Genetic insights of gray wolf population fitness

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My involvement with wolf research and agencies

- Yellowstone National Park gray wolf genetics (2004-present)
  - I have maintained the genetic pedigree and monitor genetic health, movement, disease, behavior, and reproduction

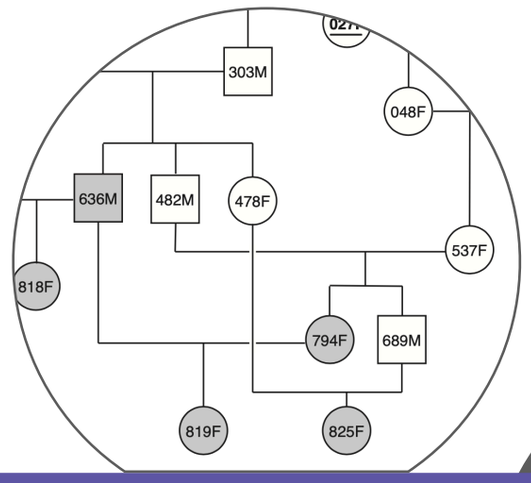
- Red wolf Recovery Team (2021-present)
  - Chair of genetics subgroup for recovery planning
  - Genetic-morphology predictions; genomic ancestry, introgression, and mate choice

- Red wolf captive breeding program pedigree genetics

My collaborative team manages two field sites

1) Eastern Texas (Galveston Island)
2) Southwestern Louisiana (Cameron Parrish, state and private land)

***Photo*: Moore-Odum FR Ranch Preserve where we collar and study canids along the Gulf Coast**



History

- Population change
- Dispersal
- Family relationships

Genomics

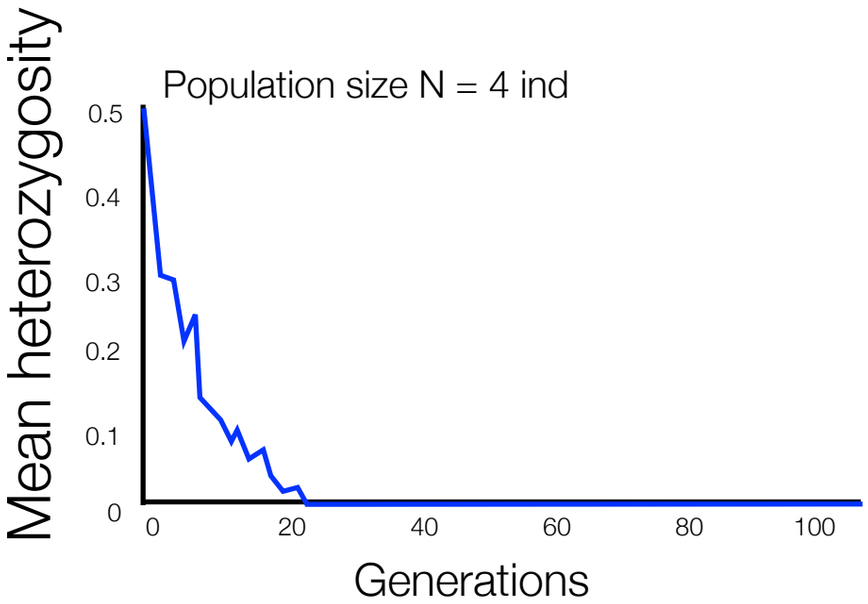
Adaptation

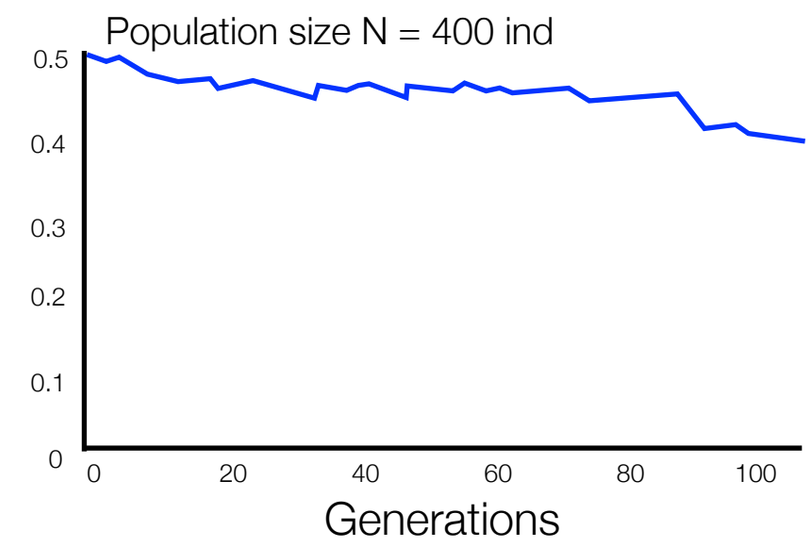
- Ecology
- Climate change
- Admixture

Conservation

- Species definitions
- Management
- Community engagement

Genetic diversity (*a.k.a. heterozygosity, genetic health, viability, fitness*) decreases at faster rates in smaller populations

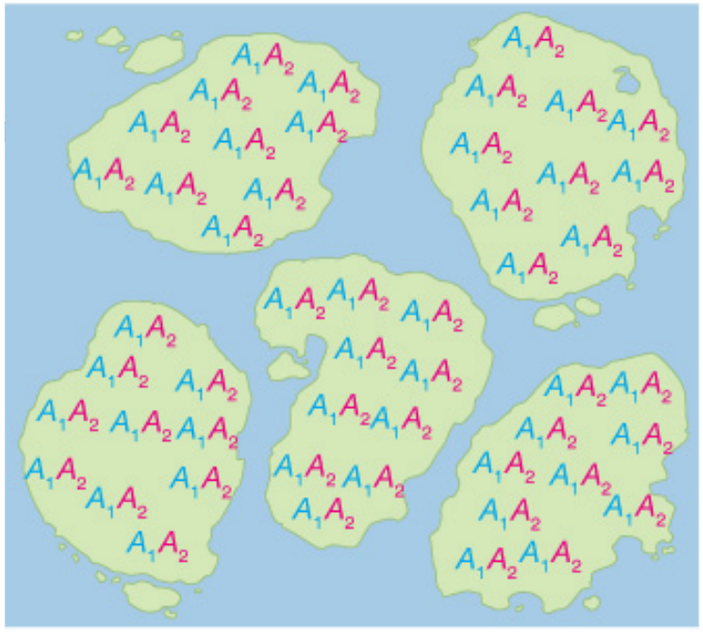




This metric (diversity or heterozygosity) is at the heart of conservation management goals.

