Ghazian Progress Report

York University, Toronto, ON

Spring 2019

**Examining microclimatic effects on vertebrate interactions with foundational plant species.**

**Examination Committee:**

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Table 1. MSc research timeline.

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| Chapter | Title | timeline |
| 1 | **A picture is worth a thousand hours: a systematic review of camera trap papers to test for reported sampling effort.** | Full-text articles have been assessed for eligibility.  Data extraction in progress and should finish in May 2019.  Chapter 1 will be drafted by September 2019. |
| 2 | **Examining plant-animal interactions at a microsite level.** | Field season will run 15/05/2019-15/06/2019.  Some statistical analyses have been done for previous year’s climate data.  Camera trap data will be extracted by October 2019.  Analysis and writing should finish in the winter of 2019. |
| 3 | **Exploring the effects of shelters on microclimate.** | Field season 2019.  Shelter design is complete.  Shelters will be built and deployed in the field May 2019.  Shelters will be re-visited August 2019 and data will be extracted.  Analysis and writing should finish July 2020. |

**Background**

In 1994 Bertness and Callaway’s1 ‘stress-gradient-hypothesis’ (SGH) paper discussed the switch from competition to facilitation under stressful environmental conditions. This sparked the interest of many for examining positive interactions. Since, various studies have focused on positive interactions in harsh environments, including arid ecosystems2–4. Facilitation is a type of positive interaction where one interacting species benefits whilst none are harmed5. Much of facilitation research is focused on plant-plant interactions6, though the emergence of studies focusing on animal-plant interactions is also observed7,8.

Foundational plant species or nurse plants are an integral part of facilitation research9. These include shrubs, perennials, trees, or cushion plants that benefit other plants or taxa10 through various mechanistic pathways that include, but are not limited to, seed trapping, abiotic stress amelioration, and soil modification9. An important agent of abiotic stress amelioration is shrub canopy, able to facilitate animals through direct and indirect shelter and refuge effects11,12. Thus, it is understood that foundational plants serve as a great focal point for a variety of studies hoping to examine plant-plant, plant-animal, plant-plant-animal, or plant-animal-animal facilitation in a given ecosystem.

Carrizo Plain National Monument (35.1914° N, 119.7929° W) is the largest remnant ecosystem of the San Joaquin Desert located in the south-eastern San Louis Obispo Country13. The plain is home to various dominant shrub species such as *Ephedra californica* (Mormon tea) and *Atriplex polycarpa* (saltbush)14. *Ephedra californica* is a well-adapted, slow-growing shrub which spreads colonially in hot deserts15, generally growing in elevations of 200-1200 m. Although severe fires can kill the plant16, it is fairly resistant to moderate fires with the ability to sprout. Ephedra’s high abundance and resilience in this ecosystem makes the perfect plant for facilitation research.

Desertification and arid region expansion is not only prevalent in the Carrizo Monument, but is also a critical global change issue17. The well-being and function of foundation plants species may depend on factors such as in temperature, variability in precipitation, extended drought periods, and radiation 18–20. The changes in the above microclimatic parameters are primarily due to anthropogenic climate change21 that significantly modifies physical and biological systems in all continents22. Climate-driven behavioural plasticity encourages shifts in habitat so behavioural regimes can continue to function23. Thus, closing this research gap by examining behavioural-ecological domains such as movement and spatial pattern, forging and vigilance, social organization, and reproductive behaviour24 is important. I propose that microclimatic parameters, such as temperature and radiation, are able to influence the associational behaviour of vertebrates with shrubs. Particularly, I’m interested in quantifying the extent to which temperature and solar radiation can influence this interaction via camera trapping data.

Camera traps allows researcher to obtain wildlife data with relatively little to no human disturbance25. Studies have explored their use to estimate population size26, examine wildlife behaviour27, and explore activity patterns and habitat use28. Although camera traps have been used to look at animal interactions with plants to an extent29, their use to examine shelter and refuge effects of foundational plants is unique. Despite previous literature’s focus on closing the gaps that exists in photographic rates as an index of density 30, to my knowledge no single study to this date has systematically compiled data from previous research to generate species rarefaction curves based on camera trap sampling effort. This is an important research gap as rarefaction curves can provide insight into the sampling effort required in a given environment to accurately determine species richness.

