Ghazian Thesis Proposal

York University, Toronto, ON

Nov. 19th, 2018

**Effects of weather on vertebrate interaction with foundational plant species: Implications for anthropogenic climate change in arid ecosystems. Hmmm any other title options?**

**Microclimatic effects on vertebrate interactions with foundation plant species.**

**Or A contrast of micro and macroclimatic effects… etc./**

**Or Temperature effects on …**

**Examination Committee:**

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**Table 1. Summary** of each thesis chapter including methods, progress, and timeline goal.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Chapter | Title | Methods | Progress | Timeline |
| 1 | **A systematic review of camera trap papers to test for reported sampling effort.** | Extract data for number of pictures taken, number of species seen, and location peer-reviewed primary literature. | -Have X papers compiled  - | -Analyse data in January 2019 and have the manuscript by end of April 2019 |
| 2 | **Plant-animal interactions on site-level? temperature gradients**  **- etc titles like you would for the papers.** | Camera trap incidents of an animal near shrub for both 2017 and 2018 data in the Carrizo National Monument at 2 different sites shrub and open  -Obtain long term weather data of each region (at least for those two years)  -confirm behaviour with shrub using camera trap video data | -Imagery data all processed  -Long-term weather data for **precipitation, air temperature, soil temperature, relative humidity, and solar radiation**  -put X videos are processed etc. | -Match data to weather February-April 2018  -Do stats May 2019  - Have a manuscript ready by Sep. 2019 |
| 3 | **Temperature effects on vertebrate animal use of foundation plant species in deserts. OR just say shelter effects on vertebrate animal interactions with foundation plant species.** | -Have 2 sites in Carrizo for the experiment  - microsite: open, shrub, shelter open, control, shelter temperature and soil, shelter radiation deploy shelters  -Measure growth of plants, take soils samples before and after  -camera trap set at a few | -Field season 2019 Spring-Summer | -Have a manuscript ready by January 2020  -Wrap-up thesis by September 2020 |

Overview table good – just be more specific and a bit more direct too.

**Background**

For decades, individualistic and competition theories were the topics most favoured by plant ecologists. However, Bertness and Callaway’s (1994) ‘stress-gradient-hypothesis’ (SGH) of competition to facilitation switch under stressful environmental conditions sparked the interest of many for the topic. Many studies have thus focused on facilitation in harsh environments including arid ecosystems (Maestre et al. 2009; Michalet et. 2014) – find a more recent review. Facilitation is defined as an interaction where one interacting species benefits whilst none are harmed (Bertness and Leonard 1997). Although most facilitation research have focused on plant-plant interactions (Lortie, Filazzola, and Sotomayor 2016), the emergence of studies focusing on animal-shrub/plant has become more prevalent in recent years Lortie, C. J., Filazzola, A. and Sotomayor, D. A. 2016. Functional assessment of animal interactions with shrub-facilitation complexes: a formal synthesis and conceptual framework. - Functional Ecology 30: 41-51.

(Dalsgaard et al. 2011; Watson 2016) . At the centre of facilitation research lies the concept of foundational plant species or nurse plants, which are usually shrubs, perennials, trees or cushion plants that benefit other plant or taxa (Gómez-Aparicio et al. 2004) through various mechanistic pathways such as seed trapping, abiotic stress amelioration, soil modification, and pollinator visitation for other plants (Filazzola and Lortie 2014) and X,Y,Z for animals (Lortie, C. J., Filazzola, A. and Sotomayor, D. A. 2016. Functional assessment of animal interactions with shrub-facilitation complexes: a formal synthesis and conceptual framework. - Functional Ecology 30: 41-51). In particular, shrub canopy is thought to be the most important agent of structural facilitation for animals through direct and indirect shelter and refuge effects (Bråthen and Lortie 2016; Lortie et al. 2018). Hence, 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. Good.