Real life is rich in biological complexity

- Species and populations can be structured into smaller groups



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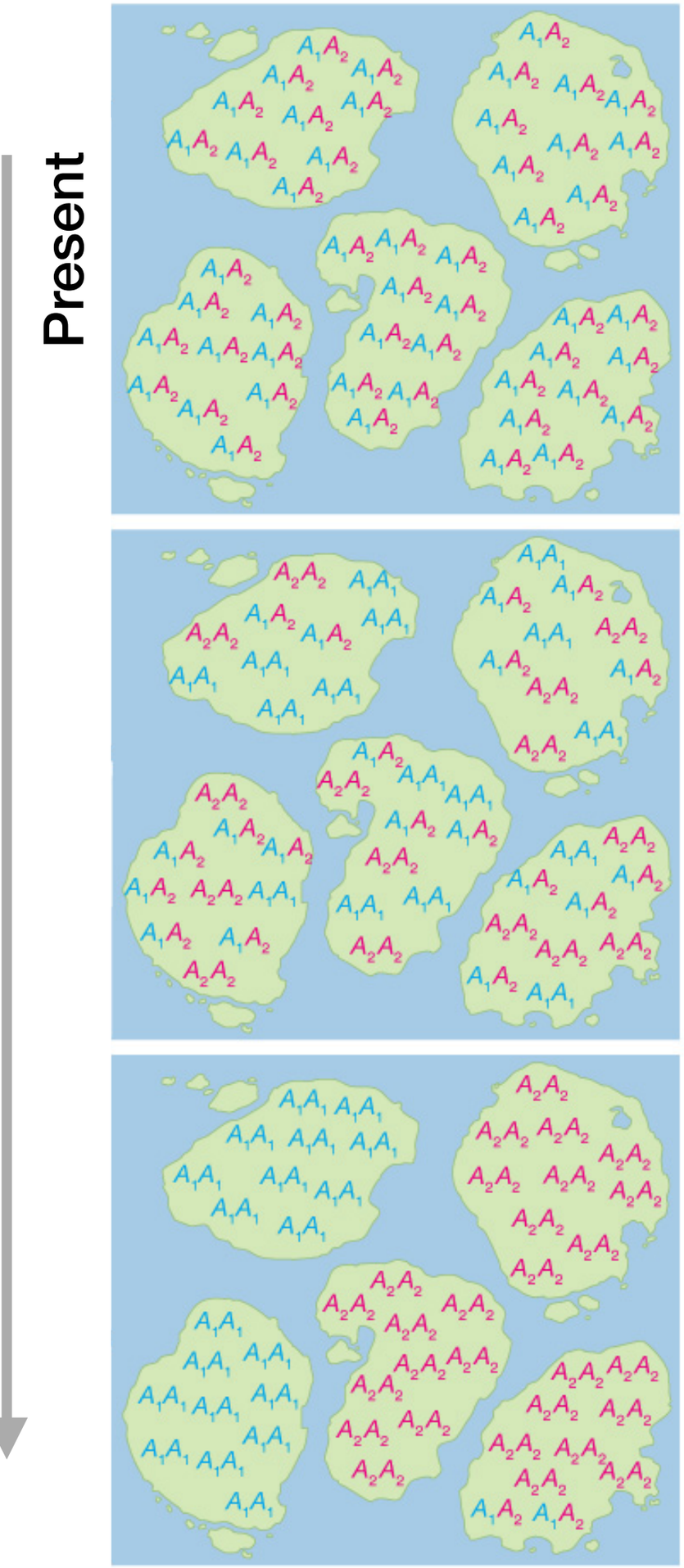
- Reduces the genetic diversity through reduced population size (***a.k.a.*** **genetic drift**)



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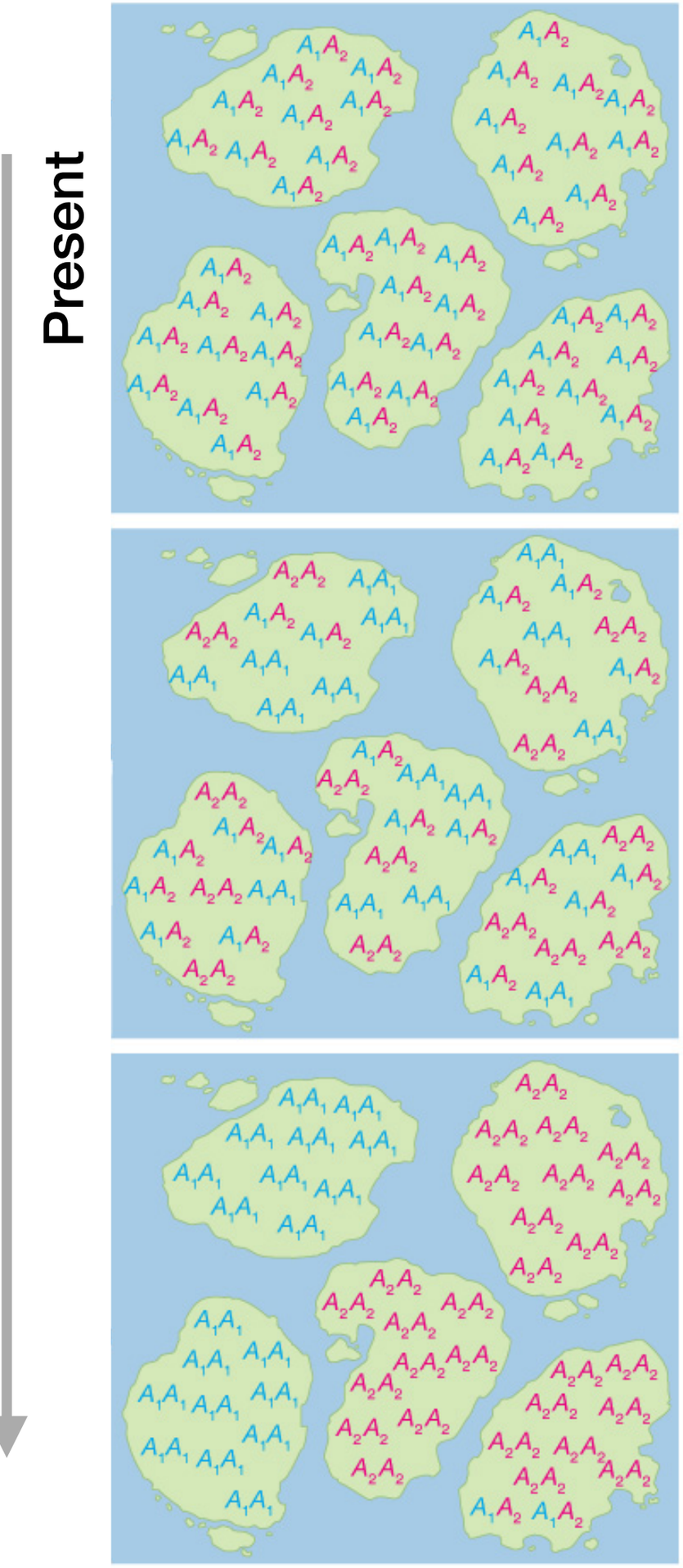
- Each subpopulation has a significantly higher risk of inbreeding



