VACANT BUGSCAPES
WRITTEN NARRATIVE

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Project Name	**Project Lot Address**
Vacant Bugscapes	2814 W. Kentucky Street

Project Executive Summary

Insects are an exceedingly critical and often overlooked link in ecological regeneration. With "Vacant Bugscapes" we propose to introduce assemblages of plants and insects that exemplify ecological and evolutionary interactions in observable, beautiful and measurable ways. At the same time, we aim to create new public spaces in Louisville, ones that are immersive and interactive, educational and inviting. Our proposal outlines plans for developing a pilot lot as an educational and community resource in collaboration with a nearby elementary school. In time we hope to expand the project to lots throughout Louisville using the model developed in this proposal. At greater scales, Vacant Bugscapes' impact will expand from localized learning and experiences to community-wide ecological restoration and rigorous restoration research.

Project Team Description

Team:

Billy Krimmel is an evolutionary ecologist who specializes in interactions between plants and insects. His research on sticky plants and their specialized insect community has appeared in the journal Nature as well as major gardening magazines such as Kew and Pacific Horticulture. Krimmel has worked with Title One schools in Portland, OR and Tucson, AZ to teach students about plants and insects. For this project Krimmel will be in charge of selecting plant and insect species and overseeing their implementation (rearing plants, collecting insects, planting plants, releasing insects); designing research and educational projects for the lot in collaboration with Brandeis Elementary School science teachers and Ohio State University (ALE Lab: Agricultural Landscape Ecology Lab, see below); developing longer-term research objectives; and obtaining funding from science-related sources (i.e., NSF).

Sara Jacobs is a landscape designer. She is particularly interested in how communities build active, accessible, and immersive landscapes that can be measured and experienced at a small scale while responding to larger social and ecological issues. Her work has been published in the United States and Asia, and her conceptual gardens have been recognized in the US and Europe. She has a Masters of Landscape Architecture from Harvard University and an undergraduate degree from the University of California, Berkeley. She believes plants and insect interaction is a way to to visualize unknown, unseen, and ephemeral landscapes. Sara will be a designer for the installation of Vacant Bugscapes as well as developing communication and representational tools for educational and community outreach.

Emily Schlickman is a landscape designer and educator. Two of her most recent projects focus on the intersection of art, landscape processes and community engagement in Ingolstadt, Germany and San Jose, California. At the University of California, Davis, Emily teaches upper-level graphic design, landscape architecture and urban design courses as a Visiting Lecturer in Human Ecology. She holds a Masters of Landscape Architecture from Harvard University and an undergraduate degree from Washington University in St. Louis. For Vacant Bugscapes, Emily will serve as a secondary designer as well as a community liaison.

Community Partners:

Community participation is crucial to the success of this project. It is vital to our vision that the Louisville community feel an active sense of ownership and pride in the space. With this in mind, we have identified key community members as initial partners in developing this project, who are described below:

Samuel Cowan and Tonda Montgomery, Brandeis Elementary School. Cowan is vice principal of Brandeis Elementary School (located across the street from our proposed lot), and Montgomery is the Science Lab teacher. Montgomery will work with us and ALE Lab to design and implement educational research projects using the lot. A letter of support from Cowan can be found in Supplemental Materials.

Agricultural Landscape Ecology Lab (ALE Lab), Ohio State University. ALE Lab is is the leading US laboratory in vacant lot restoration ecology. Gardiner's lab focuses on research pertaining to how adding native plants to urban areas affects overall insect diversity and pest control (by increasing insect predator abundances). Graduate students from the ALE lab will assist and provide training to Brandeis Elementary's science teachers in conducting plant-insect research projects. A letter of support from the ALE lab can be found in Supplemental Materials.

Other partners: Dr. James Harwood's laboratory, University of Kentucky, expert in plant-insect interactions and agricultural/garden applications; Charley Eiseman, freelance naturalist and author specializing in Eastern and Midwestern natural history; Jim McCormac, photographer and naturalist located in Columbus, Ohio and specializing on midwestern natural history; Gary Hawkins, botanist for Land Between Lakes National Forest; David Taylor, botanist for Daniel Boone National Forest.

Project Description

Overview

Vacant Bugscapes combines a need for habitat generation, outdoor education, research and public space. The proposed project works with a local school to create a public, educational landscape generated by vision and community participation. With "Vacant Bugscapes" we propose to introduce assemblages of plants and insects that exemplify ecological and evolutionary interactions in observable, beautiful and measurable ways. At the same time, we aim to create new public spaces in Louisville, ones that are immersive and interactive, educational and inviting.

Our site intervention begins with an initial staking of the vacant lot, at 2814 W. Kentucky Street, to create an immediate site identity and to allow for facile data collection. To do this, vertical poles at varying heights will be deployed in a 3'x3' grid. Then, at key points throughout the site, we will take small soil core samples to test for heavy metals and available nutrients. Based on this assessment, we will plant and help establish a variety of native plant-insect assemblages, each with unique stories to be discovered by visitors.

Our concept for Vacant Bugscapes is unique. Unlike typical native plant gardens, which tend to use idiosyncratic assemblages of plants, we use combinations organized by real ecological occurrences as well as educational themes. Some native gardens are referred to as butterfly or bee gardens because their flowers attract butterflies or bees. Our concept develops this idea to a new level, including augmentation of native insects to the garden rather than relying on nearby insects to colonize, which in urban areas are typically non-native or even invasive. Our proposal includes installation of native bee habitats to support native species instead of European honeybees, which outcompete and threaten native species. The plants we use have attributes (e.g., sticky resins) that native bees rely on to survive (e.g., using the resins as glue to adhere dirt into walls that keep parasites out). We will rear and release native species of various insects, including caterpillars, in the garden, so the butterflies feeding on floral nectar will be comprised of native species.

Most importantly, Vacant Bugscapes moves beyond butterflies and bees by adding less well-known insect species selected based on their interesting ecological and evolutionary interactions with the plants we are planting and their restoration importance. We seek restoration of entire plant-insect communities, not just single species. Learning about these species and their interactions will educate students and community members alike, enhancing their experience in the outdoors, and contribute to real restoration in a novel way.

Over time, the insects will inevitably drift, the plants will expand, and the soil will rejuvenate, creating an interactive outdoor classroom for those interested in exploring science and those interested in implementing some of these lessons in their own backyard. On the site, plant-insect interactions will provide a lens into ecology and evolution for students of all ages, starting with those enrolled at Brandeis Elementary School, located directly across the street. Students will be invited to immerse themselves in the native plants and the insects that have evolved with them over billions of years. Working with their science teachers the students will also install informational signs about each plant-insect assemblage so that community members can experience the excitement of the interactions occurring.