Global desertification and arid region expansion are critical global change issues (Asner and Heidebrecht 2005). Temperature, variability in precipitation, extended drought periods, and radiation are probable factors affecting the function of foundation species (Kogan and Guo 2015; MacDonald 2007; Tattini et al. 2006). The changes in the above weather parameters are primarily due to anthropogenic climate change (Gibelin and Déqué 2003) that significantly modifies physical and biological systems in all continents (Rosenzweig et al. 2008). Few studies have focused on the effects of anthropogenic factors on animal behaviour or the conservation of general biodiversity (Berger-Tal et al. 2016). Thus, closing this research gap by examining behavioural-ecological domains such as movement and spatial pattern, forging and vigilance, social organization, and reproductive behaviour (Berger-Tal et al. 2011) against the landscape can provide crucial knowledge for conservation paradigms and frameworks. What is weather? If you want to use, need to define and make the difference between weather and climate clear. OR maybe just dump term weather? Use micro and macro-climate as the terms and ideas? What does the limited lit on this topic usually do? Weather-driven behavioural plasticity can promote shifts in habitat so behavioural regimes can continue to function despite changes in climate (Noonan et al. 2018). Here, we propose that weather patterns?? can change in vertebrate behaviour and their interactions with foundation plant species in deserts continue to grow hotter and arid regions continue to expand. Hmm – ok – at one level I love at another – I am worried people will a. not like weather idea b. say there is loads of lit on animal species and climate-adaptation??? Is there? And c. say that some species use behaviour to manage temperature, like lizards and other poikotherms etc. – and that this is obvious – UNLESS you make it clear that it will be the frequency and extent that they have to i. adapt, ii. Change behaviour, and iii. There may be limits to their capacity to respond to temps? Need a clearer framework here.

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 Country (Noble et al. 2016). The dominant shrub species are *Ephedra californica* (Mormon tea) and *Atriplex polycarpa* (saltbush) (Stout et al. 2014). The species *E. californica* is a slow-growing shrub which spreads colonially in hot deserts (citation). It is well-adapted to alluvial substrate and shifting sand, generally growing in elevations of 200-1200 m. Although severe fires can kill the plant (Anderson 2004), it is fairly resistant to moderate fires with the ability to sprout. Ephedra’s high abundance and resilience in this ecosystem makes it the perfect plant to study positive plant-animal interactions.

Open-top Chambers (OTC) are relatively inexpensive and provide a means to manipulate parameters such as CO2, temperature, soil temperature, solar radiation, and humidity (Chiba and Terao 2014; Welshofer et al. 2018). However, 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 our knowledge, no experiment has paired Plexiglas shelter designs with camera traps in order to examine the impact of manipulations of the above parameters on animal behaviour. The closed analog is animal monitoring under solar panel arrays (citations) but these surveys typically include full light exclosure by the panels. Camera trapping allows researcher to obtain wildlife data with relatively little to no human disturbance (O’Connell et al. 2011; Trolliet et al. 2014). Previous studies have explored the use of cam traps to estimate population size (Karanth 1995), examine wildlife behaviour (Dupuis-Desormeaux et al. 2015), and explore activity patterns and habitat use (Bowkett, Rovero, and Marshall 2008). Although cam traps have been used to look at animal interactions with plants to an extent (citation), using to explore shelter effects and interactions with foundation plants is both novel and critical to better understand solar farm deployments and other developments in desert ecosystems. Then – implication.

ALSO – I think you should reorganize and can just talk about shelter effets in general and list all the ways that animals can be impacted and also reponds. THEN state that temperature could be a very important negative?? Or positive factor? On some animals and positive/negative to others – ie depends if lizards or small mammals right? Also, we want to know really very directly if ‘thermal refuges’ provided by foundation species are CRITICAL – this is the MAIN idea and needs to pop…. Develop a bit and explain please. Things likely getting hotter and drier too – shrubs and other foundation species are refuge for animals and other plants from these effects etc and here we want to warm microsites and also test general general shelter effects…. SO – are we sure our shelters will not cool??? Ie they will provide shade??? OR really are you testing shade effects on animals near shrubs and in the open??? IF SO – STILL COOL but you will need to also test warming – IF that is what you want via OTCs too – OR just do shelter and measure temperatures with hobo pendant loggers and use the natural variation under shrubs, in the open, and then under shrubs with a shelter over top and in the open with a shelter over top – ALSO great – I think this latter option is totally fine and also really SIMPLE!!!

