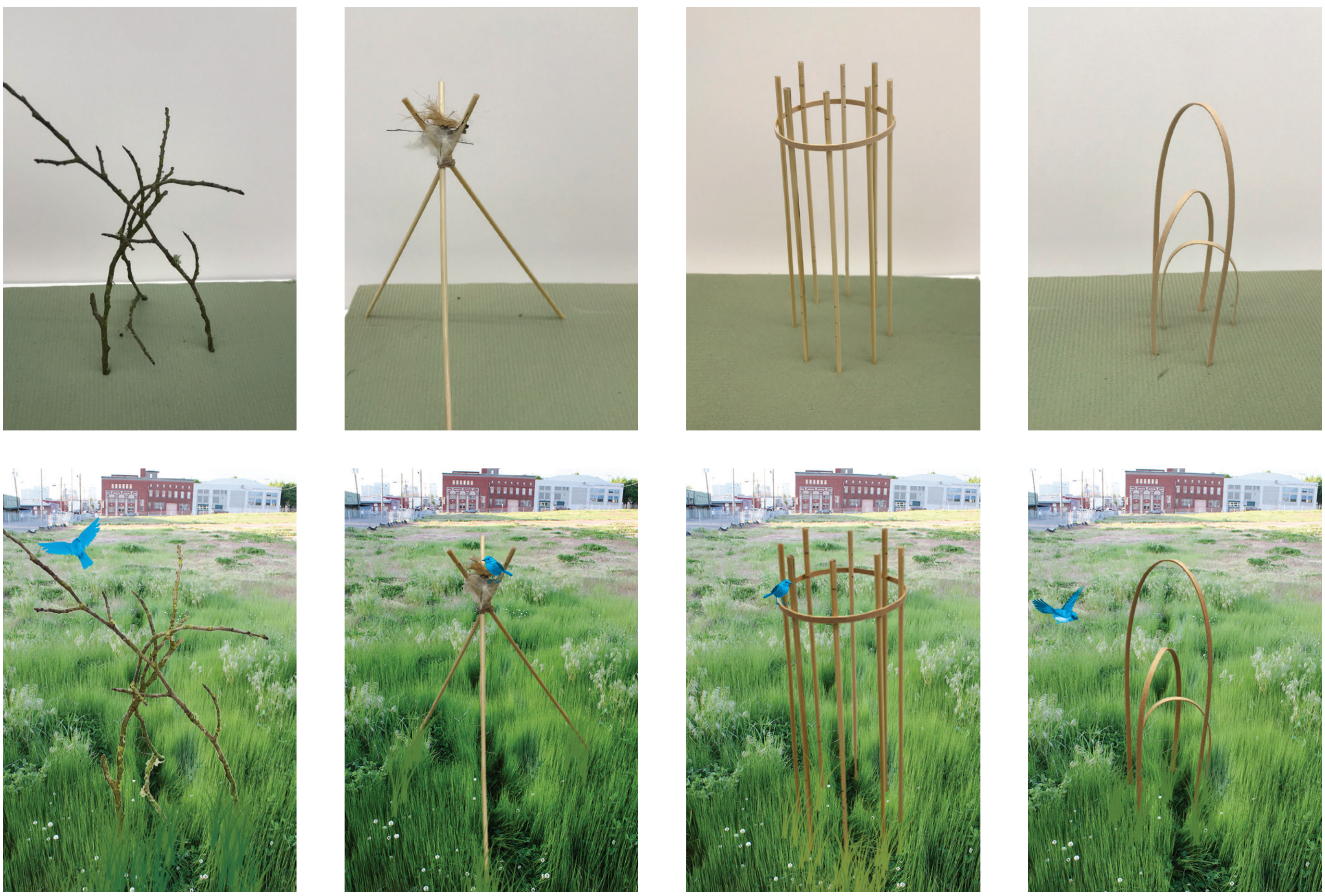
Now that site analysis has determined a reference riparian upperbank habitat type, landscape need of revegetation, seed dispersal as the animal function, birds as the animal actors and perches as the design intervention the iterative research-through-design process can begin to be tested. The design intervention is formed by research parameters determined by prior research as well as site constraints. There is no digging allowed at this site due to unknown utilities and remnant irrigation systems; everything that is taken out into the field must be removed; materials have to be carried out by foot for about a half mile; and there is risk of theft and vandalism. The research is constrained to a two-week period, so each field test of perch prototypes is monitored for four days. Using the evaluative model and success criteria previously defined, I was able to refine successive field tests to improve collaboration, function, and efficiency through a phasing process based on animal feedback.

