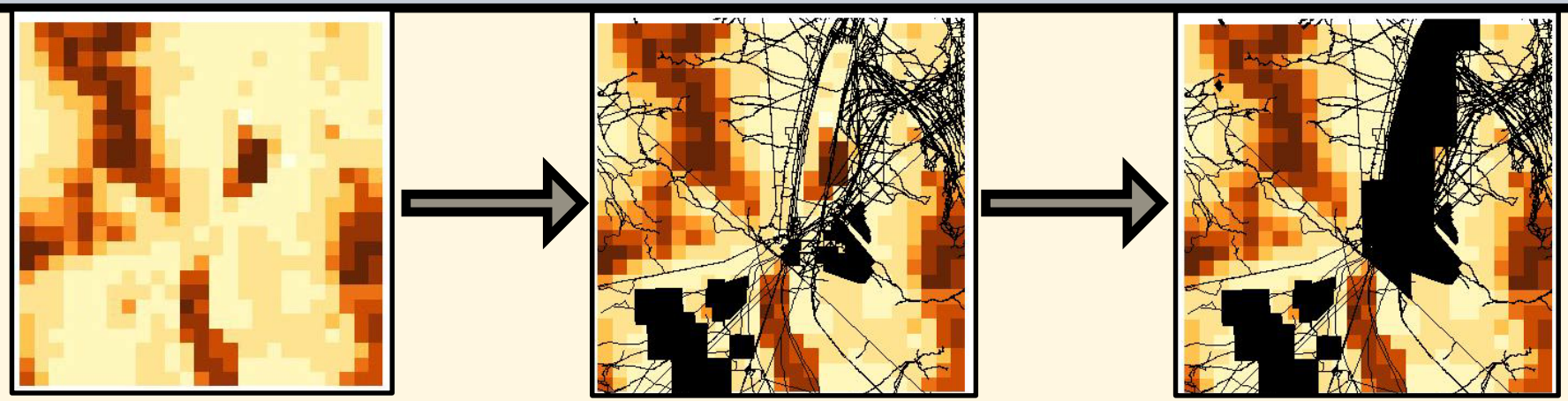
# The Shape of Things to Come:

## A Window into Desert Tortoise Connectivity in an Increasingly Urban World



Kirsten Dutcher, Jill Heaton, & Ken Nussear

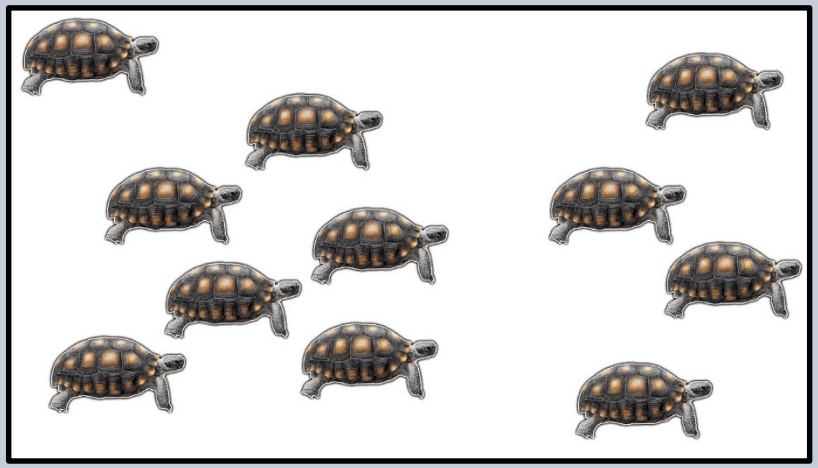
2015-UNR-1580A-Desert Tortoise Connectivity Modeling

# Project Purpose & Status

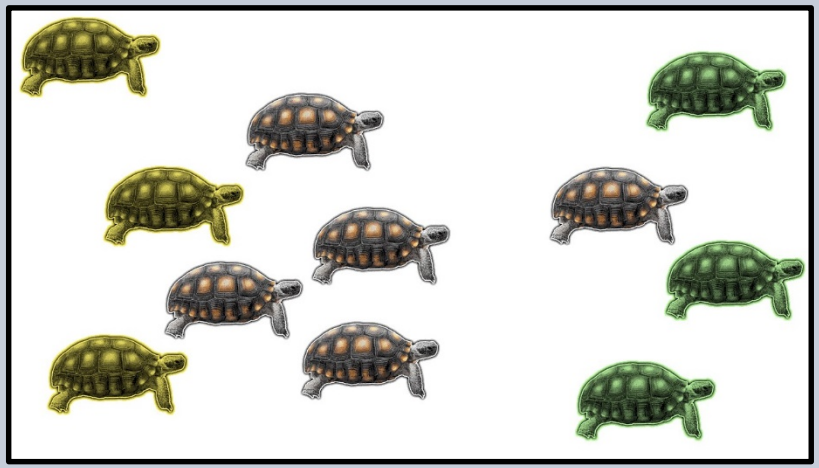
- *Understand the effects of corridors & quantify connectivity in disturbed habitat*
- *Final report & deliverable submitted*

Support provided by Clark County DCP, funded by SNPLMA, to further the Clark County MSHCP