Beyond its educational potential, the 2814 W. Kentucky Street site, and potential future sites, will also serve as public, urban spaces. Providing shade, seating, and a beautiful garden, the lot can support a number of community functions from informal playscapes, small gathering spaces for local clubs, and healing gardens for all. While seemingly small, these project parcels will have a compounding effect in the community. In time, we imagine a confetti of bugscapes across Louisville, inviting curious minds to play, learn and grow with their city, while contributing to ecological research and real restoration.

<u>Lot</u>

We chose the lot at 2814 W. Kentucky Street because of its proximity to Brandeis Elementary School, a strong magnet school with a special focus on math, science and technology. Working with science teachers at the school, who have been identified and expressed excitement about the project, we will develop science projects for educational and research purposes, using the plant-insect assemblages in the lot. These basic experiments will introduce the students to scientific research and methods in a designed outdoor setting, fulfilling a need for interactive, hands-on based learning. We will also facilitate a collaboration between Brandeis science teachers and a laboratory at Ohio State University that specializes on vacant lot restoration ecology (The ALE Lab: Agricultural Landscape Ecology Lab). Graduate students from the ALE Lab will help Brandeis teachers with plant and insect identification and natural history, plant measurements, and formulating new science project ideas. The ALE Lab will also be important in designing larger-scale implementation plans in a way that is amenable to restoration ecology research.

The site is a prime candidate for restoration as it is relatively flat, well-maintained and easily accessible. It also has variation in tree cover which will aid in creating micro-habitats for the plant-insect communities. Furthermore, the community of Parkland has already made an effort to improve the ecology of the neighborhood including the recent planting of elms along 28th St.

Regional Outlook

While our proposal focuses just on a single vacant lot and collaboration with an elementary school across the street, our concept is designed to be scaled up. We hope to eventually implement Vacant Bugscapes throughout Louisville and, eventually, the country, using the model developed in this project. By selecting lots located in immediate proximity to schools and working with the schools to manage the lots and develop them into educational tools, Vacant Bugscapes immediately creates a new resource for schools struggling with diminished funding. We hope that schools will take over the majority of operational responsibilities after we help them set them up and obtain funding and local collaborators.

By scaling our concept up to a patchwork of native plant-insect assemblages occurring throughout the city we can begin to conduct rigorous restoration ecology research with elementary school students, community members and the ALE lab. Research questions in this field include whether our gardens increase the diversity of native insect species at the level of the city, and whether home gardens are less pest-infested as a result of more native predatory species being around. At a greater scale, with native plant-insect assemblages throughout the country in lots, parks and businesses, we would facilitate a return of native species to the urban landscape. Our belief is that vacant lots, city parks and gardens are just as important for the conservation of insect species as natural, protected areas.

Assemblages

Here we include a short description of each plant-insect assemblage theme (italicized) that we will use in the garden. A full list and diagrams of species as well as experiments we will develop with Mrs. Montgomery's students using these assemblages are in the supporting documents.

Sticky plants secrete viscous goos, which trap most small insects that try to walk on them. These insects may be eaten by carnivorous plants or used to lure predatory insects that are specialized to the sticky plant surface and defend the plants against damaging caterpillars. Sticky plants also secrete heavy metals - improving soil quality and safety over time, as well as resins used by native bees for constructing nests.

Fragrant plants produce odors that communicate with insects and their own kin. When under attack by caterpillars, they release smells that attract predatory insects like wasps and ants, and communicate to nearby plants to toughen up in preparation for caterpillar damage.

Galls and leaf mines highlight the hidden diversity and wonder of the natural world. Oak apple galls are essentially plant tumors that are made (for food and shelter) by a type of wasp larva which secretes hormones that mimic the plant's own growth hormones. Once the wasp becomes an adult and flies away, new inhabitants of the gall arrive, lead their lives, then leave. Leaf mines are beautiful patterns resembling squiggly lines on leaves, made by flattened fly and moth larvae that feed in the narrow space between the top and bottom of the leaf.

Milkweed produces poisons to stop insects from eating its leaves. Monarch butterflies, though, have learned to ingest the poison and, instead of dying, use that poison to make themselves poisonous. This is an especially critical relationship as the current monarch butterfly population is rapidly in decline. The milkweed beetle uses another strategy to circumvent the chemical defense, cutting the plant's vein upstream of where it feeds so that the poisons drain out.

Insect agriculture and mutualism is exemplified by ants that raise aphids. The ants move the aphids from plant to plant and protect them from predators, in exchange for the sugary honeydew secreted by the aphids, similar to how we raise cows.

Native bee habitats are easily made by drilling holes into blocks of wood, which the bees use to make nests in. Our native bee habitats will be placed in proximity to our sticky plant community, so that the bees can easily access the sticky resins they need for nest construction.

Many insects use *mimicry* as a way to avoid predators. The spicebush swallowtail caterpillar looks alarmingly like a small snake. Its fake eyes utilize the same strategy employed in the Mona Lisa to give the appearance that they are looking at anyone looking at them. The American Painted Lady feeds on everlasting flowers, then collects the petals as it goes along and sews them into a big fake flower that it inhabits. Spiders mistake the nest as a flower sit on it and wait for prey, including wasps in search of the caterpillar inside.

We will additionally release certain *charismatic arthropods* such as the garden spider, pipevine swallowtail and the Carolina mantid. These arthropods are large and immediately exciting to watch.

Implementation Plan

Ideally, we would begin the project in the winter to allow for greenhouse development. In early spring 2015, our plants would be transplanted to the site and allowed to grow. This delay in construction would aid us in devoting more time to creating community partnerships and identifying additional sources of funding for continued maintenance. We envision "Vacant Bugscapes" as a semi-permanent installation that can grow and evolve over the years.

