

2nd Mediterranean Plant Conservation Week

“Conservation of Mediterranean Plant Diversity: Complementary Approaches and New Perspectives”

‘Assisted reproduction’ as a tool for enhancing fitness and persistence likelihood of threatened plant

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L-Università
ta' Malta

Supported by:



Reproductive constraints and Conservation concern

- Pollen limitation
- I n b r e e d i n g depression
- Compatible mating

More severe reproductive limitations in small and isolated populations

Journal of Ecology 2006
94, 942–952

ESSAY REVIEW

How general are positive relationships between plant population size, fitness and genetic variation?

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Reproductive restrictions are more likely in target populations for conservation actions

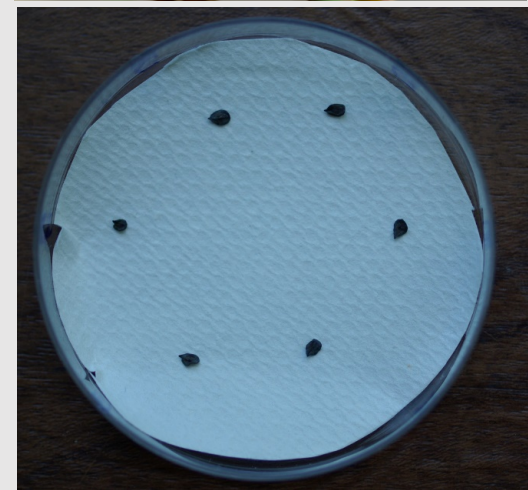
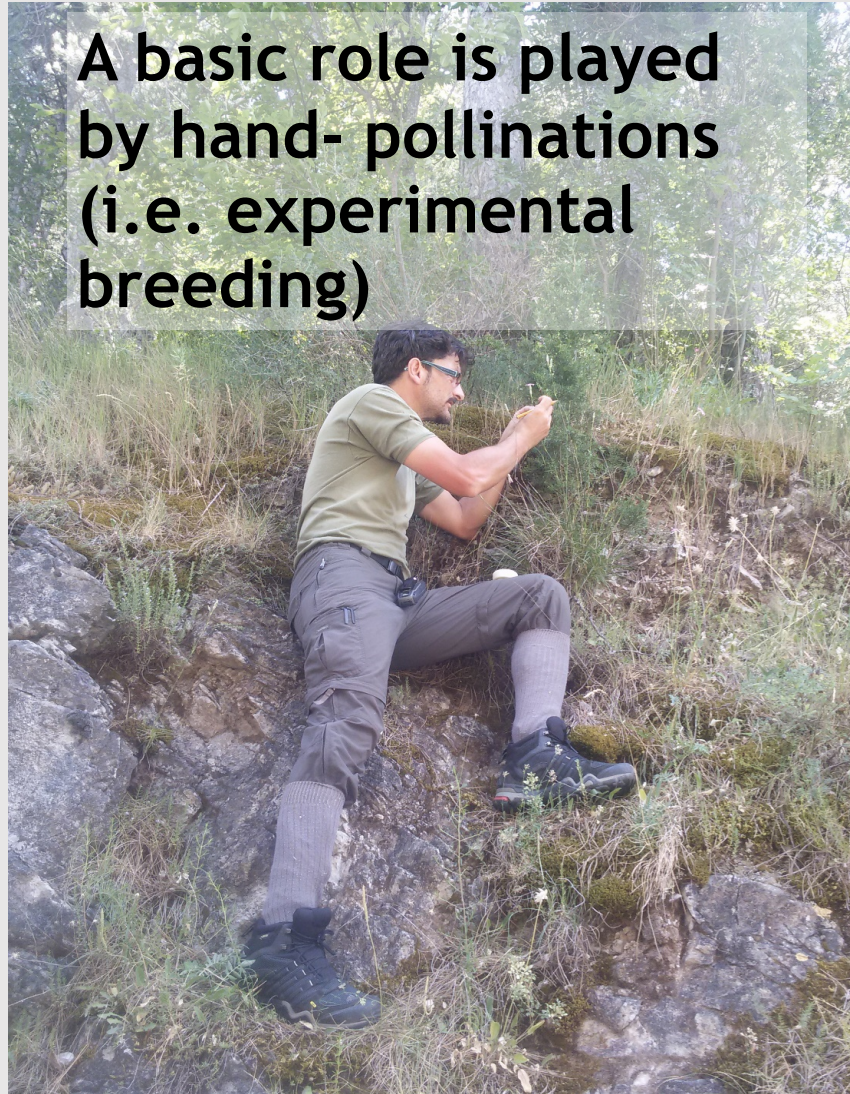
Required measures to restore population fitness