Yellowstone wolves that breed in their lifetime have lower inbreeding coefficients

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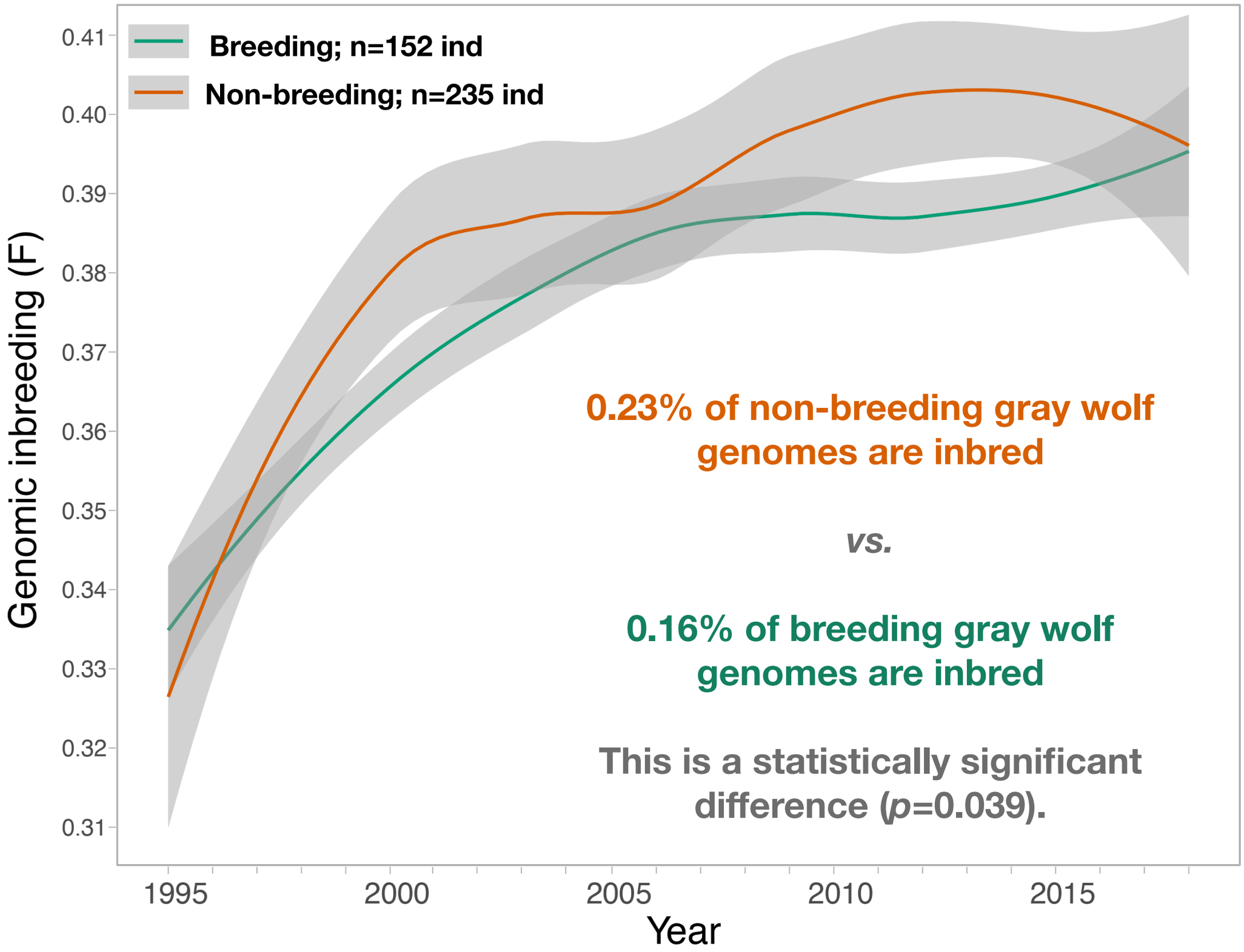
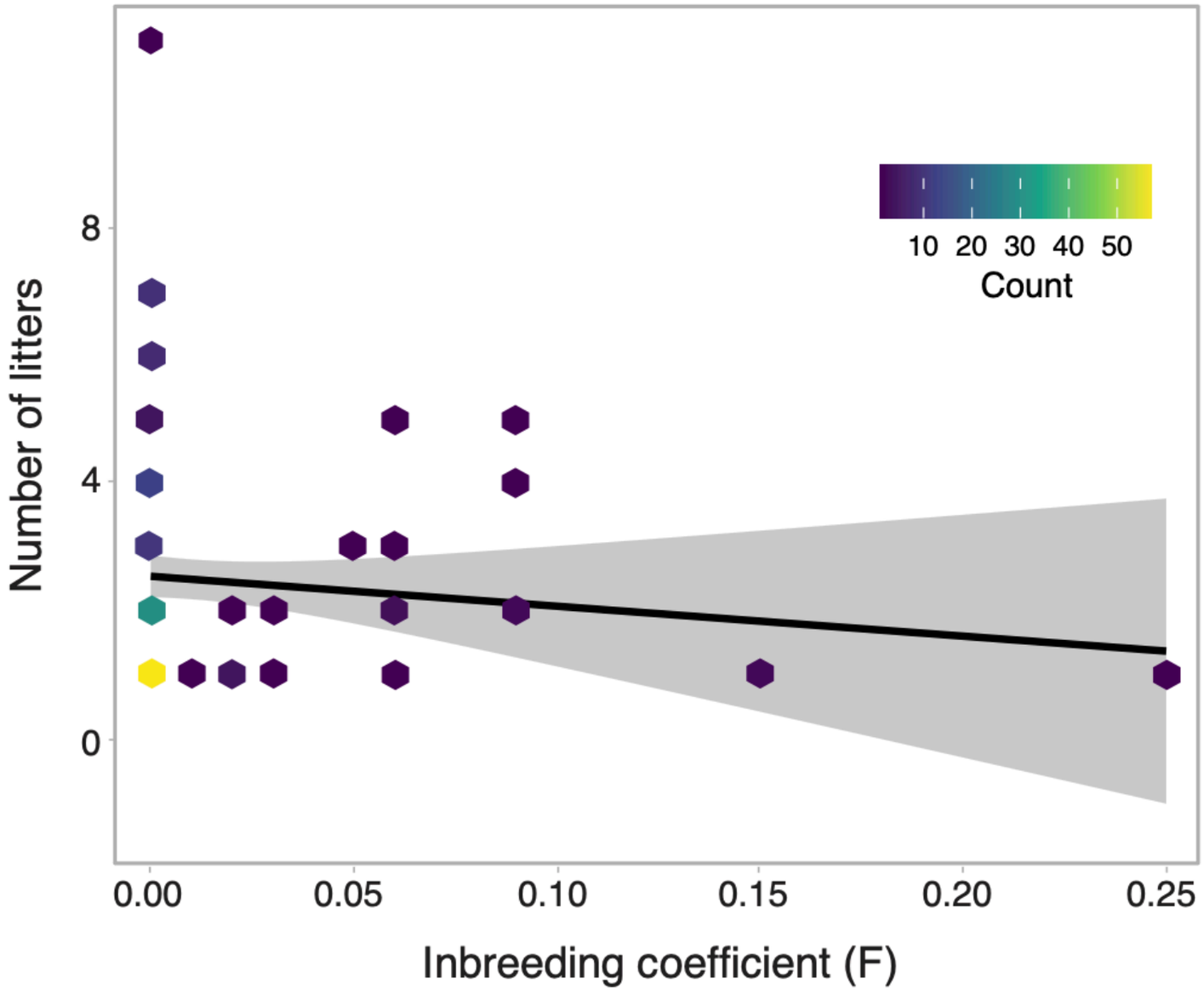


