

**ESTIMATING SEED  
DISPERSAL DISTANCE OF  
JOSHUA TREES THROUGH  
PARENTAGE ANALYSIS**

**SEAN BERGAN**

# **PLANTS, THE MOJAVE DESERT, AND CLIMATE CHANGE**

- Global warming poses a threat to plant species
- Climate change is especially severe in deserts (IPCC 2022)
- Need for some land in the Mojave desert land to be repurposed into solar and wind farms (Parker et al 2018)



## JOSHUA TREES (*YUCCA BREVIFOLIA*, *YUCCA JAEGERIANA*)

Keystone species of the Mojave desert

Range has been impacted by climate change (Cole et al 2011, Barrows and Murphy-Mariscal 2012)

Urgent to understand the future range of Joshua trees

Photo: Chuck Abbe 2007



# **SEED DISPERSAL DISTANCE (SDD)**

- Significant to determining future range of plants
  - Can the plant range outrun pressures of climate change? (Corlett and Wescott 2013)
- Distance between a parent and its offspring
- Wind vs animal dispersal

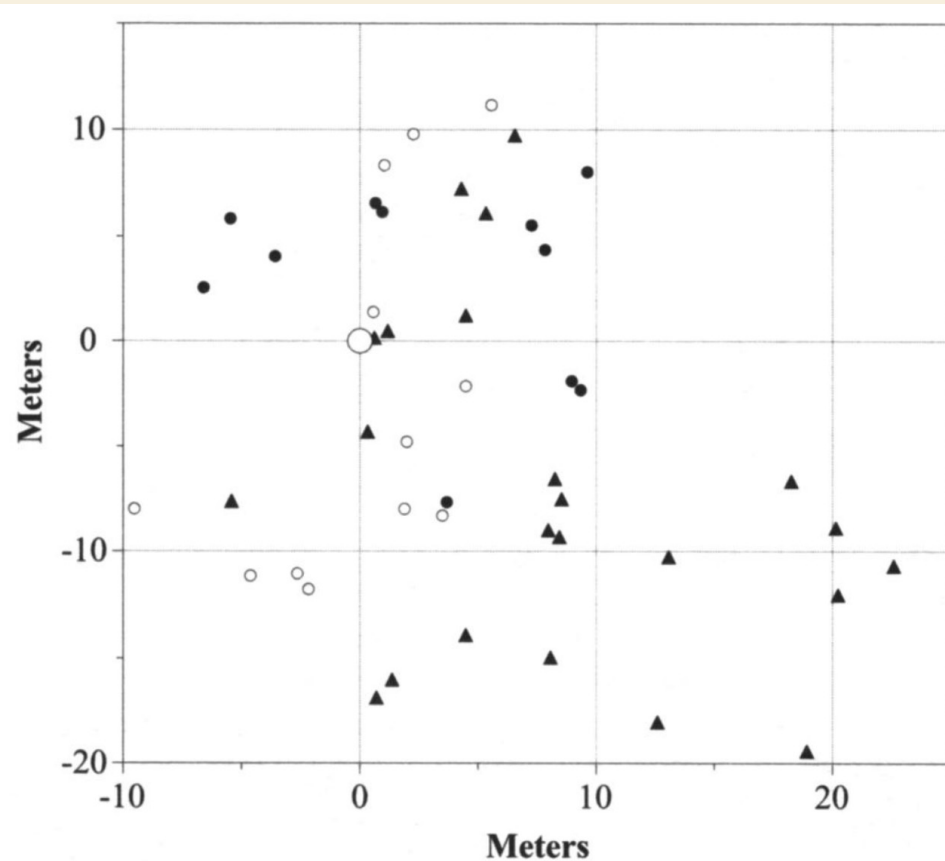


FIGURE 1. The dispersion of caches around Joshua tree 5 (large circle). Closed circles represent primary caches; open circles represent empty primary caches; triangles represent secondary caches made from the emptied primary caches. Units are in metres.

(Vander Wall et al 2006)

## THE LITERATURE ON *Y. BREVIFOLIA* SDD

SDD in *Y. brevifolia* was measured using radioactively marked seeds (Vander Wall et al 2006)

Mean dispersal distance of  $30 \pm 16.8$  m

Mainly distributed by seed caching rodents, not through wind dispersal (Vander Wall et al 2006, Waitman et al 2012)