Crops and plants can act as natural shelters by providing shading effects, reducing wind speed, and decreasing the nearby CO2 concentration31. However, various synthetic shelters can also be designed and deployed in the field to test for their influence on microclimate. Open-top Chambers (OTC) are relatively inexpensive and provide the means to manipulate parameters such as CO2, temperature, soil temperature, solar radiation, and humidity32,33. Yet, a cheaper alternative is UV-permeable Perspex shelters that can be used to increase the temperature, allow airflow, and change radiation intensity and UV permeability. To the best of my knowledge, no experiment has paired Perspex shelters with camera traps and temperature pendants in order to examine the impact of manipulations of the above parameters on animal behaviour. The closest analog is animal monitoring under solar panel arrays 34, but these surveys typically include full light exclosures by the panels. Thus, a field study testing a variety of shelter types can provide more insight into how each can influence the microclimate. This knowledge is key to the better understanding of how natural shelters, such as shrubs, may mediate the impacts of climate change on animals in the near future.

**Chapter 1:** **A picture is worth a thousand hours: a systematic review of camera trap papers to test for reported sampling effort.**

**Purpose:** Identify the relevant literature using camera trapping to examine species richness and diversity as an index of sampling effort.

**Questions:** How many hours, days, or months are needed to estimate the species richness and diversity of a given ecosystem using a camera trapping tool? What taxa are usually recorded (i.e. mammals, Aves etc.)? Does the temperature of the study period function as a covariate when predicting species richness?

**Methods:** The PRISMA diagram (Figure 1) workflow describes the process of this meta-analysis. A citation alert set up on Web of Science with key terms ensures that the review is up to date.

**Preliminary Results:** Studies were selected from a scientific database (Web of Science) using the keywords: Camera Trap\* AND Richness\*, Camera\* Trap\* AND Diversity\*, and Camera Trap\* AND Rarefaction\* Curve\*. A total of 515 studies were selected, which resulted in 397 studies when duplicates were removed. Many of the papers were either long-term, wildlife monitoring studies or agricultural. However, every so often I came across studies involving aquatic ecosystems and coral reefs. 143 studies were excluded on the basis of being: qualitative, an idea paper, a review, or focusing on one species. A study was automatically excluded if the paper was not written in English.

An entire paper was selected for the analysis if it contained the species richness/diversity and at least some sort of a measurement of time spam (hours, days, months, and/or camera trapping days), in addition to the number of records. If the study reported a measure of temperature, this was recorded; however, most studies did not. Thus, external research needs to be done in order to obtain climate data.

**Future Direction:** Currently data are being extracted from 252 full text studies. The aim is to finish this process in May, 2019 and start the statistical analysis. I hope to write the paper by September, 2019.

Papers obtained through database searching (Web of Science) Keywords:

Camera\* Trap\* AND Richness\*, Diversity\*, and Rarefaction\* Curve\*

(n= 515)

(n = 1090)

Full-text articles assessed for eligibility (n = 252)

(n = )

Records after duplicates removed   
(n = 397)

## Identification

Papers obtained from other sources, such as book chapter bibliographies

(n= 0)

## Eligibility

Records excluded for: relevance, review, opinion or idea paper, focus on one spices, qualitative, not English.

Records screened by abstract (n = 397)

## Screening

Full-text articles excluded:

Not reporting richness or diversity, number of records, and any measure of duration.

Include in synthesis

(n = )

Extracted data:

Location (lat, long), duration.hours, duration.months, camera trap days, number of records, animal richness, scientific name, year, number of cameras, number of sites, month of study, type of ecosystem, study design, and some measure of temperature for study period

## Included

Figure 1: PRISMA diagram35 used for camera trapping effort systematic review.