Process Evaluation
Each phase will be evaluated using this framework to meet the criteria for success through a phasing process based on animal feedback.





Initial ideas are tested through modeling and studied in photoshop renderings. These prototype models provide options for no digging. This research used the prior research about bird perches for seed dispersal and inspiration from abstracted trees and began to test the forms through modeling. The models provide a range of options for the birds. The first is a naturalistic option with tree branches. The second offers an incentive with nesting material which will potentially attract birds to that perch but also provides an option for plant material that contains seeds to be transported to other areas for nesting. The third offers several perching options and a circular perch so the birds can face into the wind from any direction. The fourth offers varying heights. Photoshop was used as a tool to study their forms in the landscape. These model prototypes inform the materials that might be used to construct them so that they are efficient in the field test. With efficiency in mind, they were made with inexpensive and readily available materials like bamboo, willow and tree branches.



Model Perches
The models are used to study feasibility of design

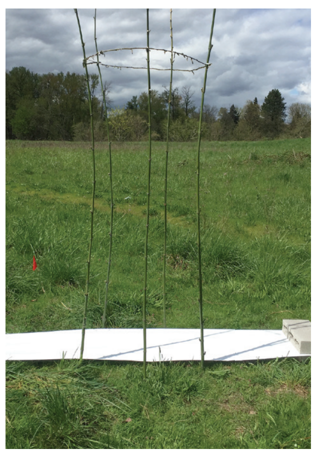
Field Test 1

Prototypes
Four prototypes that are inspired by bird needs and abstract trees

BRUSH

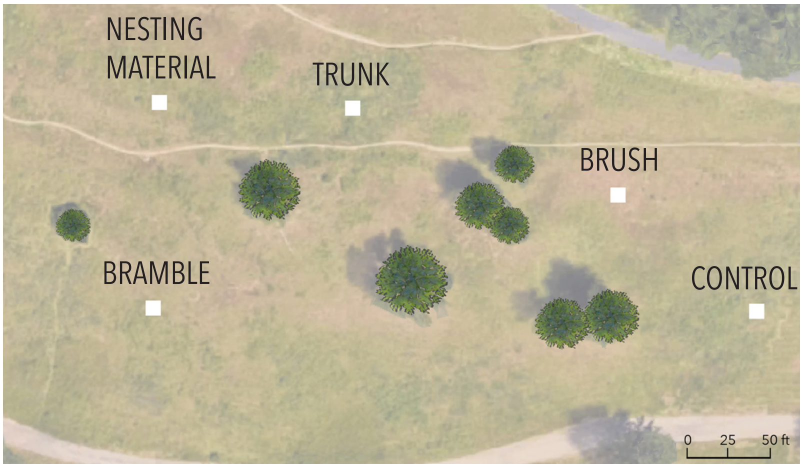
NESTING MATERIAL

TRUNK



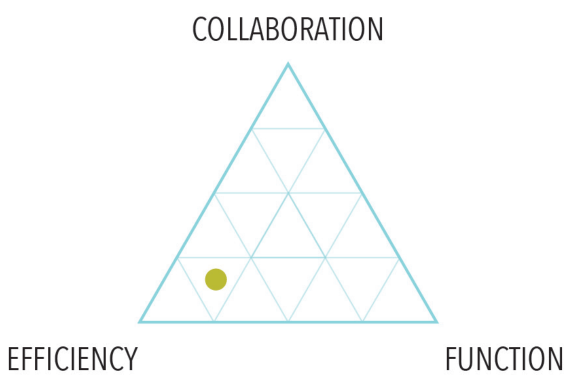
BRAMBLE

The model prototypes were built in full size. The initial prototypes were placed at approximately the same distance from the trees on site at 100ft from the base of the trees. There were five plots total including a control plot. The sticky paper was placed underneath the prototypes to graphically record function and they were observed for an hour after sunrise each day to record collaboration. After monitoring the first phase of prototypes providing a range of perching options for four days there was no resulting bird activity recorded. There were plenty of birds observed at the site flying from forest edge to forest edge and perching in the trees within the site, however, they were not interested in using the perches.



