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Research Proposal
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Seattle Greenrail: modeling the effects of replacing impervious infrastructure with pollinator-friendly green space

Abstract
As city planners realize that green space is vital for human health and happiness, and for capturing and cleaning stormwater, they are creating or restoring natural areas, but not necessarily considering the effects of these spaces on the pollinator species that may use them. The purpose of this research is to create a model of those effects, based on field data in a recently restored area, and applied to a hypothetical future replacement of impervious infrastructure with green space. The restored area to be studied is the Pollinator Pathway in Seattle, WA, on E Columbia Street between 12th Ave and 29th Ave. The second study area, to be modeled, is one mile to the West, where the Seattle Monorail connects Westlake Mall to the Pacific Science Center grounds via 5th Ave, from Pine Street to Broad Street. Initial species to be studied and modeled are common native Pacific Northwest Bumble Bees (*Bombus mixtus, B. melanopygus, B. vosnesenskii*). HexSim will be used as the modeling platform, at spatial scales from 1-block to 1-mile radii, conforming to expected pollinator flight distances. Various temporal scales will also be explored as the study progresses to capture seasonal differences between pollinators. This research is important because urbanization has reduced and fragmented pollinator habitat. Phenological asynchrony will be exacerbated with climate change, making it hard for pollinators to find food. Urban green spaces will become increasingly important refugia for pollinators as urbanization increases and effects of climate change continue to stress rural pollinator habitat.

Introduction

Pollinators provide a valuable service to humans, valued in 2005 at $215 billion (Vanbergen et al., 2013). They help 94% of wild flowering plants reproduce, as well as 75% of our crops. Pollinators are responsible for the reproduction of over 80% of plant life. They are vital not just for the production of food that humans eat, but for the continued success of other ecosystem services humans depend on, such as oxygen production, air and water purification, and shade and evapotranspirative cooling.

Urbanization and industrial agricultural practices have drastically reduced the amount and diversity of usable habitat for pollinators all over the world. This problem is exacerbated by climate change, which can change the temperature and precipitation ranges pollinators are adapted to, as well as causing or exacerbating phenological asynchrony (Singer & Parmesan, 2010).

Urban centers are starting to address the problem indirectly by creating or restoring green space. Urban green spaces boost human health and happiness, as well as provide a host of other ecological benefits (Jorgensen & Gobster, 2010). This is especially true in Seattle, WA, where the city has a goal of increasing urban canopy cover from 23% to 30% by 2037 (City of Seattle, 2015). Massive-scale urban restoration projects have been successful internationally, including Cheonggyecheon in Seoul, South Korea (Figure 1), Houtan Park in Shanghai, China (Figure 2), and Landschaftspark in Duisberg, Germany (Figure 3). In the United States, High Line Park in New York (Figure 4) has been enormously successful from a human perspective. Little research has been done, however, on the effect of these large projects on pollinators.

The purpose of this research is to model the diversity, abundance, and movement of several pollinators in the Seattle metropolitan area, focused on a mile long stretch of intentionally pollinator-friendly habitat, called the Pollinator Pathway (Figure 5). Once the model conforms to data gathered in the Pathway, the model will be applied to a hypothetical situation in which the mile long stretch of the Seattle Monorail (Figure 6) is replaced with a green space similar to High Line Park in New York City. Increasing green space increases overall habitat, as well as connectivity between existing urban green spaces, reducing fragmentation of pollinator habitat.

Objectives

- Model the current diversity, abundance, and movement of pollinators in Seattle
    - Gather data on pollinators within and around the Pollinator Pathway
    - Use gathered data to calibrate the model
- Model the effects of replacing the Seattle Monorail with a “Greenrail”
    - model effects of different percentages of habitat and non-habitat
- Model the effects again, including climate change projections, with and without the Greenrail

Methods

Study Area

The Pollinator Pathway is in Seattle, WA, on E Columbia Street between 12th Ave and 29th Ave. The project began in 2007, and is comprised of more than 60 sites, creating a 12 foot wide swath of pollinator habitat between Seattle University and Nora’s Woods (Bergmann, 2015). The second study area, to be modeled, is about a mile to the West, where the Seattle Monorail connects Westlake Mall to the Pacific Science Center grounds via 5th Ave, from Pine Street to Broad Street. The study assumes that the ends of the existing monorail structure would be extended in ramps down to the Westlake Mall and Pacific Science Center grounds, providing a continuous path of flowering plants for pollinators to follow up to the elevated section. The Greenrail would *not* be assumed to be 100% habitat, but instead a mix that includes people-friendly structures such as pervious walking path, artwork installations, and seating. Different mixes of habitat and non-habitat would be modeled to find an ideal mix that balances human use with pollinator success.

Target Species

Common native Pacific Northwest Bumble Bees (subject to change based on field data): Fuzzy-Horned Bumble Bee (*Bombus mixtus*), Black Tail Bumble Bee (*Bombus melanopygus*), and Vosnesensky Bumble Bee (*Bombus vosnesenskii*).