**Chapter 2: Examining plant-animal interactions at a microsite level.**

**Purpose:** To examine whether animal association patterns with shrubs are explained by microsite level fluctuations in temperature and light.

**Question:** To what extent do radiation intensity, air and soil temperature influence the association of vertebrates with foundational plants? How does the strength of this association change as the above microclimatic parameters increase or decrease? Is this association species-specific and does it depend on the animal’s lifestyle?

**Hypotheses and predictions:** Shrubs can act as thermal refuge for many desert animals. As temperature increases, the association for animals such as ectotherms, which rely on the environment for internal temperature regulation, may also increases. Shrubs can also provide shade that can be used by all types of animals (ectotherms or homeotherms) when radiation is at its peak and the animal needs to cool itself.

**Methods:**

Camera trapping will be done in the Spring-Summer of 2019 in the Carrizo National Monument at 2 different sites. Cameras will be moved around to maximize incidents of associational observation. Each camera will be deployed facing a shrub 3 meters away from shrub canopy. The open microsite equivalent will be placed back-to-back with the shrub camera, but evidently recording the open. Cameras will be placed exactly at ground level at any given coordinate and secured using pegs. 2 sets of temperature pendant loggers (one soil and one air) will be placed below the canopy for shrub microsite and 3 meters away from the camera in the open for the open microsite to log temperature and light intensity data in 30 minute intervals. The air pendants will be secured to pegs using zip ties and placed 2-3 cm above ground. Images collected will be saved as Joint Photographic Expert Group (JPEG) format where data such as presence/absence of an animal will be extracted. Video trap data from another lab member’s research (Mario Zuliani) will also be used to further explore and confirm the activity of these vertebrates. Shrub height, length, and width (x, y, and z) dimensions will also be recorded once before and after the study is finished. Soil moisture measurements will be recorded from under the canopy and the open on a daily basis.

**Progress to Date:**

* Carrizo monthly weather data from the year 2018 was retrieved from a nearby satellite located in Cuyama (<https://cimis.water.ca.gov/WSNReportCriteria.aspx>) to explore climate patterns of the region. Analysis showed that July, followed by August were the hottest months. February was the most humid month with the maximum humidity percentage reaching 99%, whilst July was the least humid. Total precipitation was the highest in January totalling 23.3 mm. May to September experienced no precipitation.
* During a January trip to California, I tested loggers and pendant and decided that pendants were a better choice as they were more compact and had lower chance of being chewed by animals. This ensures that data are not lost.
* Methods were further revised.
* An equipment list was made and new equipment has been ordered or is in the process of being ordered.

**Chapter 3: Exploring the effects of shelters on microclimate.**

**Purpose:** To explore how umbrella, Perspex, solar panel, and mesh shelters influence the temperature and light of their canopy.

