



# Cottonwood

## A Tree for All Reasons

Reinhard F. Stettler

- Foundation species of riparian ecosystems
- Plantation tree for lumber, fiber, biofuels
- Clean-up tree in phytoremediation
- Model system for study of tree biology and genetic engineering



Cottonwood: A key component of riparian ecosystems



Typical fall flood of the Snoqualmie River



Erosion / deposition along river meander

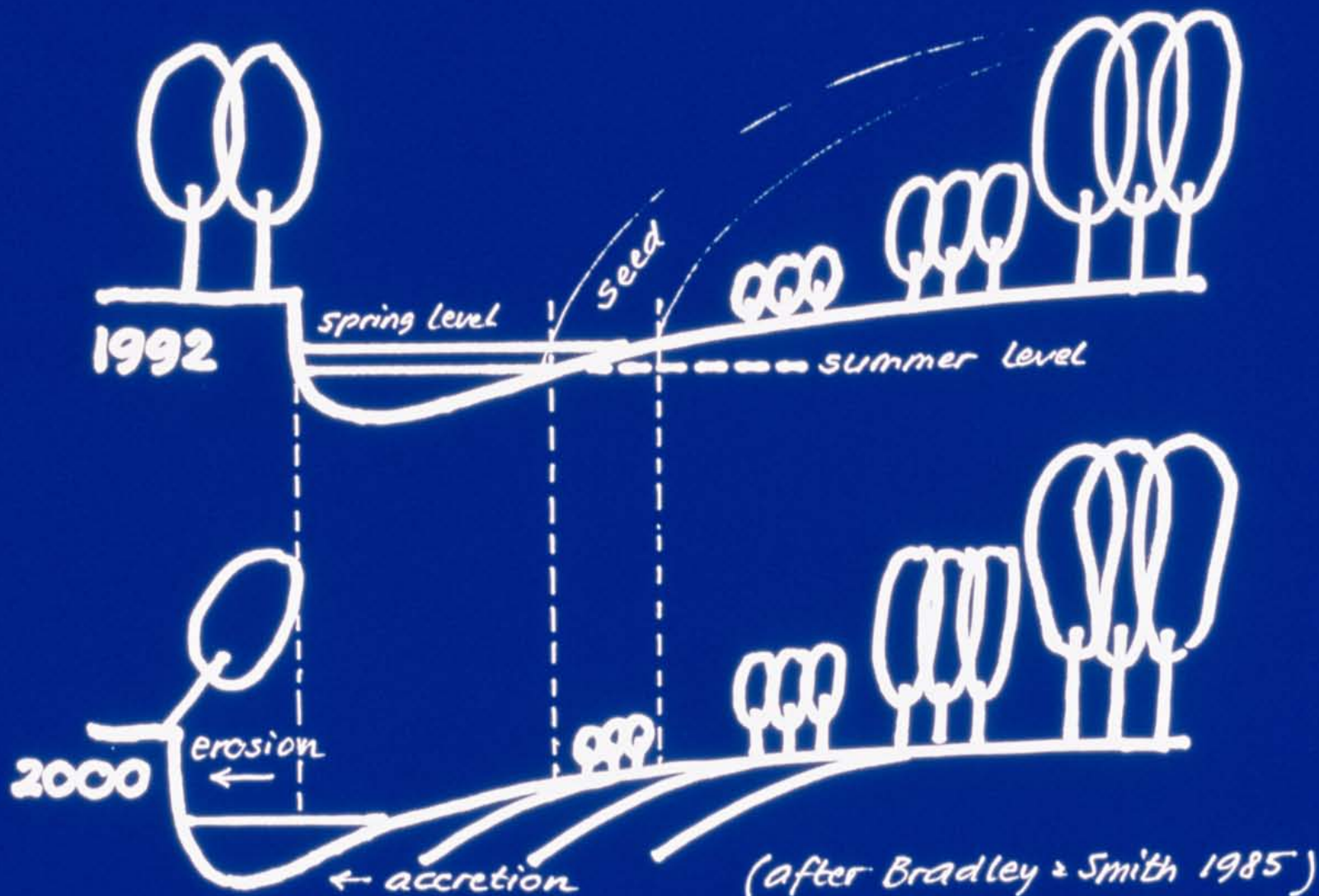


Cottonwood seed dispersal (May – June)



Instant germination and rapid root growth are critical for seedling establishment. An N – fixing *Rhizobium* helps them grow on the sterile substrate (Doty et al. 2005)

# RIVER DYNAMICS AND COTTONWOOD ESTABLISHMENT





Successive cohorts of cottonwoods along a river in Alberta (S. Rood)



Silted 2-yr seedling with newly added roots



Transported, embedded branch fragment with newly developed roots: effective asexual propagation