Decreasing genetic diversity is related to decreased fitness (reproduction & survival)

- Higher inbreeding coefficients correlate with fewer litters

- Almost 10% reduction in fitness of inbred individual gray wolves



Yellowstone NP gray wolf population
(vonHoldt et al. 2008, 2020, *in review*)

Other complexities

- Social/mating structure
- Dispersal patterns
- Inter-individual relatedness
- Intentional human-caused mortality
- Differences in reproductive success
- Skewed sex ratio
- Number of individuals reproductively active
- Etc.

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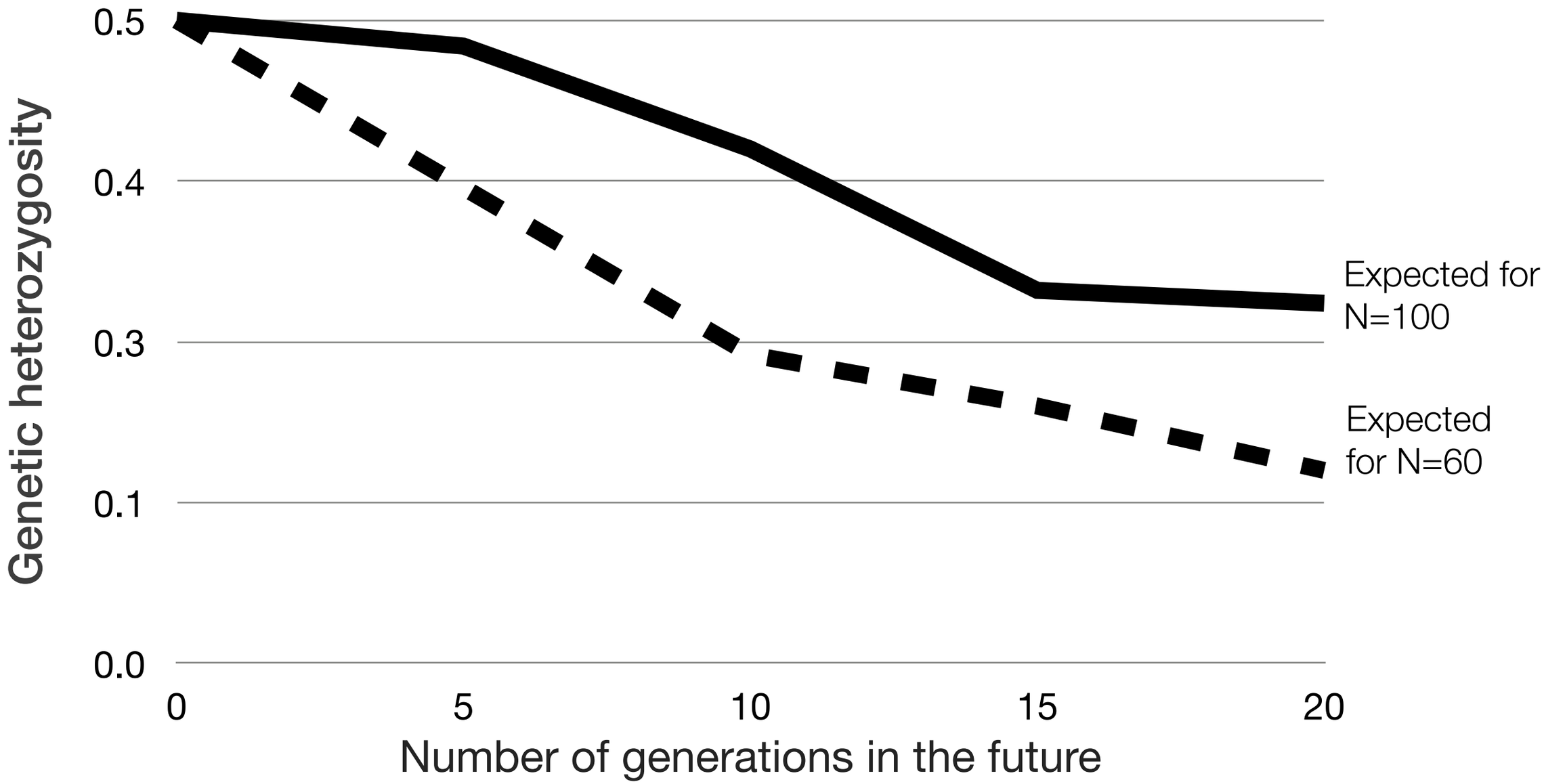
"Effective population size [**Ne**] is one of the most fundamental evolutionary parameters of biological systems, and it affects many processes that are relevant to biological conservation."