Then – in your proposal, say in year 1- you will test a very small number of OTC chambers – as a pilot only – that you may do the following year in season 2 to see if warming is important….

Separate idea – that I like – develop a bit more in a short paragraph properly here. Additionally, despite previous literature’s focus on closing the gaps that exists in photographic rates as an index of density (Carbone et al. 2001; Rovero and Marshall 2009), to my knowledge no single study to this date has been published that concentrates on generating refraction curves of number images versus species richness compiled from previous research data.

**Chapter 1: A systematic review of camera traps to generate species rarefaction curves**

**Purpose:** Identify the relevant literature using camera traps to examine sampling efficacy for abundance and richness of animals with this trapping tool.

**Questions:** How often are camera traps used as a research method? In which ecosystems is camera trapping most often used? What was the duration of sampling? How many pictures were taken? How many had animals in them? What were the animals (species)? How many species in reality settle in that habitat (GBIF)? Revise – make questions more direct – also add is sampling area and total area sampled reported. Is the field of view and sampling area of a camera reported?

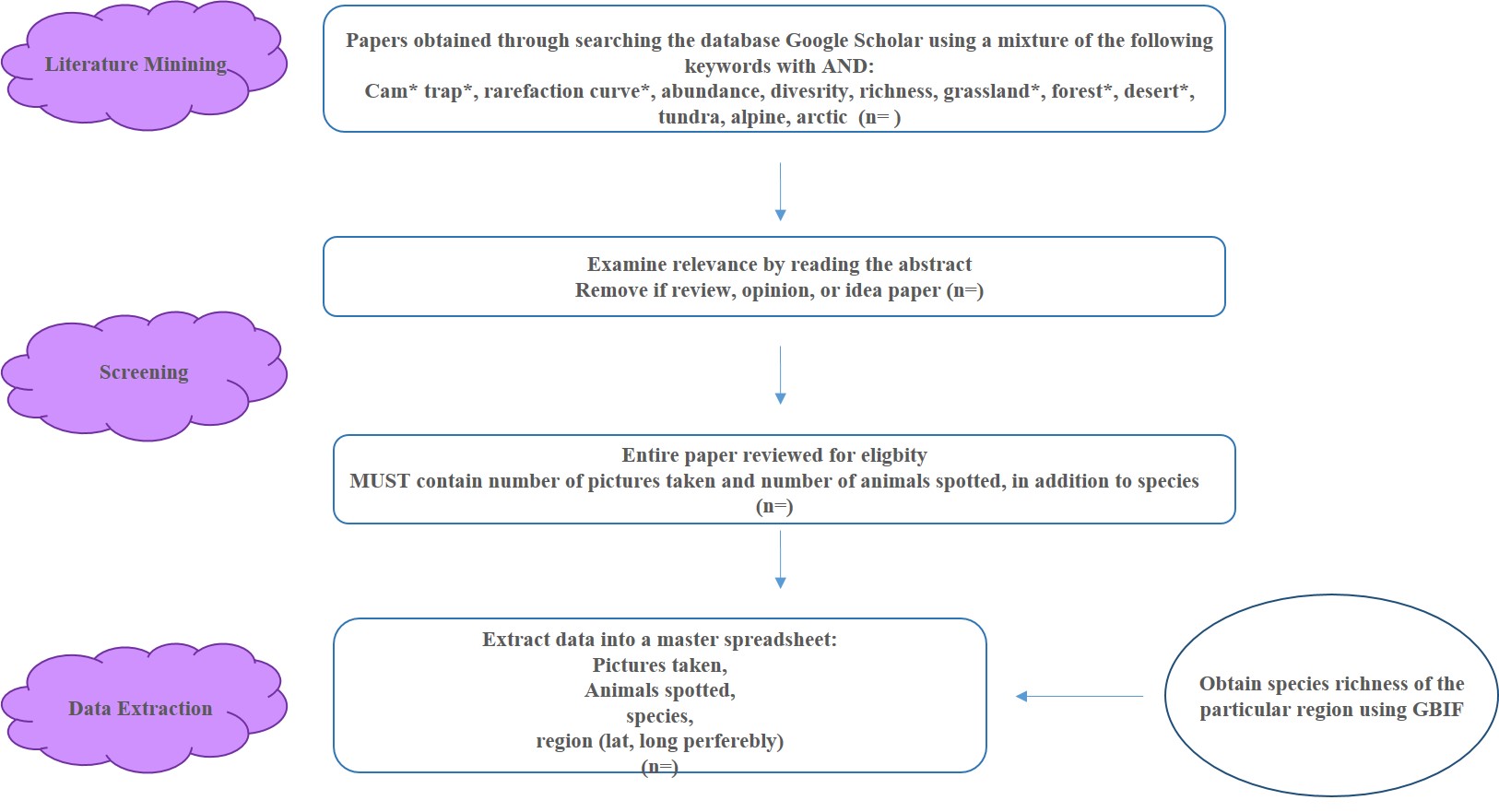
**Hypothesis:** There a few studies exploring photogenic rate as an index of density, though there is a lack of literature which has created rarefaction curves from previously published literature data-a research gap that needs more attention. – hmm – or Photogenic rate can be used to estimate population density and richness of animals if…. ?? sufficient cameras deployed?

