

Economic Impact of Global Climate Change on Pacific Northwest Water and Agriculture -- the Beginnings of Integrated Assessment.

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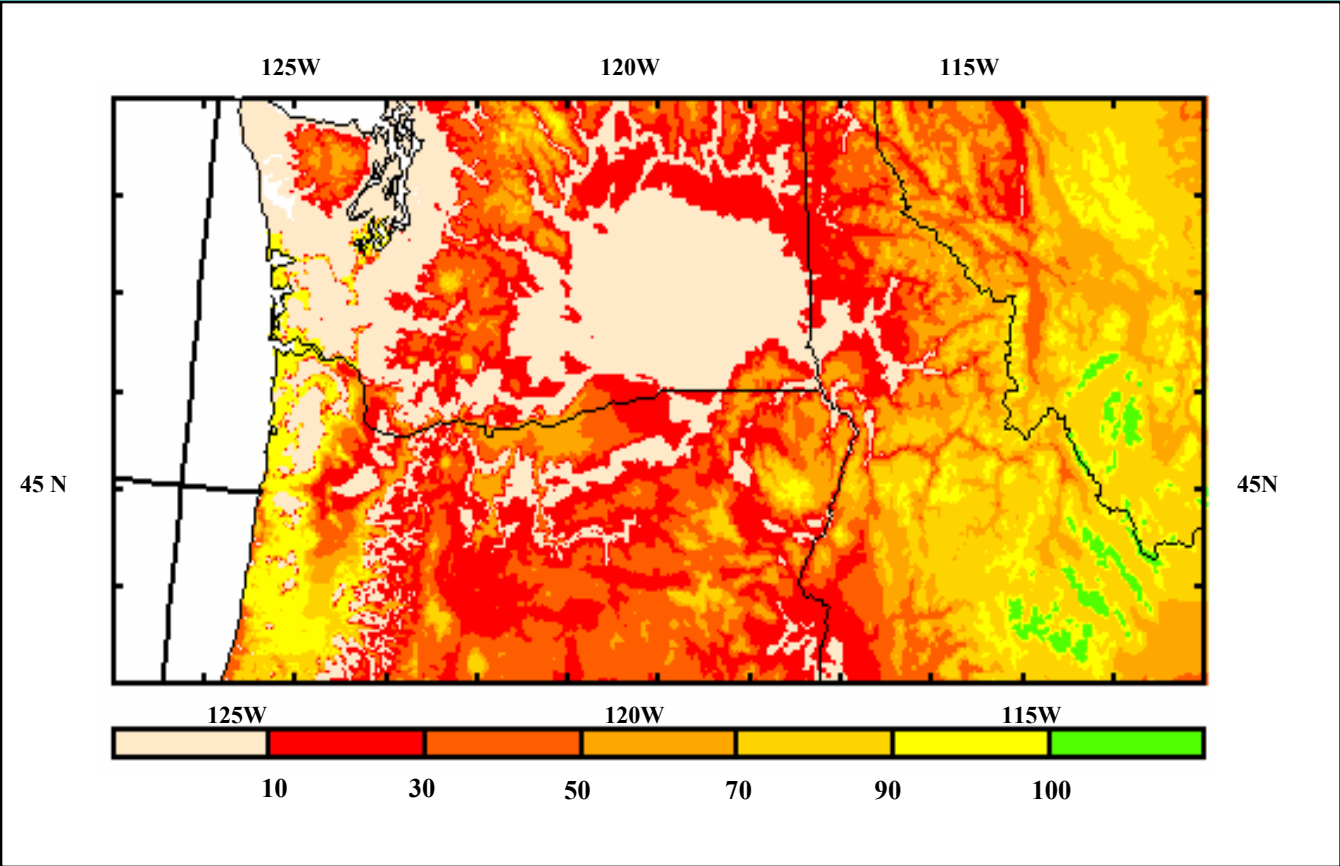
Seattle, Washington