Plant Reproduction Investigation Tools (*PRITs*)

Fitness comparisons
among plant lineages

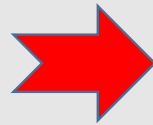


A basic role is played
by hand- pollinations
(i.e. experimental
breeding)



Commonly used in population biology studies

Not routinely integrated in conservation practices.....



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By: Xia, J.; Lu, J.; Wang, Z. X.; et al.
PLANT BIOLOGY Volume: 15 Issue: 2 Pages: 376-383
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2. **Do inefficient selfing and inbreeding depression in Janka (Caryophyllaceae)? Influence of reproduc**
By: Gargano, Domenico; Gullo, Teresa; Bernardo, Liliari

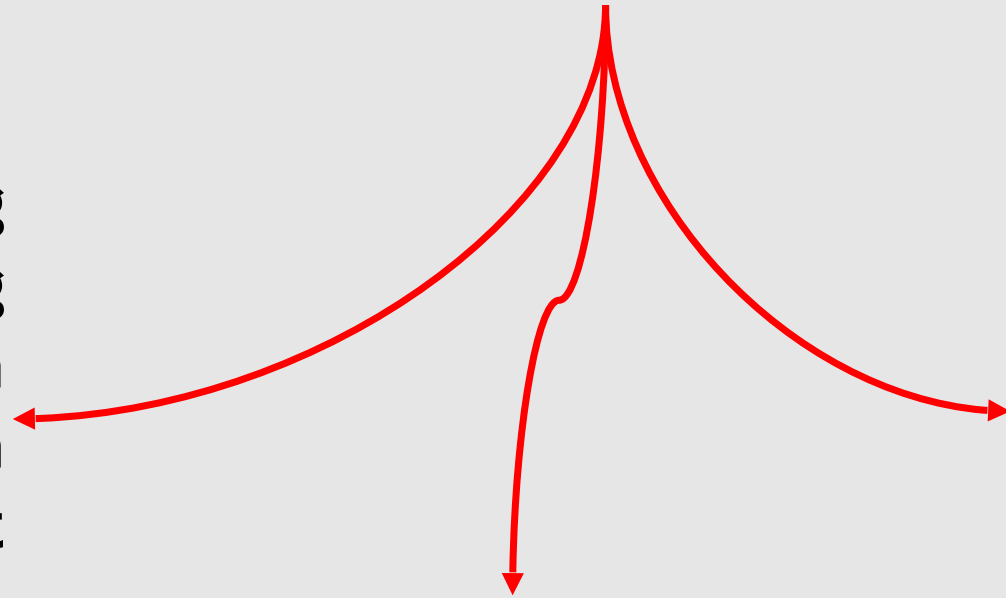
...but their usefulness is widely encouraged [Maschinski et al. 2013; Orsenigo et al. 2017]

Integrating *PRITs* in population restoration programs as a form of ‘assisted reproduction’

1) Investigating and restoring pollination efficiency within target populations

2) Evaluating the potential for fitness improvement of intra-population assisted mating

3) Evaluating the potential for fitness improvement of inter-population assisted mating



Applying 'assisted reproduction' to rare *Dianthus* species



D. balbisii Ser.

- Rare in C-Mediterranean
 - Conservation Status: NE
 - Major threats: Locally threatened by habitat dynamics and urbanization, increasing fragmentation.
-



D. guliae Janka

- Endemic to Italian peninsula
- Conservation Status: EN
- Major threats: Occurrence in small and fragmented populations, Habitat changes, Declining EOO, AOO

