

The background of the slide is a close-up photograph of pine needles and cones, slightly out of focus, creating a natural and serene atmosphere. The needles are green and sharp, while the cones are brown and textured.

GENOMICS IN SOCIETY

Forest Research in a Changing Climate

What is microevolution?

“Change within a species that occurs over a short time in a small population”

- What causes change to occur?
 - Natural selection, mutation, gene flow, genetic drift
 - Organisms that are best suited to their environments (i.e. increased fitness) tend to survive and reproduce—offspring more likely to carry desirable traits
 - Environments are constantly changing due to natural processes
 - Environments are forced to change due to anthropogenic processes

Climate change & Selective pressures

- Environments are constantly changing, but climate change is ramping up the speed, scale, and unpredictability of these changes
 - **Speed:** current extinction rates are 1000 times greater than background levels
 - **Scale:** climate change is having an impact from the Arctic to the deep sea
 - **Unpredictability:** emerging novel ecosystems with no ecological history
- As a consequence, the speed, scale, and unpredictability of selective pressures is also ramping up in tandem with climate change impacts

Trees are struggling to keep up with changes

Generation Time

Length of time between generations; informed by lifespan, age of reproductive maturity, etc.



Mobility

Capacity to relocate; trees are immobile and depend on wind and wildlife for seed dispersal



Photosynthesis

Dependent on light, temperature, and precipitations—components that make up the climate



Tree species impacted

- Ecologically, economically, and culturally important tree species are currently experiencing stress from climate change, such as:
 - *Thuja plicata* (western redcedar)—drought related die off along the west coast of NA
 - *Pinus contorta* (lodgepole pine)—amplification of the Dothistroma needle blight and the mountain pine beetle epidemic
 - *Pinus albicaulis* (whitebark pine)—alpine habitat shrinking with rising temperatures and white pine blister rust disease spread
- With no intervention, these species will succumb to the exasperated disturbances and there will be immense ecological, economic, and cultural impacts as a result

Artificial selection & Genetic modification

- **Genome:** all of the genetic material and DNA of an organism
- **Genomics:** the field of biology that studies the entire genome of an organism
- **Artificial selection:** the deliberate selection of individuals with specific traits of interest to be planted in subsequent generations
- **Genetic modification:** using breeding tools to increase the proportion of the next generation's seed that will carry alleles for desired traits (e.g. disease resistance) that will increase an organisms fitness in projected future climates

Artificial selection & Genetic modification – Example

- By selecting for resistance to Dothistroma needle blight, researchers are enhancing the survival of lodgepole pine seedlings in future climate scenarios
- This research is being done by using methods such as:
 - 1) **Mapping the genome:** Using next-generation sequencing to scan millions of short DNA scripts and piece them together into a complete genome
 - 2) **Identifying candidate genes:** Finding alleles held in common by trees that survived Dothistroma needle blight; using molecular markers
 - 3) **Testing and planting:** Running genotyping experiments to identify if seeds carrying the candidate genes survive Dothistroma needle blight; planting and spreading resistant seeds