


# The Effects of Habitat Fragmentation and Pollination Outcrossing on Fitness in *Oenothera harringtonii*

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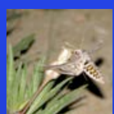
## Abstract

*Oenothera harringtonii*, Harrington's evening primrose, is a self incompatible, annual, endemic species whose primary pollinators are hawkmoths. This species is increasingly found in a fragmented habitat in SE Colorado, but the effects of fragmentation on fitness remain unknown. Previous studies have shown reduced fitness in fragmented populations of *O. macrocarpa*.[1] The objective of this study was to determine whether differences in fitness result from pollination crosses between populations, within populations, and between siblings and from fragmented and unfragmented populations. These crosses served as a proxy for pollination events that could occur naturally. We predicted that fitness would be lowest in sibling crosses, highest in between population crosses, and intermediate in within population crosses. We found no significant differences among populations or cross types in fruit width, fruit length, fruit weight, seed abundance, and seed weight. However, sibling crosses resulted in seeds with viability rates significantly lower than seeds from between and within population crosses.




A. *Manduca quinquemaculata*, B. *Hyles lineata*, C. *Anthophora sp.* D. Agapostemon sp.

## Introduction

*Oenothera harringtonii* Wagner, Stockhouse, and Klein (Onagraceae), Harrington's evening primrose, is an annual plant species endemic to south-central Colorado. Populations of this species are currently threatened by habitat fragmentation caused by suburban/urban development, livestock grazing, and recreational use of habitats[1]. *Oenothera harringtonii* is self incompatible and relies on two main pollinator groups: hawkmoths, visiting primarily at night, and bees, visiting mainly during the day. Bees tend to forage locally, whereas hawkmoths can travel miles every night, potentially pollinating flowers between populations and allowing for cross pollination and preventing inbreeding depression. Unfortunately, habitat fragmentation, which can result in increased light pollution, pesticide use, and predation, may result in plant populations that are less attractive to hawkmoth pollinators. Fitness may be reduced in fragmented populations if they are predominately visited by bees, who forage locally and may increase mating events within populations or between related (sibling) individuals[2,3].

## Hypotheses

1. Fruit and seed fitness is lowest in plants of sibling crosses, highest in between population crosses, and intermediate in within population crosses.

2. The fruits and seeds of plants from fragmented populations are less fit than those of plants from unfragmented populations.

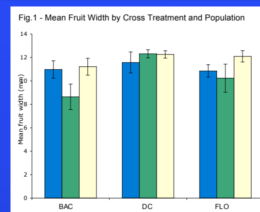
## Methods

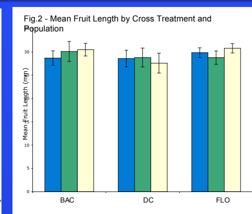
*Oenothera harringtonii* seeds were collected from naturally occurring populations in southeastern Colorado during summer 2008. These seeds were germinated and the resulting plants were grown in the greenhouse at the Chicago Botanic Gardens in Glencoe, Il. Hand pollinated crosses of four types were performed on the plants: outcross - sibling (between plants from the same maternal line), outcross - between populations (between plants from different populations), outcross - within population (between plants from the same population), and self (pollen from the same flower). Floral morphology data (corolla diameter, floral flare, herkogamy, floral tube length) were taken on the flower receiving pollen, and the pollen source was recorded for all crosses. Mature fruits were collected approximately two to three months post pollination and were stored at room temperature in coin envelopes.

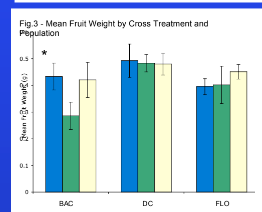
The length, width, and weights of fruits from three maternal-line populations (BAC [Baculite Mesa], FLO [Florence], and DC [David's Canyon]) from the three outcrossed cross types were measured. Seeds from each fruit were counted using a Seedburo Model 801 Count-A-PAK Seed Counter. A subset of 35 seeds from each fruit was individually weighed using a Mettler Toledo Excellence Plus XP Analytical Balance. The seed subsets from fruits with over 50 seeds were then scored for viability using the procedure described by Grabe (1970).