-Robin Waples (wildlife population geneticist), 2002

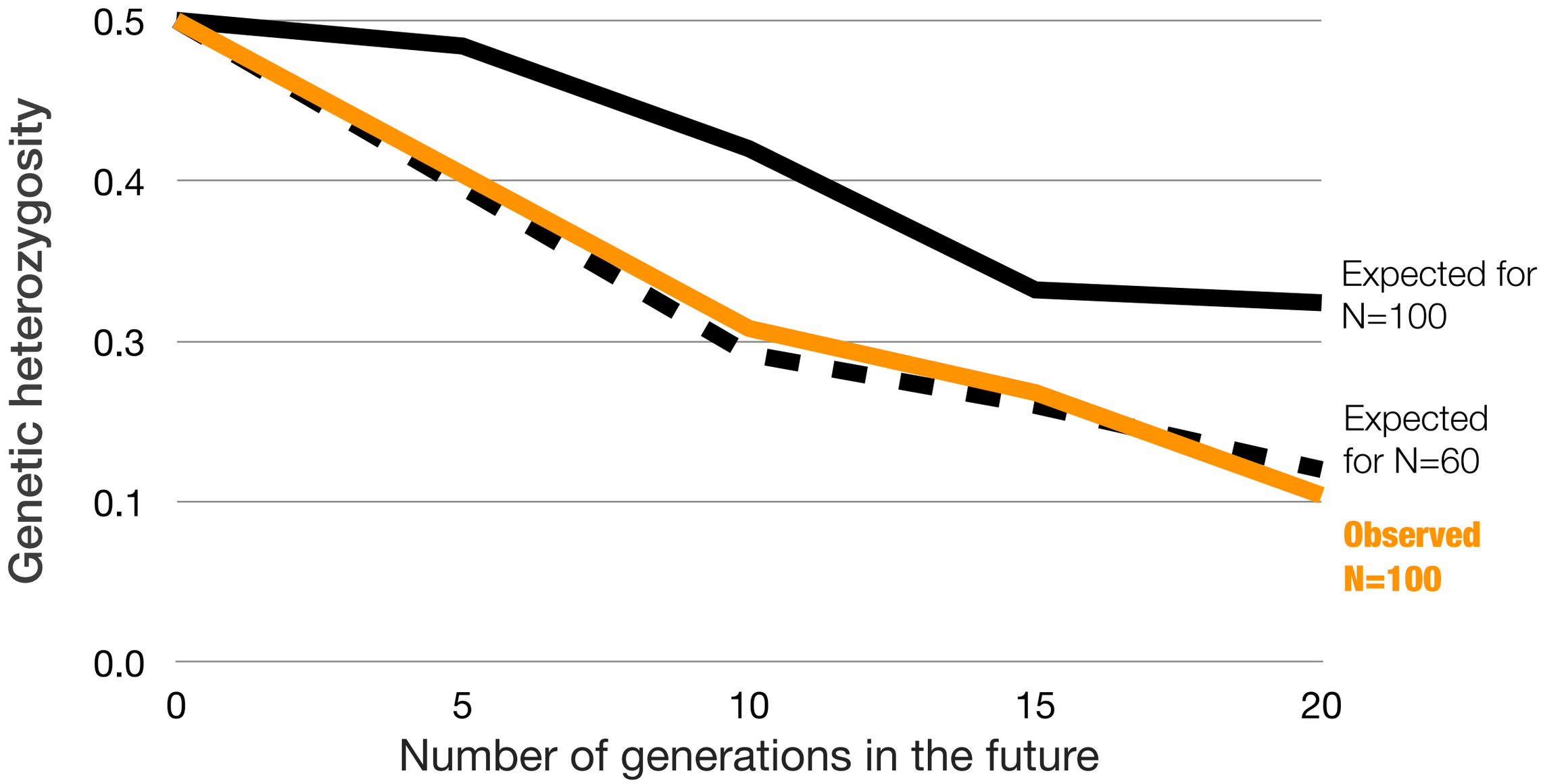
Effective population size, Ne



Theory tell us that smaller populations lose genetic diversity at a faster rate

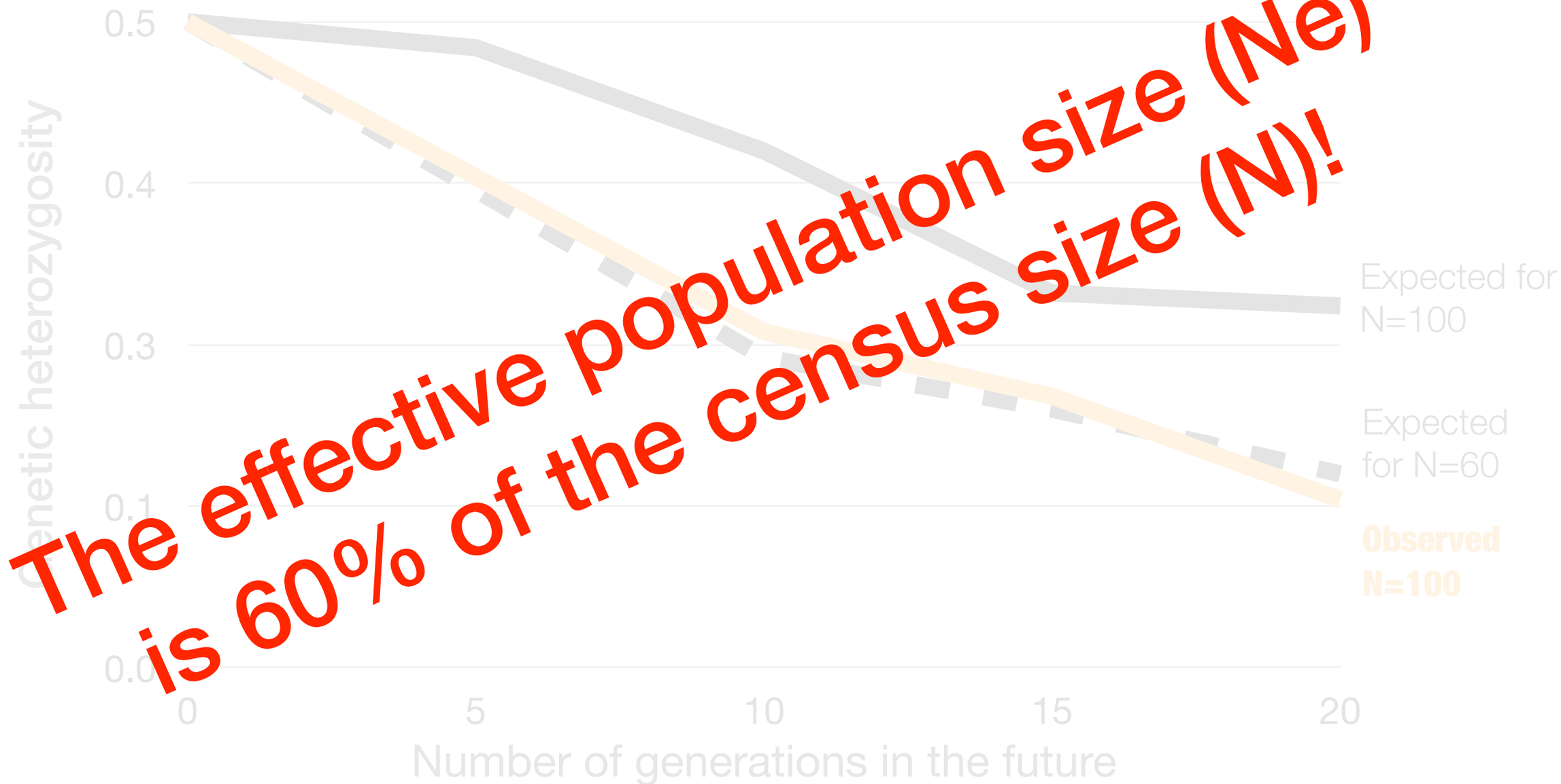
(*e.g.,* through genetic drift and inbreeding)

Effective population size, Ne



Comparing the observed rate of loss to that of theoretical expectations, we see that 100 individuals lose diversity as if there were only 60 individuals.