Outline

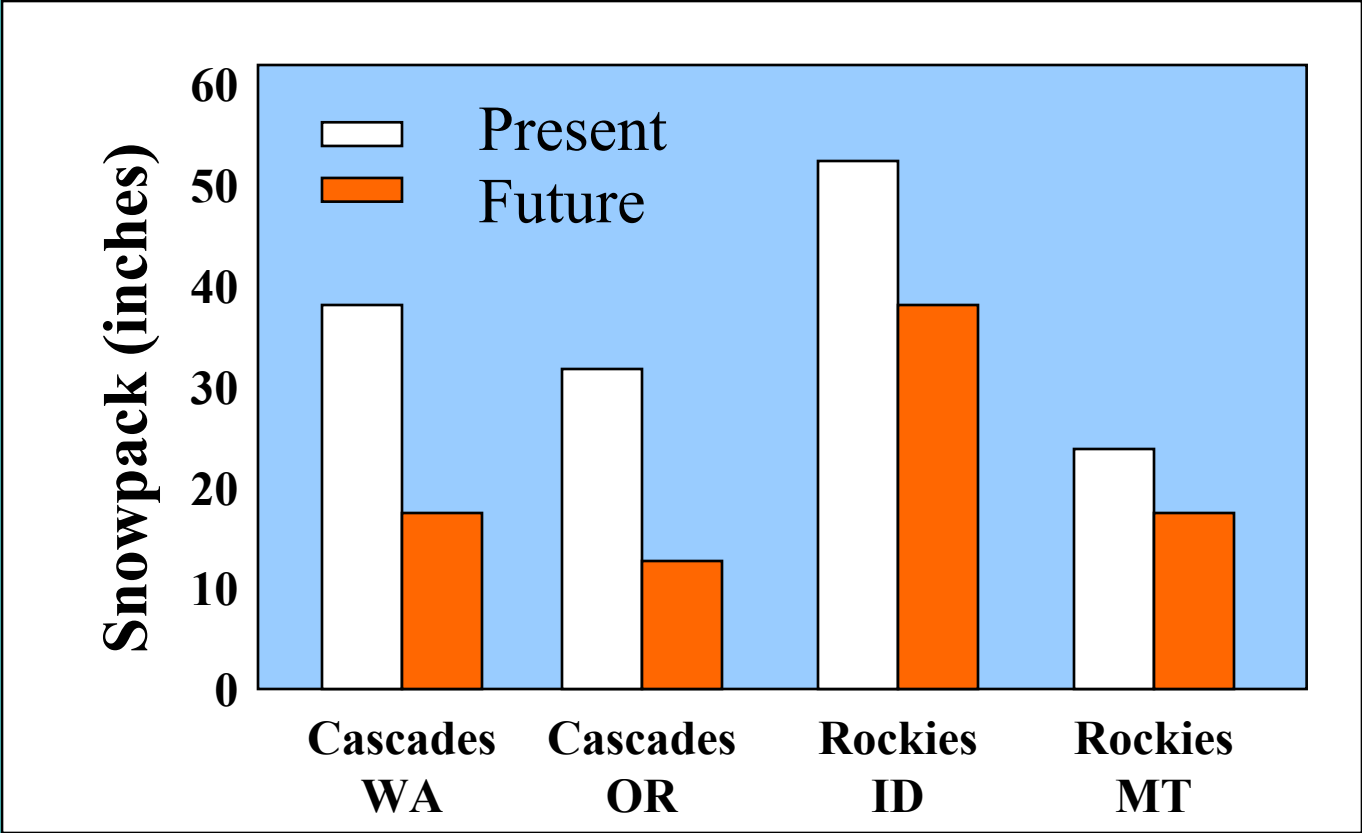
- Impacts of climate change on water availability
- Impacts on water management
- Economics of crop production and the Yakima Valley