<u>*Building Permits:</u> We do not need to apply for any building permits for the beds or stakes.
<u>*Zoning:</u> Public garden projects are allowed in residentially zoned areas so long as we observe property setbacks. Additional parking is available in the Brandeis Elementary School lot across the street.
<u>Specimen Collection Permits:</u> We have submitted special use permits to Daniel Boone National Forest and Land Between Lakes National Forest for collection of insects, and have been in contact with the respective botanists regarding when and where to find our species.
<u>Insurance:</u> We are waiting on a quote from Neace Lukens on liability insurance. They gave us an upper estimate of $1000/yr, which we are currently using in the budget. We are also requesting a certificate of insurance from Brandeis Elementary to cover students during outdoor classes.
*Information provided by David Marchal, Department of Codes and Regulations

<u>Implementation timeline: Milestones, dates, and associated costs</u>
<u>Winter 2015</u>
Objective: Purchase plants, seeds; rent greenhouse space
Costs: The majority of seeds will be obtained for free from the USDA Germplasm System (http://www.ars-grin.gov/npgs/). Species not available from the Germplasm System (Columbine, Anaphalis) will be purchased from Prairie Moon Nurseries ($200). Greenhouse space will be rented at Ohio State University ($200/mo. for 3mo. = $600). The ALE lab will facilitate this and hire someone to plant the seeds (5 hours, $20/hour = $100).
Total Winter 2015 budget: $900

<u>Spring-Summer 2015</u>
Objective: Establish lot. This will be accomplished with donated labor, particularly from our team

and Brandeis students. We will establish plants, set up poles and take soil samples. All team members will stay in Louisville for one week to do this.
Cost: Accommodations (hotel: $100/night, 6 nights = $600), rental car ($50/day, 7 days = $350) and expenses in Louisville (3 meals/day/person = 63 meals; $15/meal = $945).
Air fare from CA to Louisville and back for our three team members: approximately $1200.
Poles and groundcover, plus miscellaneous site materials: $1000.
Soil testing kits (40 kits, $12/kit = $480).

Objective: Collect Insects. Krimmel will go to Daniel Boone and Land Between Lakes National Forests to collect insects. Each trip will take approximately 2-3 days. Krimmel has identified locations where target insects occur, with help from Forest Service botanists that we are in contact with.
Costs: Gas money (approximately 401 miles, $3/gallon, 20mpg vehicle = $60)

Objective: Release insects. During our visit to Louisville, all team members will release insects with the ALE lab's participants, Mrs. Montgomery and Brandeis Elementary students; this will be complemented with educational materials and activities beforehand.
Cost: No cost
Total Spring-Summer 2015 Implementation Costs: $4735

Ongoing Operations and Maintenance Plan
The plants that we are proposing for the site are native and thus, do not require a lot of maintenance such as intensive irrigation. We are working with Brandeis Elementary to incorporate educational activities into ground maintenance. Essentially, the students would monitor the plants and insects then communicate the maintenance needs to our team and the school's groundskeeping staff, whose salaries we would augment based on the amount of work they do on the lot (estimated in the budget, below).

<u>Spring-Summer 2015</u>
Objective: Conduct science project with students
Cost: No cost

Objective: Maintain lot (students monitor, groundskeeping staff maintains)
Cost: 1 hour/week, 20 weeks, $20/hour = $400

Total Spring-Summer 2015 budget: $400

<u>Spring-Fall 2016</u>
Objective: Ongoing science projects
Costs: No costs

Objective: Collect and release more insects in spring
Cost: Airfare for all team members ($1200), accommodation for 6 nights ($600), rental car for 7 days ($350), food ($945), gas ($60)

Objective: Maintain lot
Cost: $400
Total Spring 2015 budget: $3655

Detailed Budget
Liability insurance: $1000/yr. for 2 yrs. = $2000
Winter 2015
Purchase of plant species: approx. $200
Greenhouse space will be rented at Ohio State University: $200/mo. for 3mo. = $600
Dr. Gardiner's lab will hire someone to plant the seeds: 5 hours, $20/hour = $100
Spring-Summer 2015
Travel for three team members: $1200
Accommodations: (hotel: $100/night, 6 nights): $600
Rental car ($50/day, 7 days): $350
Expenses in Louisville (3 meals/day/person = 63 meals; $15/meal) = $945
Gas and travel to collect bugs: (approximately 401 miles, $3/gallon, 20mpg vehicle): $60
Site materials (poles, groundcover, paint, seating, soil testing kits): $1480
Lot Maintenance: 1 hour/week, 20 weeks, $20/hour = $400
Spring-Fall 2016
Additional site visit in spring: Airfare for all team members ($1200), accommodation for 6 nights ($600), rental car for 7 days ($350), food ($945), gas ($60), lot maintenance ($400)

Total Project Budget (Winter 2015-Fall 2016): $11690

Additional Funding Sources
Since our project will not commence until next winter (when we will use greenhouses to jumpstart our plants), we will have time to find additional sources of funding to fill in the gaps. The scientific research and restoration applications of this project open new doors to funding, in particular the National Science Foundation, which is increasing its support of informal and formal science education for elementary school students.

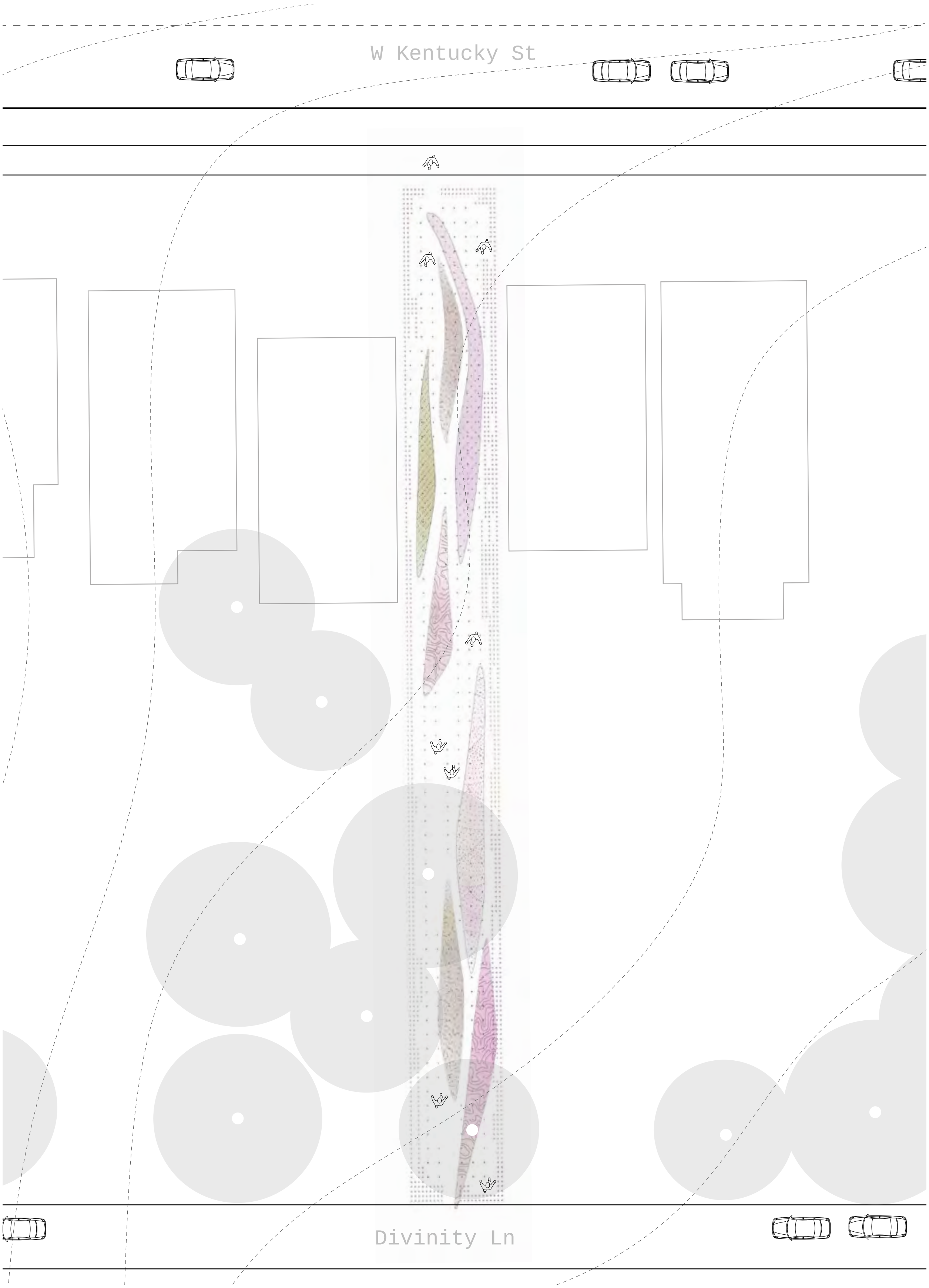
Brightside Naturescape Grant (proposal submitted March 26 2014):
http://www.louisvilleky.gov/Brightside/Green/NatureScapeGrants.htm