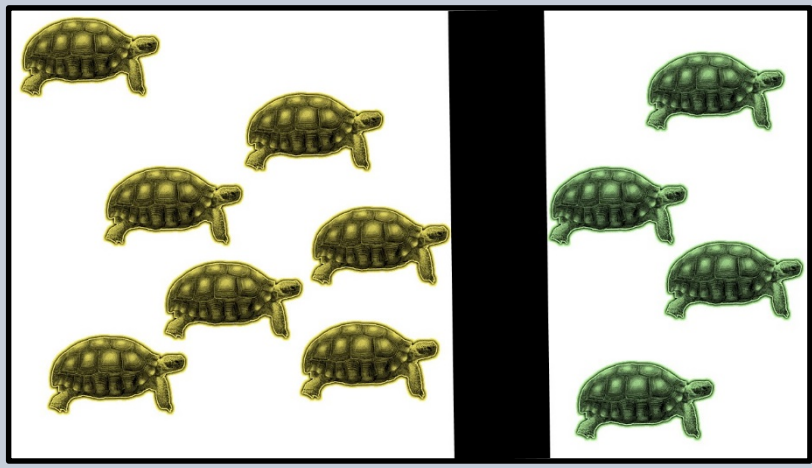
# Genetic Connectivity



Panmixia

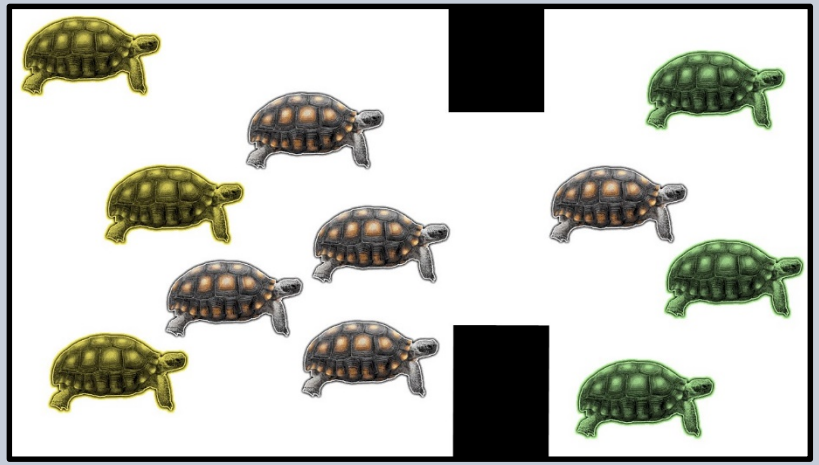


Isolation-by-Distance

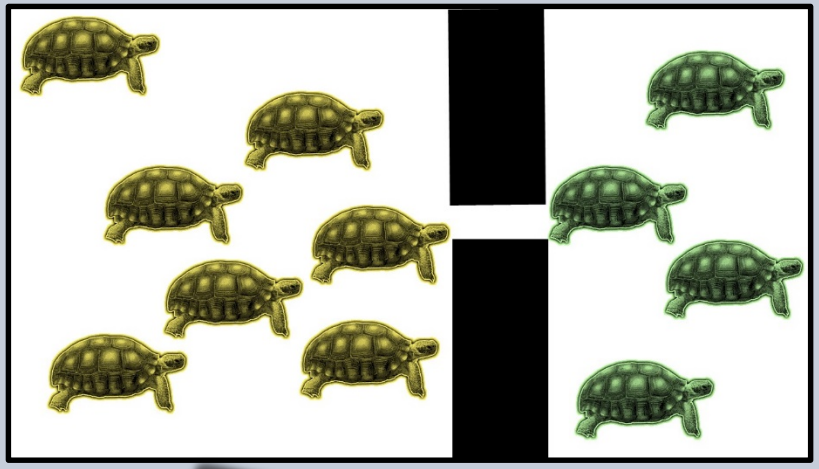


Isolation

# Gene Flow, Barriers, & Corridors



Gene Flow

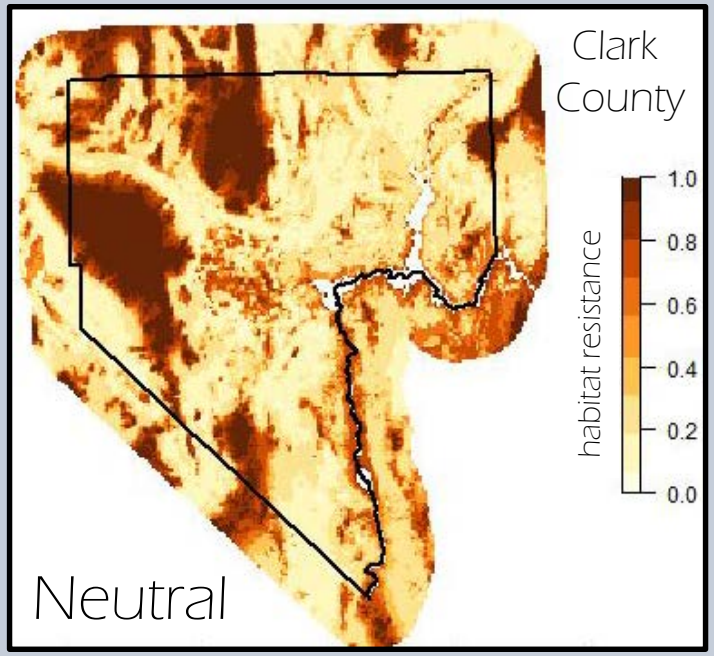


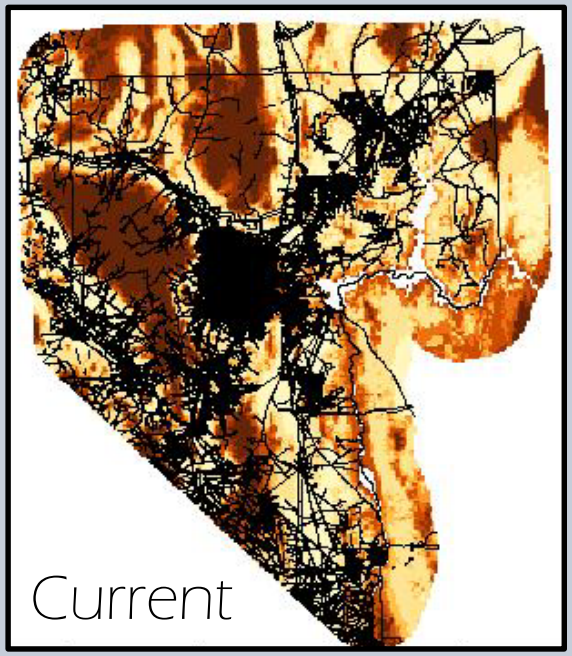
~~Gene Flow~~

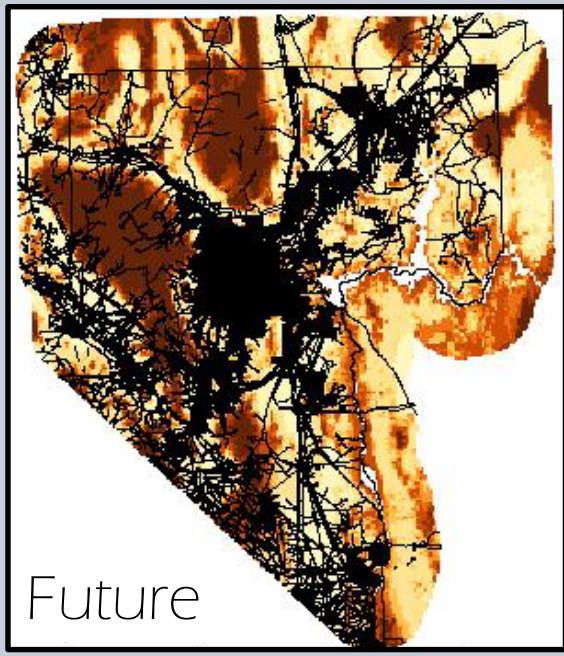
# Main Connectivity Takeaways

- Effect of population density & addition of corridors
- Impacts of habitat disturbance on population size & gene flow
- Indicators of corridor success/failure

# Disturbance & Lag Times




Time

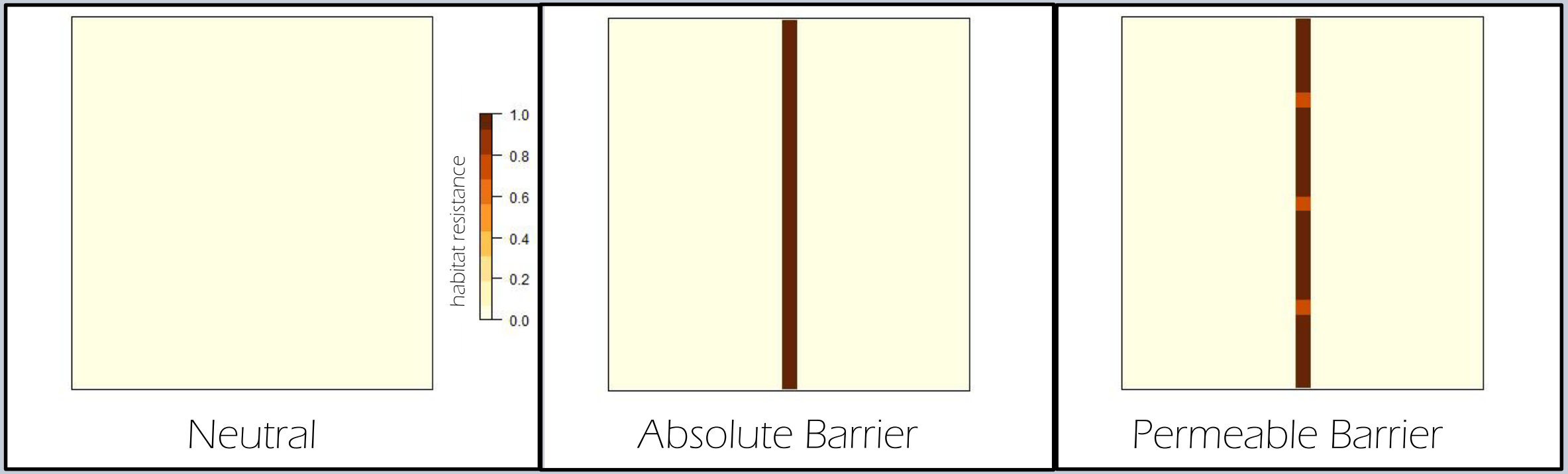
1 generation

200 generations

# Forward-in-Time Simulation Modeling

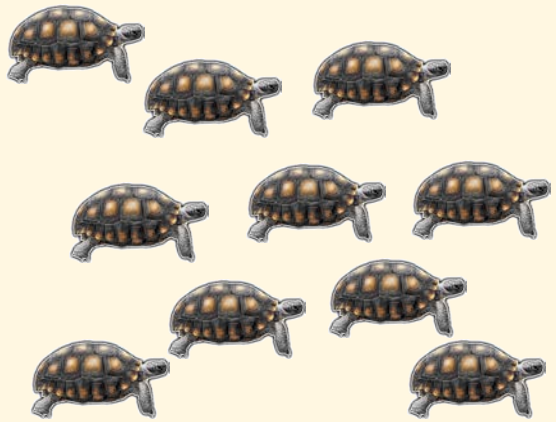
- Genotypes - 20 microsatellite loci
- Time - 200 tortoise generations
- Resistance surface - 0 to 1

# Proof-of-Concept Models



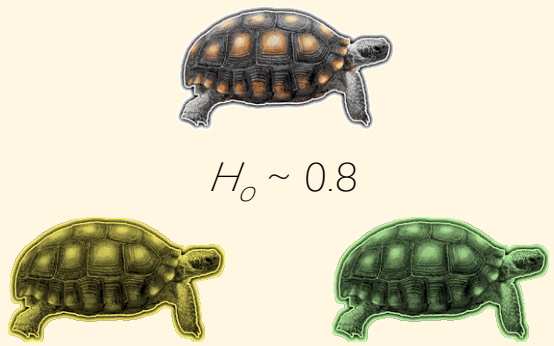

Population densities: low (3/km$^2$), moderate (14/km$^2$)

# Population & Genetic Analyses

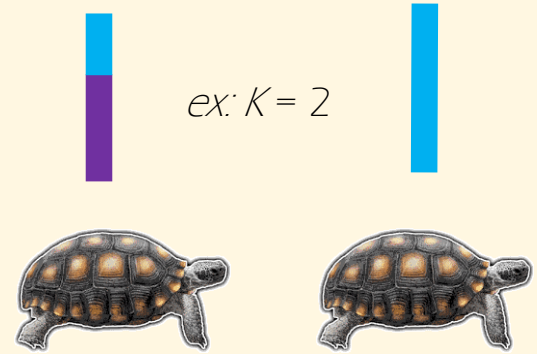


Population Size

Dutcher et al. in review
Hagerty 2008




Genetic Diversity



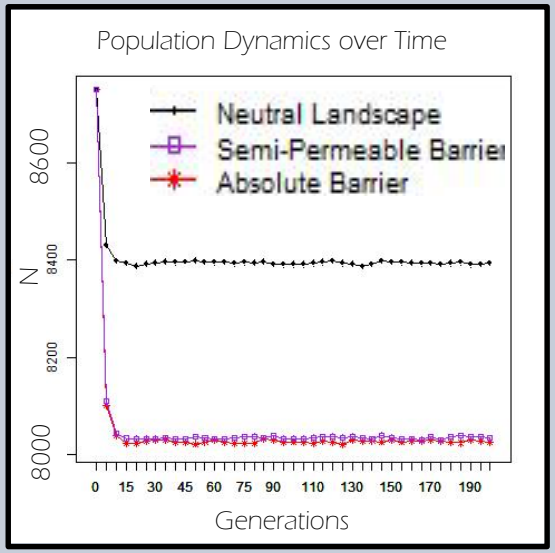

Genetic Structure

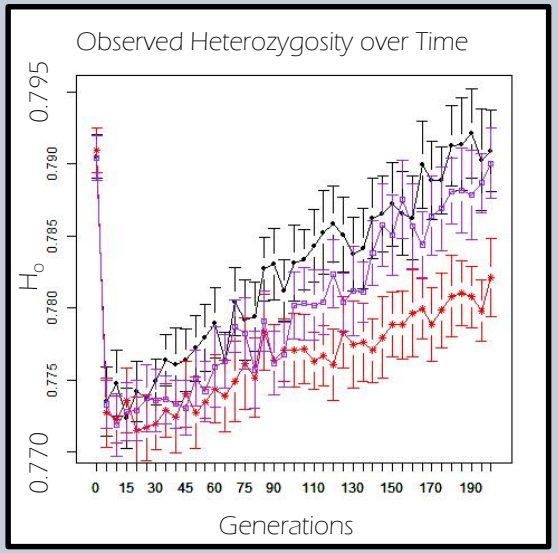
Time series

Generation 200

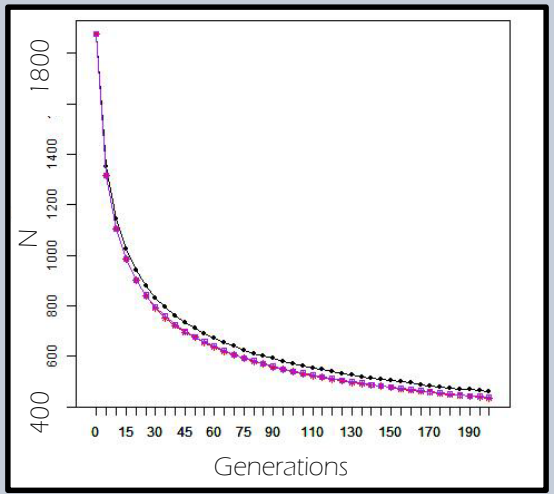
# Population Size & Genetic Diversity

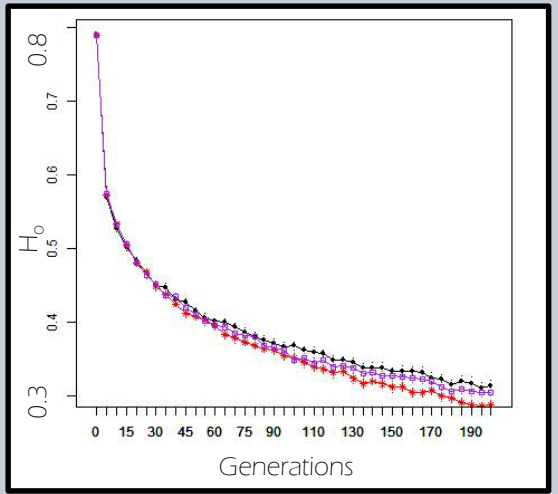
Moderate Density ($14/km^2$)