**Predictions:**

* Many studies using camera traps will focus on one type of animal
* Studies generally only report how many photos were captured/processed and how many different species were seen
* Very few will focus on minimizing repeat visits
* Widely used in studies in grassland and forests – revise all these to relate better to the big idea

**Methods:** Figure 1 represents the workflow for extracting relevant data. Literature will be obtained through keyword searches in Google Scholar?? Web of Science instead please – also explain how you did it too etx/.. Species richness data will be obtained via GBIF.

**Preliminary Results:** revise and state what you have accomplished to date.



**Figure 1:** Workflow used to select the relevant literature for generating rarefaction curves from cam trap literature.

**Chapter 2: Shrub-animal interactions etc review title versus long-term weather data: A look at correlation.**

**Purpose:** To explore whether animal association patterns with shrubs are explained by site-level climate data daily. That is it right?

**Questions:** Does temperature, precipitation, solar radiation, and humidity correlate with the number of incidents a vertebrate is found near a foundational plant? If yes, what are these animals doing? Revise –

**Hypotheses and predictions: ??**

As temperature, drought, and the intensity of the sun increases, vertebrates are likely to interact more often with shrubs since foundational species provide many benefits to through various mechanistic pathways.

1. Vertebrates can be found forging, mating, resting, and cooling near shrubs, benefiting from the canopy coverage and shelter and refuge effects provided by the foundational plant.

H: Shrubs are thermal refuges for desert animal populations.

P1. As temperature increases, the strength of association for some animal species increases.

P2: Seasonal variation, time of day, and shrub size all modify shrub-animal interactions.

P3: Different species of animals rely on refuges to varying extents, i.e. poikotherms versus endotherms etc..

**Methods:**

**Cam trapping**

Explain how they were all set up – how long – where how etc… like Methods for a paper please.

Camera trapping has been done in the Spring-Summer of 2017 in the Carrizo National Monument at 2 different sites: the same sites were re-sampled in 2018. Cameras were moved around to maximize incidents of associational observation. Each camera was deployed facing a shrubs with their respective open microsite facing the back to serve as control. How high off the ground?

**Processing**

Images collected were saved as Join Photographic Expert Group (JPEG) format. These dataframes were then manually examined for the presence of animals. A datasheet was created where every row corresponded to a unique image. Additionally, data was recorded for the year, region, calendar date, microsite, rep, photo rep, and week number. If a vertebrate was present in the photo, further info on the type of vertebrate, time block, actual time, temperature, and additional observations were also recorded. Images from cameras were clear enough during both day and night (low light condition) to distinguish between animals. An animal was classified as present if as little as a section of a body part (i.e. tail) made it into the captured image. Because the dates and timestamps are generally wrong on these traps, dates must be manually corrected manually or in R. Behavioural data are to be obtained from video traps as a collaborative effort with Mario. For the most part the same parameters as above are to be recorded alongside behaviour.

