

Landscape Genomics

A tool for managing public lands in the face of changing environments.

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



Historical approaches

Historically, identifying adapted planting stock has been done through the use of seed zones and provenance tests.

Images: Courtesy of Deems Burton, USDA - Forest Service and Jessica Wright, USDA- Forest Service

760

52/

325

526

533

150

540



Response curves expected from seedlots derived from seed zone collections

The desired goal





Mean response curves with 95% confidence limits applied.



Figure credit: Nicholas Wheeler, University of California, Cavis

Approaches and their relationships

Phenotype = Genotype + Environment

Provenance or Common Garden Trials

Phenotype X Environmental Associations

Marker Assisted Tree Breeding

Landscape Genomics

Genotype X Phenotype Associations

Genotype X Environmental Associations

What is the scientific basis?

25 YEARS

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

not cold tolerant

200 YEARS

100 YEARS

0 YEARS

Figure credit: Nicholas Wheeler, University of California, Davis



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: Bradley St. Clair, USDA Forest Service



What are the scientific goals of a landscape genomics project?

- Characterize
 - The genome
 - Signatures of selection
 - Spatial distribution of allelic diversity
 - Statistical association between genotypes and environments



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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Steps in the process



Figure Credit: Nicholas Wheeler, University of California, Davis



The role of landscape genomics in a changing world

Figure Credit: David Neale, University of California, Davis





Drought and insects changing the landscape





Genotype by environment associations





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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.



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