Discovered some secondary caches

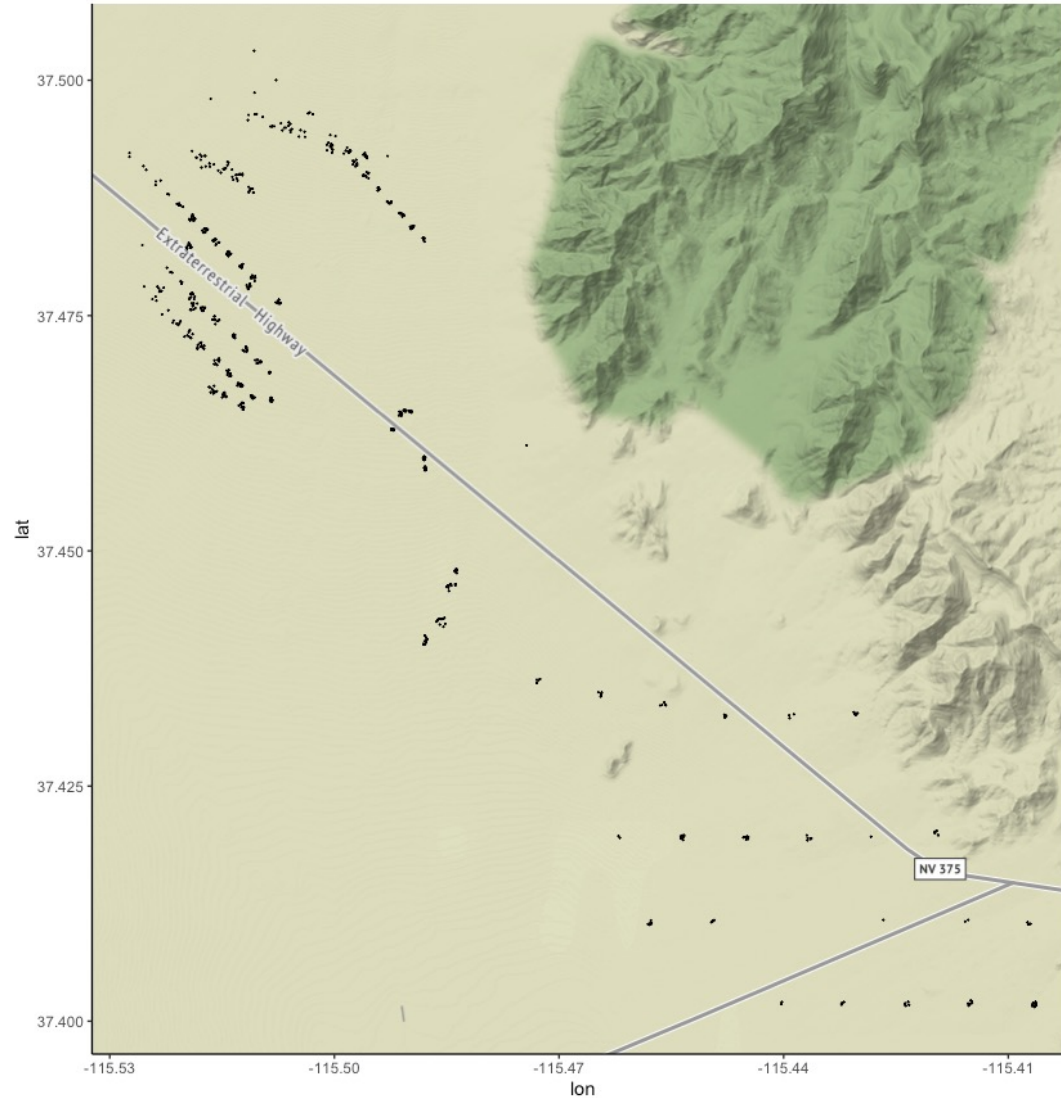
# HOW TO BUILD ON THIS

- Difficult to find secondary and tertiary caches, potentially leading to underestimates of SDD (Vander Wall et al 2006)
- Tracking seeds alone makes it difficult to find *effective SDD* (Gelmini-Candusso et al 2019)

# GENETIC METHODS

- Microsatellite data
  - Areas where nucleotide patterns repeat
  - Highly variable regions of the genome
  - Loci for Joshua trees have been characterized (Flatz et al 2012)
- Pedigree reconstruction
  - Using genetic data to infer parental relationships
  - FRANz (Almudevar et al 2003)

Y. brevifolia sample distribution in Tikaboo Valley, NV



## DATA COLLECTION

Microsatellite data with coordinates provided by the Smith lab

Parent-offspring pairs were inferred through FRANz (Almudevar 2003)

How will this differ from SDD characterized in the literature?

Coordinates of sampled Joshua trees (n=716) in Tikaboo Valley, Nevada





## SOME DUBIOUS RESULTS

Some inferred parental relationships were cyclical ( $n = 52$ ), which is biologically impossible

Not significantly different from the other parent-offspring pairs (two-sample  $t(100.04) = -0.68, p = 0.49$ )

| Sample group                       | Median Distance | Mean Distance        | Max Distance | Min Distance |
|------------------------------------|-----------------|----------------------|--------------|--------------|
| Cyclical relationship distance (m) | 147.11          | $639.07 \pm 1690.91$ | 8778.65      | 3.48         |
| Viable relationship distance (m)   | 159.25          | $829.83 \pm 2113.98$ | 13433.5      | 0            |

Table demonstrating distances between viable ( $n = 186$ ) and biologically impossible/cyclical ( $n = 52$ ) parent-offspring pairs.