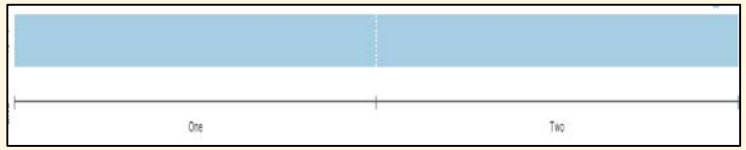
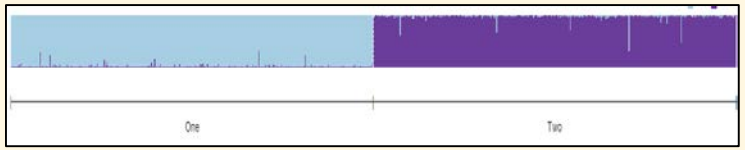
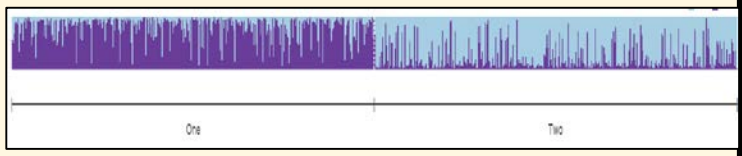
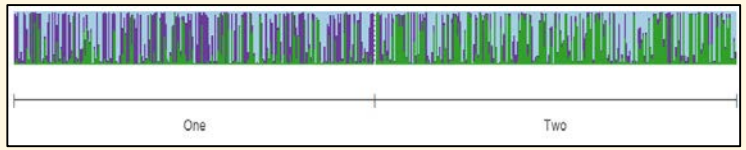
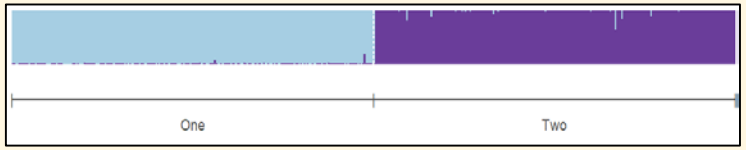
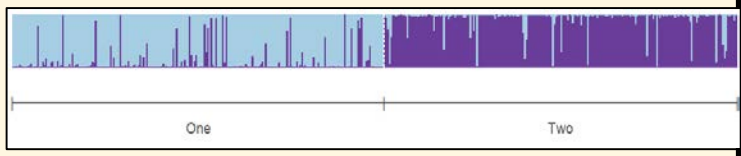




Low Density ($3/km^2$)



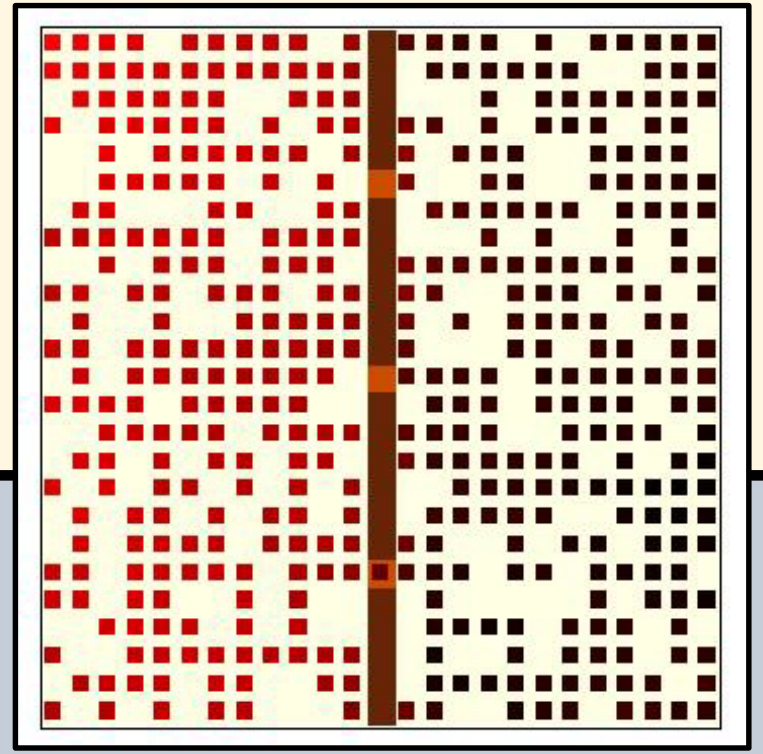



# Population Genetic Structure

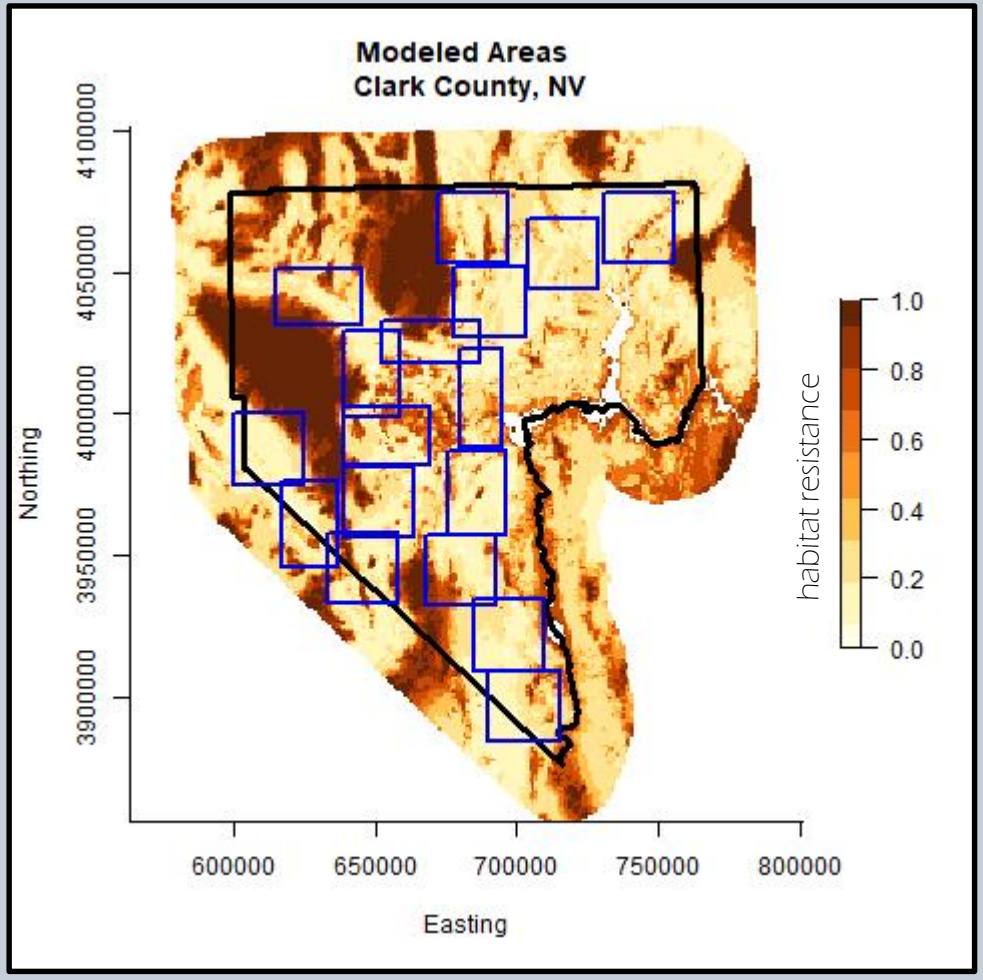
| | Neutral | Absolute Barrier | Permeable Barrier |
|---|---|---|---|
| Moderate ($14/km^2$) |   $K = 1$ |   $K = 2$ |   $K = 2$ |
| Low ($3/km^2$) |   $K = 3$ |   $K = 2$ |   $K = 2$ |

# Takeaway: Effect of Population Density & Addition of Corridors

- *The addition of corridors improves connectivity*
- *Higher densities improves connectivity*
- *1 migrant/generation ≠ former gene flow*