NSF Discovery Research K-12 Grant (proposal due October 16 2014):
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=500047&org=DRL&from=home

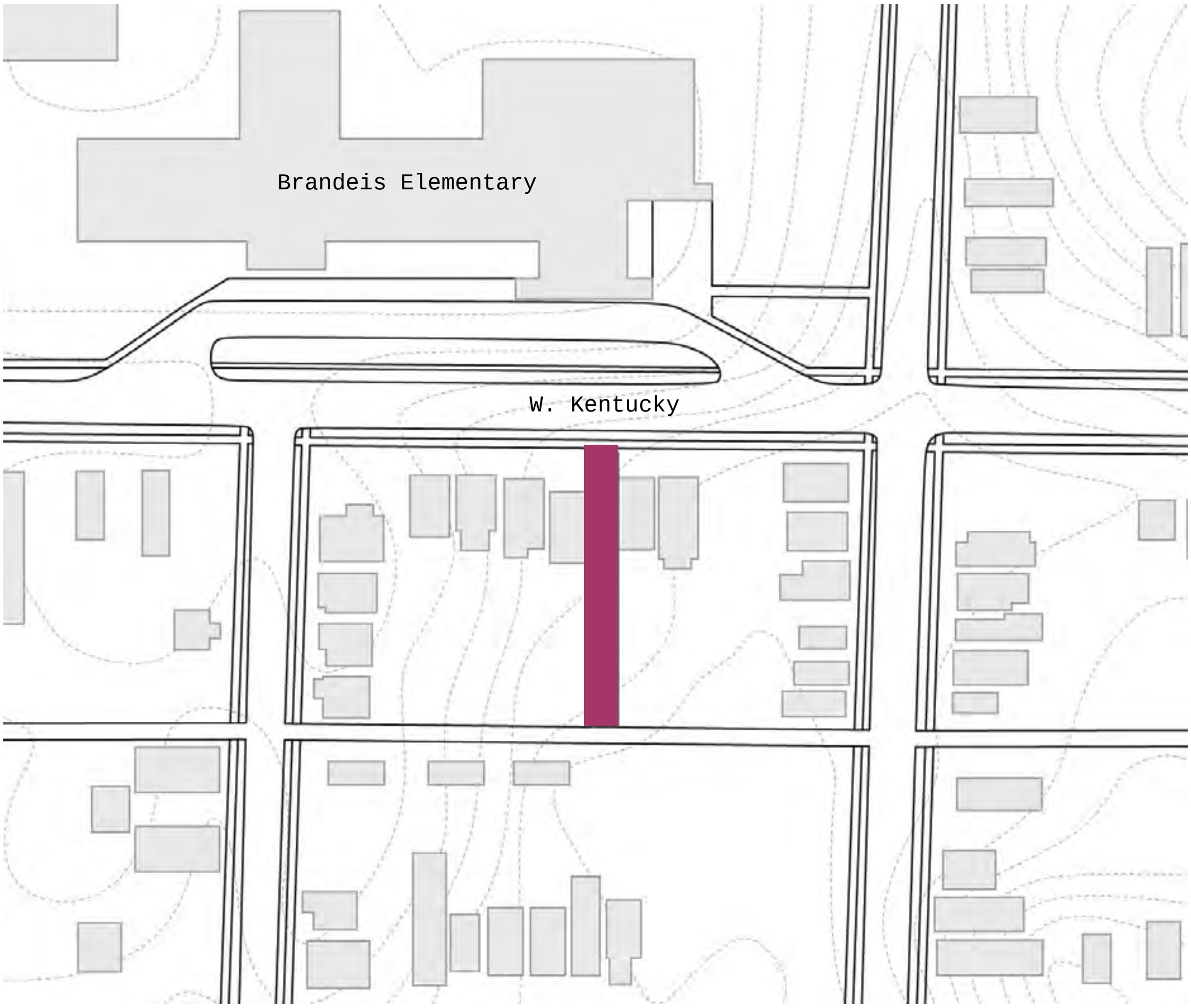
NSF STEM-C Partnerships Grant: (proposal due March 18 2015):
http://www.nsf.gov/pubs/2014/nsf14522/nsf14522.htm