# REPRODUCTIVE EVENTS

## SEXUAL

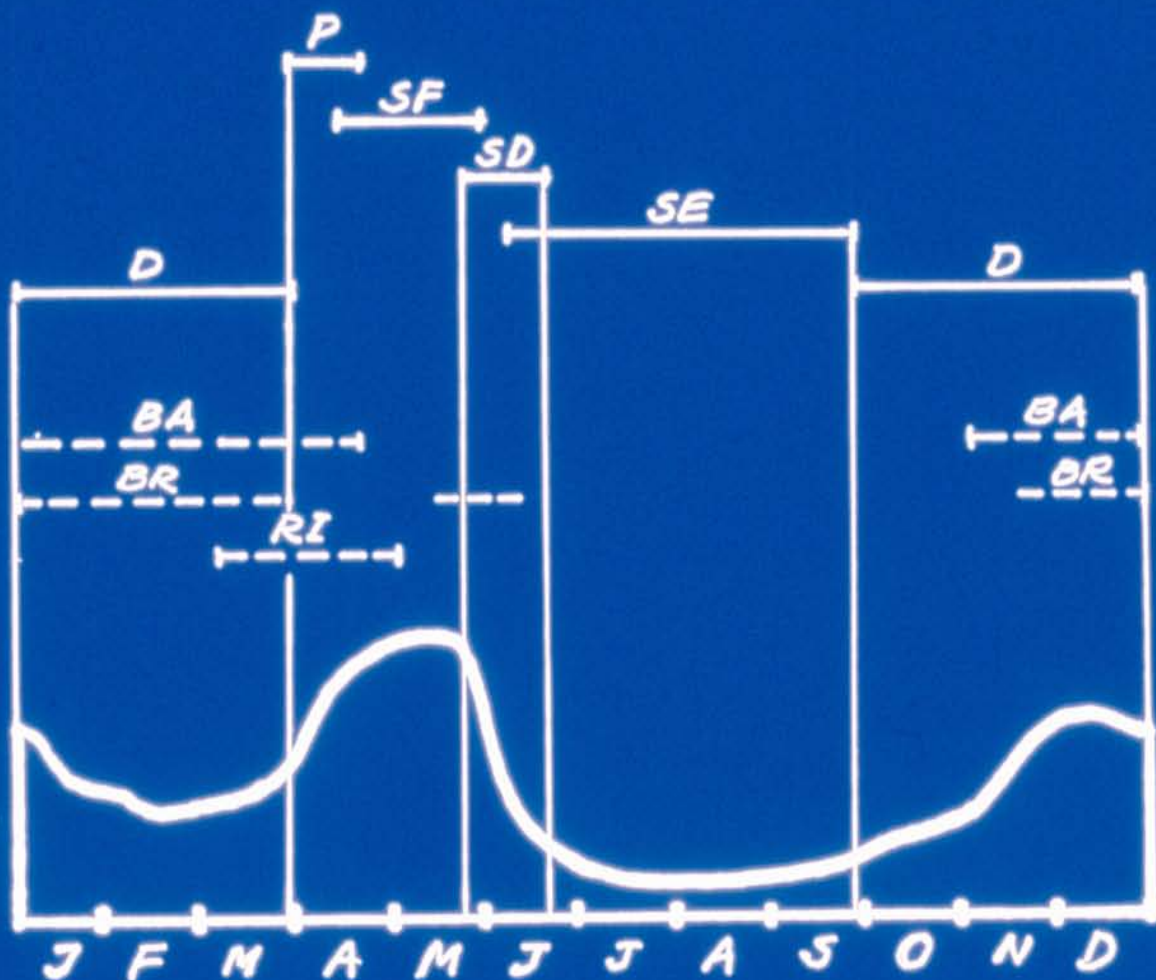
Pollination  
Seed formation  
Seed dispersal  
Seedl. establ.

