# Landscape Genomics

Genetic tools to inform seed source decisions for assisted migration.

Landscape genomics attempts to explain which genetic and environmental factors play a role in how organisms adapt to their surroundings.

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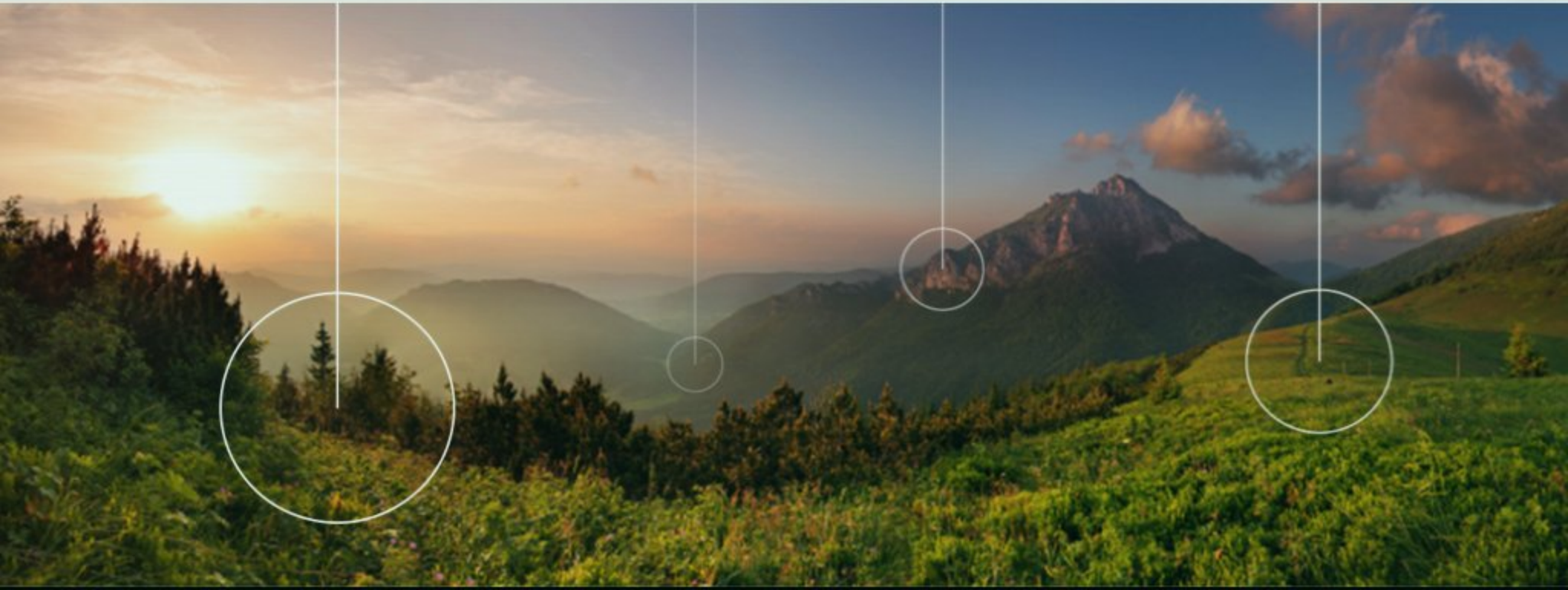

# Historical approaches

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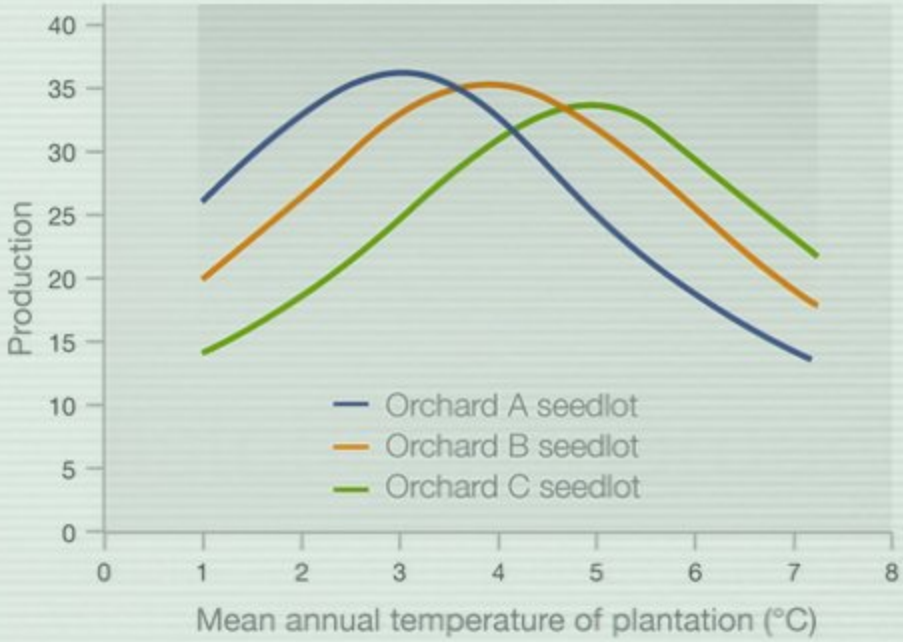
# The desired goal

Planting adapted trees that thrive in the landscape.