ADDITIONAL MATERIALS

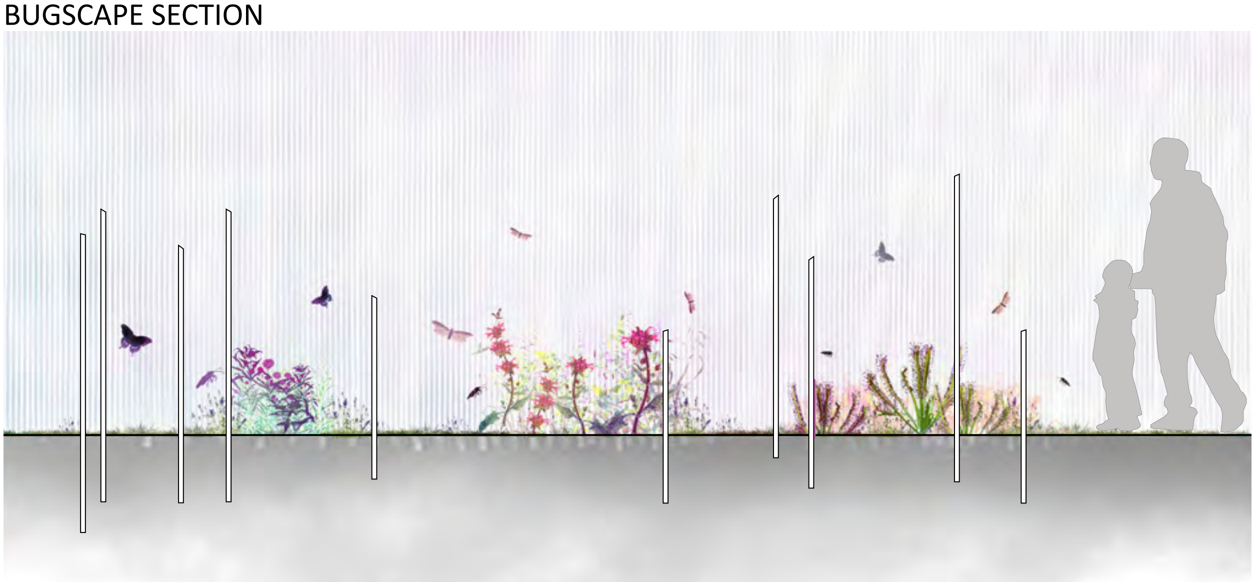
SITE PLAN



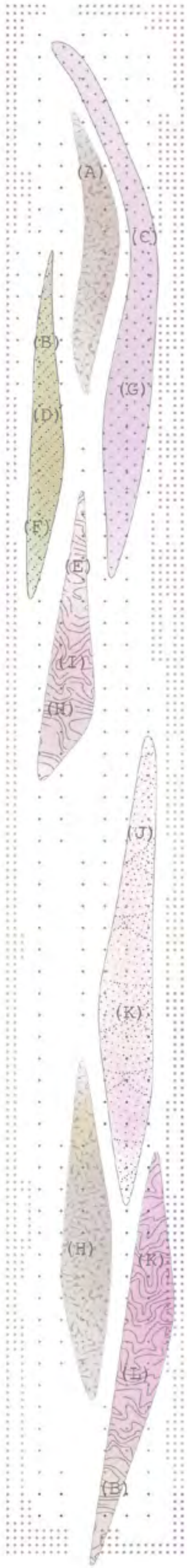
NEIGHBORHOOD CONTEXT



BUGSCAPE SECTION



PLANT SELECTION AND PROJECT SCABILITY



(A) Milkweed

(B) Sticky Plants

(C) Cudweeds

(D) Goldenrod

(E) Sundew

(F) Salvia Azurea

(G) Aphid Plants

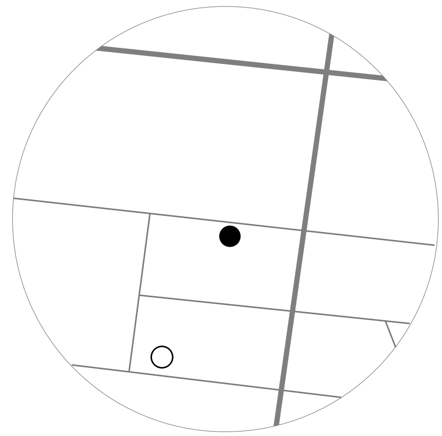
(H) Hedge Nettels

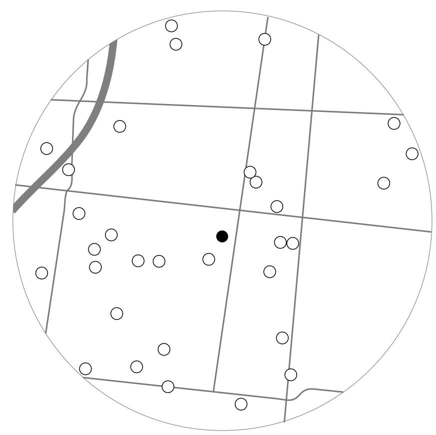
(I) Spice Bush

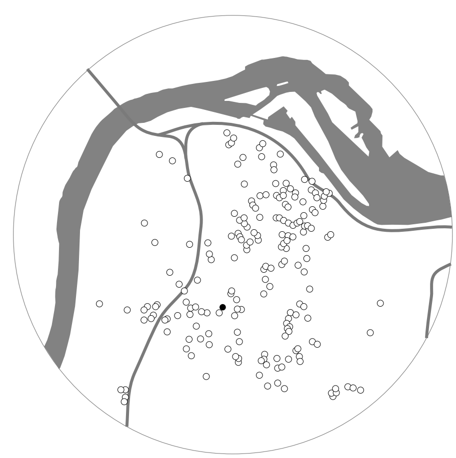
(J) Columbines

(K) Pipe Vine

(L) Clammy Locust

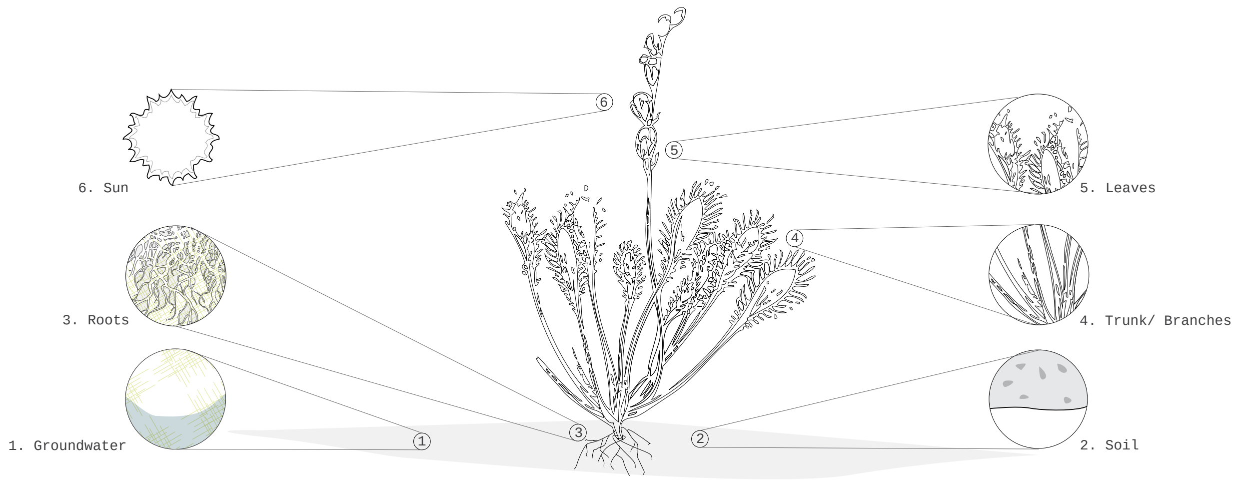






PLANT SELECTION

PLANTS + INSECTS



Plant-Insect Assemblages

Sticky plants and specialist arthropods: Specialization, coevolution, adaptation, soil remediation, carnivorous plants and wacky food webs
Explanation: Sticky plants catch many insects in the sticky hairs that coat their surface. Only certain insects with the right adaptations can walk on them, and these insects are specialists of sticky plants. On these plants they eat the dead insects that coat the surface. They also use smells released by the sticky secretions to find prey for themselves. Some of the sticky secretions are produced by the plants, and others are toxins like heavy metals that are taken up from the soil then excreted as a way of detoxification. Sundews are carnivorous plants that grow in bogs, which are increasingly threatened by human land use. Bogs have virtually no nutrients in the soil, so the plants must eat insects to obtain nutrients (i.e., fertilizer). Bees use resins from sticky plants to construct the walls in their nests that keep parasites out – the sticky resins bind with dirt to make a cement-like structure.
Potential school projects: (1) Correlate plant choice by bugs with traits (smells, stickiness); (2) Soil remediation; (3) Use of resins by different bee species (what species of bee use what species of sticky plant?)
Plants: Sticky catchfly (*Silene caroliniana*), sticky chickweed (*Cerastium glomeratum*), curlycup gumweed (*Grindelia squarrosa*), clammy locust (*Robinia viscosa*), clammy cuphea (*Cuphea viscosissum*), roundleaf sundew (*Drosera rotundifolia*)
Insects: Green lynx spider (*Peucetia viridens*), various plant bugs (*Macrolophus spp, Dicyphus spp.*), stilt bugs *(Jalysus wickhami, Jalysus mediospinosa*), assassin bugs (*Pselliopus punctipes*), sundew plume moth (*Bucklaria parvulis*)

Fragrant plants and insects: Similarities and differences with sticky plants, cues, insect senses, chemical defense
Explanation: Fragrant plants are similar to sticky plants in many ways. Their smells are made by hairs secreting scented fluids, just like the hairs that secrete sticky fluids on sticky plants, but instead of being sticky they are fragrant and often toxic. Many of the same bugs that specialize on sticky plants also specialize on fragrant plants, although the reasons why are somewhat mysterious. Fragrant plants communicate with bees and predatory bugs through their odors – different odors indicate different states of nectar production and herbivory, which the bees and bugs use to find food.
Potential school projects: (1) Correlate plant choice by bugs with plant traits
Plants: Blue sage (*Salvia azurea*), hedgenettles (*Stachys aspera, Stachys pilosa*), cudweed (*Anaphalis margaritaceae, Pseudognaphalium spp*)