Perch Location
The prototypes are 100ft from the base of the trees

The trees within the site added a variable that was missing from the research in Brazil. I assumed that these perches would function at a distance from these trees just as with a forest edge. I hypothesized the trees within the site may make the birds preference perches differently than they would with a grassy field with no trees. After no bird activity and examining only wind dispersed seeds and debris not related to birds on the sticky paper, I determined these prototypes were not collaborative or functional.



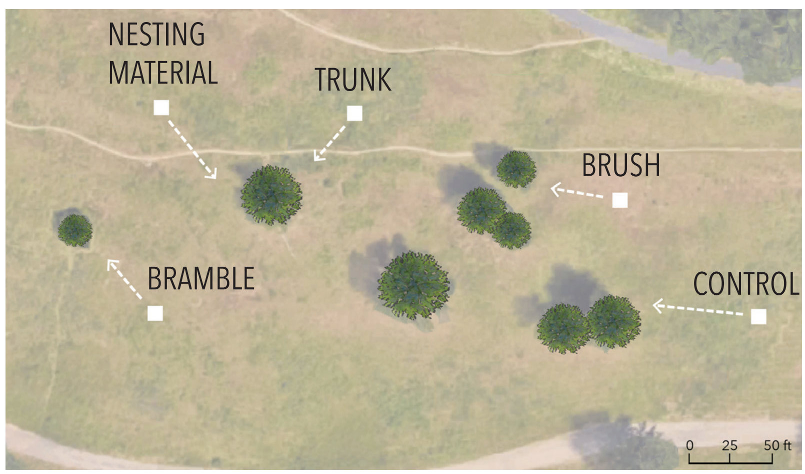
Evaluate Success
These prototypes are efficient

The observations did reveal that there is a lot of bird activity in the trees within the site, but they were not using the perches. All of these trees have dense branches or blackberry brambles at the base providing shelter from rain and safety from predators. After some continued research on how to attract birds to a residential yard, it is recommended that birds be provided with a brush pile to seek refuge in the event they need to escape a threat (Link 2015). The prototypes at their current distance away from the trees may be too exposed which may be the reason for the birds' inactivity.

Field Test 2

The next phase of testing was with the same five prototype plots at a closer distance to the trees at 15ft away from the base of the trees. Now, the birds have an opportunity for refuge in the lower branching of the poplar trees and the blackberry brambles at the base. Moving the perches towards the base of the trees will result in a seed dispersal pattern that is outward from these trees similar to Steve Handel's approach at Fresh Kills Landfill.

Perch Location
The prototypes had to be moved closer to the trees so birds would not be exposed



The prototypes in their new positions were observed for four more days. At the end of observations and examining the sticky paper, the prototype that offered nesting material appeared to encourage the most activity. There was observed disturbance in the prototype. There would be no reason for human vandalism nor another species of animal to disturb the structure. This was assumed to be evidence of bird activity. The sticky paper also recorded some fibers that dropped from the pile of nesting material that would also indicate activity.

BEFORE

AFTER

Observations
The nesting material prototype was disturbed showing signs of activity

CONTROL PLOT

DETAIL

NESTING MATERIAL PLOT

On the sticky paper, there were no obviously bird dispersed seeds on either the control or the nesting material paper. The debris was assumed to be mostly wind dispersed seeds and organic debris from the tree canopy. This prototype seemed to have the most potential for collaboration and was used for successive refining. Considering, this particular incentive will be attractive for birds when they are building nests in the spring, they may not be as active with this perch design in the late summer and fall when there are seeding and fruiting native plants. The bird activity with nesting material does show that creating an incentive may produce more collaboration.

Observations
The sticky paper under the nesting material prototype had fibers on the sticky paper

Field Test 3

Prototypes
Three prototypes that respond to bird interest in nesting material and provide more incentives like shelter and food