Response curves expected from provenance trials




Response curves expected from landscape genomics trials

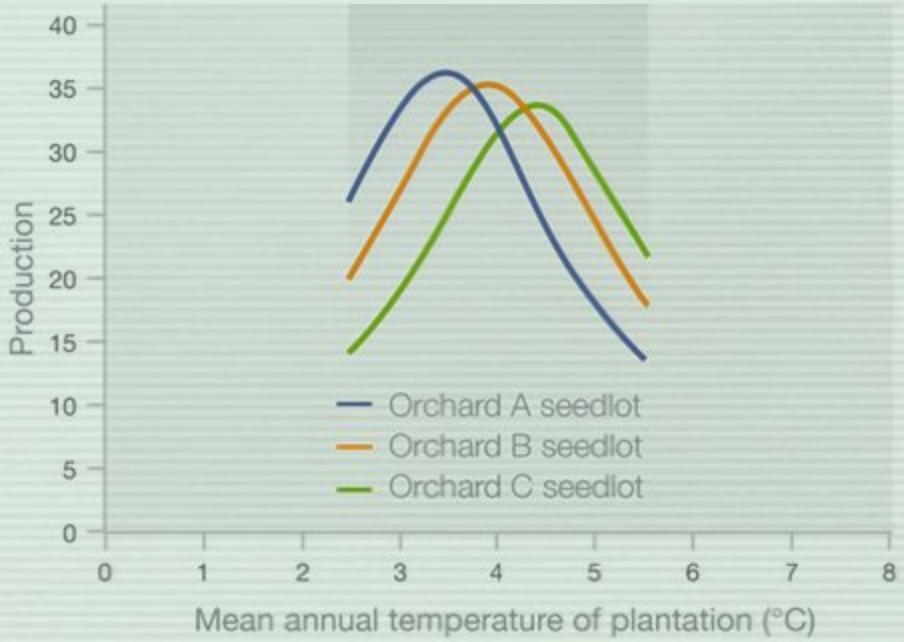



Image: Adapted from O'Neill et al., TICtalk, December 2007

# Approaches and their relationships

**Phenotype** = **Genotype** + **Environment**

| | |
|---|---|
| Provenance or Common Garden Trials | **Phenotype** x **Environmental** Associations |
| Marker Assisted Tree Breeding | **Genotype** x **Phenotype** Associations |
| **Landscape Genomics** | **Genotype** x **Environmental** Associations |

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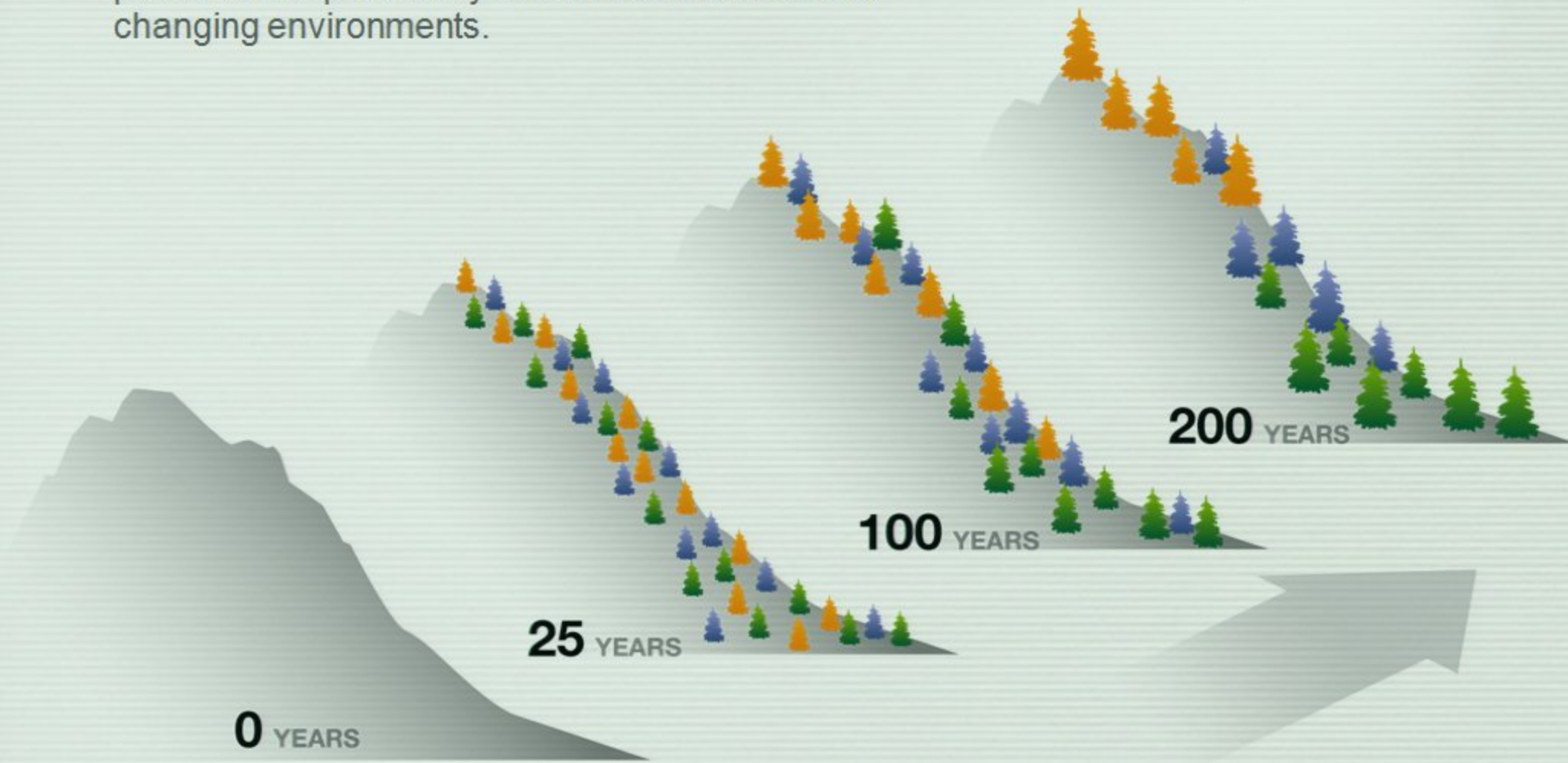
# What is the scientific basis?