Insects: Same as for sticky plants

Galls and mines: Hidden diversity and beauty, hostplant manipulation
Explanation: Galls are essentially plant tumors that insects make, then live inside. The insects - flies and wasps usually - release hormones that mimic the plant's own hormones. They do this to trick the plant into growing tissues made of just the right materials to feed a growing insect. Once the insect that makes the gall leaves, it leaves a large ball-shaped habitat on the plant that other insects move into. Leaf mines are made by tiny, flattened flies and caterpillars that live in the narrow space between the top and bottom of leaves. When they eat they leave a white

mark with unique patterns that can be really beautiful.
Potential school projects: (1) Identify the insect by the gall/mine; (2) See what moves into the galls when the gall-maker leaves; (3) Consider how the shape of the leafminers (flattened) is well-suited for living in the (thin) space between leaf epidermis; (4) Make leaf miner art, try to draw like the leaf miners, etc
Plants: Goldenrod (*Solidago speciosa*) red columbine (*Aquilegia canadensi*), red and white oak (already on lot!)
Insects: *Eurosta solidagnis* (goldenrod galls), *Phytomyza aquilegivora* (columbine leaf mines), cynipid gall wasps (already on oaks on lot!)

Milkweeds and their insects: Chemical defense, adaptations, coevolution and conservation
Explanation: Milkweeds produce a toxic latex that is poisonous to most animals, including humans. Only specialized insects that have adapted to it can eat it, such as the milkweed beetle, which cuts the veins carrying the latex upstream from where it feeds to drain out the latex. Monarch butterflies, whose habitat is becoming increasingly threatened, also eat milkweeds. Milkweed aphids, beautiful yellow aphids, have populations that rapidly boom and bust.
Potential school projects: (1) Learn about monarch migrations and biology, rear out monarchs; (2) cut vein upstream and see if it affects milkweed beetle growth as it feeds downstream
Plants: Milkweed *(Asclepias syriaca*)
Insects: Monarch butterfly (*Danaus plexippus*), milkweed aphids (*Aphis nerii*), milkweed beetle (*Tetraopes tetrophthalmu*)

Everlastings and painted ladies: Camouflage, manipulating plants and predators
Explanation: Painted ladies are beautiful butterflies that eat everlastings and cudweeds and make shelters by gluing the petals from the flowers they eat together to construct nests that look almost identical to actual flowers. They probably use these nests as a camouflage from predators - the nests look so much like flowers that some flower-dwelling spiders will actually sit on them and wait for wasps and bees to come, which they eat. The spiders might also protect the caterpillars from their own predators, like parasitic wasps.
Potential school projects: (1) Observe spiders, wasps and bees foraging on the nests and compare with species on actual flowers to see if they are the same species; (2) Paint nests green (make them not look like flowers) vs. white (like flowers) and see if more spiders hang out on the white nests
Plants: Everlastings and cudweeds (*Pseudognaphalium obtusifolium, Pseudognaphalium hellerii, Anaphalis margaritaceae*)
Insects: American Painted Lady (*Vanessa virginiensis*)