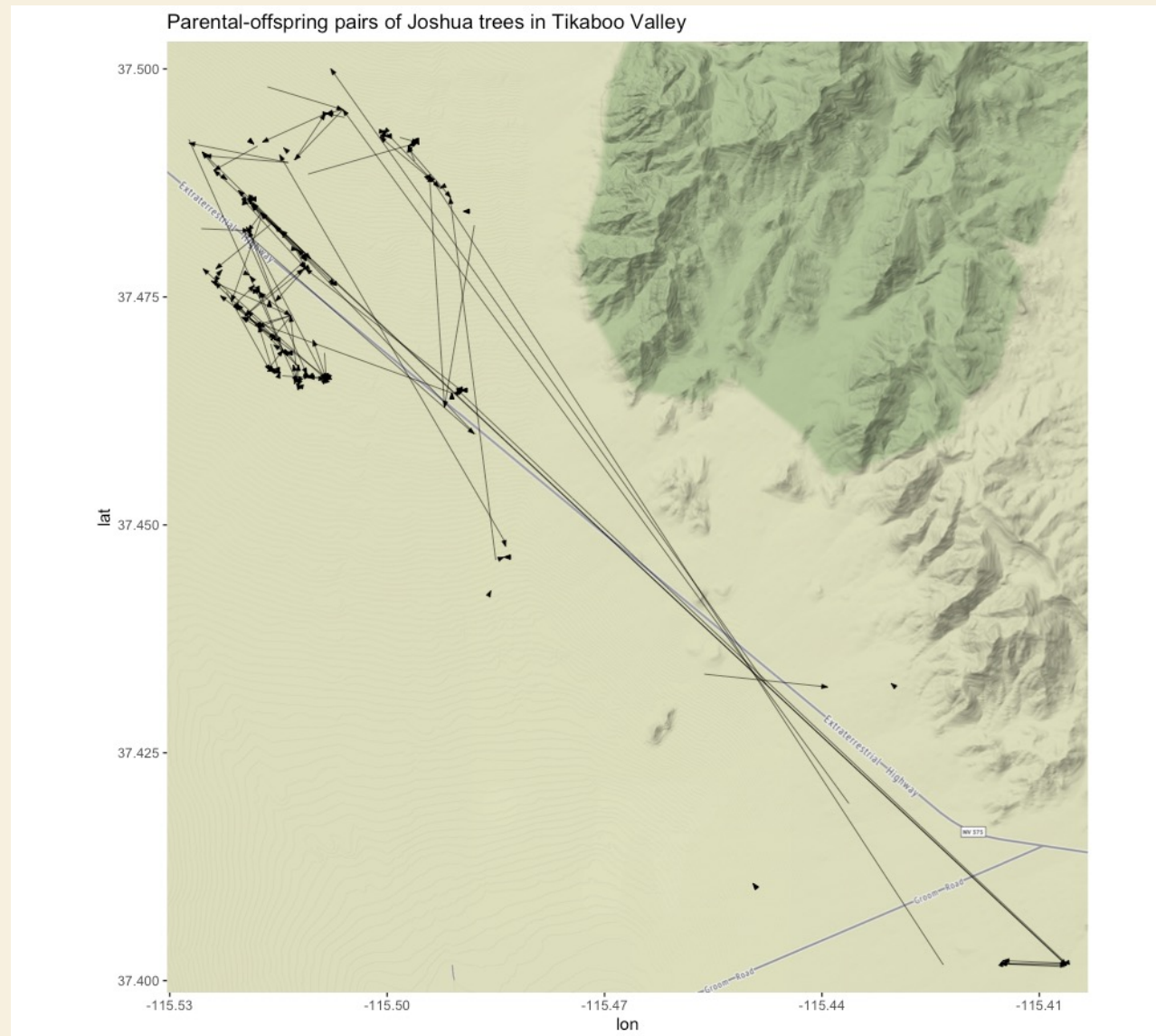
## POTENTIAL LONG-DISTANCE DISPERSAL (LDD)