An organism's genetic makeup determines it's adaptive potential and probability of survival in diverse and changing environments.



# How can it help land managers?

Landscape genomics can provide tools that facilitate incorporation of adaptive genetic potential in selecting planting stock or designing programs for reforestation, ecosystem restoration, and species conservation planning.

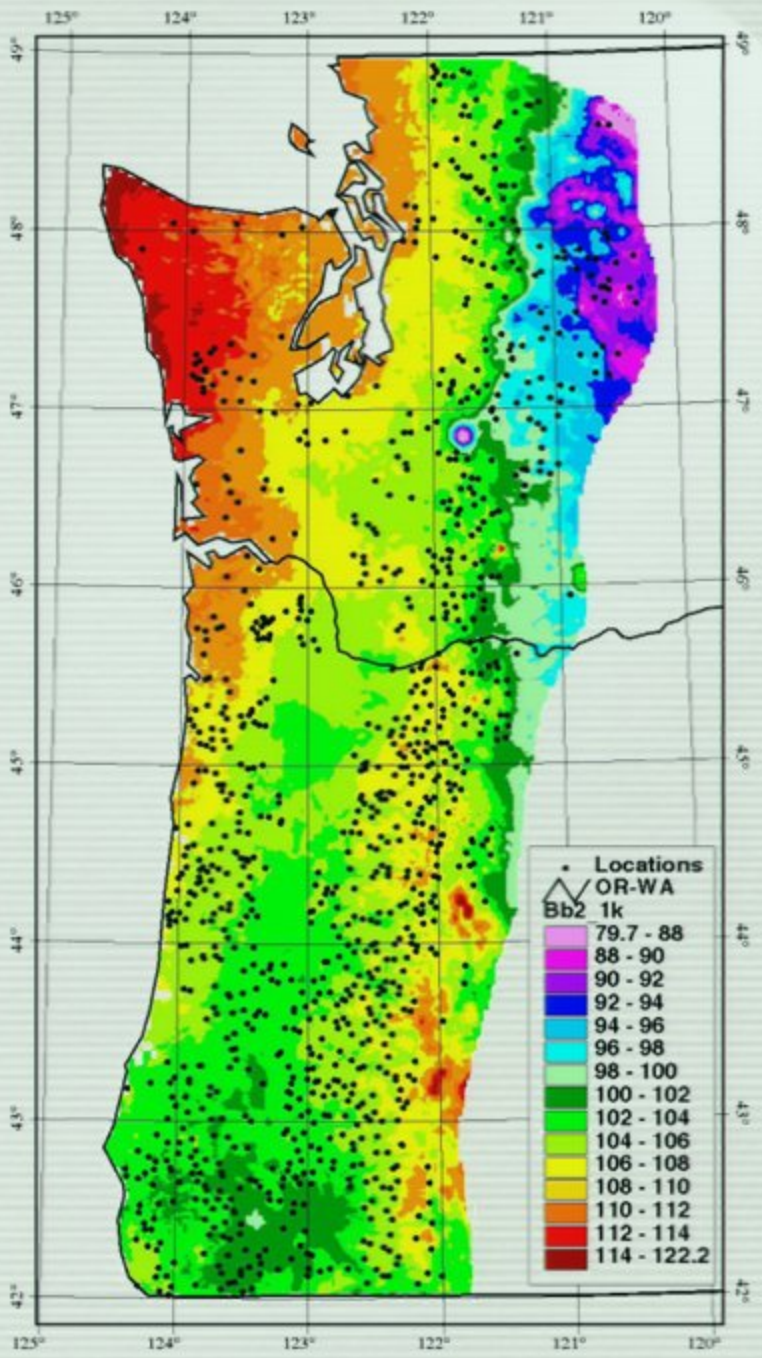
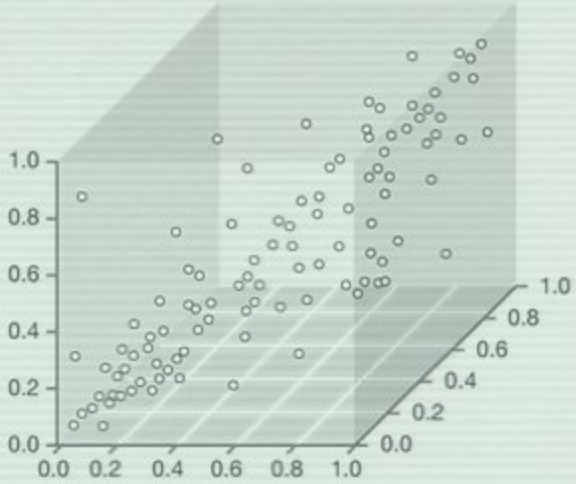