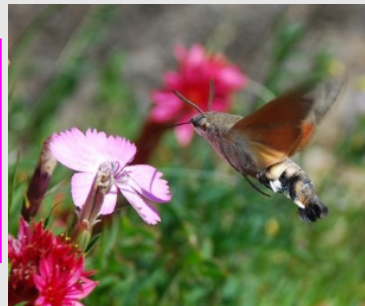
Biological & Ecological Remarks

MATING SYSTEM

- PROTERANDRY
- MALE-STERILITY
- SELF-COMPATIBLE BUT LIMITED SELF-FERTILIZATION



POLLINATION SYSTEM
- GENERALIST, INVOLVES
MOTHS, BUTTERFLIES, AND
FLIES



HABITAT

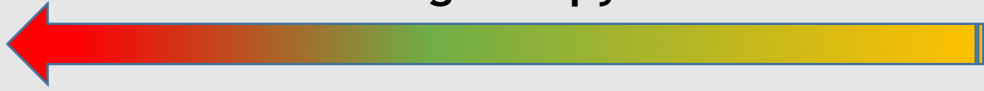
- EDGE-SPECIALISTS TYPICAL
OF BORDERS BETWEEN
WOODY AND OPEN PATCHES
AT LOW/MIDDLE ELEVATION



1) Using *in situ* 'assisted reproduction' to evaluate and buffer habitat-driven fitness loss in *Dianthus balbisii*



Increasing canopy closure

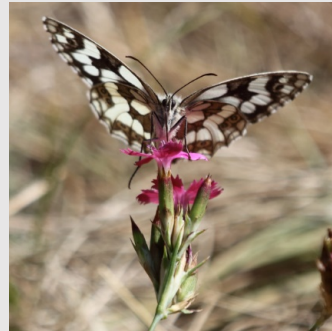


Little efficient
pollinators



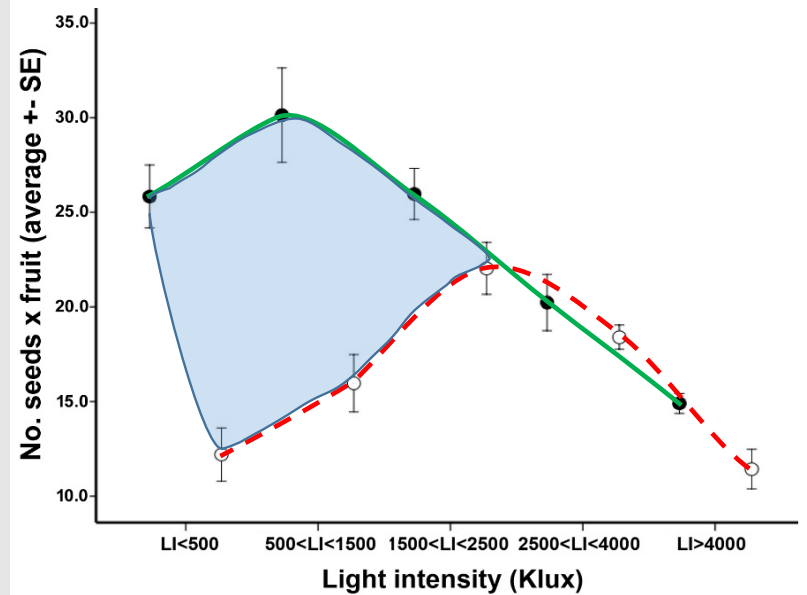
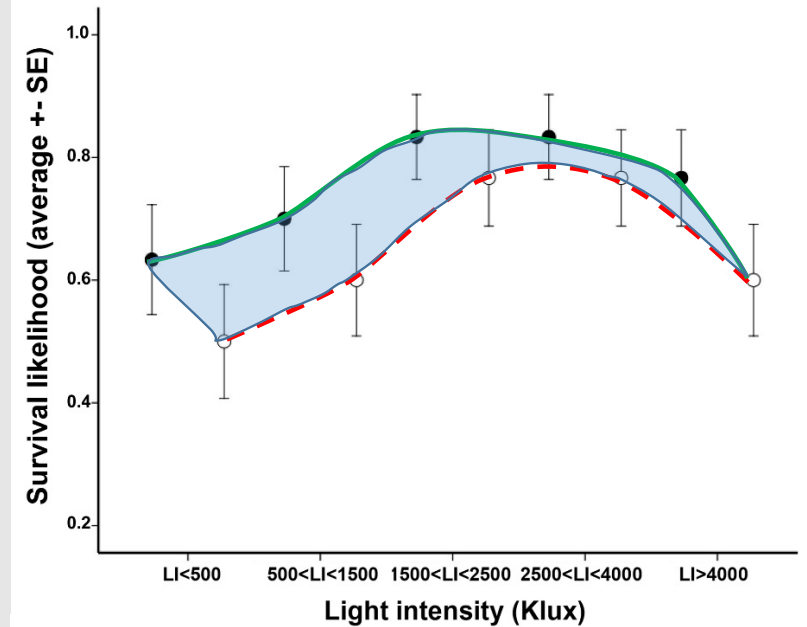
Highly efficient
pollinators