Dormancy

## ASEXUAL

Branch abscission  
Stem/br. breakage  
Root initiation

Stream discharge

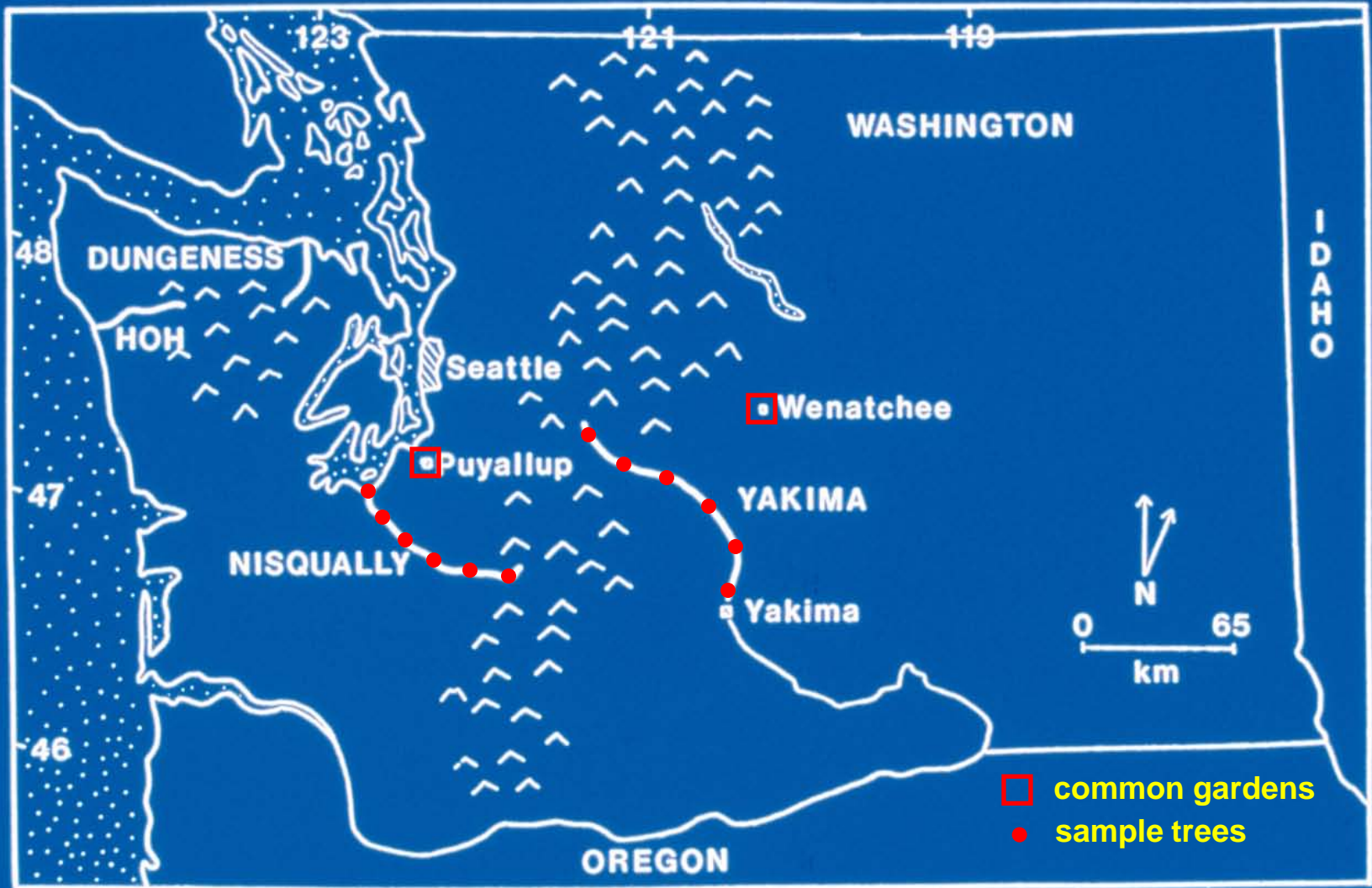


REPRODUCTIVE SCHEDULE OF BLACK COTTONWOOD  
IN RELATION TO STREAM DISCHARGE OF A TYPICAL  
WEST-CASCADE RIVER

# Adaptation

Trees, as all organisms, may be viewed as systems of environmental tracking, making use of relevant ancestral experience. (after R. Levins, 1968)

This experience is encoded in their DNA. But DNA is more than a memory bank: it is the “software” that programs a tree’s growth, development, and response to biotic and abiotic cues.



Climatic adaptation of cottonwoods east and west of the Cascades, as studied in common gardens (J.Dunlap, 1991)



## Ecological race formation along Yakima River near Cle Elum

Larger {  
Stem Volume  
Leaves  
Stomates  
Fewer Stomates/sq.cm.  
Rust resistant

Smaller {  
Stem Volume  
Leaves  
Stomates  
More Stomates/sq.cm.  
Rust susceptible



Hybridization can combine traits among the 30 species of *Populus* worldwide and capture hybrid vigor



P



X



93-968

*Populus trichocarpa*

ILL129

*Populus deltoides*

F<sub>1</sub>



X



family 53

53-246

53-242



X



53-246

ILL129

F<sub>2</sub>



family 331

B<sub>1</sub>



family 342

Pedigree breeding of poplars (Toby Bradshaw)