Effective population size, Ne



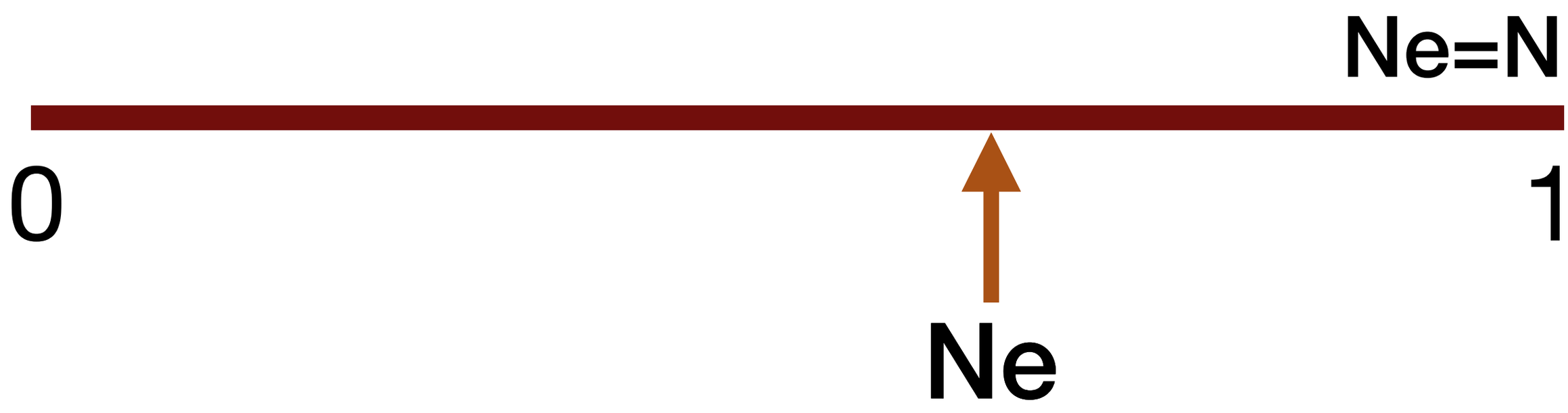
Comparing the observed rate of loss to that of theoretical expectations, we see that 100 individuals lose diversity as if there were only 60 individuals.

The ratio of Ne/N is most informative in the real world

Skewed sex ratio,
number of breeding individuals,
reproductive success, etc

Ne=N

The ratio of Ne/N is most informative in the real world



Mate choice, relatedness of mates,
lack of genetic connectivity, etc.

