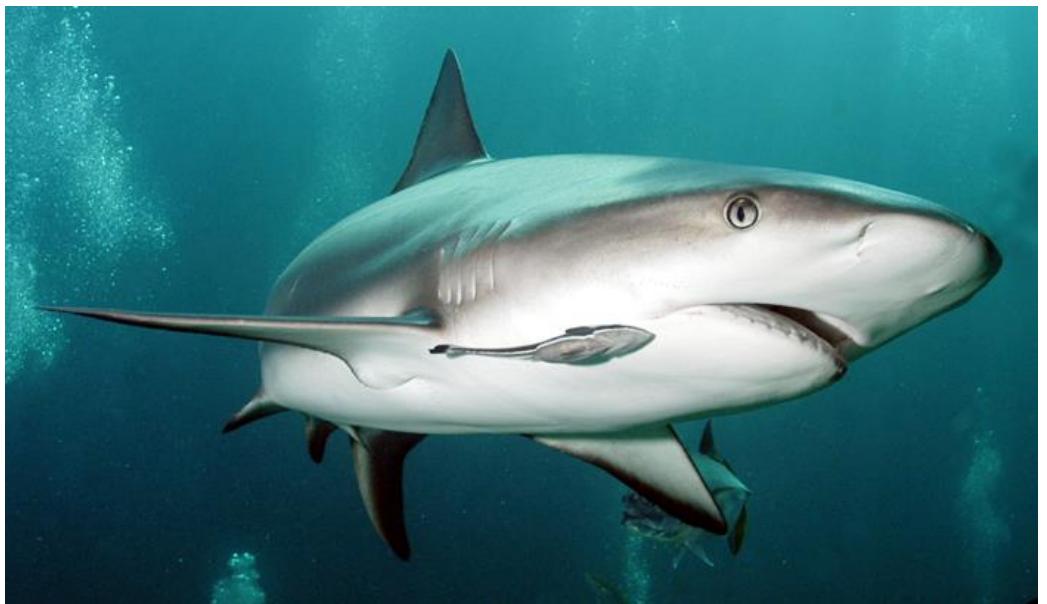


Pollination and Seed Dispersal of *Cactaceae* by Avian Interactors

Malory Owen & Christopher
Lortie
Spring 2019 Progress Report





[Shark and remora](#), [shrub and cactus](#), [clownfish and anemone](#), [mycorrhizae](#), [bee and flower](#), [kelp](#), [gastropod](#), and [sea urchin](#)



Mutualism

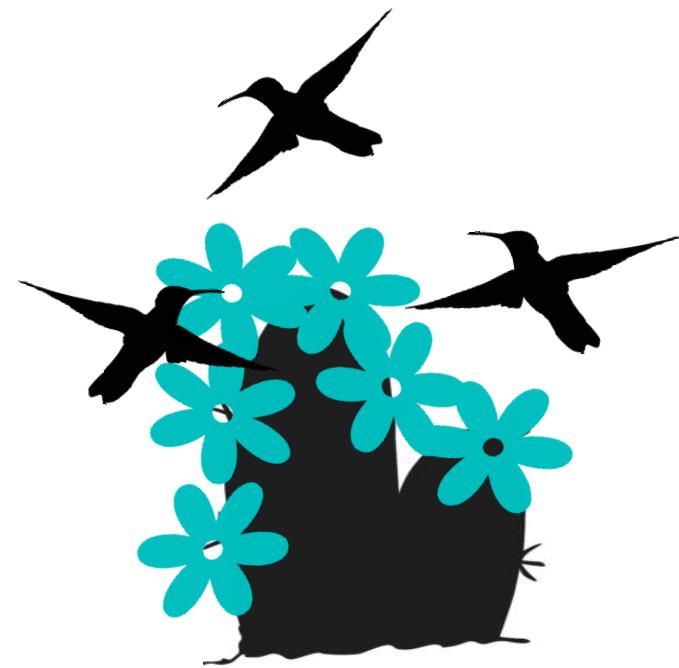
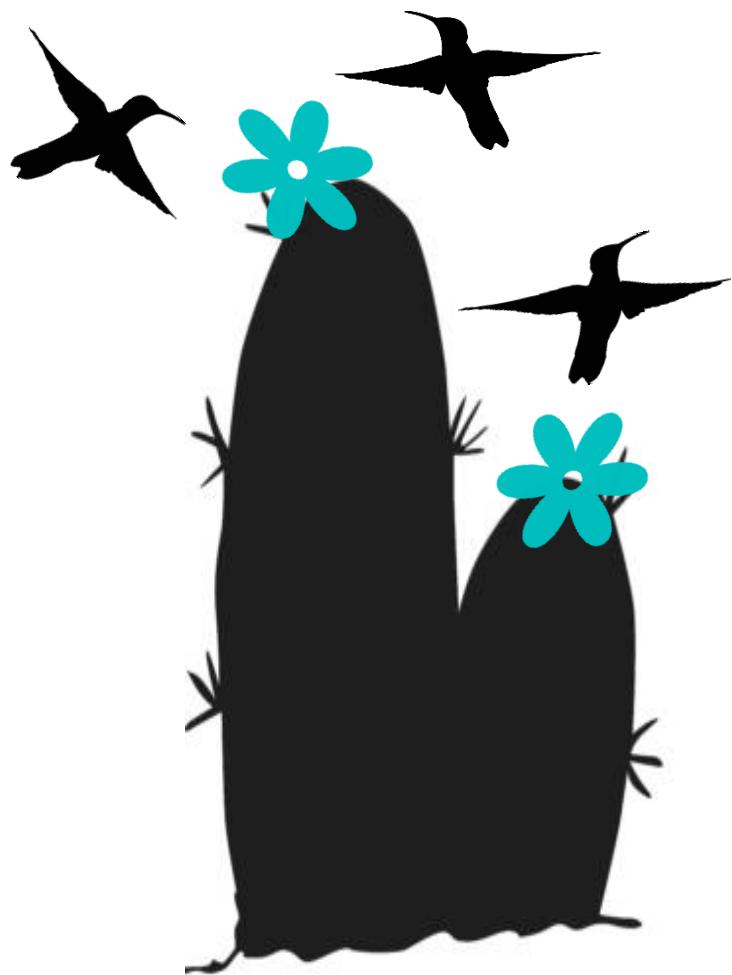
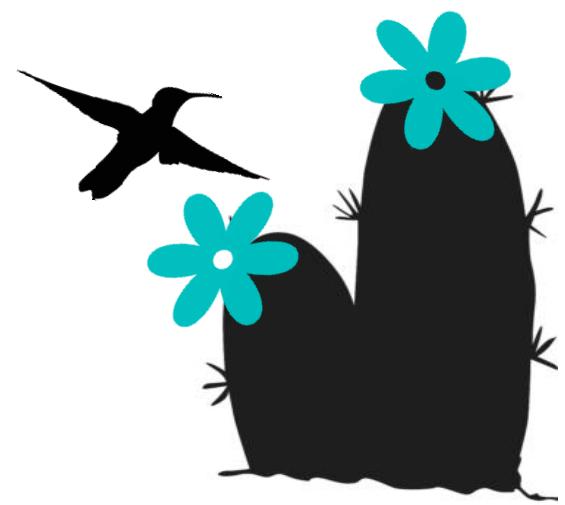