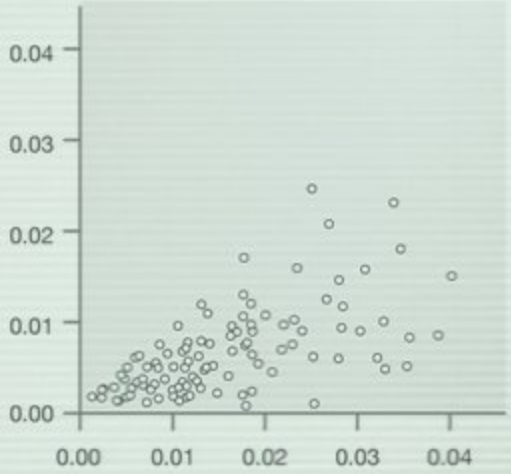

Figure credit: Courtesy of Brad St. Clair, USFS

# How is Landscape Genomics done?

**1** Identify important genes

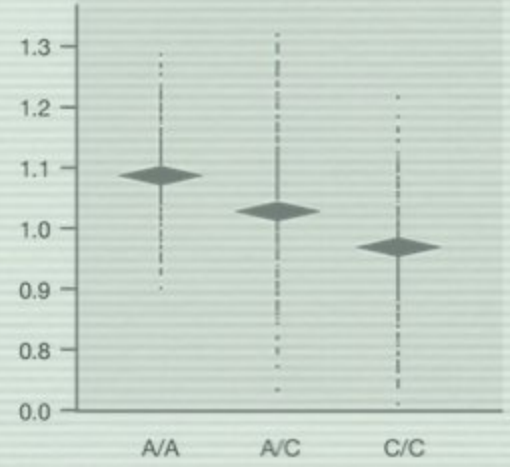


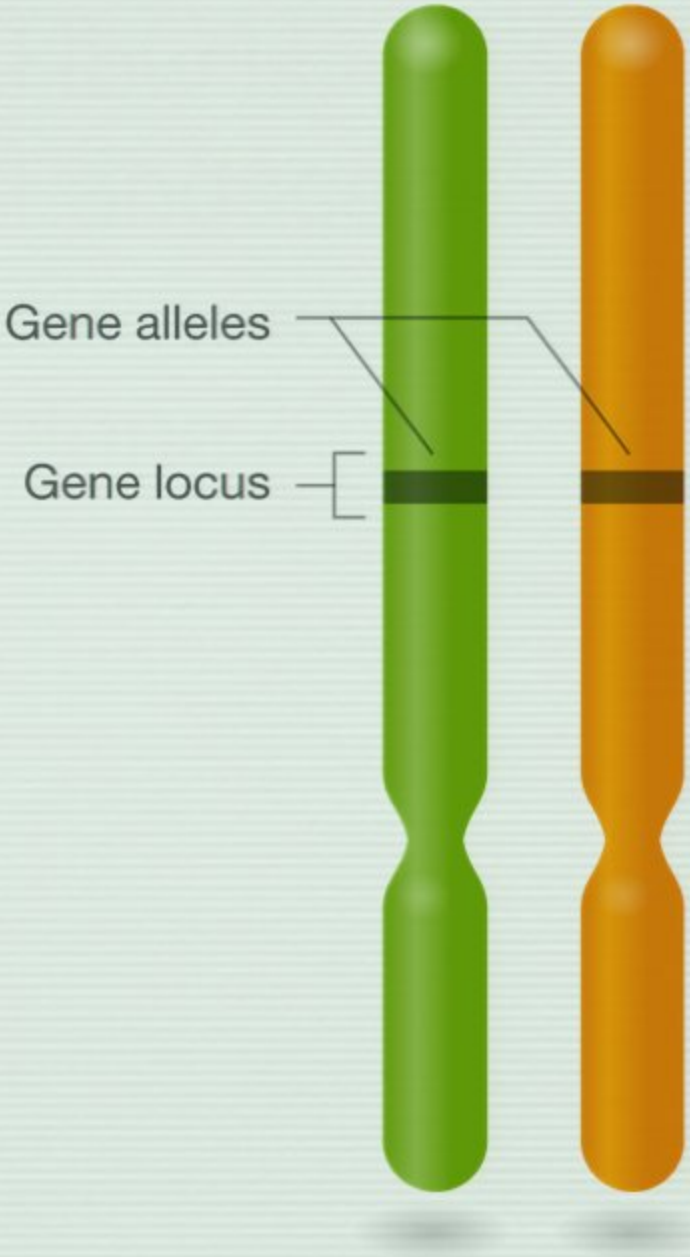

**2** Determine allelic diversity




**3** Determine spatial distribution of alleles


**4** Test for associations






# Alleles

Alleles are alternative forms of a gene.