Middle efficient
pollinators



-Qualitative and quantitative fitness loss with increasing canopy cover
-Hand-cross pollinations help in filling fitness gaps over the habitat gradient

[Gargano *et al.*, 2017, *AoBPlants*]



2-3) Using intra- and inter-population assisted mating for restoring a threatened population of *Dianthus guliae*

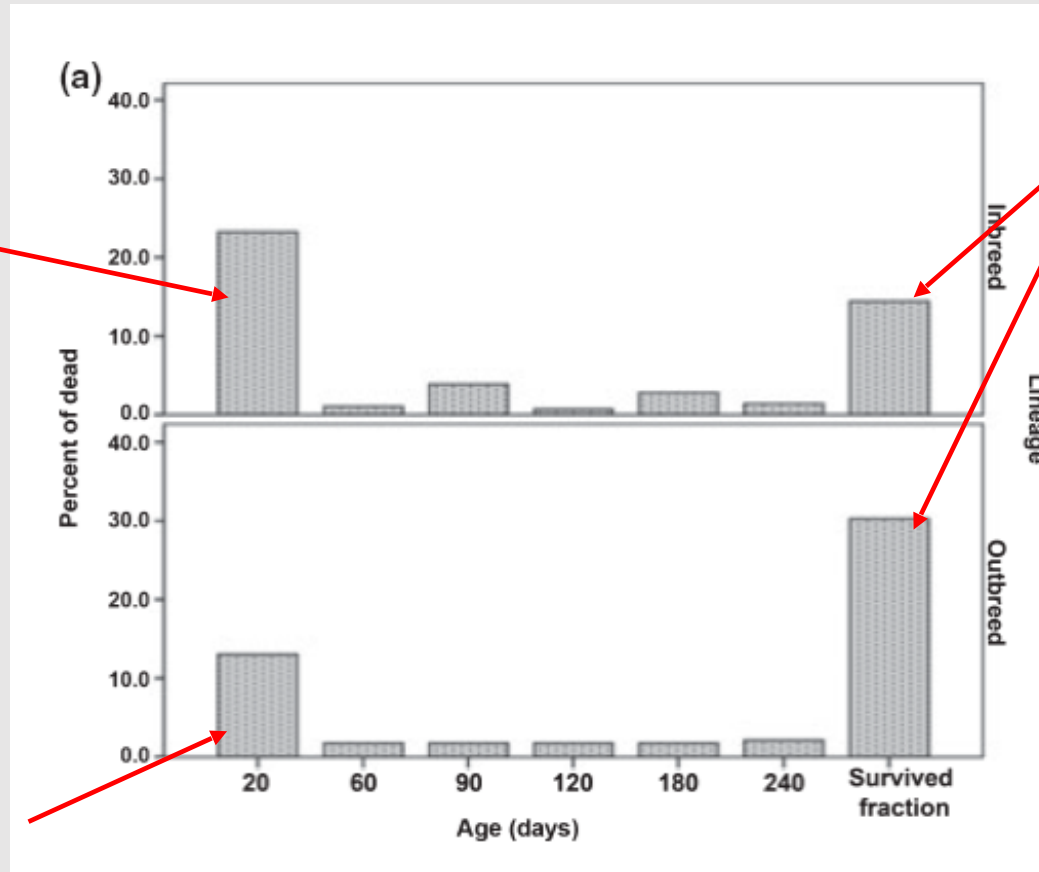


‘Assisted reproduction’ to optimize fitness by local mating