Mutualism

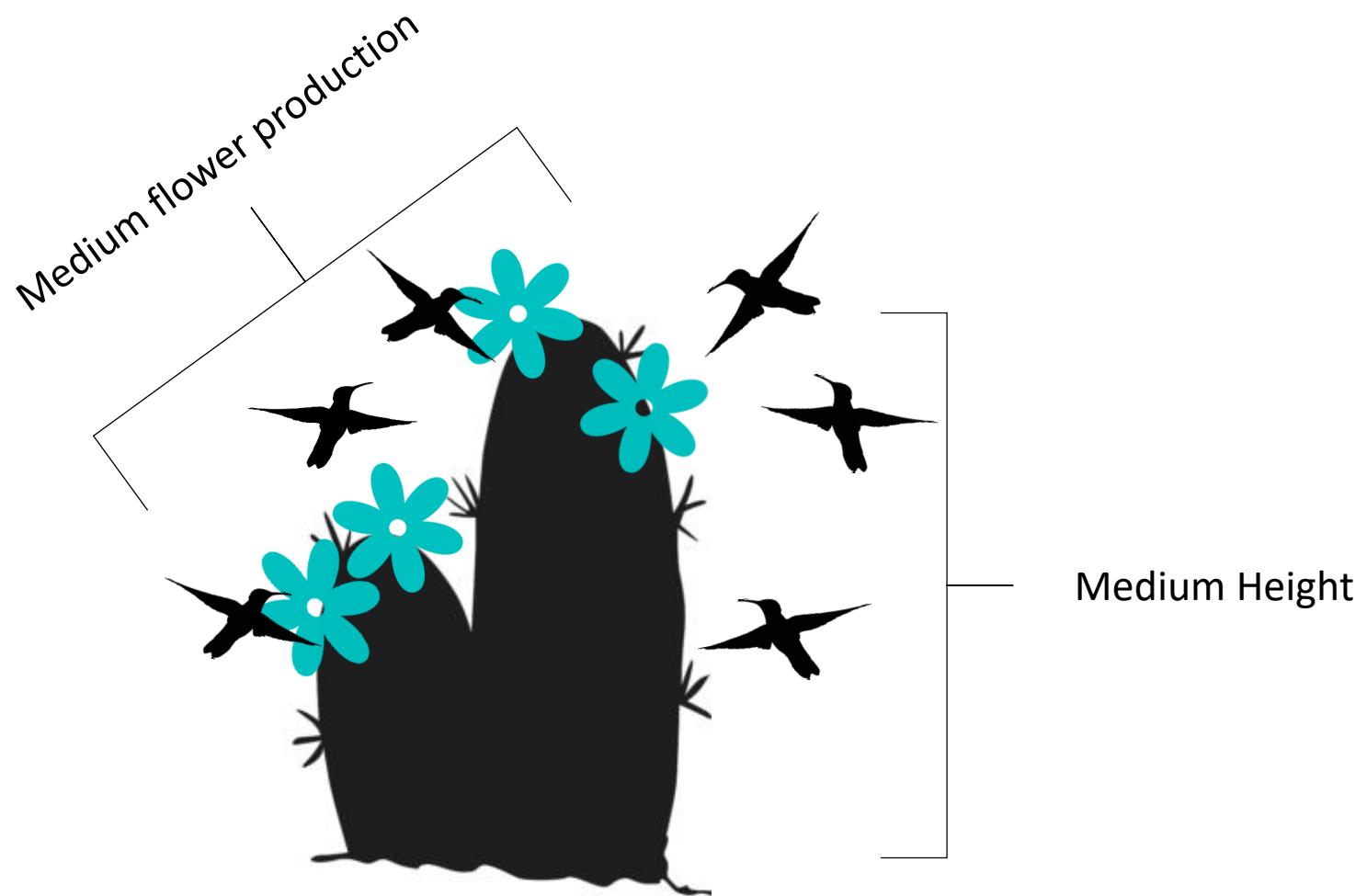


Same habitat
Same interactors

Double Mutualism







Plants must make **tradeoffs** to
maximize two mutually exclusive
structures

Chapter 1: A meta-analysis of physical allocation in *Cactaceae* reproductive structures

- Purpose: Review literature on *Cactaceae* reproduction outputs, analyze reported values, and determine research gaps and future directions for agro-eco investigations.
- Research Questions:
 - Are reproductive outputs in *Cactaceae* (flowers, fruits, and seeds) correlated?
 - How does *Cactaceae* phylogenetic distance related to reproductive output?
 - Where are *Cactaceae* reproductive studies relative to native and nonnative *Cactaceae* locations?
 - What research gaps exist in *Cactaceae* allocation research, and what opportunities for agro-eco interdisciplinary work have been unexplored?