# Clark County Modeled Landscape Locations

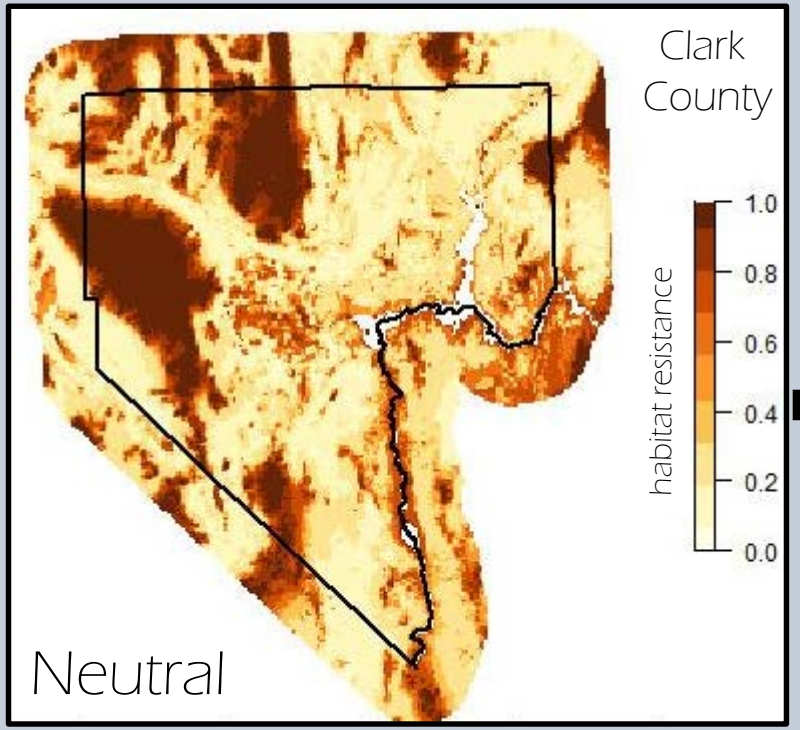


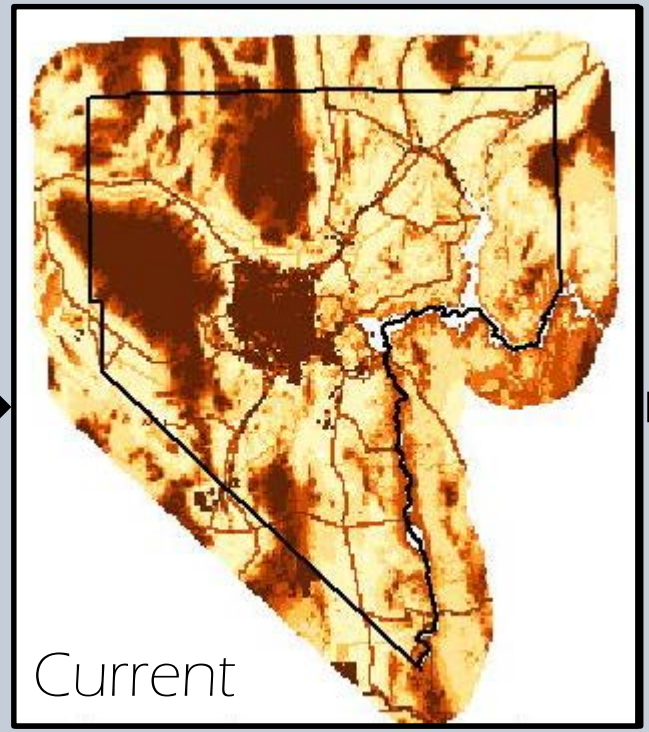

Locations: 17

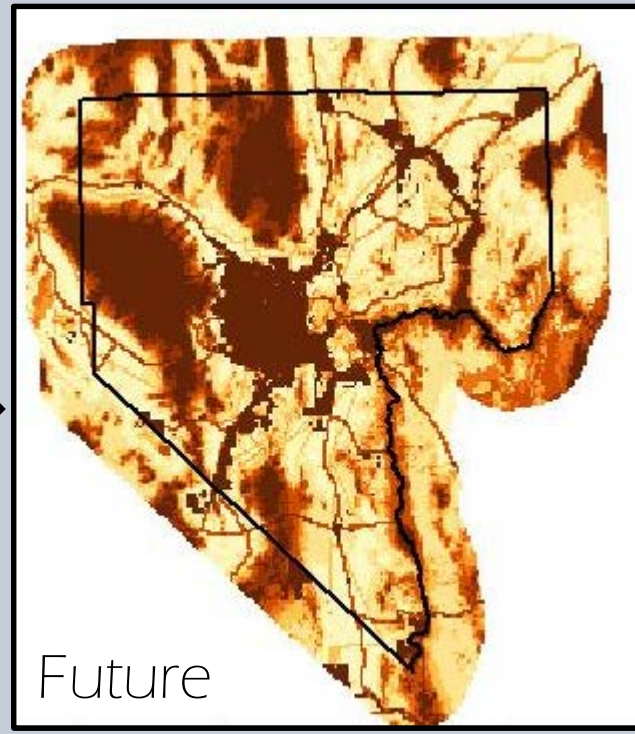
Area of each: 525 to 625 $km^2$

Density: 1 to 24/$km^2$

# Resistance Surfaces

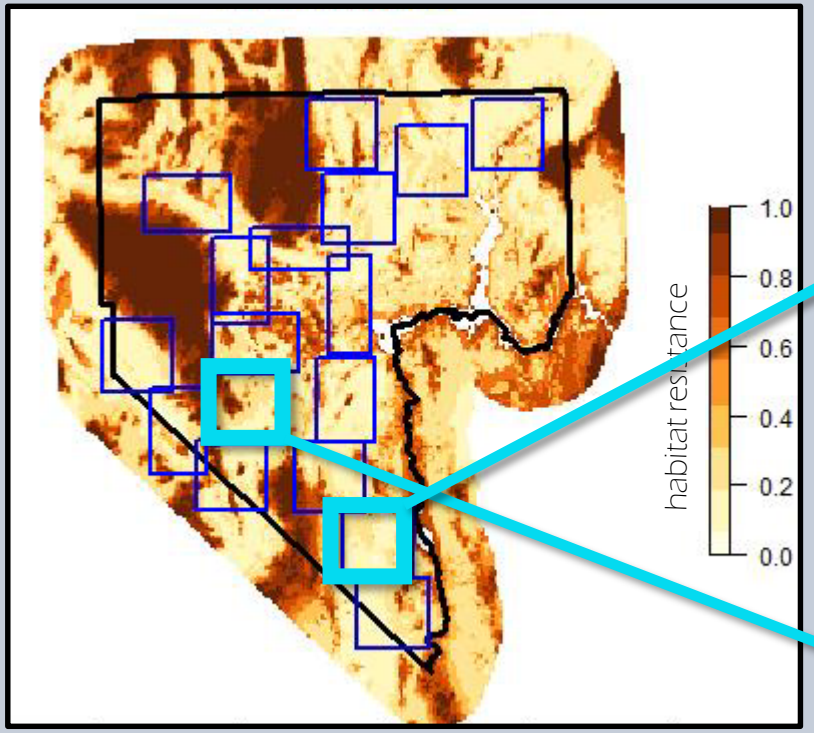


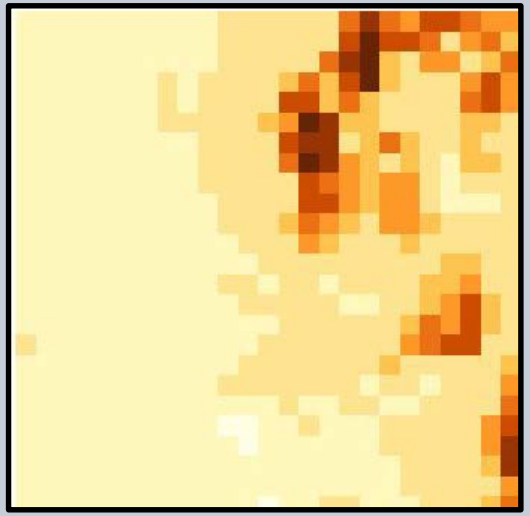

Adapted from Nussear et al. 2009

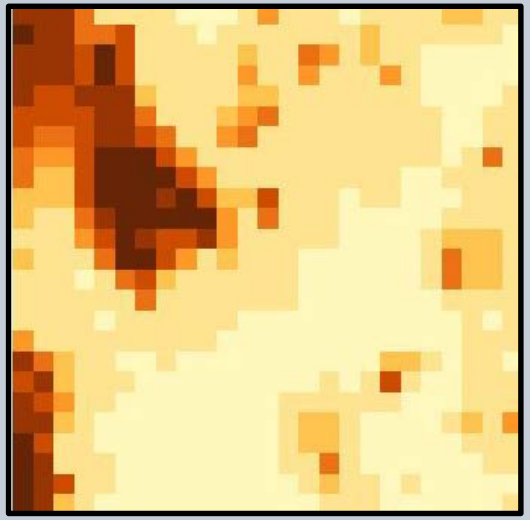
# Bounding the Landscape




Laughlin

Jean/Roach

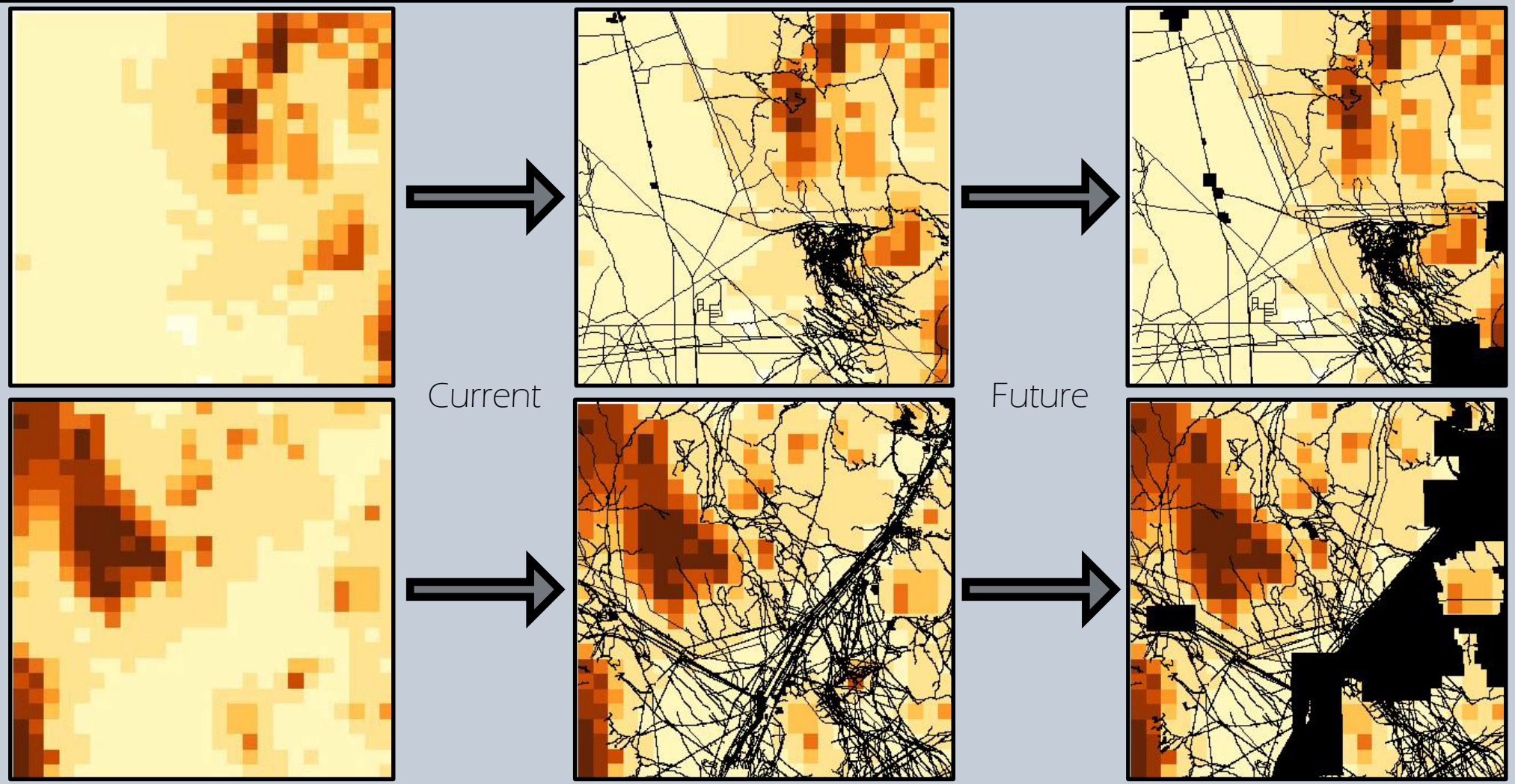




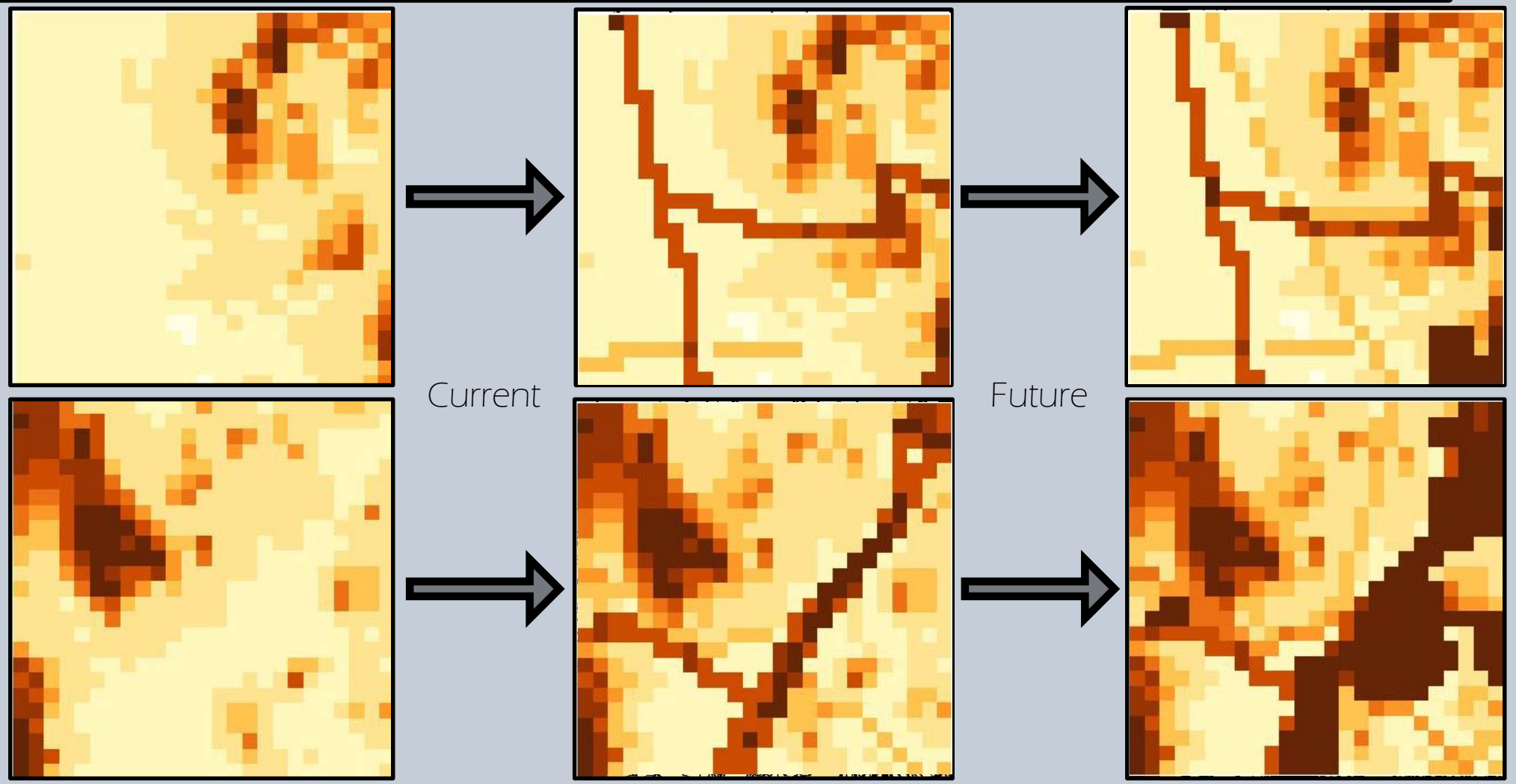