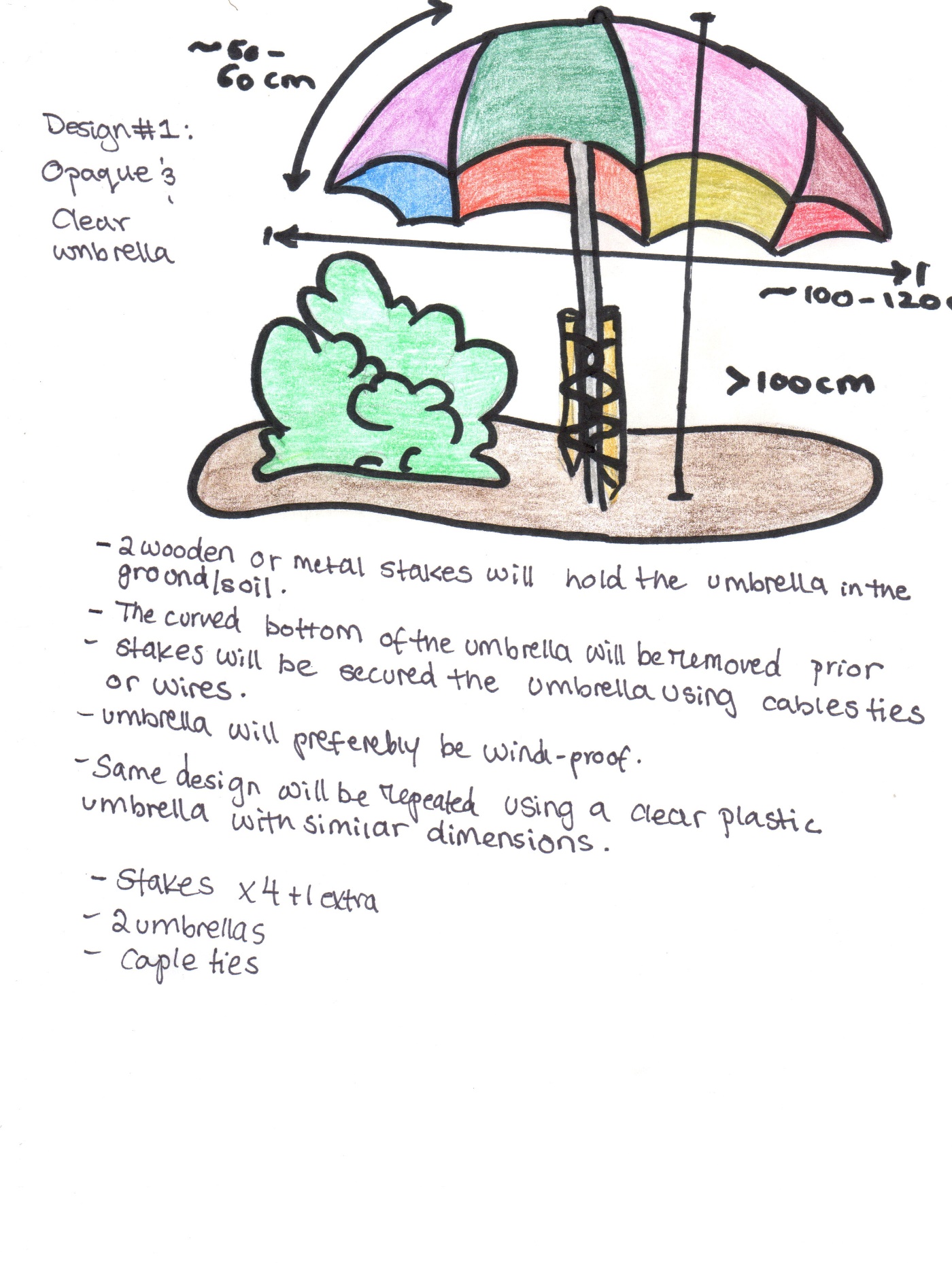
**Questions:** How does the canopy coverage of various shelters differ? To what extent does the shelter material and design affect temperature and light fluctuations? What are the implication of this study for various climate change scenarios? Do solar farms alter the microclimate of their respective microsite?

**Hypotheses and predictions:** Foundation species, shelter, and relatively large objects in desert ecosystems influence microclimate, association behaviour, and population dynamics including movement.