## Results

### Fruit Size Measurements



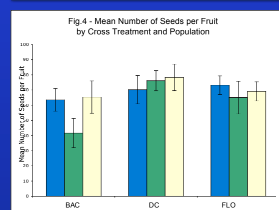





A. Maturing Fruits. B. Mature Fruits of *O. harringtonii*

Fig. 1-3 – There are no significant differences in mean fruit width, fruit length, or fruit weights between different cross types of between different populations, pairwise ANOVA p-value > 0.05 for all comparisons.

### Seed Number and Weight Measurements



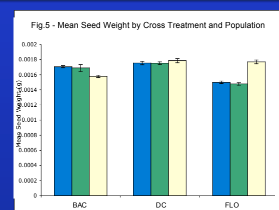
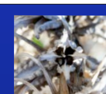
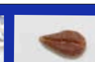




Fig. 4 and 5 – There are no significant differences in mean seed quantity or mean seed weight between different cross types or between different populations, pairwise ANOVA p-value > 0.05 for all comparisons.

Seed and open fruit with seed inside.

### Seed Viability

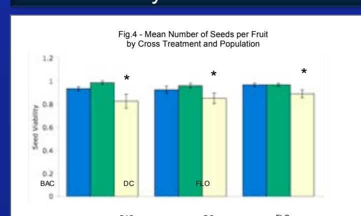
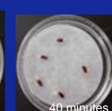
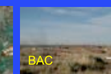



Fig.6 - Seed viability for sibling crosses (83-89%) were significantly less than that of between (93-97%)and within (96-99%) populations, pairwise ANOVA p-value 0.0008.




Time series of seed viability test for seeds from a sibling cross (FLO125-1-10 x FLO 125-2-8).




Range of *Oenothera harringtonii*, southeastern Colorado. Yellow dots are Fragmented populations (FLO & BAC), Blue dot is the Unfragmented population (DC).

## Discussion and Future Studies

Our results show that regardless of cross treatment (between populations, within populations or sibling), plants invest similar amounts of resources in fruits and seeds. However, fewer seeds from sibling crosses are viable.

Hypothesis 1. Fruit and seed fitness is lowest in plants of sibling crosses, highest in between population crosses, and intermediate in within population crosses.

We found no differences between cross treatments for any measure of fruit (length, width, weight) or seed (number, weight) fitness.

Seed viability was significantly lower in sibling crosses than between and within population crosses though was still quite high (83-89%). We found no significant difference between the later cross treatments.

Hypothesis 2. The fruits and seeds of plants from fragmented populations are less fit than those of plants from unfragmented populations.

We found no differences between populations (fragmented and unfragmented) for any fruit and seed data measured.

Future studies should include additional populations from both fragmented and unfragmented areas to determine if these patterns are consistent with an increased sample size. Additionally, similar data on field grown fruits & seeds would show how plants behave under more natural conditions. If resources and time are limited, focusing on seed viability should be the goal of future projects.

## Conservation Implications

Conservation Implications

*Oenothera harringtonii* provides an opportunity to study the consequences of habitat fragmentation, particularly for species of conservation concern and the pollinators on which they depend for long term population persistence. Because *O. harringtonii* is an annual, is self incompatible and relies on pollinators for reproductive success, the effects of habitat fragmentation might have immediate effects on fitness. Over 70% of the world's flowering plant species are dependent on insect pollinators for reproduction[5]. The fact that pollinators are declining at alarming rates is well known, and one of the main causes is habitat loss and fragmentation[5]. Research on the effects of habitat fragmentation are crucial to protecting pollinators and the plants they pollinate.

### Acknowledgements

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### Literature Cited

[1]Ladyman 2005, [2]Cunningham 2000, [3]Moody-Weis and Heywood 2001, [4]Grabe 1970, [5]NRC 2007