# Resistance Surfaces

Laughlin

Jean/Roach

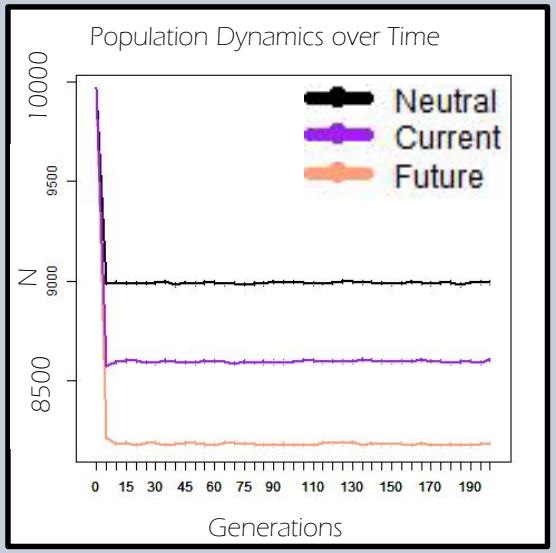


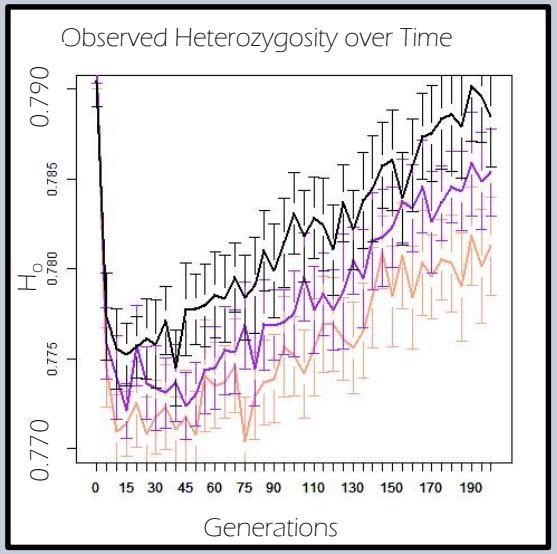
# Resistance Surfaces



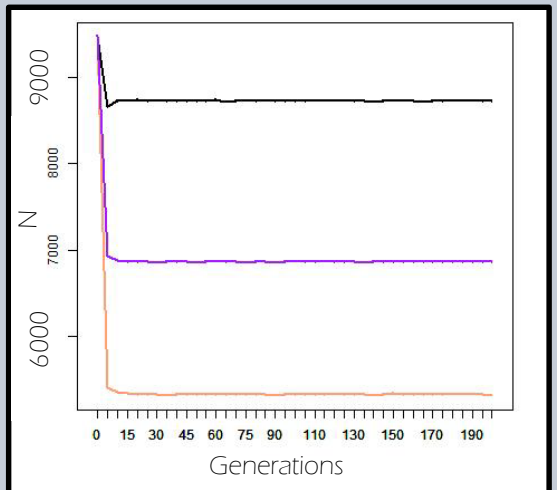
# Population Size & Genetic Diversity

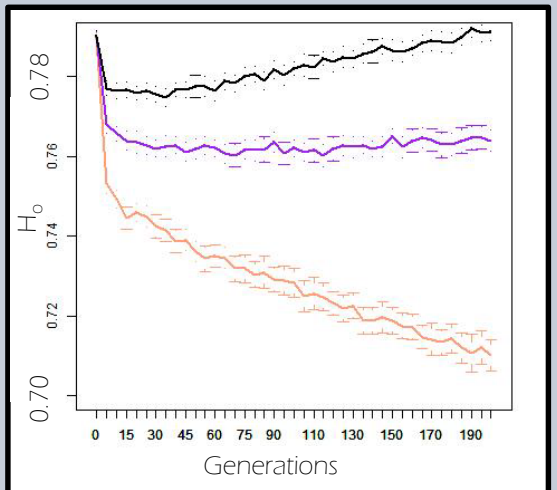
Laughlin



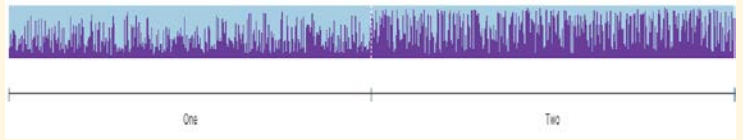
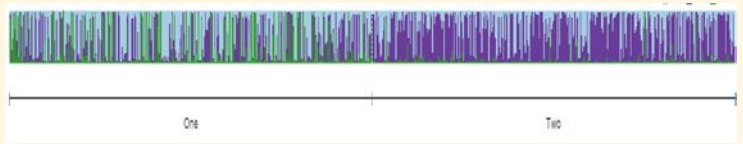
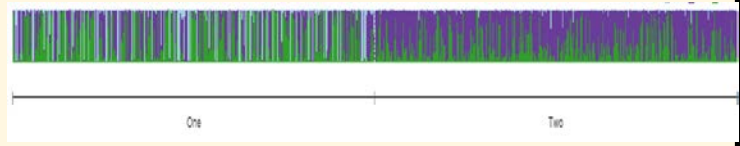
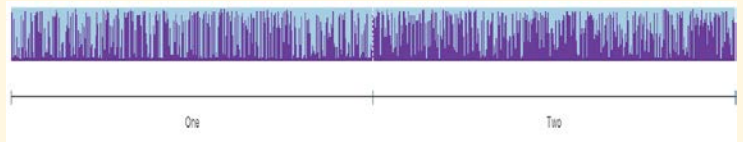
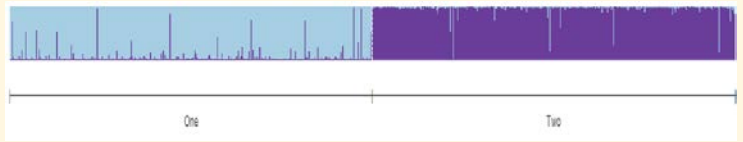
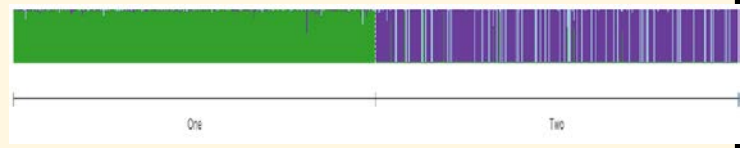