**Site-level climate data**

Explain a but please. Carrizo data for weather parameters of interest for both 2017 and 2018 were obtained from the following website:

http://ipm.ucanr.edu/calludt.cgi/WXSTATIONDATA?MAP=&STN=BLACKWLL.A

**Statistics**

Point-biseral correlation analyses are to be performed examining the relationship between the continuous weather variable and the binary variable presence/absence of animal (Gupta 1960). Effects of covariates may be studied through an ANCOVA. Effects of multiple weather parameters may be explored through Principle Component Analysis (PCA) (Bryant and Yarnold 1995). Version R etc… and put link to the Github repo here too.

**Chapter 3: OTC field experiment to manipulate weather parameters: a look at causation.**

**Purpose:** To physically manipulate temperature and solar radiation intensity using open top chamber designs (or a variation) paired with camera traps to examine whether the increase/decrease in in the above parameters significantly affects shrub visitation instances.  **See above – I think this year, you do shelter above shrub and in open, with controls without shelters, measure temp and RH with loggers, cam trap, and maybe even do visual observation and see how this impacts the local animal pop. BE SOOO COOL I mean HOT….. then next year OR this year just pilot the OTCs… I think really hard whereas the shelter is a great idea and much easier. MIGHT COOL tho – but that ok too. Can measure and see.**

**Hypotheses and predictions:**

1. Incidents of animal capture will be significantly different between shrub versus open microsites because foundational plant species are beneficial to many vertebrates.
2. High increase in temperature will slow plants growth and visitation rates; hence, decreasing the diversity of the soil microbiota, whilst a small increase may promote visitation.
3. Decrease in solar radiation intensity, depending on the extent, may or may not promote plants growth.
4. Temperature manuplated shrubs *may* show significantly higher instances of visitation compared with unaltered shrub microsites.

**Revise///**

**H: Foundation species, shelter, and relatively large objects in desert ecosystems influence animal behaviour and population dynamics including movement.**

**P1 – etc…**

**Methods:**

UV-permeable Perspex shelters…

ALSO – ONE MORE IDEA what about having a shelter that also BLOCKS all light – emulate a solar array – your experiment BEGS the question and this is a HUGE implication!!!

Etc

chambers will be built in the field using the design similar to figure 2 design. Shelters will be built from Plexiglas glued together. Each chamber will be high enough to account for the height of the individual shrub; however, chosen shrubs will generally be of the same volume and stature to minimize treatment differences. A hole will allow for the entrance and exit of animals. The presence of the shelter will result in an increase in temperature which will be measured by temperature loggers. Soil temperature and relative humidity will also be recorded via loggers. Shelters also have the ability to increase CO2 concentrations??? without altering the air; thus, carbon dioxide meters will be used to record the change in the concentration of this gas. Solar radiation intensity can be manipulated by Plexiglas of different darkness intensity that either UV permeable or impermeable. Soil microbiota samples will be taken once before the start of the study and once when the study is completed, and analyzed to reveal possible microbial differences. Shelter sites would be paired with simple open and shrub microsites. Furthermore, a mesh shelter that does not manipulate any weather parameters will be used as control. Shrub height, length, and width (x, y, and z) dimensions will also be recorded once before and after the study is finished for both shelter and non-shelter microsites. The study will take place in site 3 and 4 of Carrizo. Table 2 summarizes the treatments and replications. Cam traps will be paired with 4 sets of shrubs, 4 sets of open, and 4 sets of shelters (2 sets in each site).

**Table 2.**  **Replication** breakdown for open-shrub microsites and open-top-chambers.

|  |  |  |  |
| --- | --- | --- | --- |
| **Microsite** | **OTC** | **Replication** | **Total** |
| **2** | **4** | **X 8:**  **X4 in site 3**  **X4 in site 4** | **64** |
| Shrub | Control (no shrub) |
| Open | Temperature |
|  | Radiation intensity |
| Mesh shelter (control) |  | |

**Stats**

Statistical analyses will focus on examining the differences between and within groups for different parameters and to see whether correlation, in fact translates to causation.



Whoa!!! Dude NOOOOO

**Figure 2:** Similar to the shelter design to be built in the field. Walls will be built out of Plexiglas of various colours depending on the treatment group. Length, Width, and height will depend on the given shrub. A ‘door’ will allow animals to enter or exit. (Picture courtesy of Google Images)

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