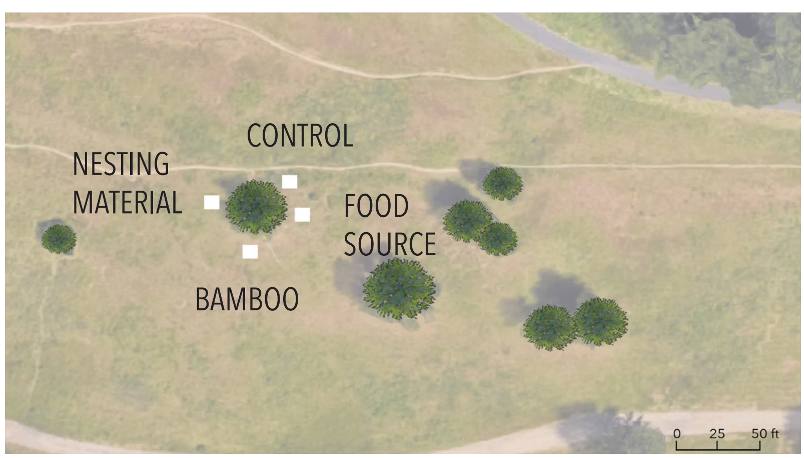
BAMBOO

NESTING MATERIAL 2.0

FOOD SOURCE

The nesting material prototype informed a new phase of three prototypes with incentives and one control plot that were monitored for another 4 days. The new prototypes all have similar forms to the original and were moved near the tree with the most observed bird activity. The first prototype provides a suet block as a food source. While the birds are eating, they may bring seeds with them on their feathers or the seeds may pass through their digestive systems. The second prototype is a refined and strengthened version of the nesting material to be able to withstand heavier traffic and bigger birds. The third prototype is a perch of the same form but the bamboo vegetation is left on to provide shelter.

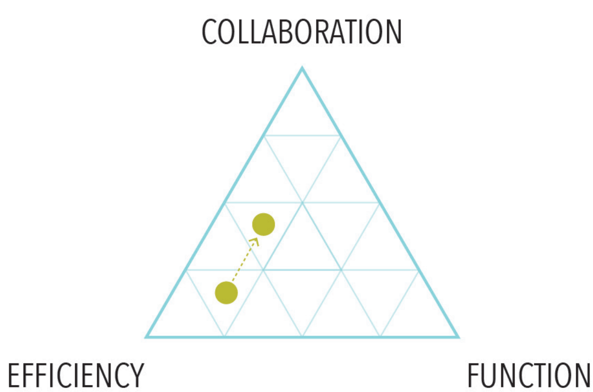
Perch Location
The prototypes were moved to the same tree



A trail camera was set up to record collaboration potential and it managed to capture images of birds in the area. These prototypes can continue to be refined and monitored for longer periods of time. Verified in these photos, blue jays and sparrows, may be potential animal actors for this site in the spring.

Observations
Using a wildlife camera, a sparrow (left) and a blue jay (right) were in close proximity to the perches

These prototypes cannot be confirmed as collaborative within the four-day period because the birds were not recorded resting on the perch where they would have time to disperse seeds. The sticky paper resulted in a significant amount of debris from the tree canopy. There were wind dispersed seeds and fibers from the nesting material prototype indicating bird activity. The suet block had some evidence of birds eating but very little. The sticky paper under the strengthened nesting material prototype had more evidence of fibers that had been dropped. The sticky paper underneath the bamboo shelter prototype had a significant amount of bamboo vegetation that had dropped which could be from the wind or from bird activity. These photos are evidence that birds are within close proximity to the prototypes and are likely to be more collaborative than the previous phase of prototypes.