Jean/Roach



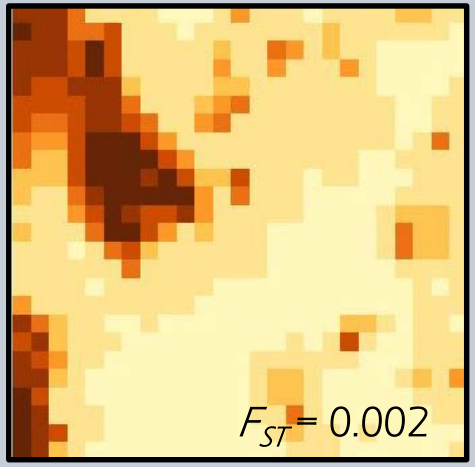
# Population Genetic Structure

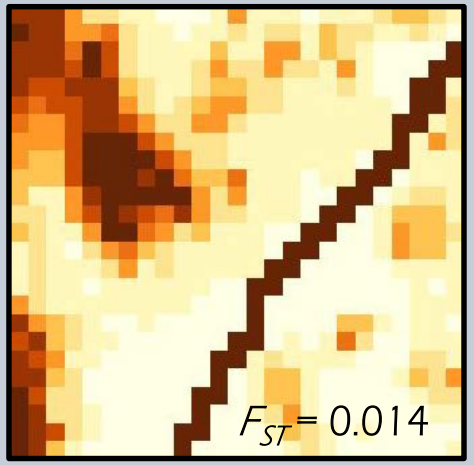
| | Neutral | Current | Future |
|---|---|---|---|
| Laughlin |   *K* = 2 |   *K* = 3 |   *K* = 3 |
| Jean/Roach |   *K* = 2 |   *K* = 2 |   *K* = 3 |

# Takeaway: Impact of Disturbance on Population Size & Gene Flow

- Disturbance reduces population size, diversity, & connectivity
- Pay attention to population size

# Corridor Success Index (CSI)



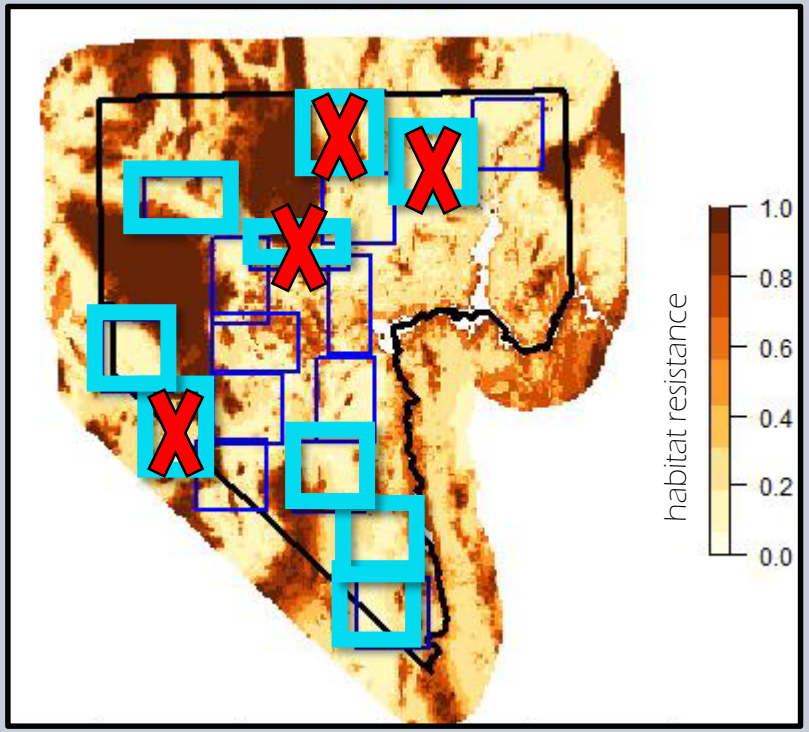




Neutral Landscape

Absolute Barrier

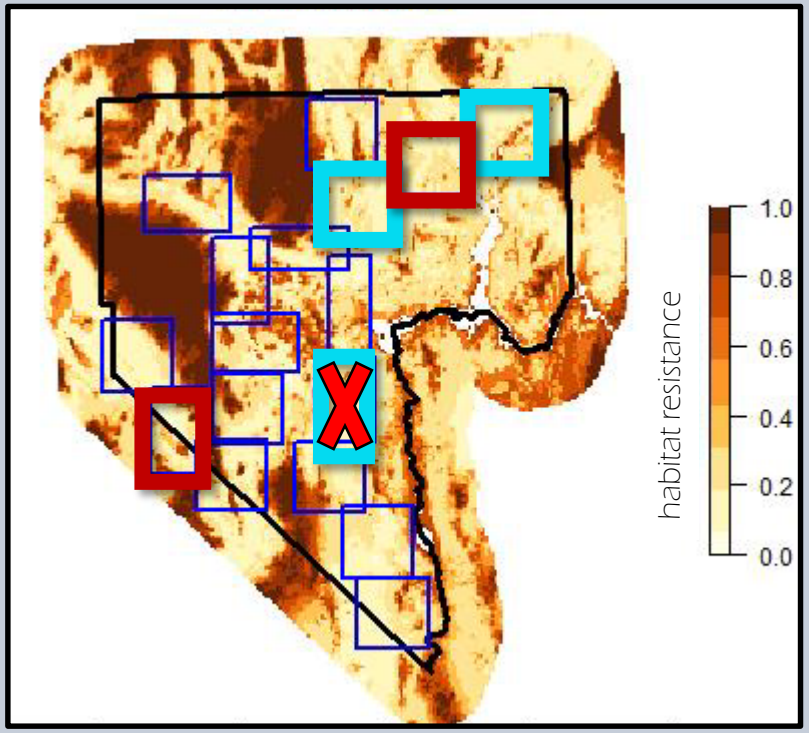
1 CSI 0

# High Levels of Genetic Connectivity (CSI = 0.7-1)




| Current | Future |
| --- | --- |
| Laughlin | Laughlin |
| Eldorado Valley | Eldorado Valley |
| Trout Canyon | Trout Canyon |
| Sandy Valley | X |
| Searchlight | Searchlight |
| Indian Springs | Indian Springs |
| Las Vegas North | X |
| Coyote Springs | X |
| Moapa Valley | X |