Mean distance = 856 m

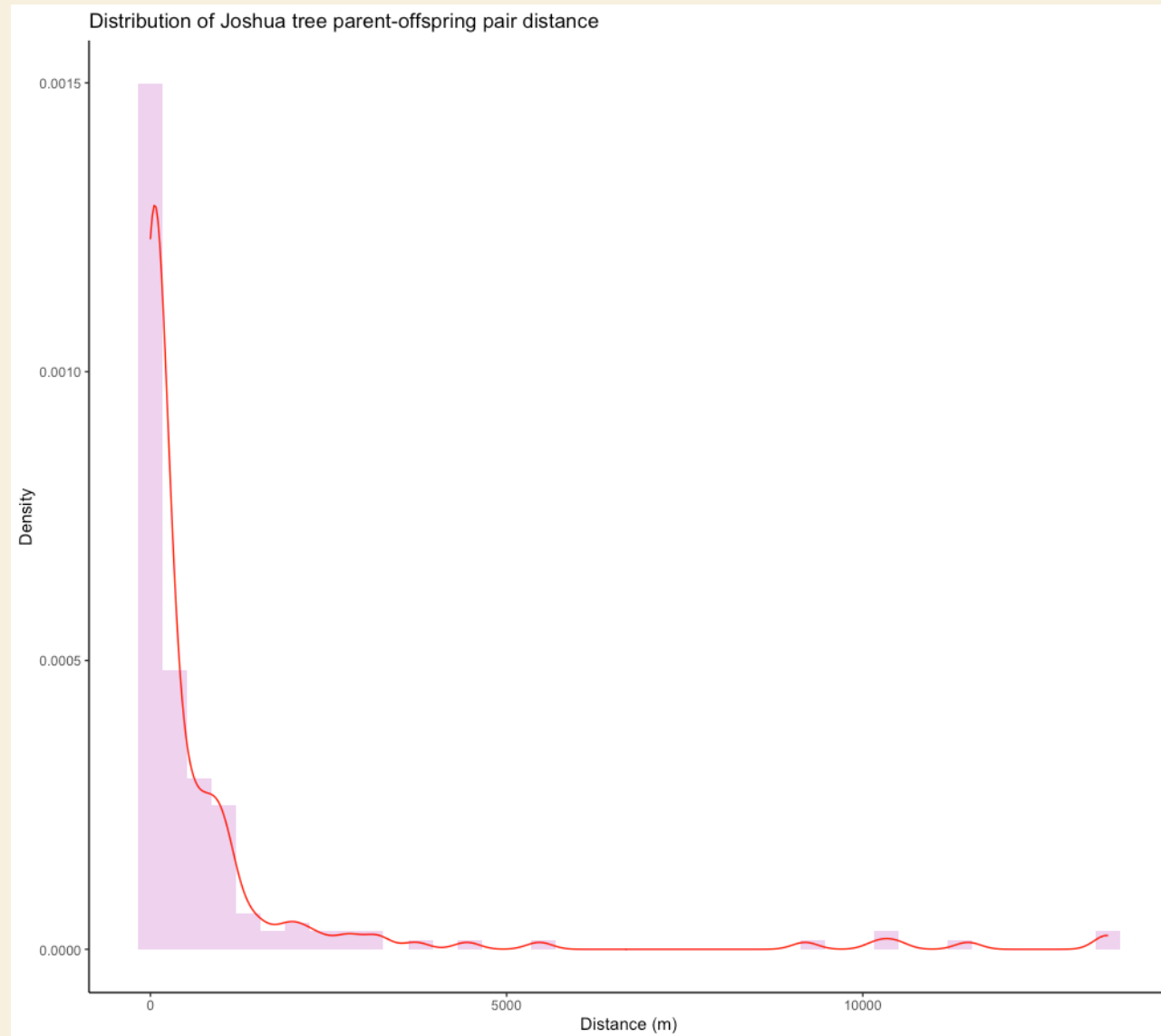
Median distance = 159 m

Significantly greater than the  
30.0 m average from Vander  
Wall et al (2006) (one-sample  
 $t(185) = 5.16$ ,  $p < 0.05$ )

Possible long-distance dispersal  
(LDD) events were observed  
(as far as 13 km)



Map of parent-offspring pairs of Joshua trees (n=186) in Tikaboo Valley, Nevada.



Distribution of Joshua tree parent-offspring pair distances (n=186) in Tikaboo Valley, Nevada.

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# **SOME CONSIDERATIONS**

- No distinguishing between maternal and paternal parentage
  - Not likely the cause of LDD events (Marr et al 2000).
- Dubious parent-offspring pairs call to question the validity of the remaining results

# FURTHER ANALYSIS

- Alternative pedigree reconstruction software – COLONY (Jones and Wang 2010; Wang 2012)
- Comparative analysis of *Y. brevifolia*, *Y. jaegeriana*, and their hybrids



# **POSSIBLE IMPLICATIONS**

- If LDD is occurring, what mechanism is it through?
  - Hasn't been observed through birds (Lenz 2001)
- Projections of how the potentially greater SDD and LDD events impact future range (Corlett and Wescott 2013)

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**SPECIAL THANKS**

**QUESTIONS?**