Snow pack would be significantly reduced with climate change

Annual mean snow pack at 2xCO2 as % of control

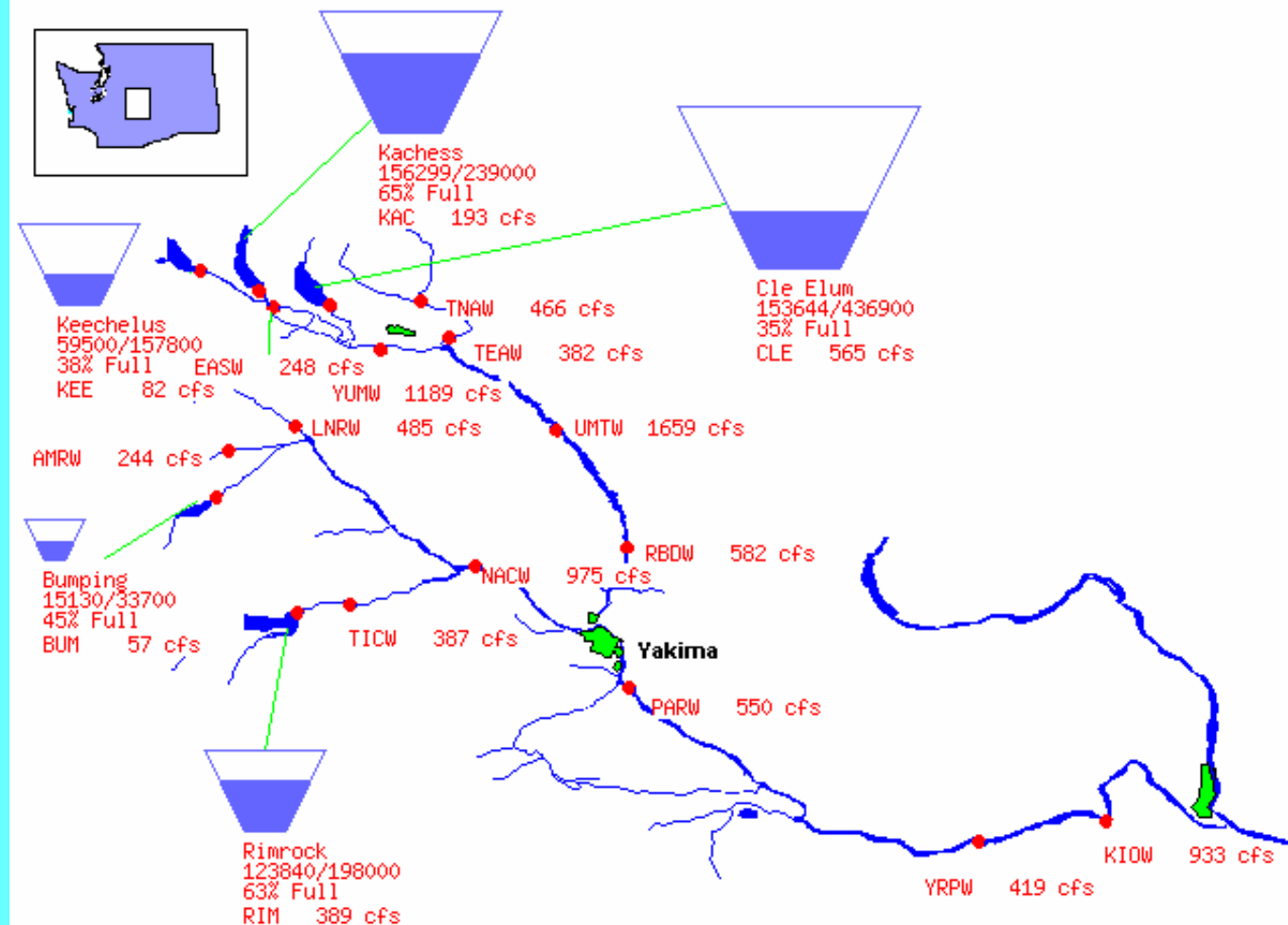