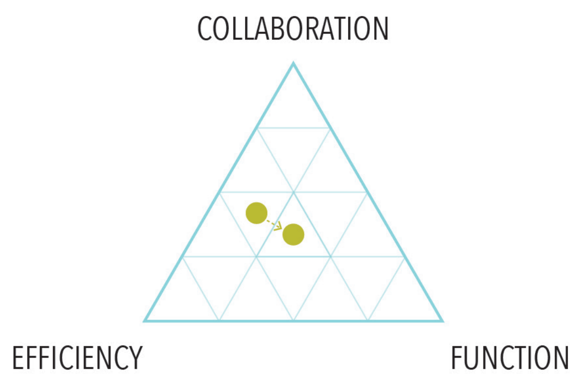


Evaluate Success
These prototypes are efficient and collaborative

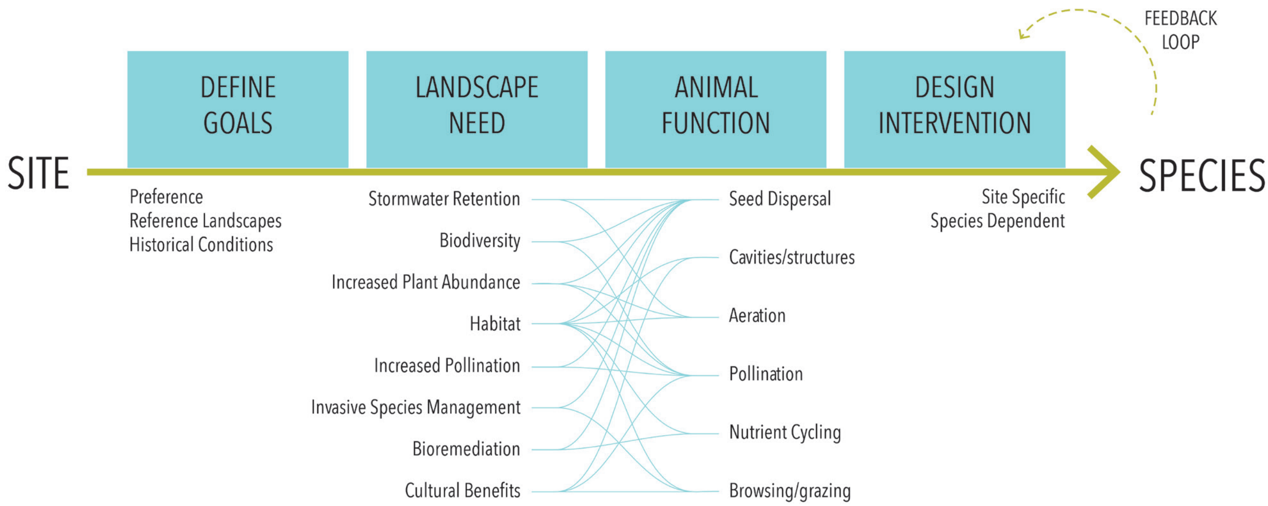
RESEARCH THROUGH PROTOTYPE DESIGN

Now that this prototype phasing has developed perches that are moving in an efficient and collaborative direction, they need to be functional to meet all three criteria for success. There are a few things that can be tested through prototype design but, it will need to be implemented at the proper time. According to the temporal analysis of the seed dispersal function in this area, the most functional time to implement the perches would be in the summer to fall seasons when native trees and shrubs are fruiting and seeding. To confirm function, the sticky paper can be examined by a plant biologist to determine seed quantity and identification. To ensure that the birds are dispersing the desired plant material, the designer could also collect seeds from native plants and provide them for dispersal.

Evaluating Success
These prototypes must be implemented at the right time of year to be functional



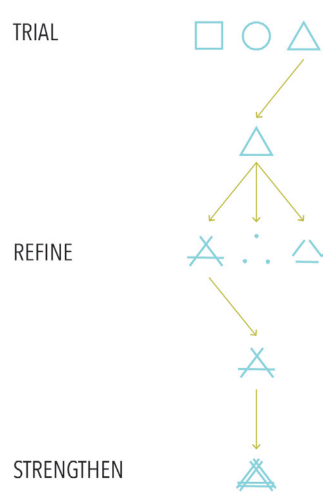
Once function is established, and the prototype is successfully facilitating ecological restoration, these prototype designs can begin to test dispersal patterns. Initial processes of dispersal can be analyzed with the debris on the sticky paper. Based on the unpredictable contributions of animals it may be difficult to facilitate a desired pattern yet intentional placement of these perches will impact different patterns with new growth.



Framework Diagram
Define goals and determine landscape need of a site to encourage animal functions with design interventions which are improved by a feedback loop

This research developed a process to co-create with animals based on goals of ecological restoration. The phases of prototype perches encouraged seed dispersal with birds to address landscape needs of the site and were refined and strengthened based on bird response to be collaborative, functional and efficient.

This research-through-design iterative process can be expressed in three or more phases. The first provides options that are assumed to encourage a particular outcome. After observations or data collection, the most successful prototype can be determined. The next phase of prototypes can create a refined phase of prototypes that have a more focused form or approach. Based on the success of these prototype from this focused phase, the form and approach can be refined further to strengthen the potential for success and achieving the desired outcome.