Hypothesis

- Flower production will be greater than but correlated to fruit production. However, fruit production will be negatively correlated with seed production. Abundance of fruit or seeds will also be negatively correlated with mass of fruit or seeds, respectively.



Methods

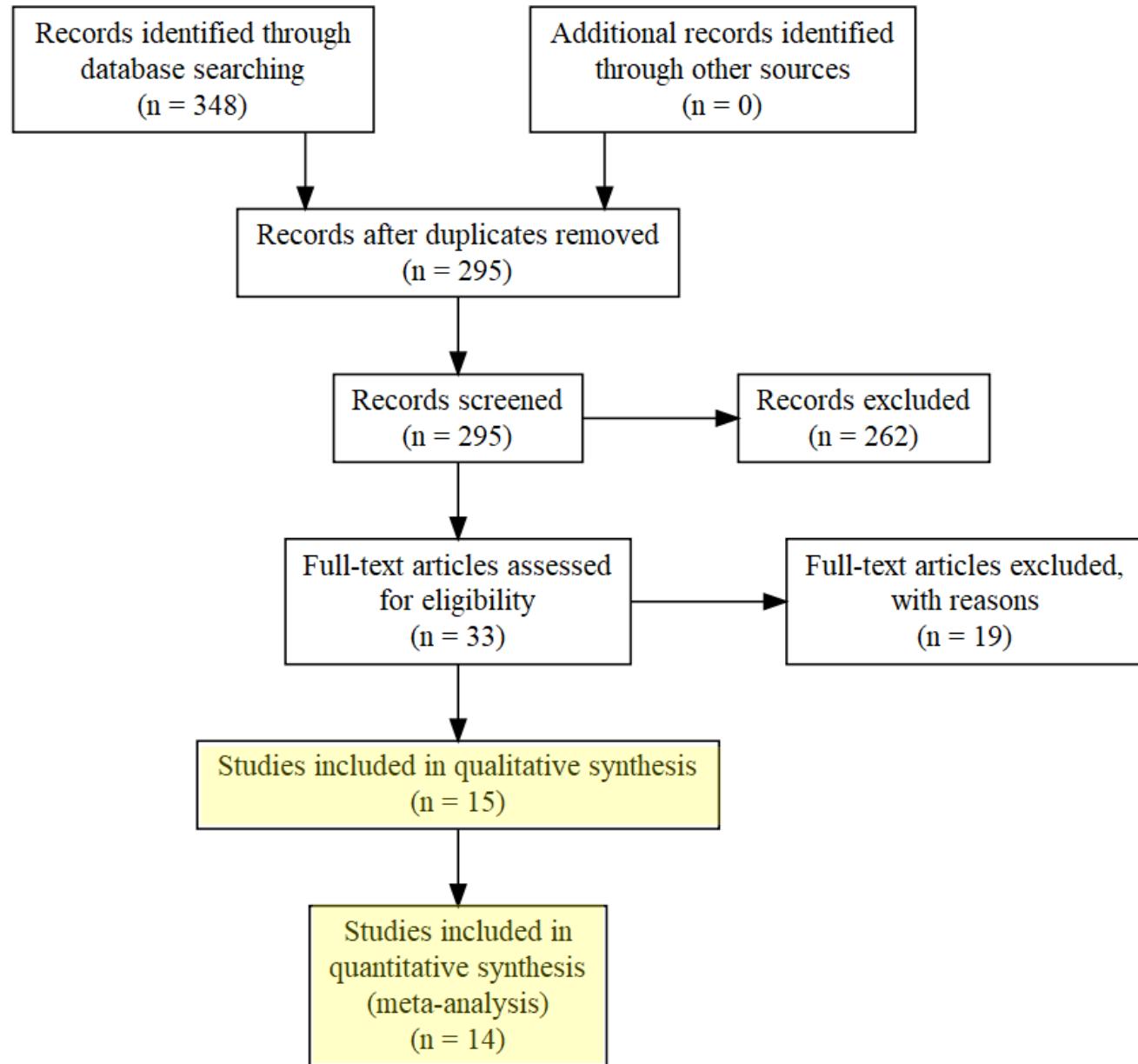
Completed:

- Systematic Review
- Web of Science

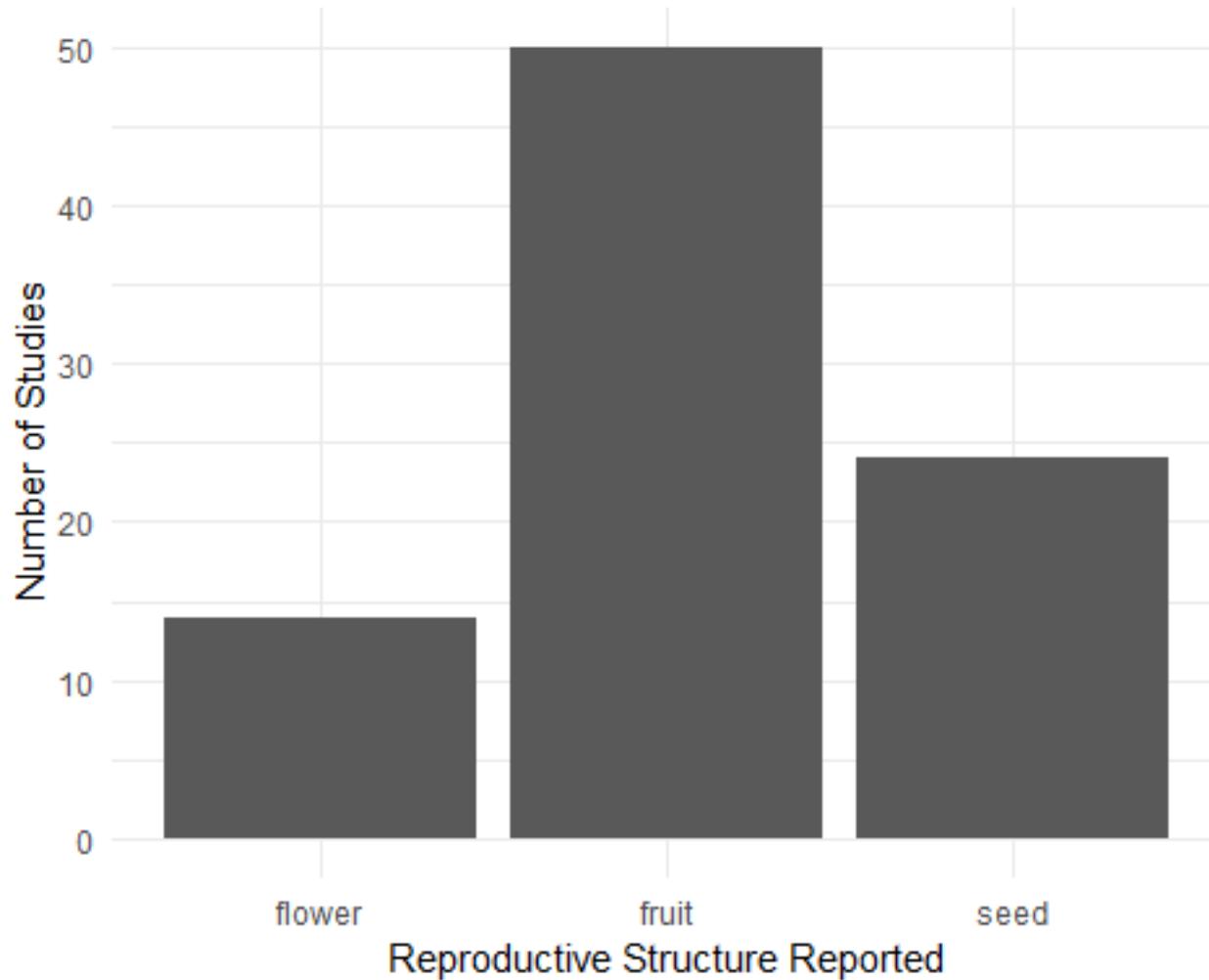
Future:

- Add flower* to search terms
- Older papers
- Analyze in R package “metafor”

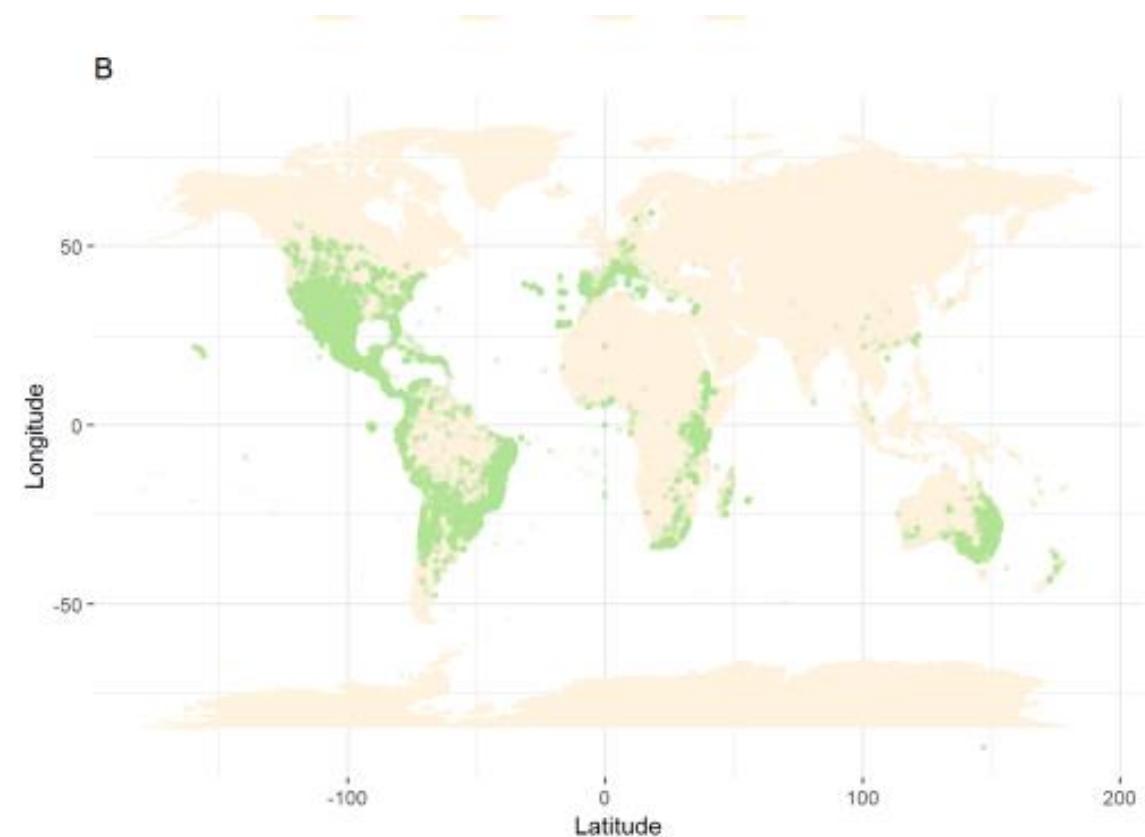
Search	Terms	Hits	Refines
1	cact* and allocat*	25	topic, last five years
2	cact* and fruit* and size	63	topic, last five years
3	cact* and seed and fruit*	110	topic, last five years, articles
4	cact* and seed and size	53	topic, last five years
5	fruit* and seed and size and allocat*	69	topic, last five years
6	cact* and size and allocat*	10	topic, last five years
7	cact* and fruit and agricultur*	18	topic, last five years
	total	348	