# Intermediate Connectivity (CSI = 0.35-0.69)




Current

BCCE

Dry Lake

Mesquite

Future

X

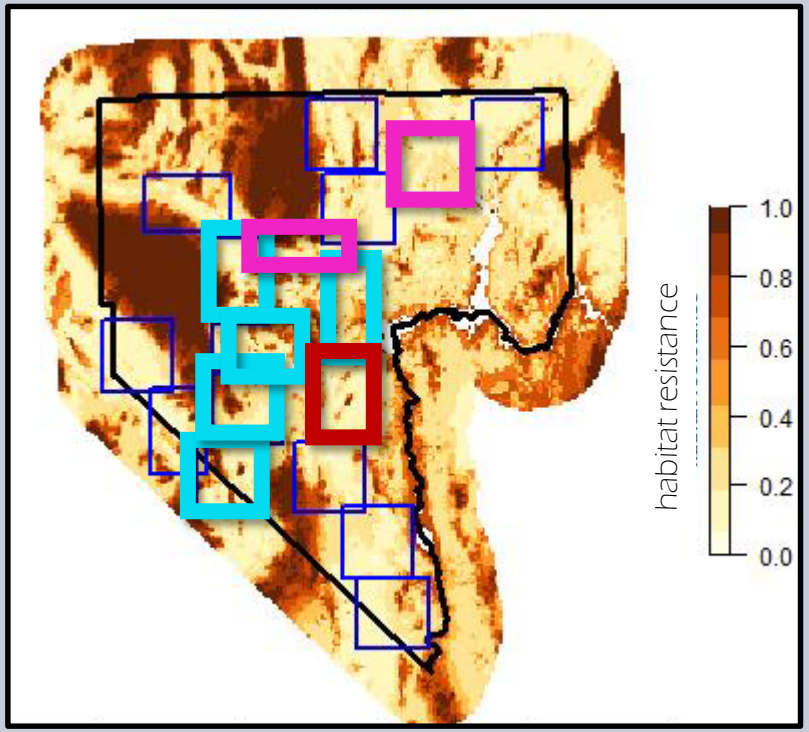
Dry Lake

Mesquite

Coyote Springs

Sandy Valley

# Low/No Connectivity (CSI < 0.35)

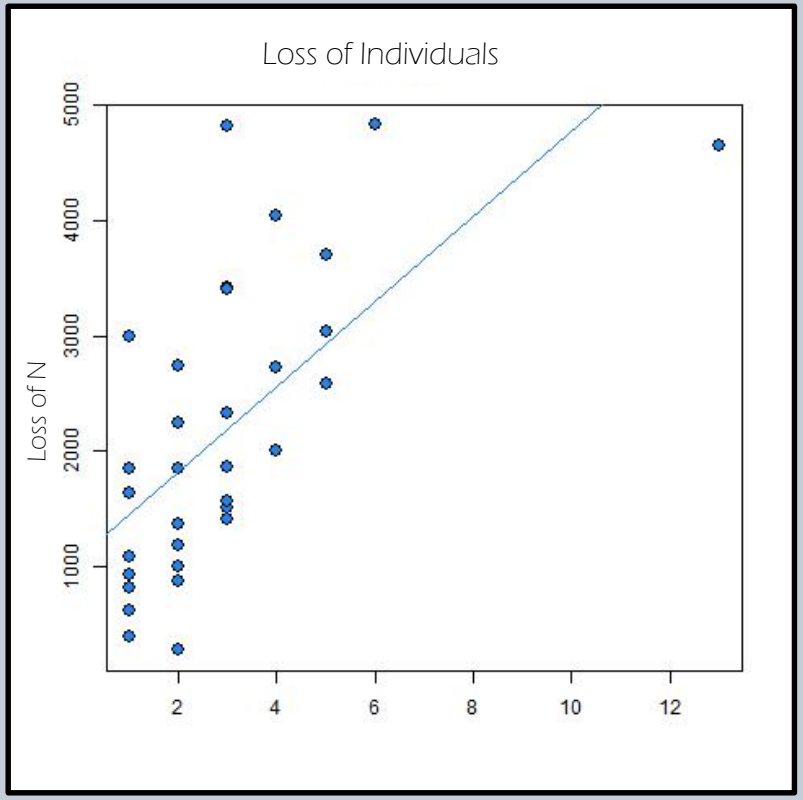


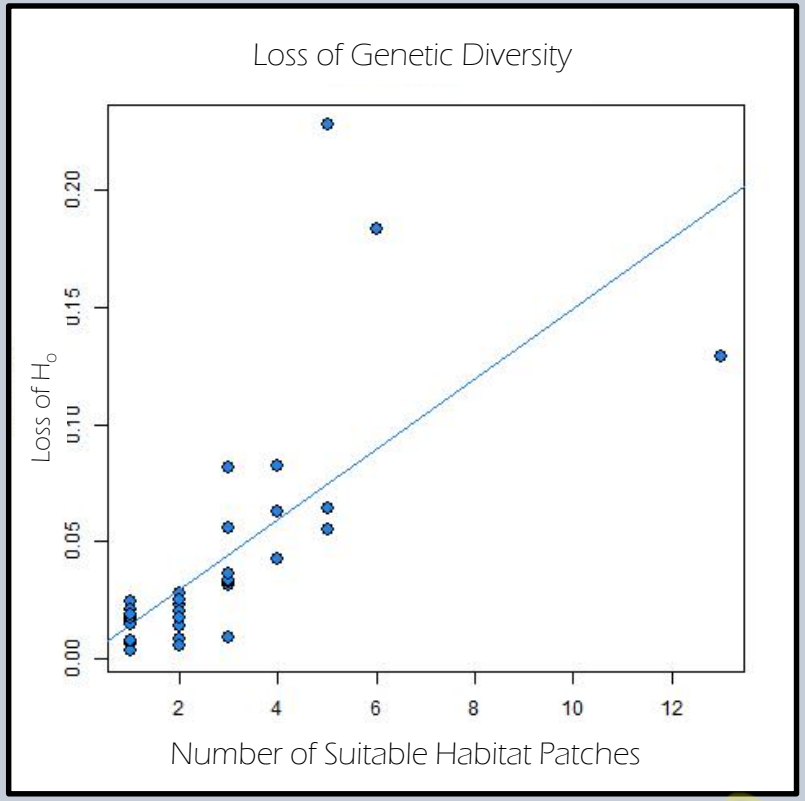

| Current | Future |
| --- | --- |
| Ivanpah Valley | Ivanpah Valley |
| Las Vegas West | Las Vegas West |
| Las Vegas East | Las Vegas East |
| Red Rock | Red Rock |
| Jean/Roach | Jean/Roach |
| | BCCE |
| | Moapa Valley |
| | Las Vegas North |

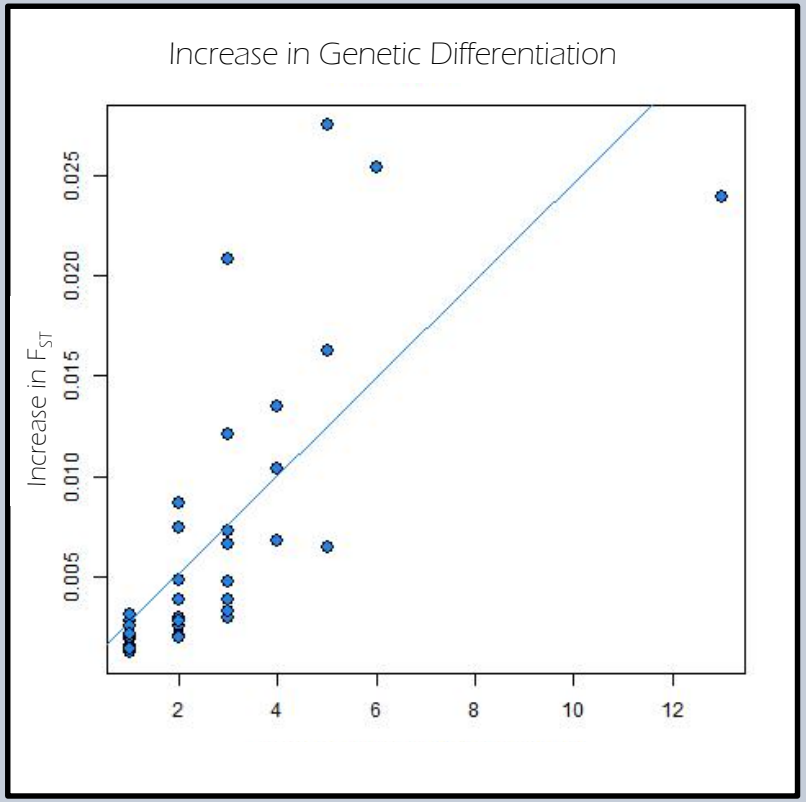
# Landscape Metrics

- Number of habitat patches – measure of fragmentation
- Percent habitat area – measure of habitat loss

# Fragmentation & Connectivity



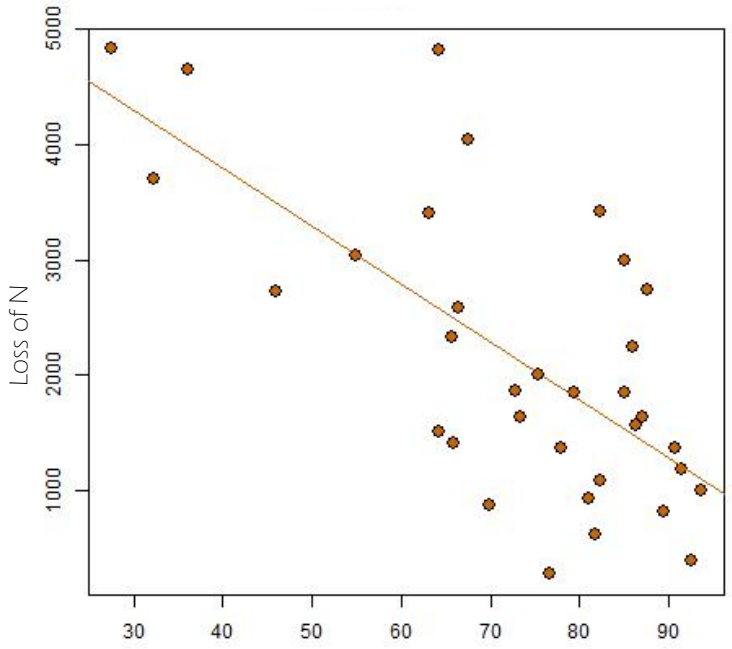



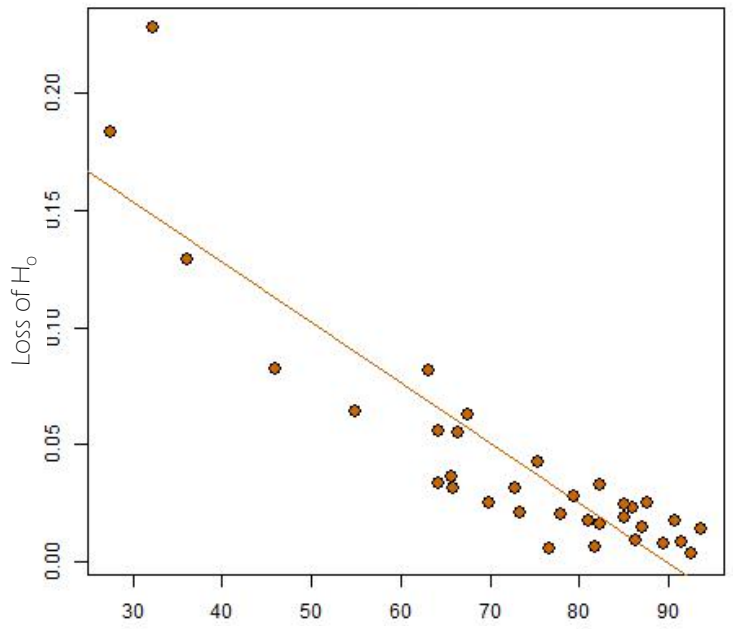

Increasing Fragmentation

# Habitat Loss & Connectivity

Loss of Individuals

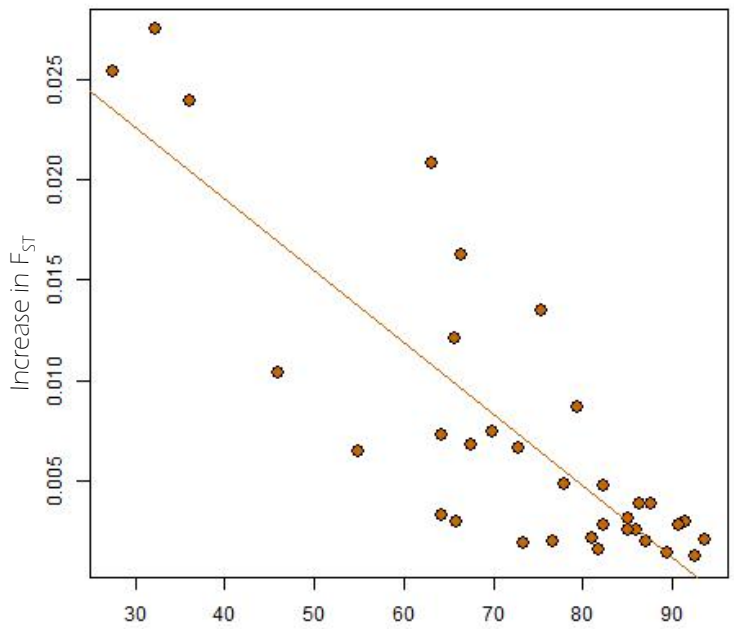



Loss of Genetic Diversity




% Suitable Habitat Area

Increase in Genetic Differentiation




Increasing Habitat

# Habitat Loss & Fragmentation

Photo courtesy of USGS

# Takeaway: Indicators of Corridor Success/Failure

- More habitat + less fragmentation = more connectivity
- Landscape dependent individual management units

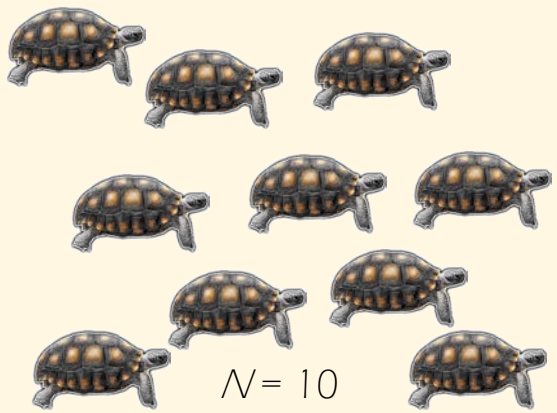
# Management Recommendations

- *Low/no connectivity landscapes – prioritize for restoration*
- *Intermediate connectivity – strategically restore connectivity*
- *High connectivity – maintain existing habitat*

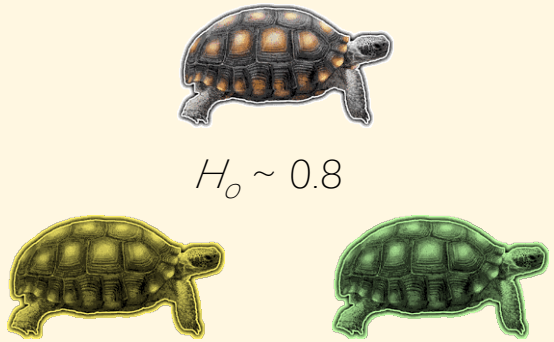
# Thank you

Scott Cambrin
Kimberley Jenkins
Lee Bice
Todd Esque
Kristina Drake
Felicia Chen
Ben Gottsacker
Amanda McDonald
Sara Murray
Jordan Swart
Marjorie Matocq
Anna Mitelberg
Amy Vandergast