A diploid cell has two copies of each gene (i.e. two alleles) at each locus.

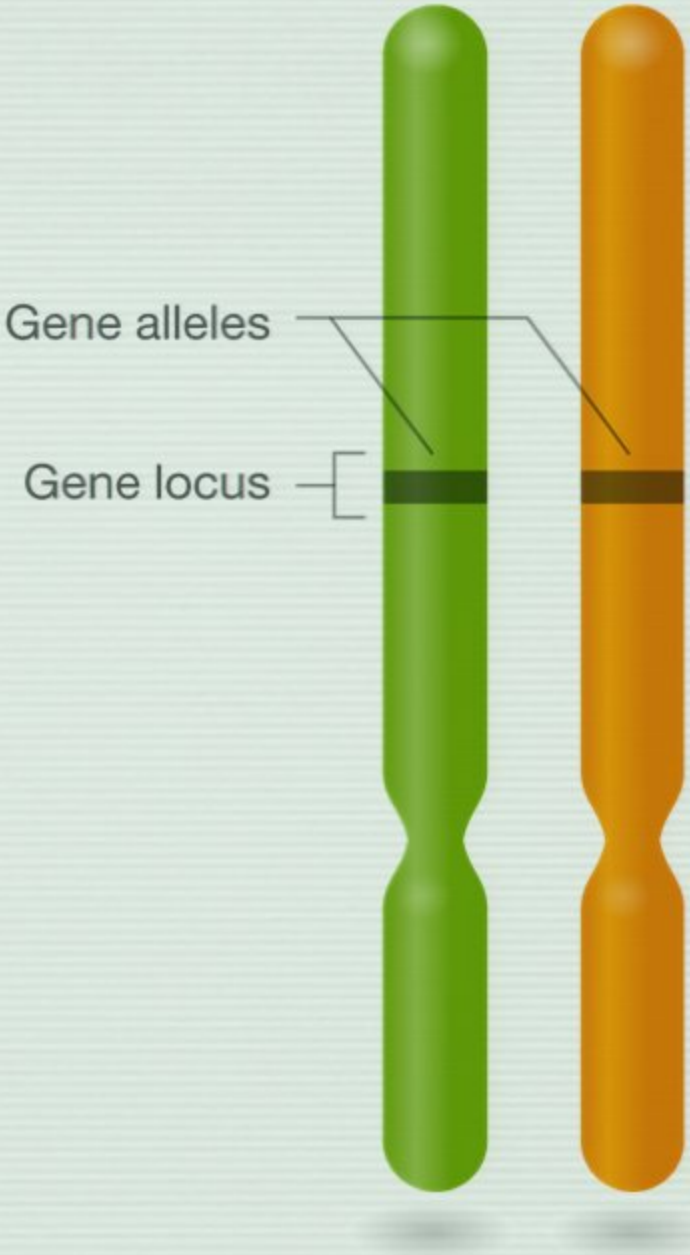
New alleles arise through mutation.

Alleles on homologous chromosomes may be the same or different (homozygous vs. heterozygous).

# Trait heritability

Students from the University of Connecticut line up by height:
5’0” to 6’5” in 1” increments. Women are in white, men are in blue.



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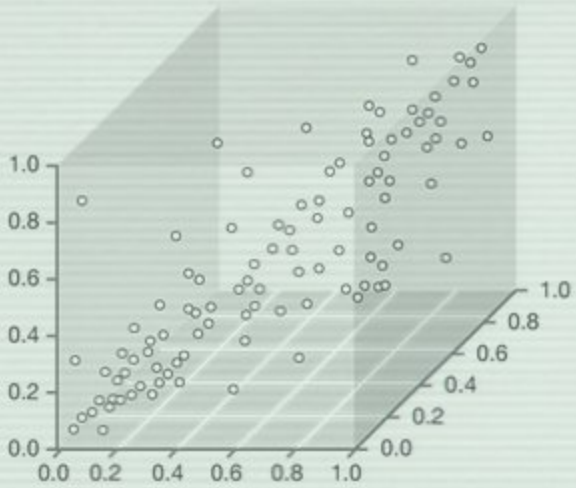


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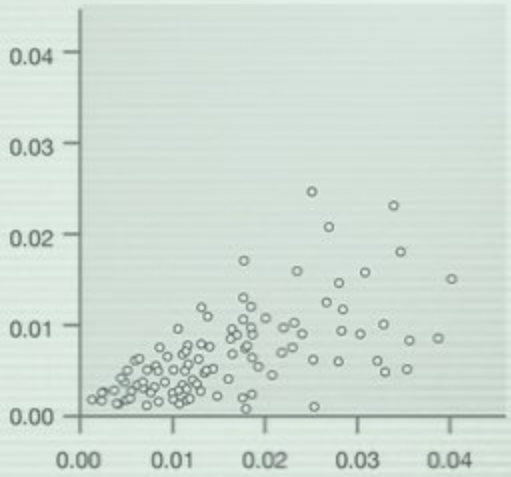