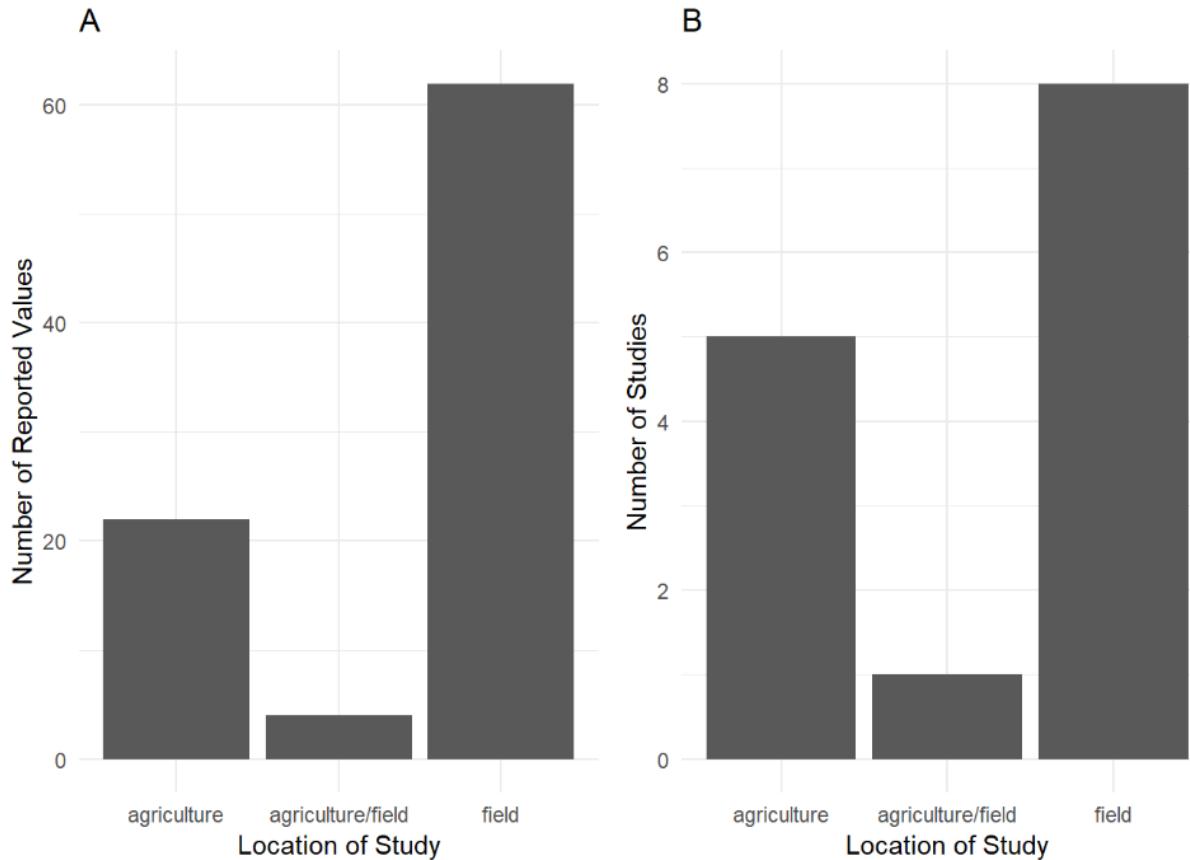
Preliminary Results



Preliminary Results



Preliminary Results

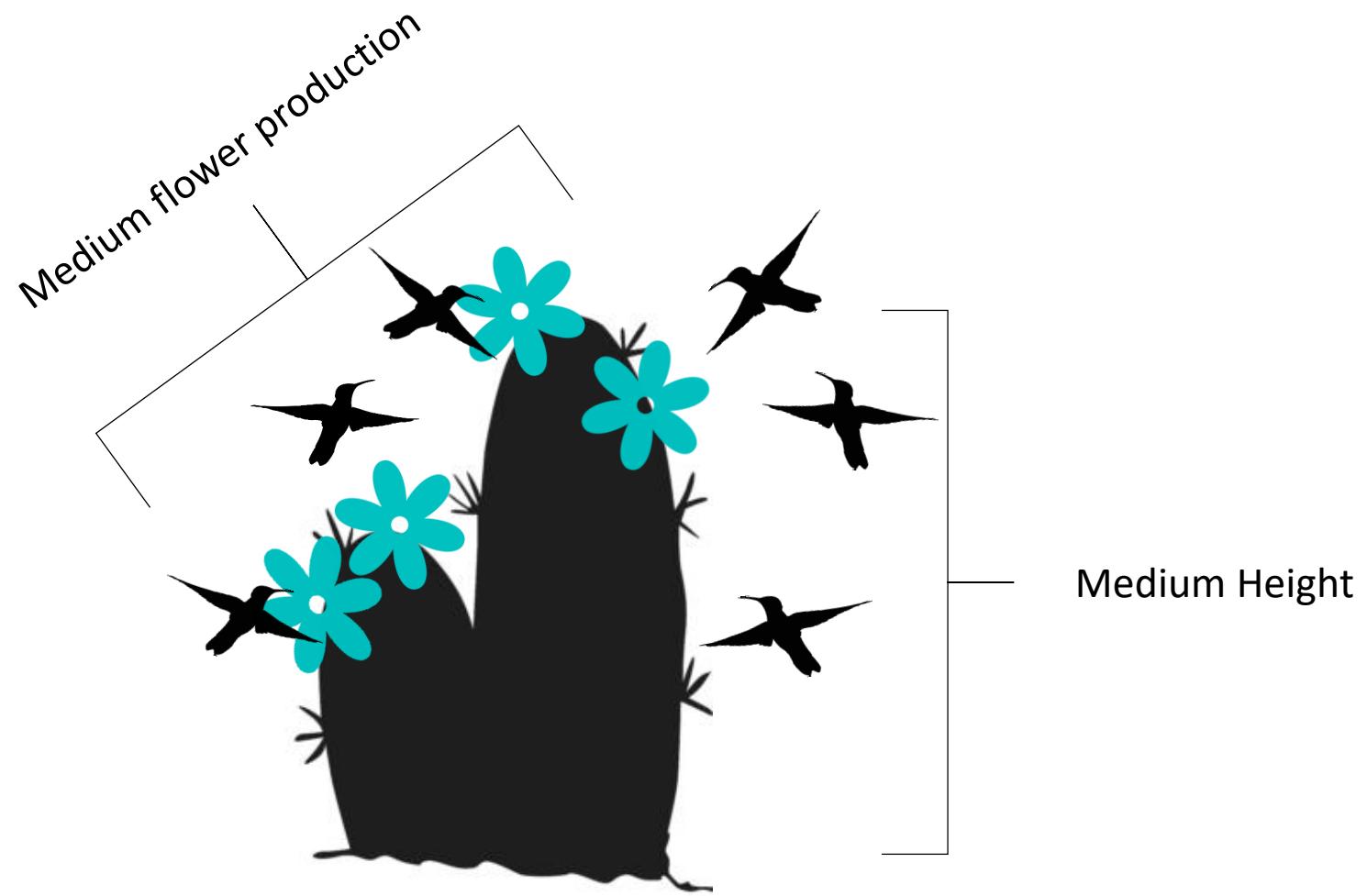


Chapter 2

- Purpose: The aim of this study is to determine the strength of this double mutualistic interaction between birds and a foundational species of cactus based on morphological characteristics of cactus individuals.
- Research Questions:
 - Are reproductive structures of cacti correlated with each other or with *Cylindropuntia acanthocarpa* volume?
 - What Avian communities are associated with *C. acanthocarpa*?
 - How strong are Avian-*C. acanthocarpa* double mutualistic interactions?

Hypothesis & Predictions

- Hypothesis: *C. acanthocarpa* individuals that maximize size *and* reproductive output via allocational tradeoffs will have the showiest reproductive displays, and therefore the most pollinating and seed dispersing Avian visitors.
- Predictions:
 - Flower and fruit production will be positively correlated, but cactus volume and reproductive output will be negatively correlated.
 - Avian visitation rates and diversity are dependent on cactus morphological characteristics.
 - Avian diversity at a *C. acanthocarpa* individual is different than avian diversity at the entire site.



Methods: Preliminary Cactus Survey

- *Cylindropuntia acanthocarpa*,
Cylindropuntia echinocarpa,
& *Opuntia basilaris*
- Transects or haphazard
- Major, minor, and vertical axes measured
- Health index (1-5)
 - Branch death, rot, and scarification



Methods: Experimental Manipulations

- *Cylindropuntia acanthocarpa*
- Small, medium, large class sizes
- 0%, 25%, 50%, 75%, 100% flowers or fruits removed
- 7 replicates (105 total cacti, 3.5 hours per day)
- 1 hour focal observations

- Ethogram
- Species/behavior identification aided by 150-600mm digital camera
- Measure sucrose content in flowers
- Weigh fresh fruit and seeds



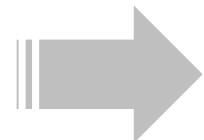
Methods: Joy Sampling

- Area search
 - 50 hours total (2 hour sessions)
 - Mesohabitat
 - Geotag
- Point count
 - 50 hours total (2 hour sessions)
 - Monitor one cactus