The ratio of Ne/N is most informative in the real world

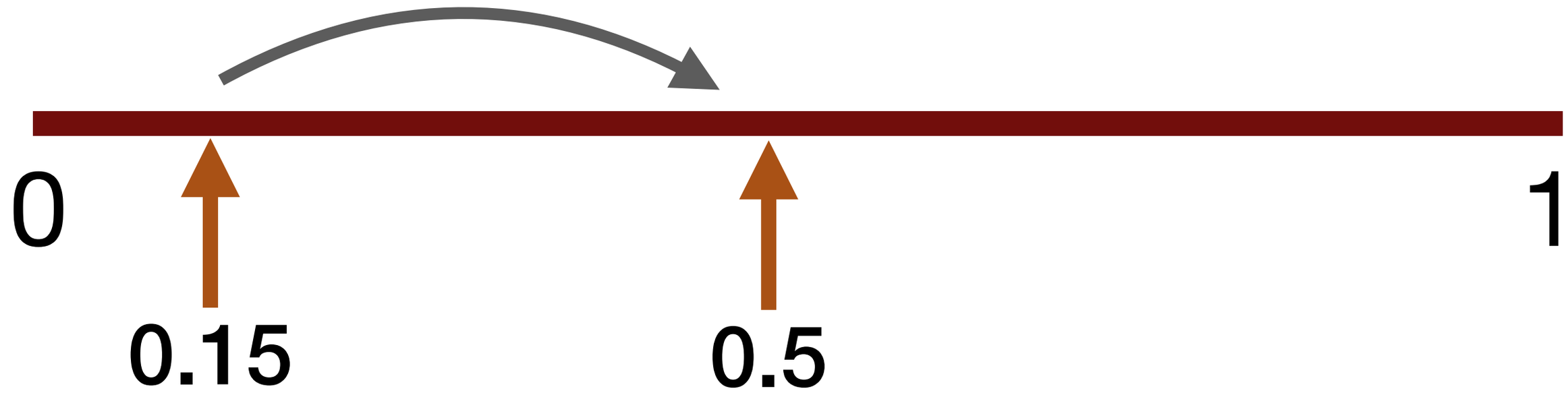
If N=216 wolves,
then Ne~32 wolves

Ne=N

If N=216 wolves,
then Ne~130 wolves

The ratio of Ne/N is most informative in the real world

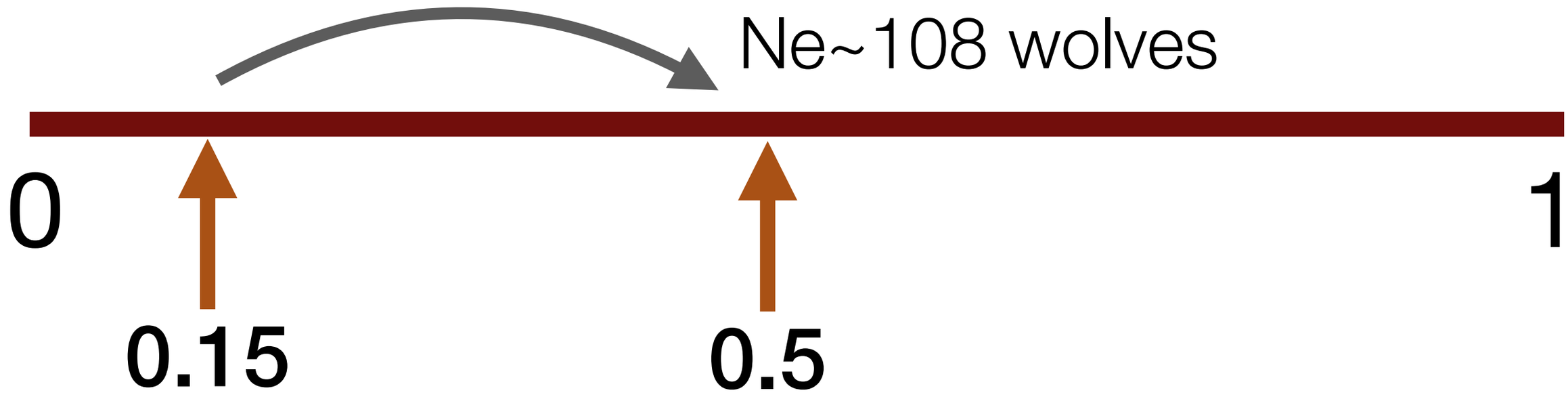
<u>Effective</u> dispersal where a wolf migrates into the inbred population and reproduces — this will boost Ne/N



High inbreeding

The ratio of Ne/N is most informative in the real world

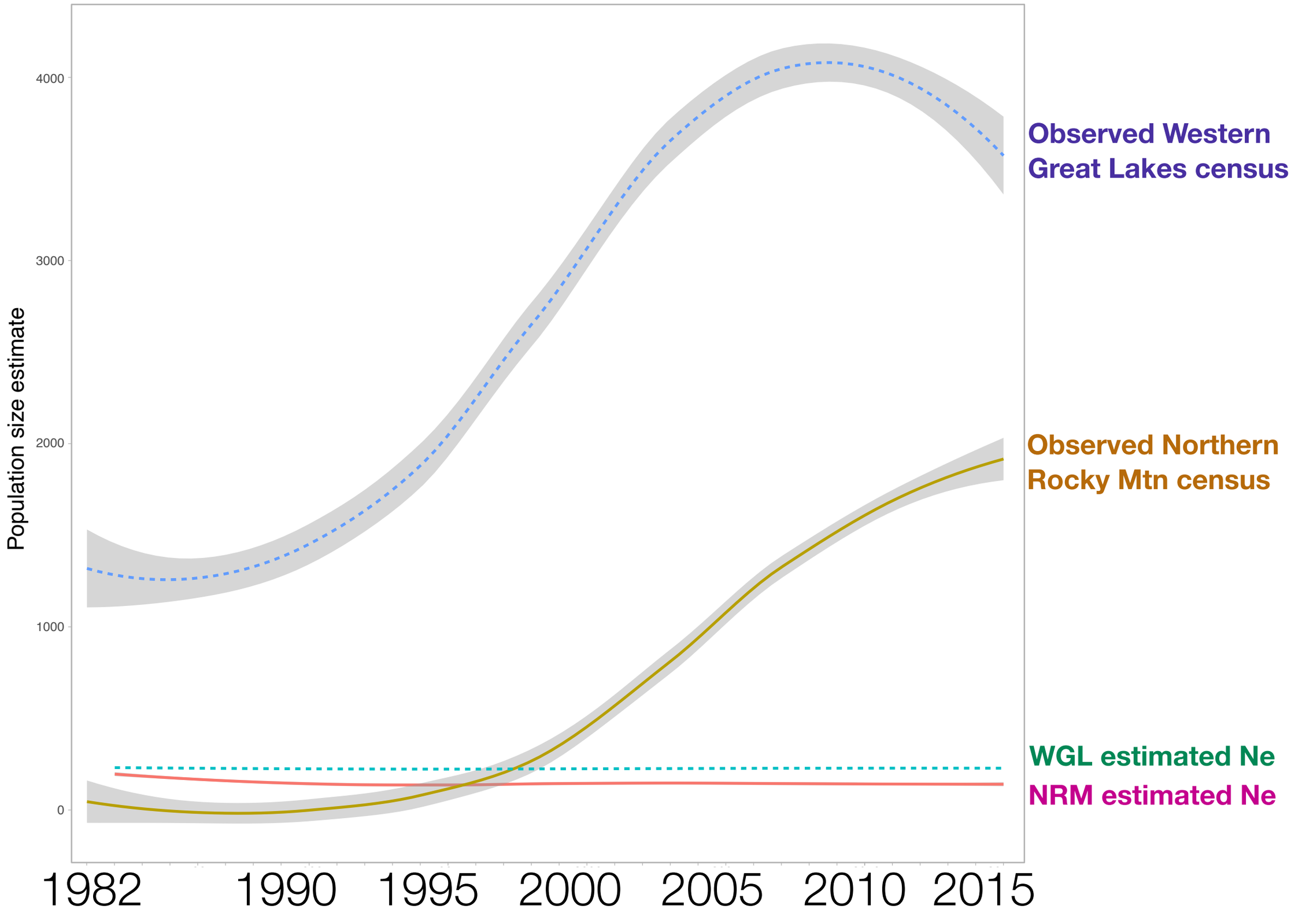
If N=216 wolves, genetic connectivity increases Ne~108 wolves