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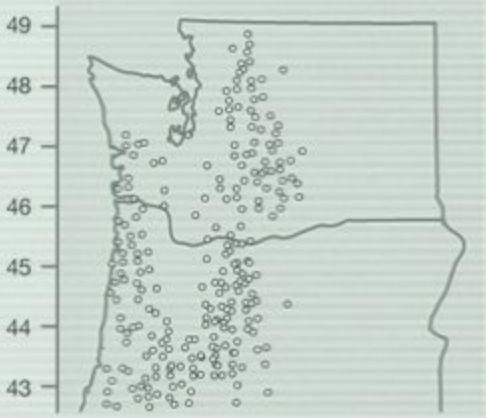
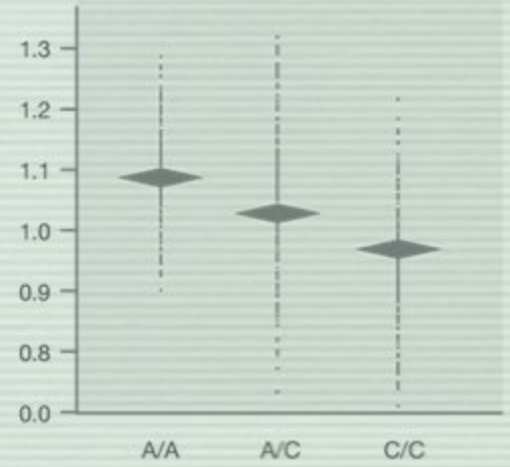
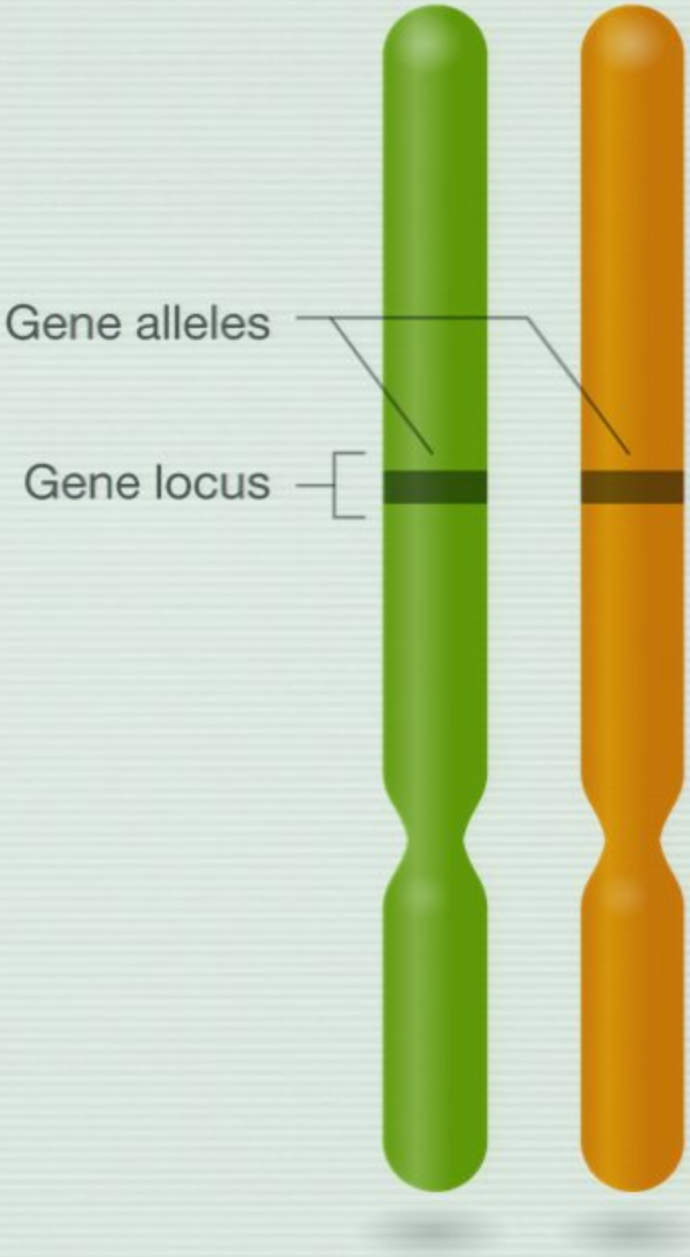