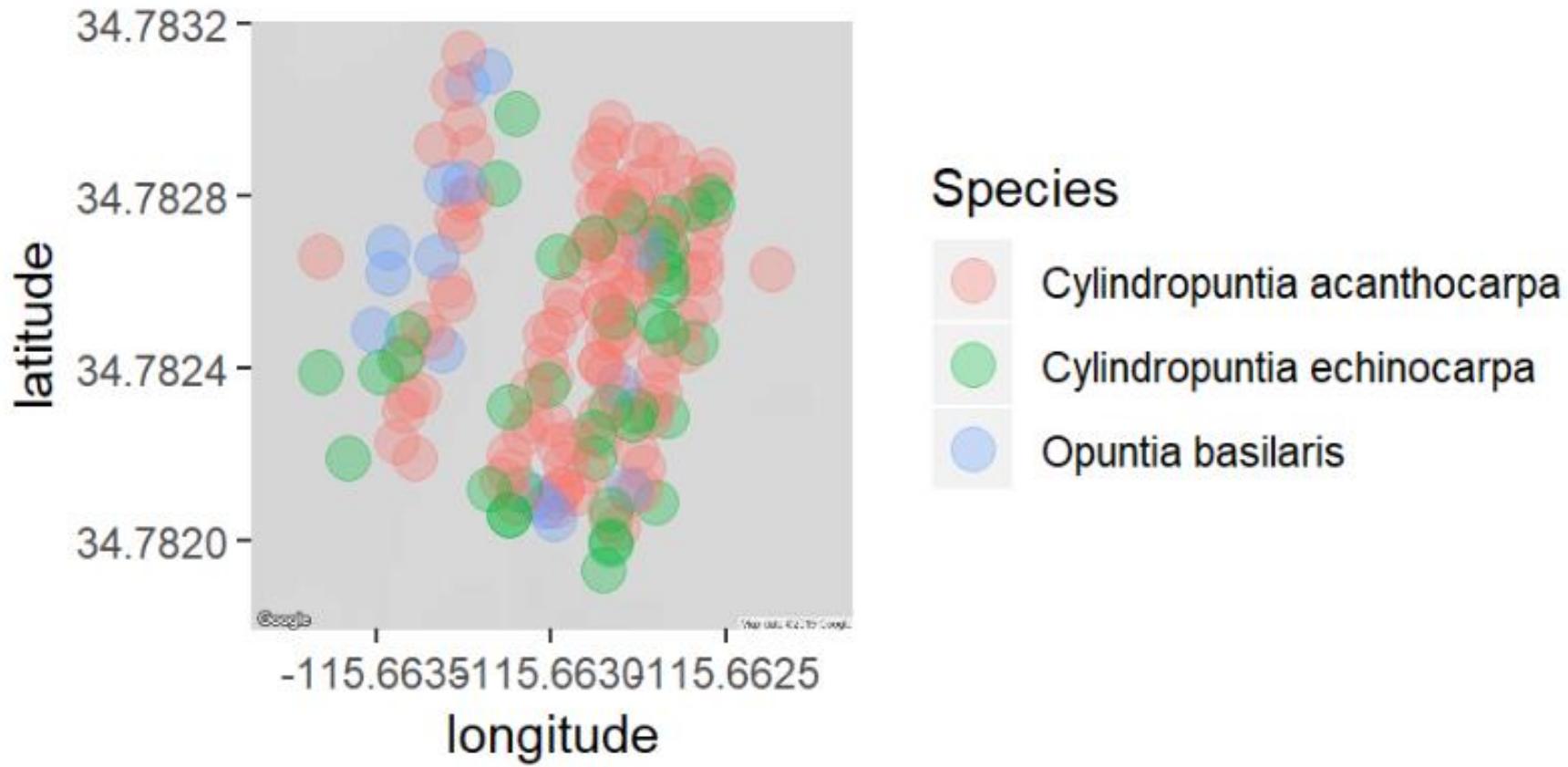


Paired Observations

- 20 cactus individuals
- Geotag
- Count flowers in May, fruit in August

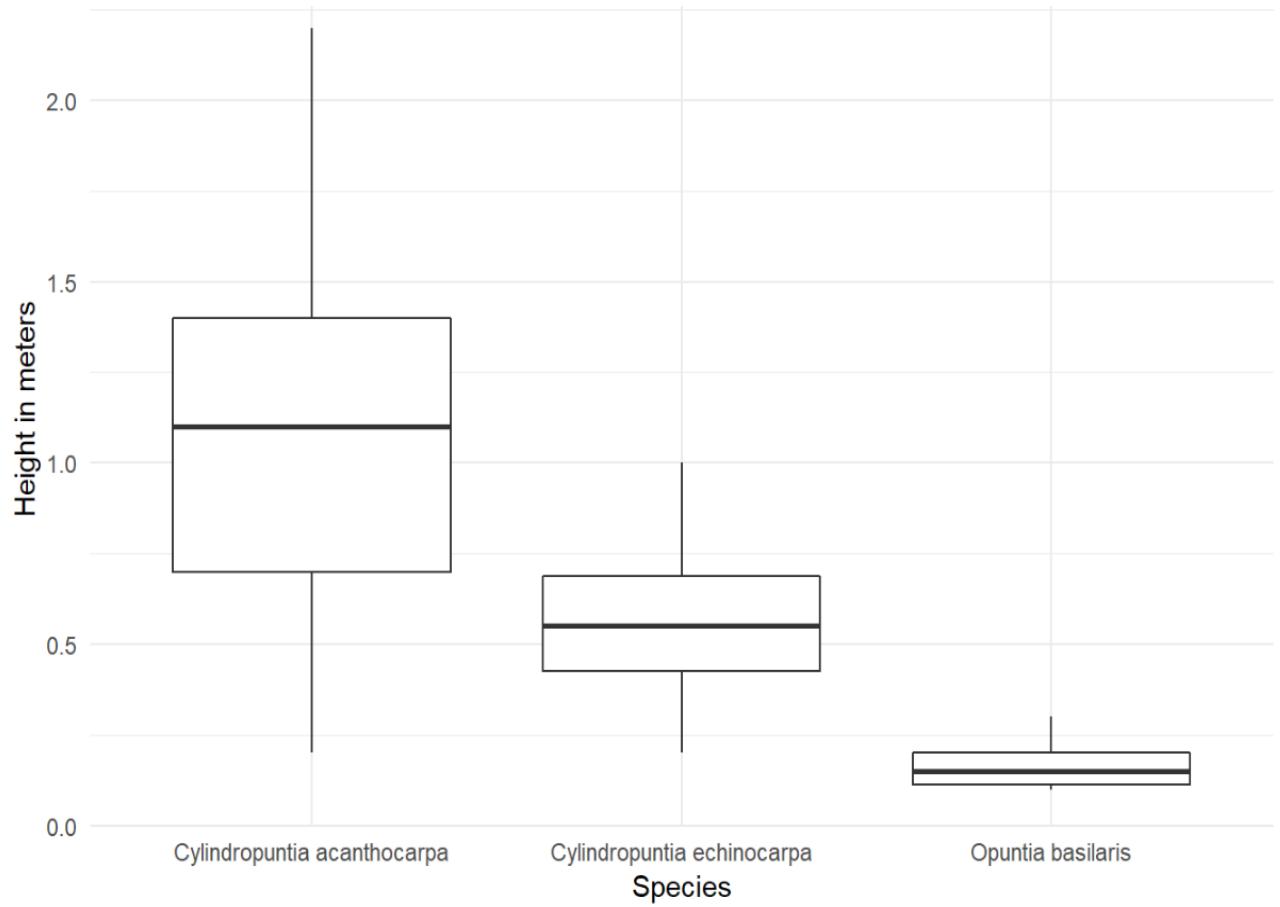


Preliminary Results: Location



Preliminary Results: Size

- Kruskal-Wallis, Chi-square = 3.71, $p > 0.0001$, df = 52
- Means heights of 1.04 meters for *C. acanthocarpa*, 0.55 meters for *C. echinocarpa*, and 0.17 meters for *O. basilaris*



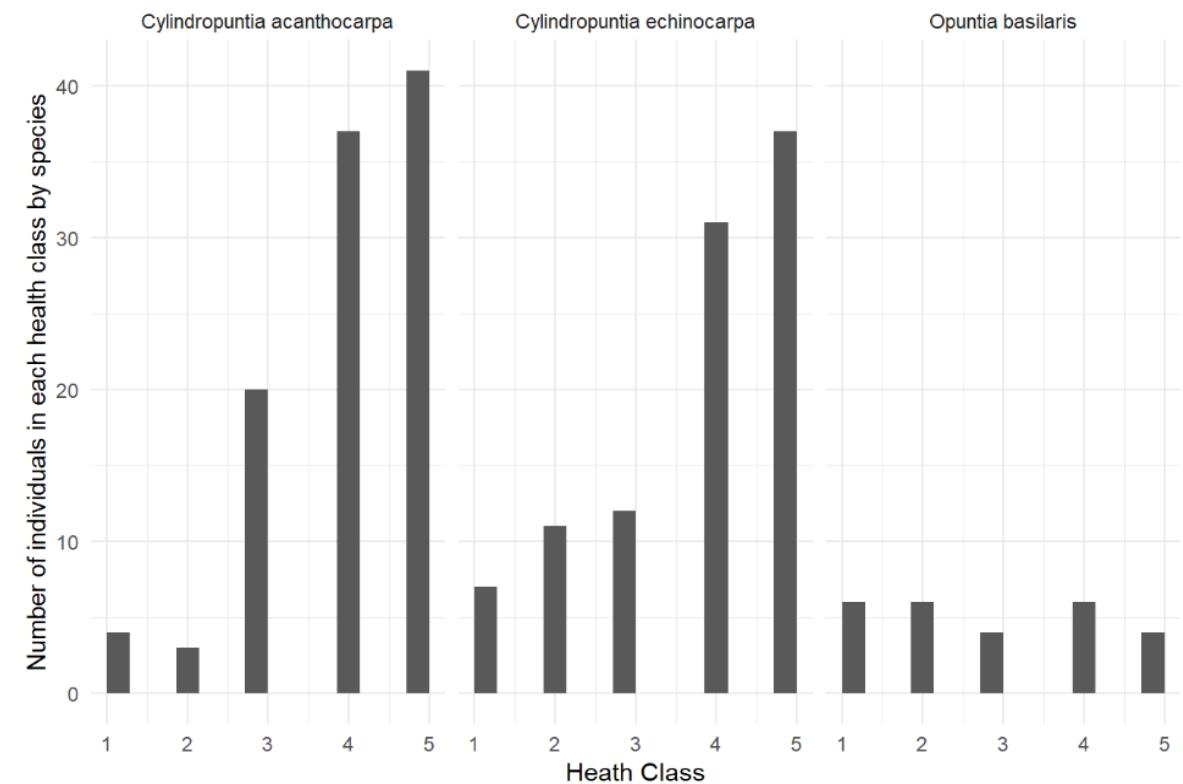
Preliminary Results: Size Class

Species	Small	Medium	Large
<i>Cylindropuntia acanthocarpa</i>	<85cm	86cm - 152cm	>153cm
<i>Cylindropuntia echinocarpa</i>	<45cm	46cm - 72cm	>73cm
<i>Opuntia basilaris</i>	<15cm	16cm - 22cm	>23cm

Preliminary Results: Health

- Pearson's Chi-squared Test,
 $\chi^2 = 27.325$, $df = 8$,
 $p > 0.001$

	1	2	3	4	5
C. acanthocarpa	4	3	20	37	41
C. echinocarpa	7	11	12	31	37
O. basilaris	6	6	4	6	4



Discussion

- Abundance, size, and health were “strongest” in *C. acanthocarpa*
- One study species > three study species
- Likely foundational species



Looking forward

- Mega-bloom year
- *C. acanthocarpa* facilitation experiments
- Shrub/cactus mapping



If we understand:

Positive Interactions



Habitat Structure



Restoration/Protection of
Deserts



Thanks for listening!