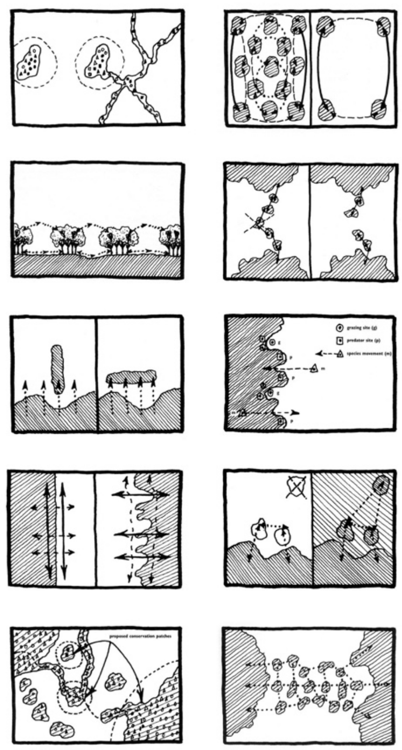


Prototype Phasing
The process of observing prototypes with the most potential and refining and strengthening them.

CHAPTER 4
NEXT STEPS

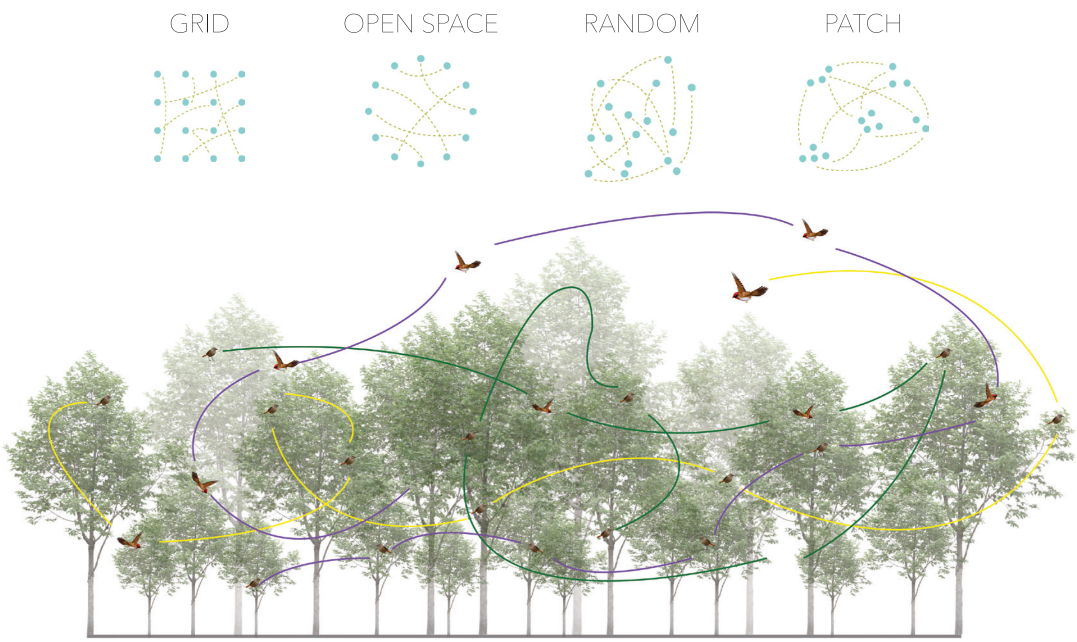
PROTOTYPE TO LANDSCAPE SCALE

Ecological restoration and habitat types can be realized in different sizes, forms, population potential, and management practice (Lyle 1999). Richard TT Forman, a research professor at Harvard, produced a framework for thinking about landscape ecology with four principles: patches, edges and boundaries, corridors and connectivity, and mosaics (Dramstad et al. 1996). The designer must consider the appropriate habitat type as well as the principle that is appropriate for the site based on the ecological context. These various forms may be determined by the landscape scale of the prototype design interventions.



Landscape Ecology
Richard TT Forman's framework of principles for landsacpe ecology: patches, edges, boundaries, corridors and mosaics

This iterative process of prototyping will inform how to encourage seed dispersal with a design intervention at the landscape scale or, the landscape with equivalent ecological conditions. It is unknown if the number, size and location will influence animal function patterns, but this is a factor that may also go through a trial and refine process. Animal unpredictability will make the designs more complex but may be directed with intentional facilitation. The design at the landscape scale will continue to be directed and maintained by animal and site response. Specifically, the placement and quantity of these perches may influence the dispersal pattern. If placed in a grid, the revegetation may occur outward from the trees on site. If placed around the perimeter, the revegetation can occur throughout the middle as birds connect from perch to perch across the middle. The designer must decide how far apart and how many are needed for the desired outcome.