Very high initial mortality with further peaks in later life stages



High initial mortality, then it becomes constantly low



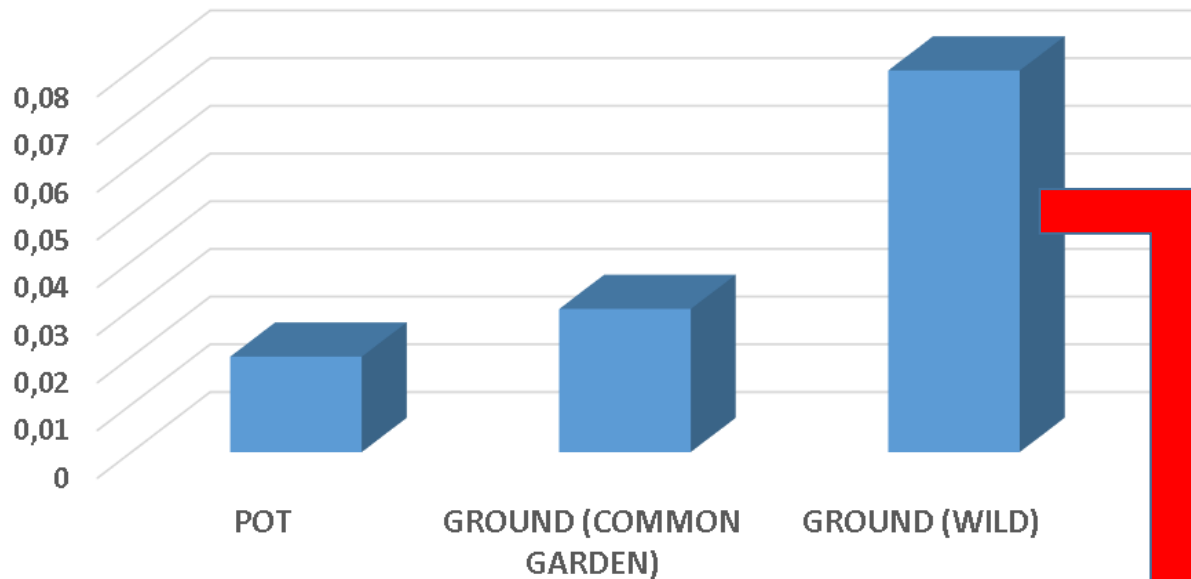
The fraction of plants reaching flowering is much higher in the outbred lineage



Mortality patterns in lineages of *Dianthus guliae* obtained by inbreeding (upper side) and cross-fertilization (lower side) from a very small population.

[Gargano et al., 2011, *Plant Biology*]

♀ (SURVIVAL)