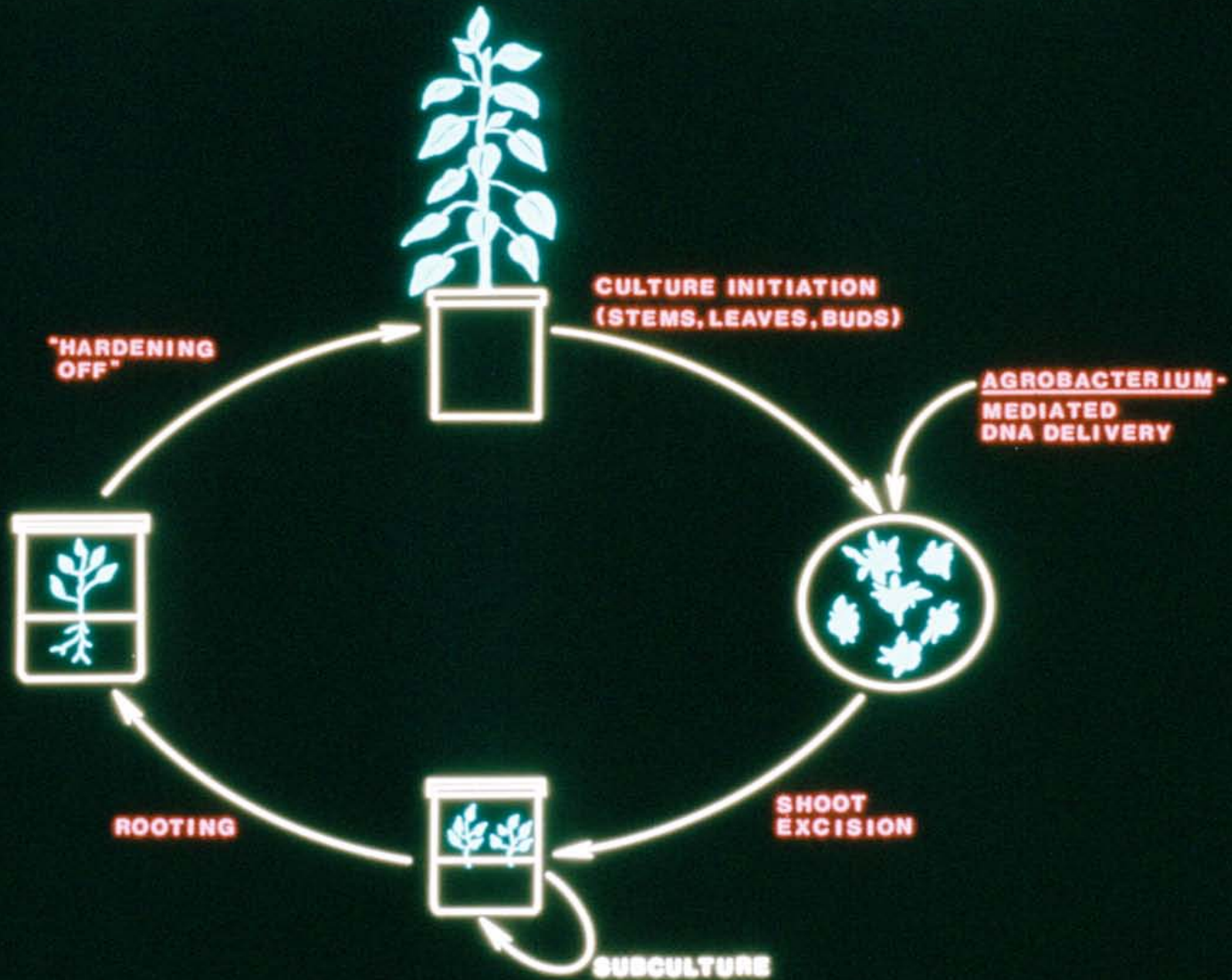


Harvest of a 7 – year old F<sub>1</sub> hybrid plantation for pulp near Clatskanie, Oregon (James River Corp.)



**F<sub>2</sub> hybrid variability in leaf fall: Replicated 5 – year old full-sibs in common garden near Clatskanie, Oregon**

# POPLAR TISSUE CULTURE/ TRANSFORMATION



Tissue culture and genetic engineering of poplar (Toby Bradshaw)

# New Molecular Tools

The complete genome sequencing of a *P.trichocarpa* tree (Tuskan et al., Science 313:1596, 2006) set the stage for:

- better understanding of basic tree biology
- tracking adaptation to climate change
- more targeted and sustainable plantation production
- more efficacious phytoremediation

# Take – home Lessons

- The manifold adaptations of cottonwood to the riparian and climatic variables have a strong genetic basis
- Genetic manipulation of poplar species has opened the door to new uses of these trees and made old uses more effective
- To understand nature, we have to poke it

# CREDITS

Jeff Braatne    Toby Bradshaw

Sharon Doty    Joan Dunlap

Tom Hinckley

Dan and Nico Stettler