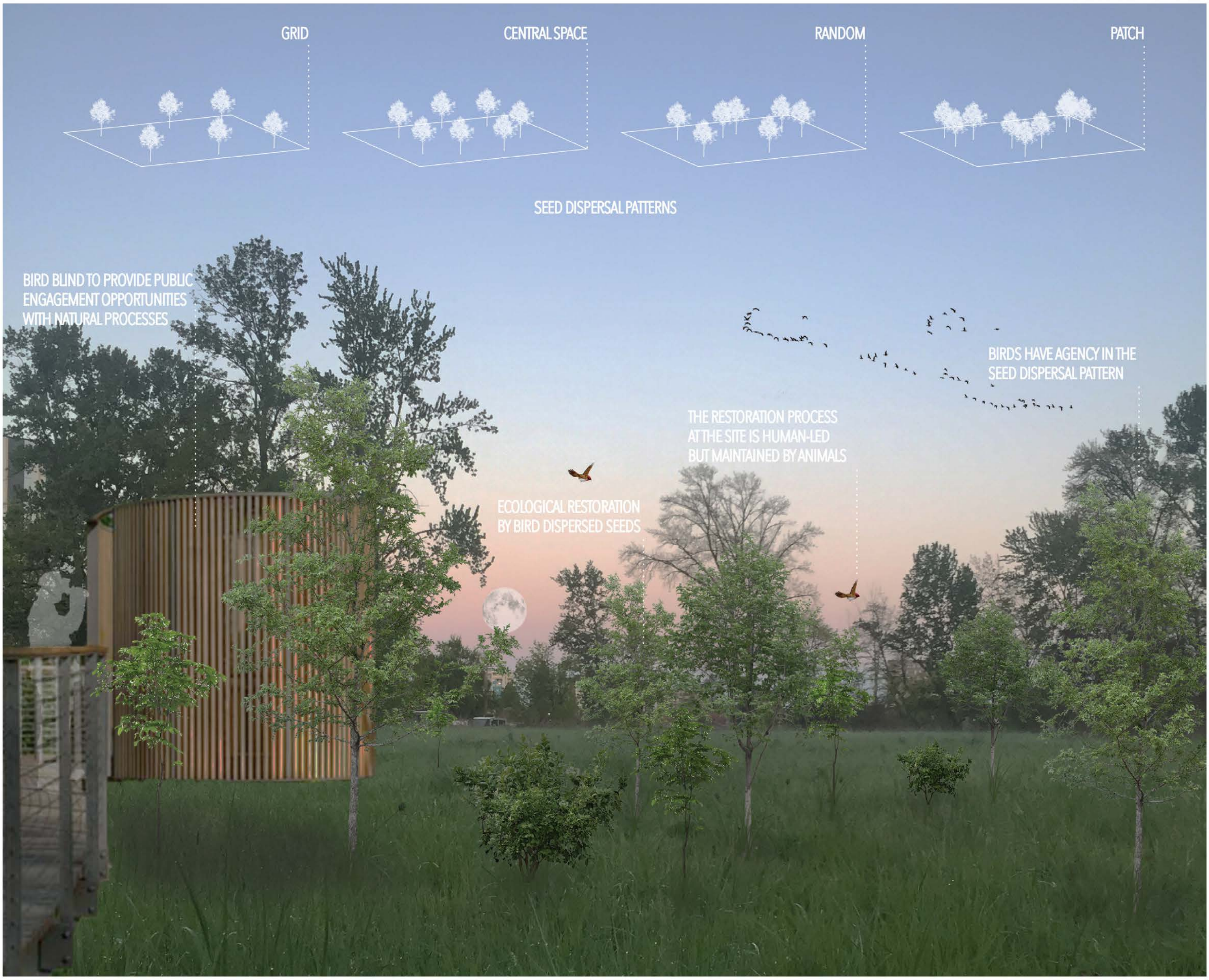
Design Patterns
Diagrams of patterns that may be developed from landscape scale interventions that are realized by birds and unpreditable behavior

The designer has to think about the length of time these design interventions are in place. They may be temporary structures that catalyze the ecological restoration or permanent structures that become the ecological restoration itself. The design interventions can produce a maintenance regime for the site in the long term. These design interventions at a landscape scale may be time intensive. For this reason, they will have the greatest potential at sites that have an abundance of time like neglected sites and vacant lots. Once the restoration work has begun, the site can support a larger population size of species and more biodiversity which can contribute to restoration at a faster pace. The time frame will depend on the project but could potentially take 5-10 years to begin to see results. This slow process is what develops the complexity in ecological restoration that cannot be replicated with human intervention.