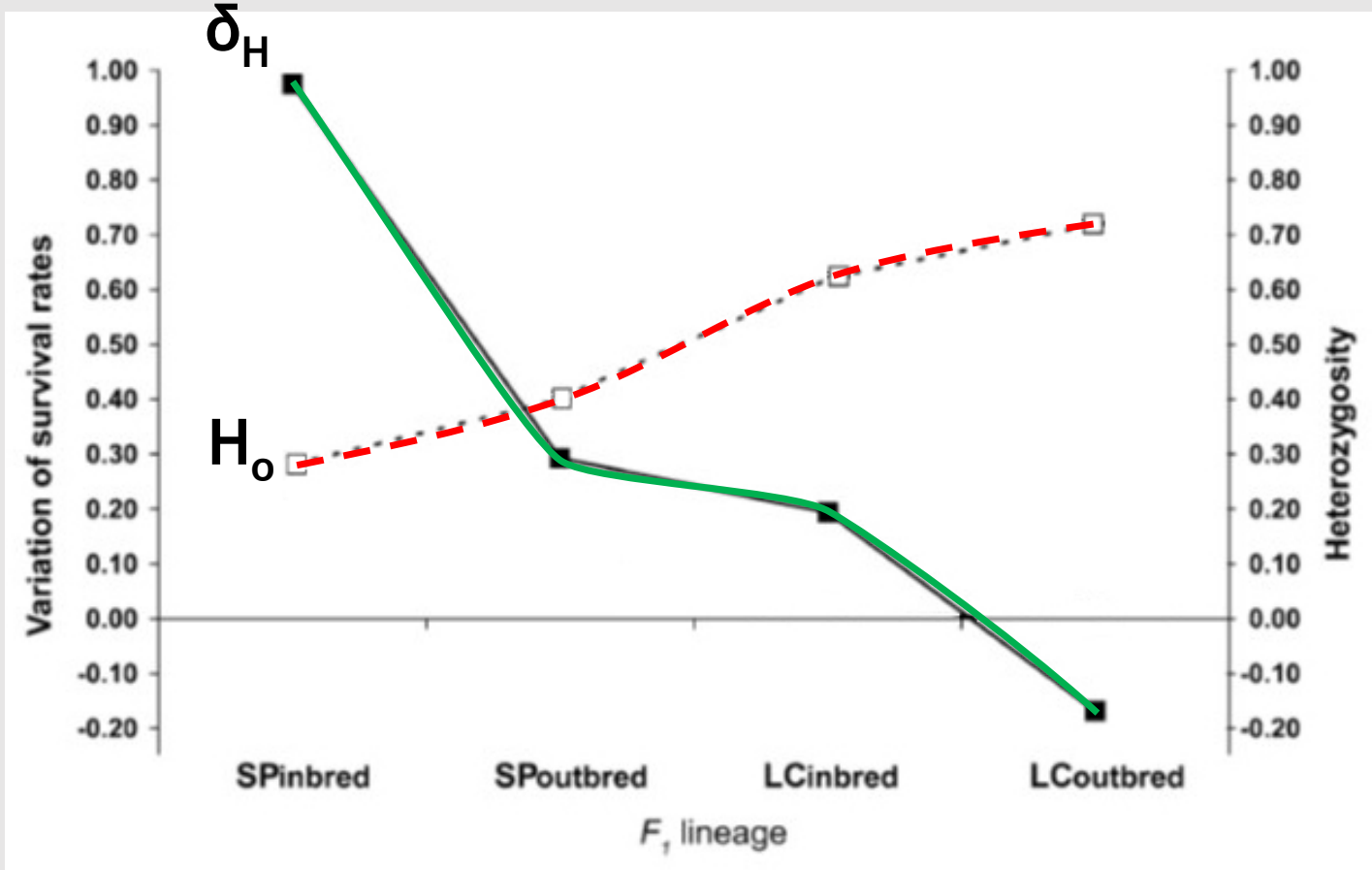
The fitness gap between inbred and outbred progenies augments across cultivation protocols simulating increasing ecological harshness.

[Gargano *et al.*, 2011, *Plant Biology*]

Using experimentally crossed offspring would augment chances of success of a reinforcement program.

'Assisted reproduction' to evaluate benefit of inter-population mating

Fitness differences among 4 lineages of *Dianthus guliae*, from 2 source population, subjected to crossing within-population and crossing between population