Potential for significant reductions in mountain snow pack

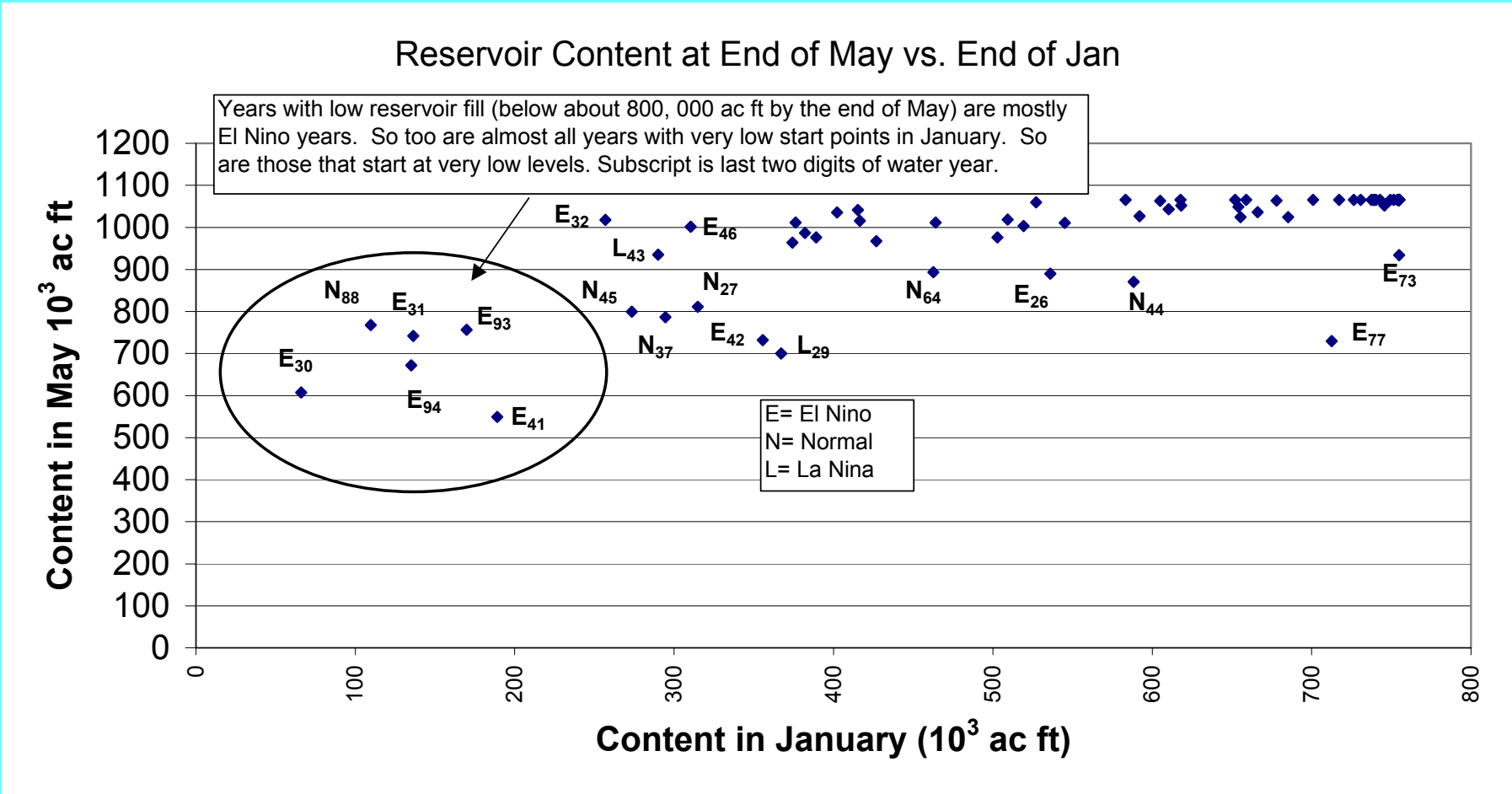


Yakima Basin, WA, with storage facilities