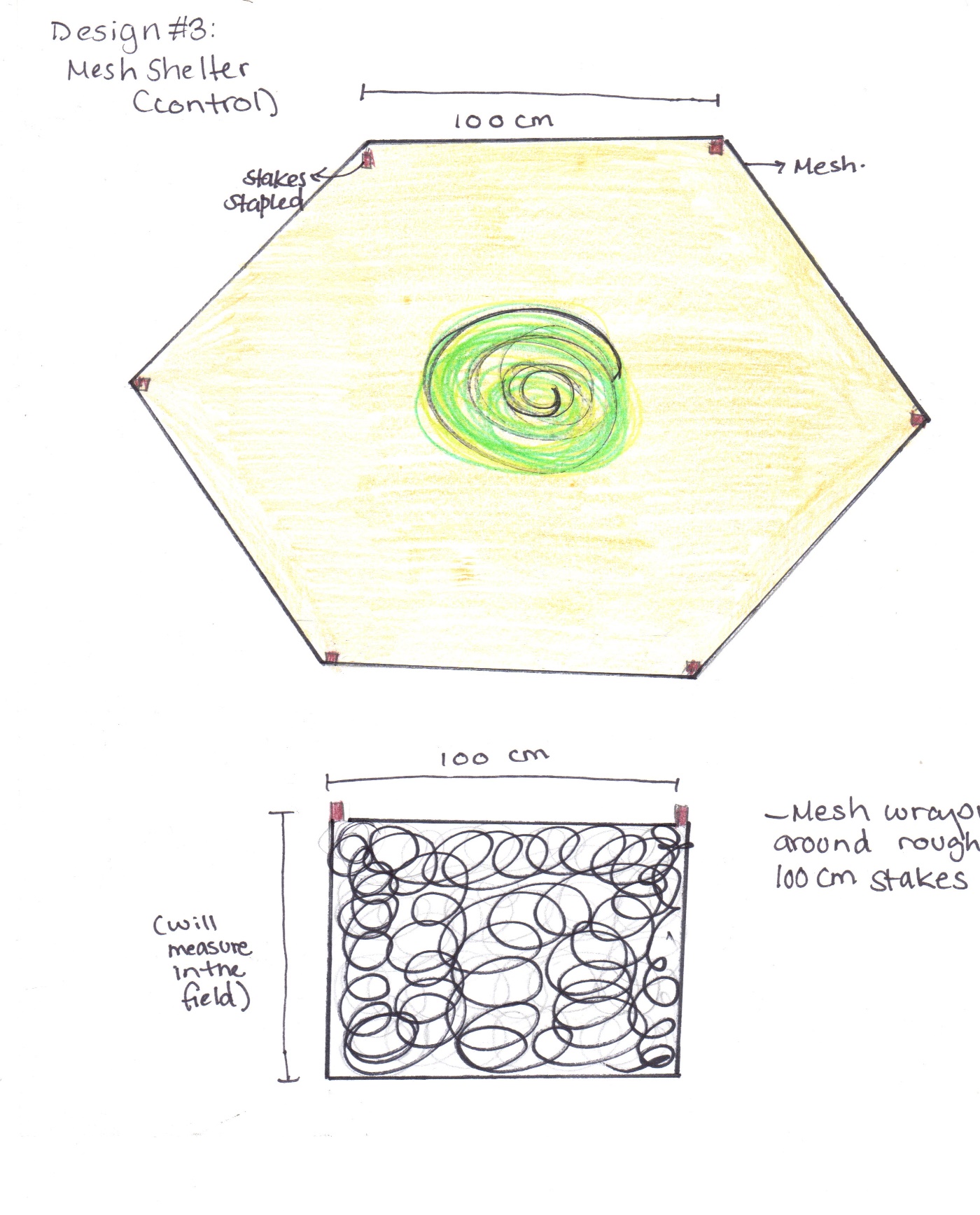
**Methods:** Shelters will be built and deployed in a Bureau of Land Management secured lot in Hollister, California. The types include: umbrella opaque, umbrella clear, mesh, Perspex OTC, solar panel. Details on each shelter type can be found below in Figures 2-4 (Note: measurements are rough estimates and may be subjected to change). One set of temperature/light pendant will be placed into the soil under the shelter canopy and one will be secured to a peg using zip ties and placed 2-3 cm above ground, still under the canopy. The same will be repeated outside in the open directly beside the shelter to serve as control. Pendants will log data in 1 hour intervals. Shelters will be re-visited in August where temperature/light data will be downloaded.