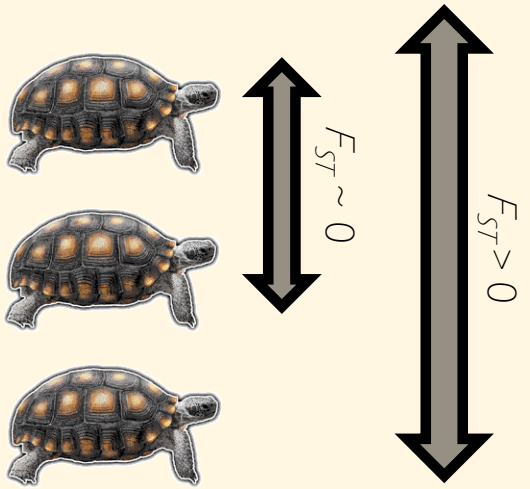
# Population & Genetic Analyses



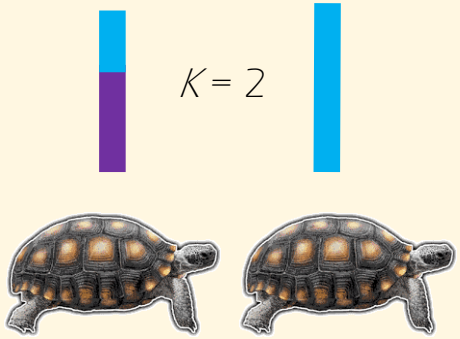

Population Size




Genetic Diversity




Genetic Differentiation



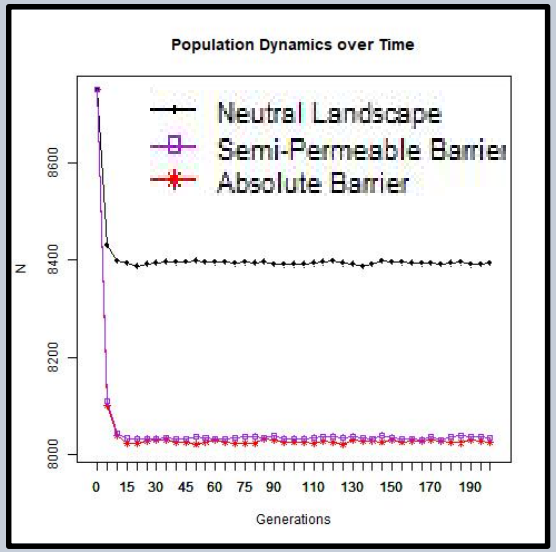

Genetic Structure

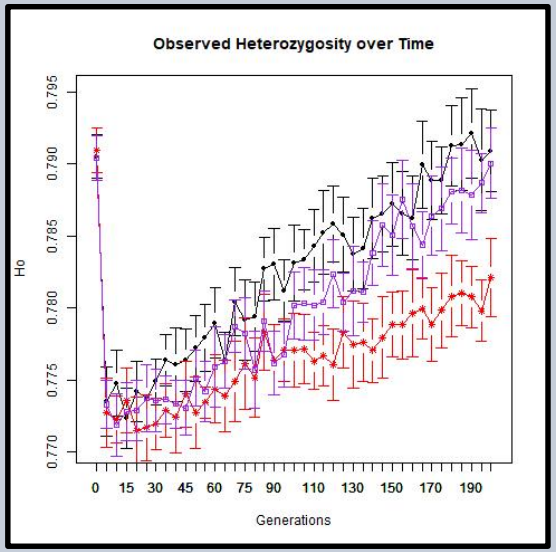
Time series

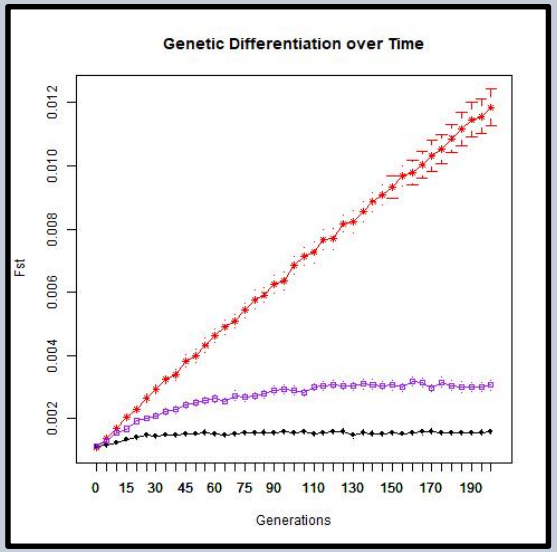
Generation 200

# Population, Heterozygosity, & Differentiation

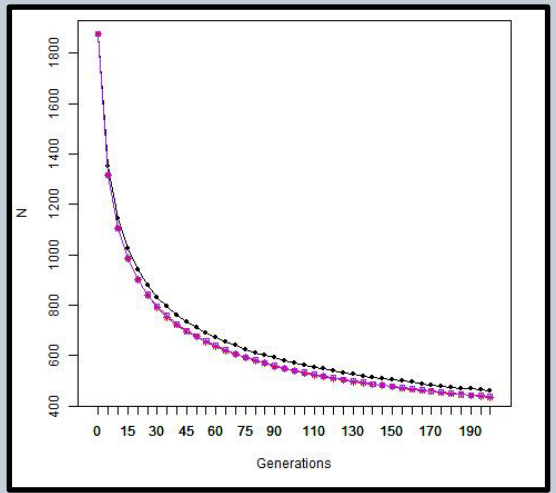
Moderate Density

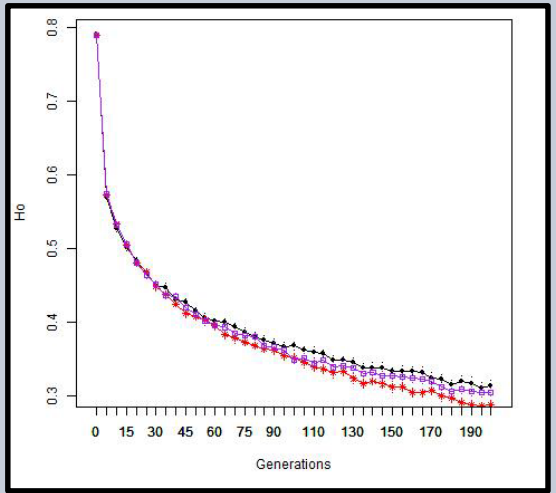


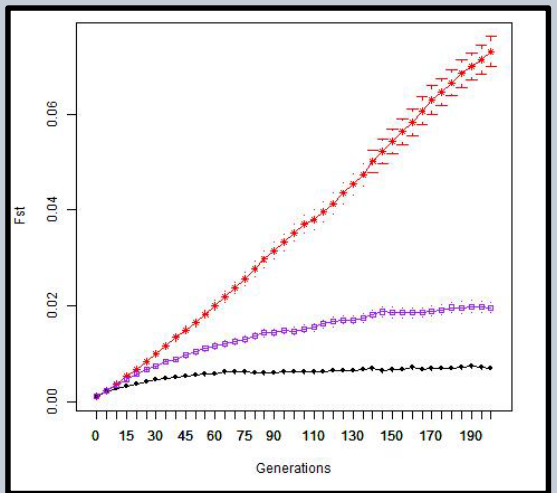




Low Density

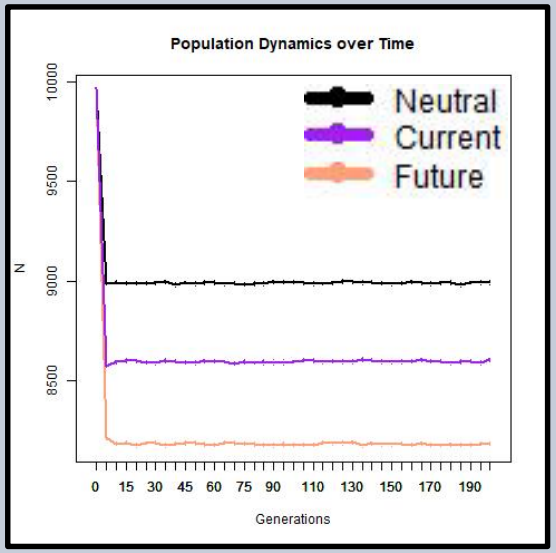


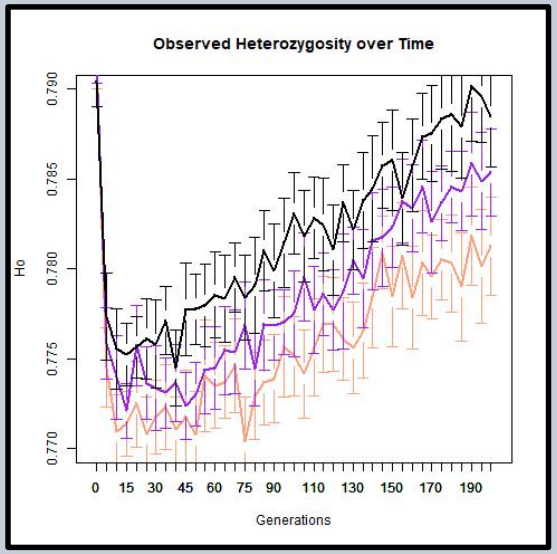



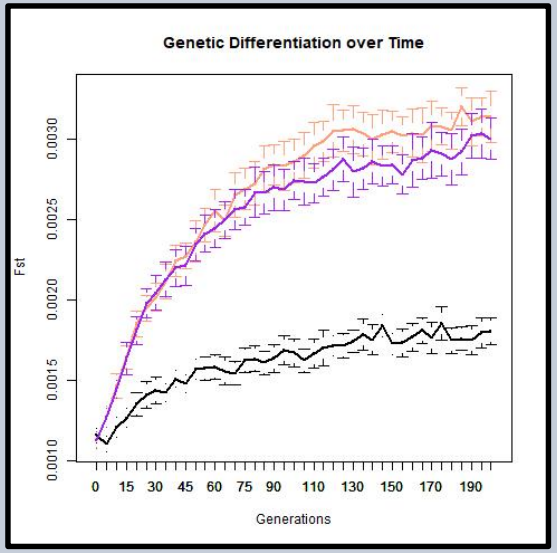



# Population, Heterozygosity, & Differentiation

Laughlin




Jean/Roach