Ant-aphid interactions: Farming by insects, mutualisms
Explanation: Ants 'tend' aphids commonly, meaning they protect them from predators and parasites, move them around within and between plants, and feed on the honeydew the aphids secrete. This interaction is common among many different species of ants and aphids, and represents an easily observable mutualism with many tangible parallels to how humans interact with our natural world.
Potential school projects: (1) Remove aphids from plants with soapy water, then monitor plants to see how soon the aphids recolonize, and whether that correlates with the distance the plants

are from the ant colony (do the ants move aphids to new plants?); (2) Manipulate high-protein food access to the ant colony (add or don't add ground beef) and see whether it affects how many aphids the ants kill (they feed on the aphids when they need protein, but just drink their honeydew when they have ample protein).
Plant: Milkweed (*Asclepias syriaca*)
Insects: Ant: *Lasius neoniger* (we will establish a colony, with a reproductive queen), Aphid: Milkweed aphid Aphis nerii

Various exciting megafauna: pipevine (*Aristolochia macrophylla*) + pipevine swallowtail (*Battus philenor*), spicebush (*Lindera benzoin*) + spicebush swallowtail (*Papilio troilus*), Carolina mantid (*Stagmomantis carolina*), garden spiders (*Argiopes aurantia*)

Pest control by predators in Bugscape: Urban restoration ecology, pest management, biological control, economic benefits of insects
Explanation/School Project: Higher insect diversity is thought to provide economic benefits, particularly by insect predators controlling pests of crops and gardens. Using a technique established by Dr. Gardiner's lab ('Prey Buffet'), we will have students make caterpillars out of soft clay, then leave the caterpillars in their school garden where they grow vegetables. When birds or insects try to eat the caterpillar (representing pests), they leave small marks in the shape of their mouth, allowing identification. The students will deploy the caterpillars then collect them and look at them under a microscope to determine what, if anything, tried to eat it. They will then see whether the species that tried to eat it is one that we put in the garden.

Caterpillar scavenges entrapped insects on a sticky plant

A native bee pollinating a sage plant; bees use the odors from the plant's hairs for information on nectar availability

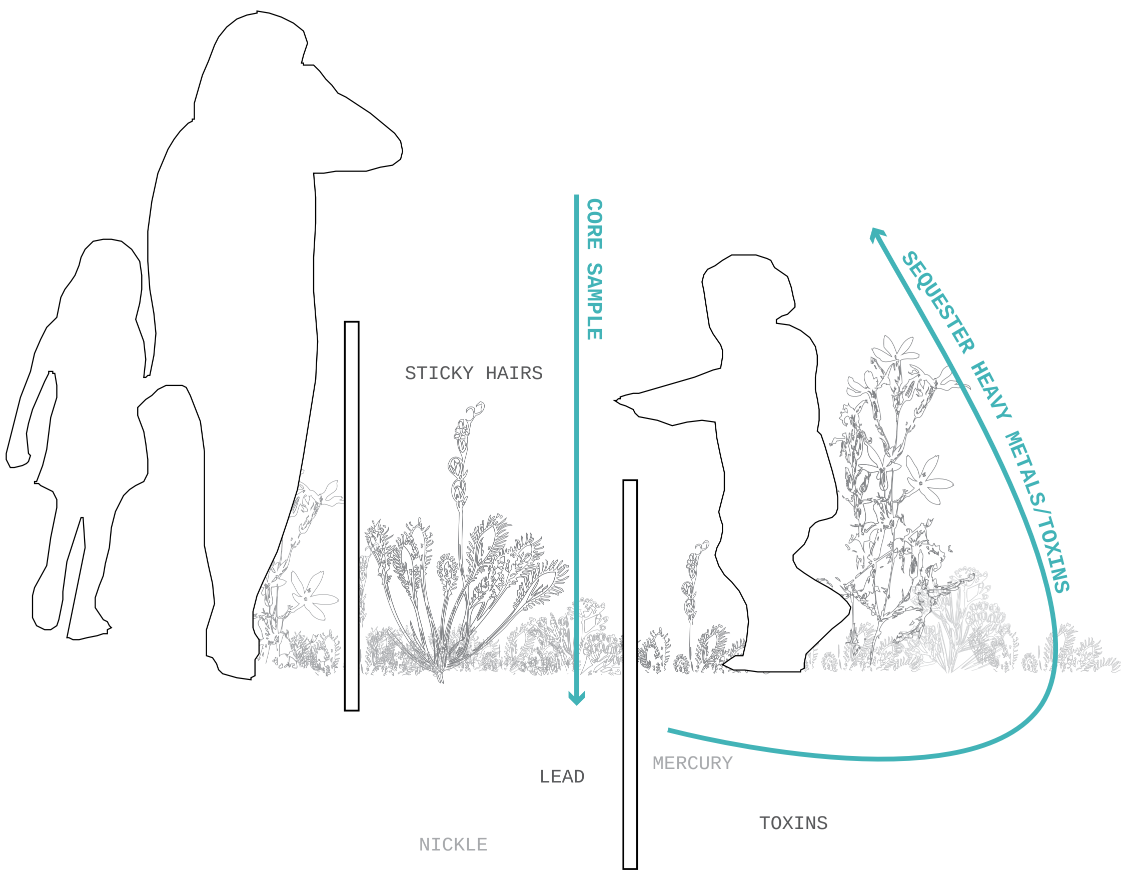
American painted lady caterpillar and its nest, made of petals from the flowers its eats. These nests resemble extra large flowers of the plant.

Left: Oak apple galls; they look like fruits but are actually tumor-like growths made by a wasp that feeds inside them. Right: Columbine leaf mines. The arrows show where the actual insect (a fly larva) that makes it is located.

Carolina mantid, spicebush swallowtail caterpillar (the 'eyes' are actually on the rear end of the caterpillar).