**4** Test for associations



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# Steps in the process

Define the study

Work on the ground

Extract & sequence DNA

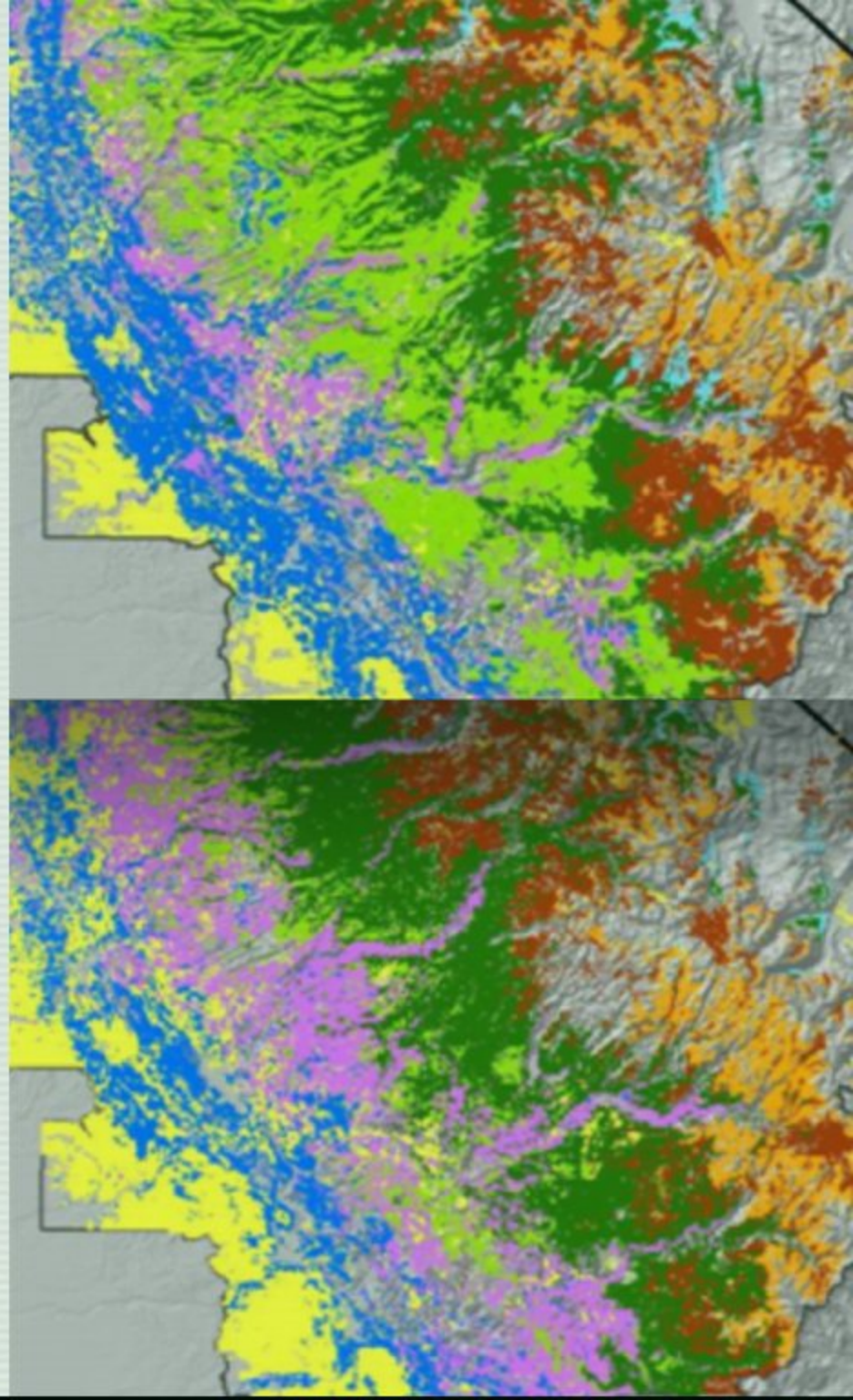
Collect environmental data

Identify genes under selection

Identify associations

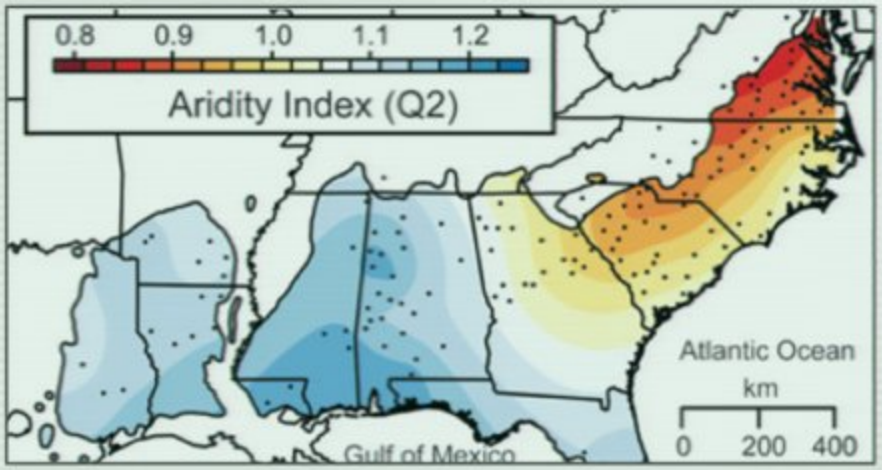
Build a model

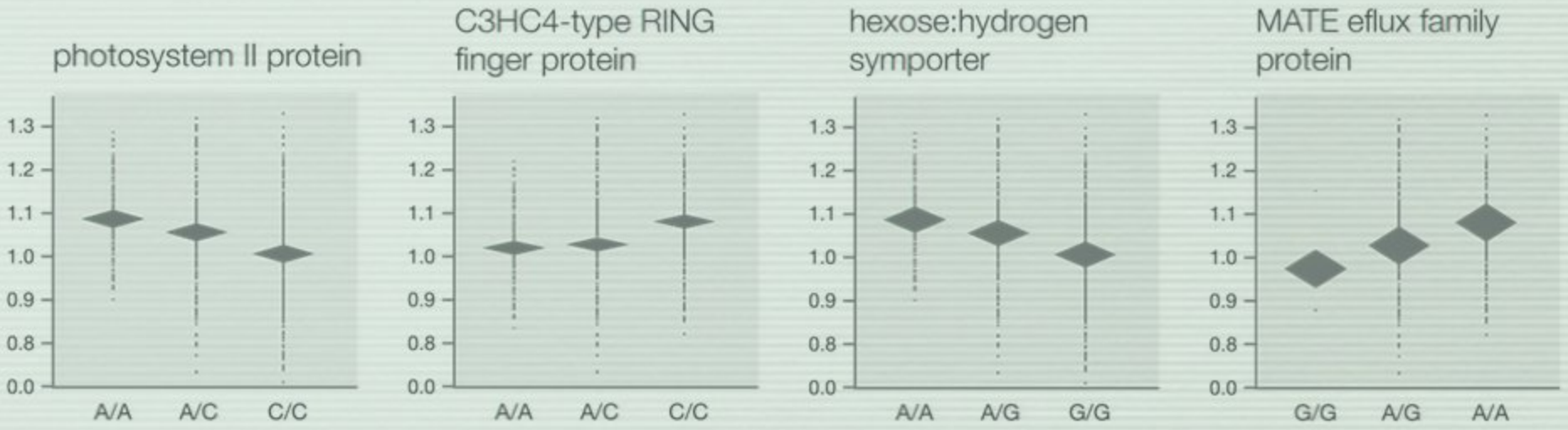
# The role of landscape genomics in a changing world



# Drought and insects changing the landscape

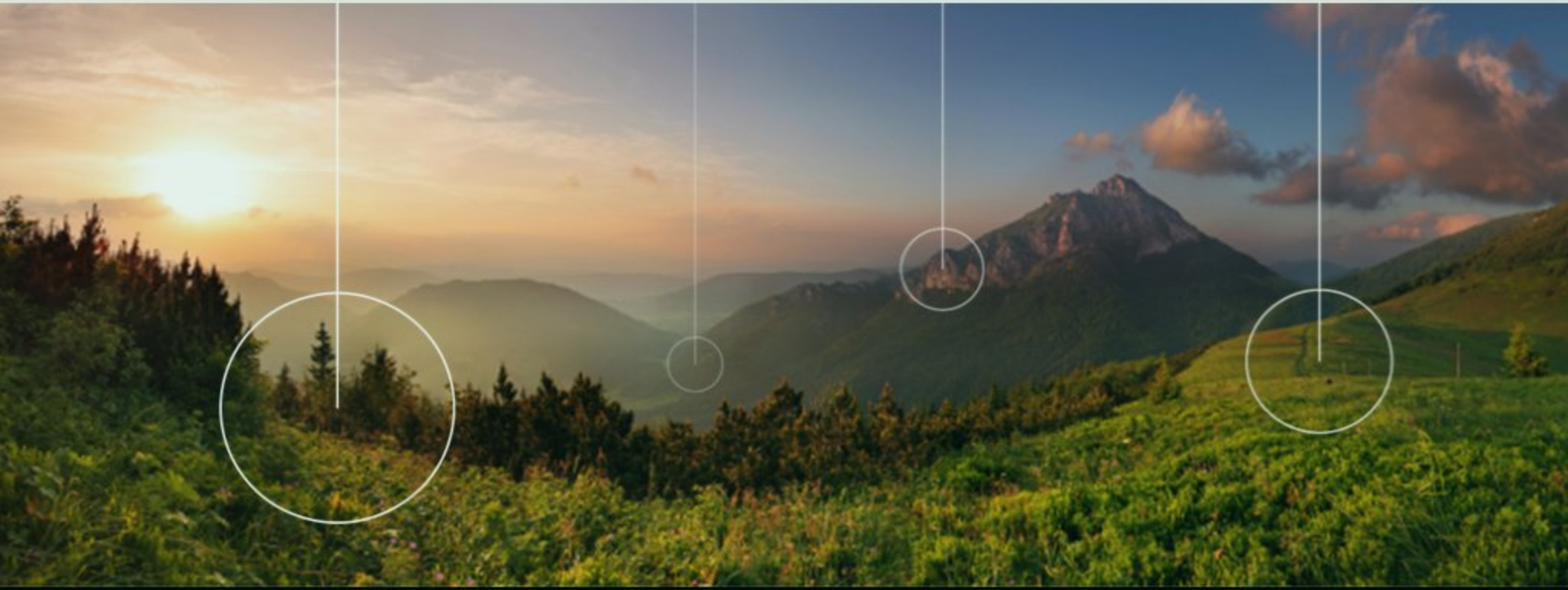
# Genotype by environment associations




Eckert et al. 2010. Genetics 185: 969-982

Landscape genomics will provide forest land managers precise and easy to use tools to assist in maintaining adapted and healthy forests faced with changing climates. These tools will complement traditional, but expensive and time-consuming, long-term provenance testing approaches.



For more information, please visit the US Forest Service Reforestation, Nurseries & Genetics Resources website at **http://rngr.net**