**Progress to Date:**

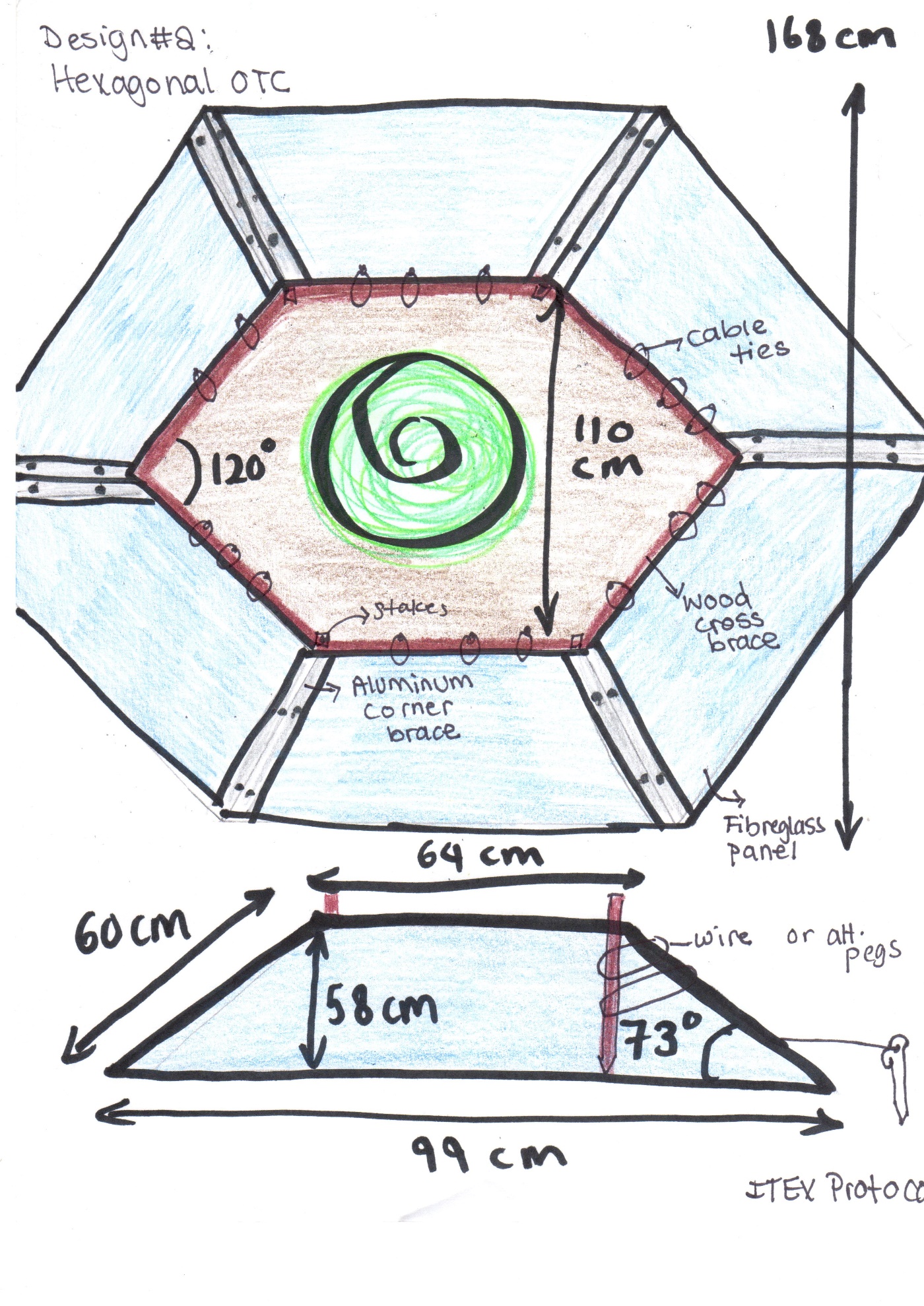
* Hollister was visited in January and rain-out Perspex shelter prototype was built and deployed with loggers.
* Methods were refined and shelter designs were modified.



**Figure 2. Umbrella Shelter** One clear that allows light through and one opaque, which limits the amount of light coming through.



**Figure 3. Mesh shelter**



**Figure 4. OTC/Perspex Shelter** This design will be modified to use Perspex instead of fibreglass sides. Because aluminum sides come in a 90° angle, the hexagonal shape will be modified into a square to make assembly easier.

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