If N=216 wolves, then Ne~32 wolves

North American gray wolf Ne/N ~ 5-9%

vonHoldt et al. (2023) preprint on BioRxiv



To increase the overall probability of population survival, increase the effective population size

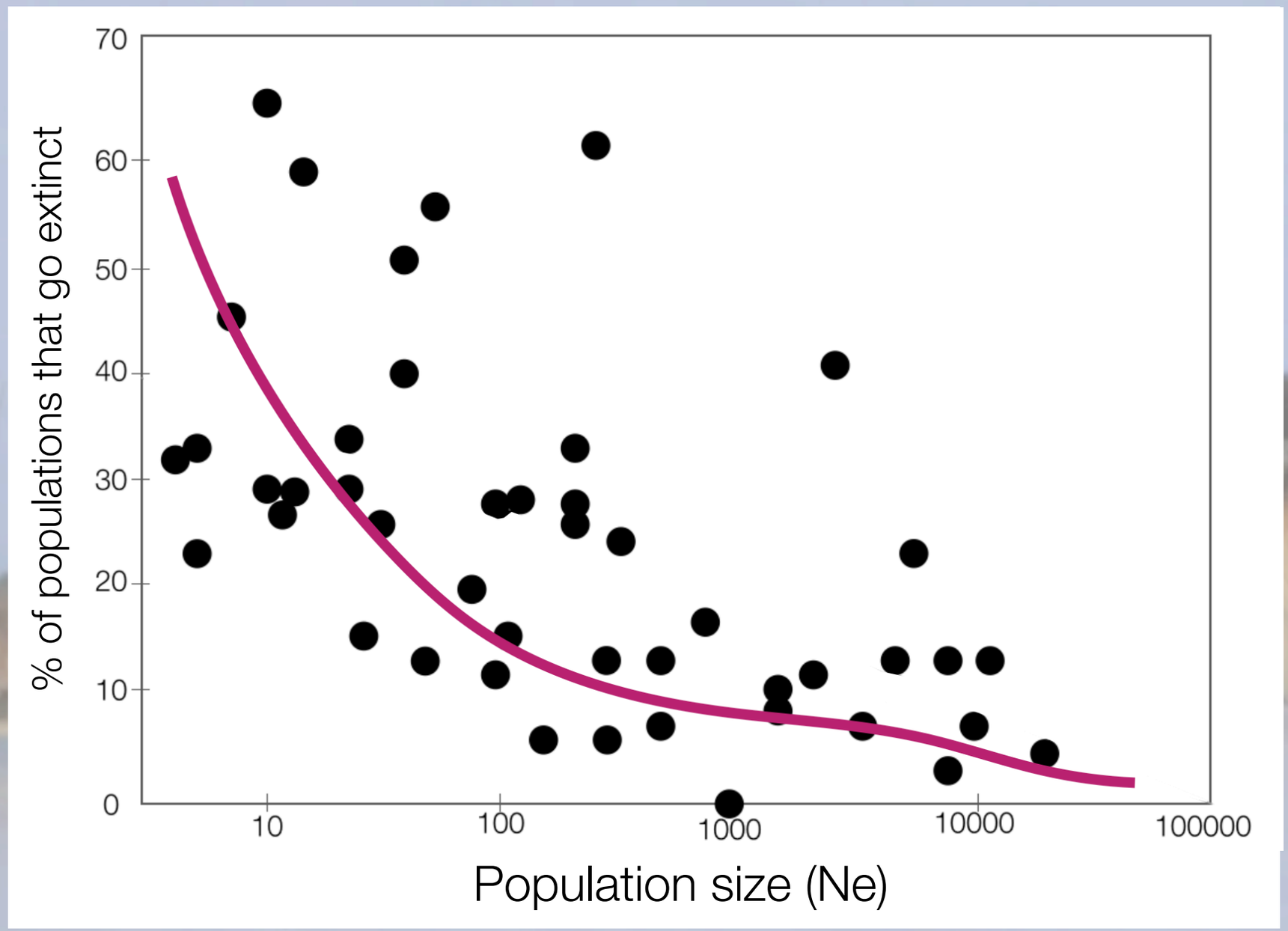


Photo: Kira Cassidy, NPS

Supporting a self-sustaining wolf population

- For recovery and long-term sustainability, we need to see an increase in the effective population size across gray wolf populations.

- Build in coexistence strategies for wolf populations to be able to increase in number and expand their distribution.

- Increased genetic connectivity and dispersal == decreases inbreeding == increases Ne estimates

- Gray wolf Ne is only A TINY FRACTION of the census sizes

- **Breeding and dispersing individuals are critical** for safeguarding the future of gray wolves

Gratitude and thanks!!!

Happy to take questions!

Photo: Rolf Peterson, MTU