This research-through-design process may require ongoing monitoring of the design interventions and continued adjustments until the restoration process is established. These perches may need to be maintained, replaced, or strengthened. This long term restoration process and research-through-design approach will leave room for adjustments in a landscape scale if, for example, the conditions change on the site.

Public Engagement
The trail camera captured curious people passing on the nearby path

These landscape scale designs should consider the human experience of them. Will the design be an educational opportunity including interpretive signage or will the design be sensitive to human presence? These co-created spaces have potential for programming and engaging the community such as a bird blind to encourage observation without disturbing the animals and the restoration process. People will be curious about the design interventions themselves, which may be educational if they make the animal functions visible for obvious interpretation. A separate public engagement opportunity or interpretation included as a part of the design intervention may both be considered for public engagement while being mindful that the primary purpose of the work is to produce successful co-creation.



Project Potential
Animal co-created spaces can be more suitable, cost effective and opportunities for public engagement

DISCUSSION

This research aims to provide a research-through-design approach to co-create with animals for ecological restoration. Success is defined in this project as collaborative, functional and effective. This research proposes a framework to co-create with animals. The designer must define their goals; determine the landscape need of their site; identify animal functions that are available on the site that can address the landscape need; research the animal function and animal actor to understand the most encouraging intervention for those actors; and produce prototypes to refine the design intervention based on their goals.

Temporal aspects of the site and the animal functions are very important considerations that will influence the appropriate time to install the design intervention. The form of the design intervention may change based on targeting a particular species, responding to the site or animal, or the intention of directing the function to produce a particular pattern. The designer may do as much research as possible, but there is a point where they must see how the animal responds to the design intervention. This research gives animals agency in determining how the desired outcome is achieved. The resulting design is animal-centered ecological restoration.

In particular, animal functions can provide us with solutions for neglected sites we don't have the means to address. Co-creation with animals may be more cost effective because the animals are already providing these functions, more suitable for native species because the species themselves are creating the space and it is not human imposed. Co-created spaces will highlight the importance of animal functions and can make them more visible to the public eye. Co-creation with animals could be an attraction to the space and interpretive signage could relay how the space was created using animal functions. Working with animals will make nature more accessible in urban areas, provide urban refuges for animals, and create opportunities for the public to care about animals and their needs.

Co-creation with animals is site-specific, but this framework is transferable. It is broadly transferable within the PNW because the species database is specific to that area. The framework transfers to other regions but will need to be adapted to specific species and their physical and temporal differences.

Prototyping is the process for understanding how to design with each species more effectively. The research is limited because the design interventions are time intensive and the results are specific to a particular site.

Future research can explore co-creation potential in depth with each of the functions at various sites. This research also brings up more questions that need to be addressed. Scaling up to the landscape scale opens up questions of maintenance, and possibilities of multi-species collaborations. This process of co-creation may function best if integrated and studied in combination with other methods of ecological restoration or green infrastructure. The project recognizes animal agency, but also hints at questions of animal autonomy, animal awareness, and other ethical considerations that have not been addressed. After producing successful design interventions, monitoring protocols need to be established to provide performance metrics and compare human and animal centered interventions. This research starts the conversation about what is possible in co-creating with animals and what is an appropriate way to define success.

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IMAGE SOURCES

Cover image:	Contains photo from Oregon Fish and Wildlife Oregon Fish and Wildlife Office, Oregon Chub Photo Gallery https://www.fws.gov/oregonfwo/species/data/oregonchub/Photo Gallery
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pg 63.	Site context aerial photo: Chris Weaver
pg 84.	Richard Forman Diagram: Dramstad et al. 1996.
pg 87.	Seed dispersal perspective drawing contains Maya Lin's bird blind from the Confluence project