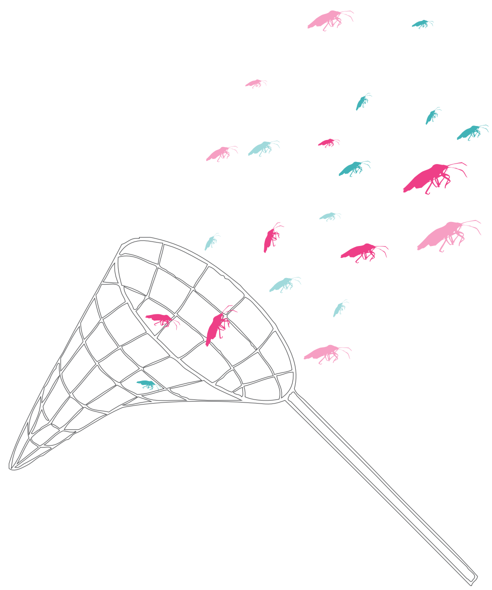
EXPERIMENT NO. 1:
STICKY PLANTS AND SOIL REMEDIATION

1. TAKE CORE SAMPLES TO SEE IF HEAVY METALS ARE PRESENT IN THE SOIL. STICKY PLANTS WILL SEQUESTER HEAVY METALS AND TOXINS. CHECK CORE SAMPLES OVER TIME, TO SEE IF HEAVY METAL LEVELS CHANGE. SIMULTANEOUSLY CHECK METAL LEVELS IN PLANT SECRETIONS.



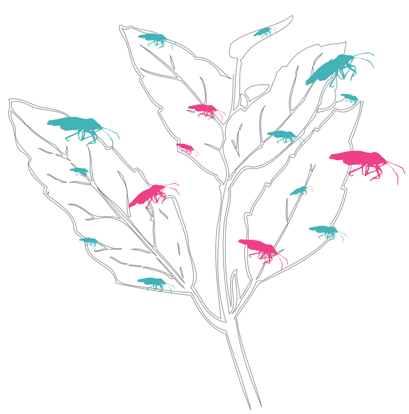
EXPERIMENT NO. 2:
HOST PLANT CHOICE BY INSECTS. WHAT PLANT TRAITS DO THEY LIKE?

1. RELEASE STICKY PLANT SPECIALIST INSECTS

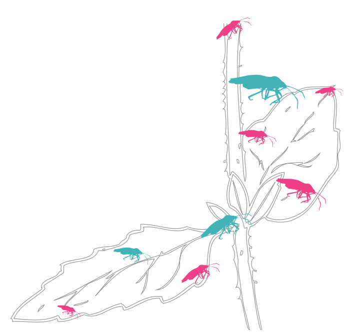


2. MEASURE WHAT PLANTS THEY GO TO

3. MEASURE DIFFERENCE IN PLANT TRAITS
(SMELL, LEAF TRAITS, THICKNESS)



11 BUGS OF SPECIES A
5 BUGS OF SPECIES B



3 BUGS OF SPECIES A
6 BUGS OF SPECIES B

EXPERIMENT NO. 3:
INDUCE PLANT DEFENCES

1. SPRAY 1/2 OF PLANTS WITH METHYL JASMONATE.
WAIT A FEW WEEKS.

METHYL JASMONATE (A PLANT HORMONE) TURNS ON THE PLANTS IMMUNE SYSTEM, MAKING THEM BETTER DEFENDED AGAINST INSECTS THAT WANT TO EAT THEM. PLANTS TREATED WITH METHYL JASMONATE SHOULD GET EATEN LESS = LESS LEAF DAMAGE

2. COMPARE LEAF DAMAGE OF PLANTS WITH
AND WITHOUT METHYL JASMONATE TREATMENT.

WITH METHYL JASMONATE

WITHOUT

Brandeis Elementary School
2817 West Kentucky Street
Louisville, Kentucky 40211
(502) 485-8214
Fax 778-7354

Jefferson County Public Schools
Shaping the Future

March 28, 2014

To Whom It May Concern:

Brandeis Elementary School wishes to partner with Emily Schlickman and colleagues of the University of California, Davis, for consideration of developing a vacant lot in Jefferson County for student learning and instructional purposes in the Louisville Lots of Possibility Competition.

The aforementioned project will include the development of an outdoor classroom and public space on the proposed vacant lot for assemblages of plants and insects that support ecological regeneration. The site, 2814 W Kentucky Street, was chosen primarily because of its proximity to Brandeis Elementary as it is located directly across the street. Brandeis Elementary School is a progressive science and technology-focused public magnet elementary program, and the thought of an outdoor classroom could be a great resource for the students as well as the larger neighborhood.

Brandeis teachers and students would greatly appreciate the opportunity to work in conjunction with the University of California, Davis on this worthwhile project in developing goals and educational projects for the vacant lot. The possibilities can be endless as Brandeis teachers work with students in developing science knowledge and skills.

Thank you, in advance, for your consideration. Brandeis looks forward to participating in this valuable and creative project.

If you have any questions or concerns, please do not hesitate to contact me at Brandeis Elementary School at 502-485-8214.

Eduactionally,

Sam L. Cowan II
Assistant Principal

College of Food, Agricultural, and Environmental Sciences
Ohio Agricultural Research and Development Center
The Agricultural and Urban Landscape Ecology (ALE) Lab
Department of Entomology

Thorne Hall
1680 Madison Avenue
Wooster, OH 44691

330-202-3555 Ext. 2560 (Office Phone)
567-215-5880 (Mobile)

hoekstra.10@osu.edu

April 3, 2014

To Whom It May Concern,

I am writing this letter on behalf of the ALE Lab at The Ohio State University to show our support of Billy Krimmel's project for the Lots of Opportunities competition being held by the city of Louisville, Kentucky. We love the concept of using the space as an educational platform to teach elementary students about the benefits of native plants to arthropod communities and the relationships between them through ecology and evolution related experiments.

Billy contacted us because we are heavily involved in vacant lot research in Cleveland, Ohio. We have just started a new, large scale study this year that will examine how the selection of green infrastructure alters biodiversity and ecosystem functioning, focusing on arthropods, within the greenspace. The project includes 64 vacant lots that are split between eight neighborhoods in such a way that each lot in a neighborhood will have a different planting treatment. The planting treatments range from a control to a prairie style habitat with tall grasses and a high diversity forb mix. Our goal is to be able to suggest a greenspace design to the City of Cleveland that will be beneficial to both the city and to the arthropod communities and other wildlife inhabiting the spaces.

In addition to the vacant lot study, our lab is also working with EPA to design rain gardens using native plants and Cuyahoga river dredge material to provide a distributed storm water management network that also supports beneficial arthropods and other wildlife. The rain gardens have been installed and we will begin data collection this summer. In previous studies, our lab has quantified arthropod communities and ecosystem services they provide within community gardens and farms established on vacant lots.

We understand that as part of Billy's project, we will be assisting and advising the teachers at Brandeis Elementary School on the scientific aspects of the planned lessons and experiments they will be conducting with the students and are happy to do so. Additionally, we will also be happy to help Billy and his team with any questions they may have on designing conductible experiments for the students utilizing the lot. If you have any questions, please feel free to contact.

Sincerely,

Nicole Hoekstra