Study Design

This study will construct a HexSim model of pollinator diversity, abundance, and movement throughout the Pollinator Pathway, calibrated with existing data already collected. If collected data is not sufficient for calibration, more will be gathered, using standard techniques of fluorescent powders (Townsend & Levey, 2005) and/or stable isotope analysis (Brosi et al., 2009). HexSim will be used to model different spatial scales from 1-block to 1-mile radii, and different temporal scales to detect differences between year-round and seasonal pollinators. GIS data of Seattle's canopy will be used to construct potential habitat patches within HexSim, some of which will need to be ground-truthed to verify suitable flowering plant species to support the target pollinators outside of the Pathway. The model will evaluate the Pathway both as a habitat itself as well as a corridor for pollinators traveling between other habitat sites, and whether it constituted a source or a sink for these populations, as demonstrated by Schumaker, et al (2014).

Importance

The Seattle Monorail is an established landmark (Roberts, 1999). Any proposal to replace it with an elevated park will likely meet heavy resistance. In a world of rapid climate change, however, our ideas of what should and should not be preserved warrant challenging. Do the cultural benefits of preserving this historic landmark outweigh the ecological, economic, and social benefits of replacing it? Modeling the Greenrail's benefits to pollinators would be a step towards answering that question, as those benefits could be quantified, especially if the Greenrail habitat spaces included communal garden patches for downtown residents to use. Large-scale urban projects created many of the problems we face today, and large-scale *green* urban projects should be included as a potential solution. Adaptive management techniques and climate change adaptation strategies are becoming commonplace is urban planning policy documents. While preserving ties to our cultural heritage is important, we should not limit ourselves from exploring ways to adapt that heritage to create a more livable future.

Budget

Item	Cost
Labor (student capstone or research)	Free
Travel	Free (U-Pass)
ArcGIS	Free (UW license)
HexSim	Free
Blacklight	$20
DayGlo powder	$250 / lb
Stable Isotope Sampling 300 samples ($10 each)	$3000
Total	$3,270

Appendix

Figure 1: Cheonggyecheon, Seoul, South Korea (http://www.kcet.org/)

Figure 2: Houtan Park, Shanghai, China (http://www.intechopen.com/)

Figure 3: Landschaftspark, Duisberg, Germany (© Mark Wohlrab)

Figure 4: High Line Park, New York City, NY (Demetrius Freeman/The New York Times)

(© Sarah Bergmann)

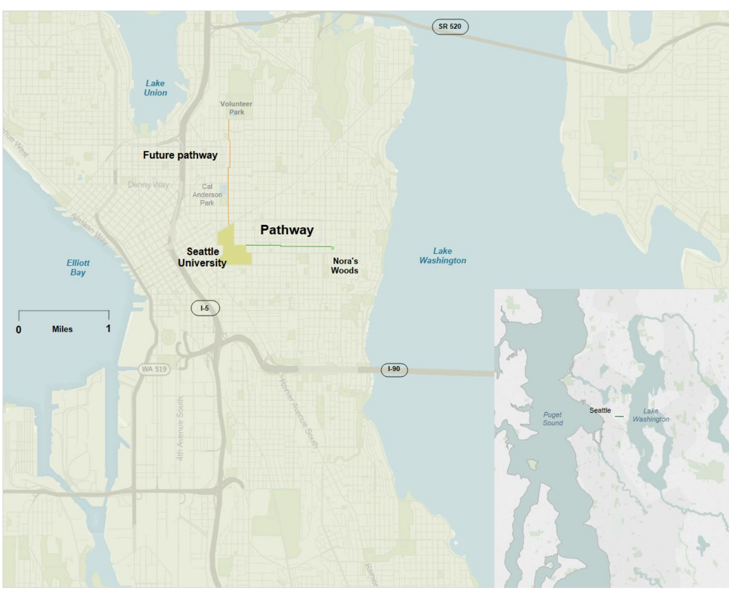

Figure 5: Pollinator Pathway, Seattle, WA (Dennis Bratland)

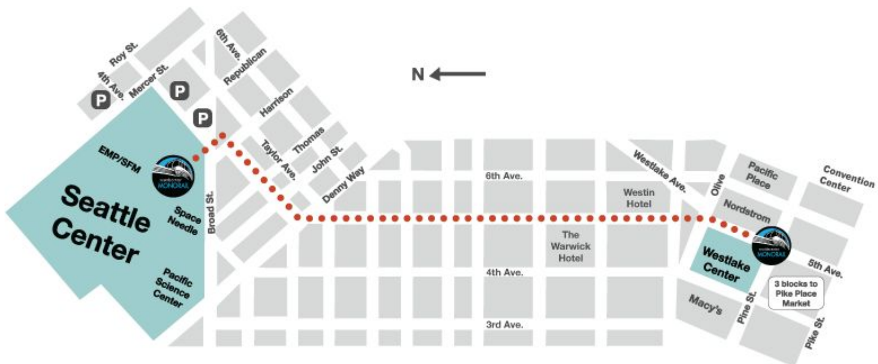

Figure 6: Seattle Monorail Route (http://www.seattlemonorail.com/)

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