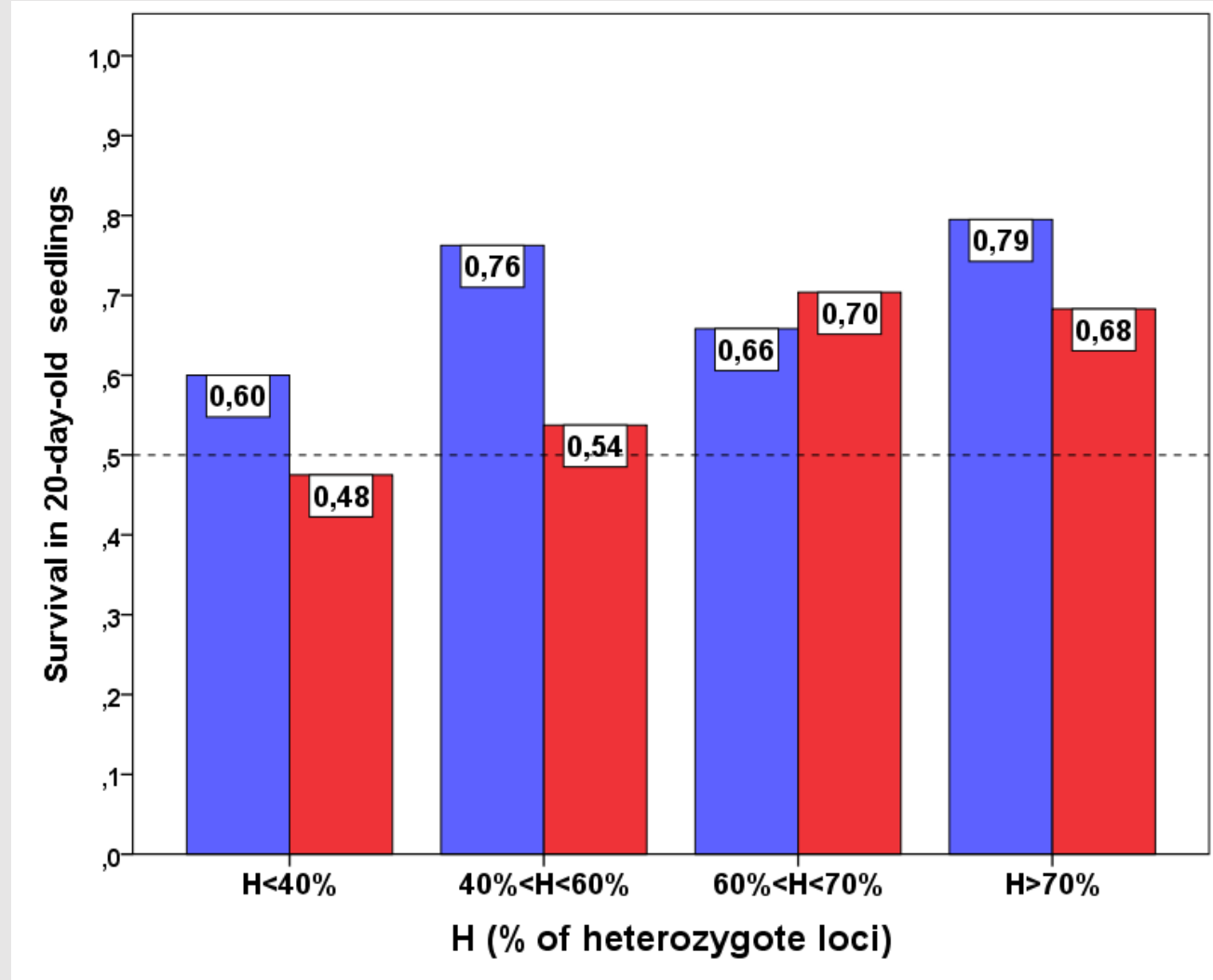


[Gargano et al., 2015, Conserv Genet]

Inter-population ‘Assisted mating’ to reduce ‘future maladaptation’

Early survival rates in lineages of *Dianthus guliae* obtained from different models of within- and between-population pollinations, showing different heterozygosity and experimentally subjected to a different aridity stress.

[Gargano et al. in prep.]



Blue bars: wet scenario; Red bars: dry scenario

Why use 'assisted reproduction' in conservation practices

Efficient and cost-effective tools

Based on pollen transfer between individuals and populations

Evidencing and mitigating fitness limitations in threatened populations

Improving reintroduction programs by supporting both planning and realization phases

!Fitness benefit can increase in more severely depleted populations!

THANK YOU