05/06/2001

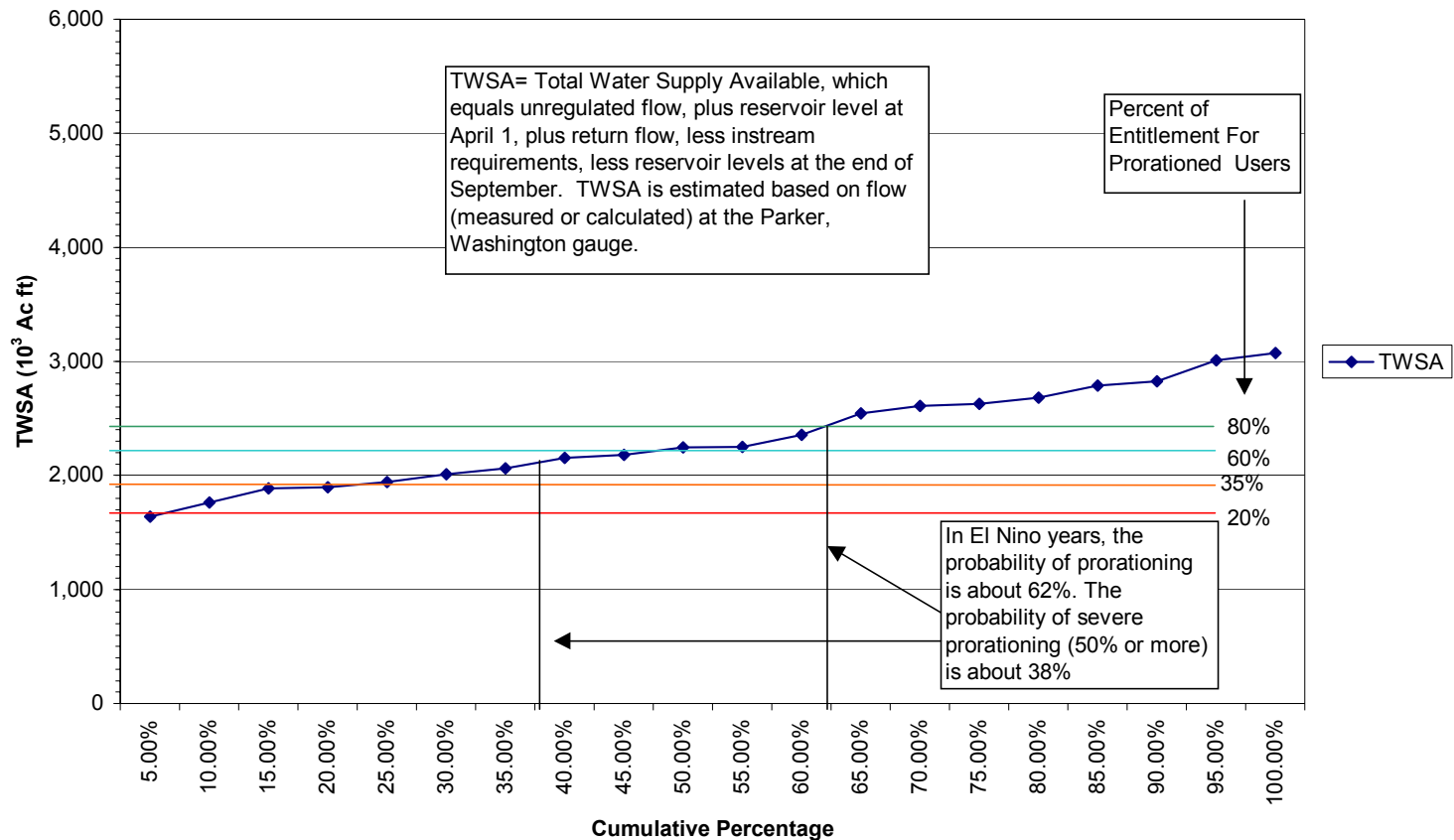


Low precipitation years and reservoir fill



Water prorationing: El Niño

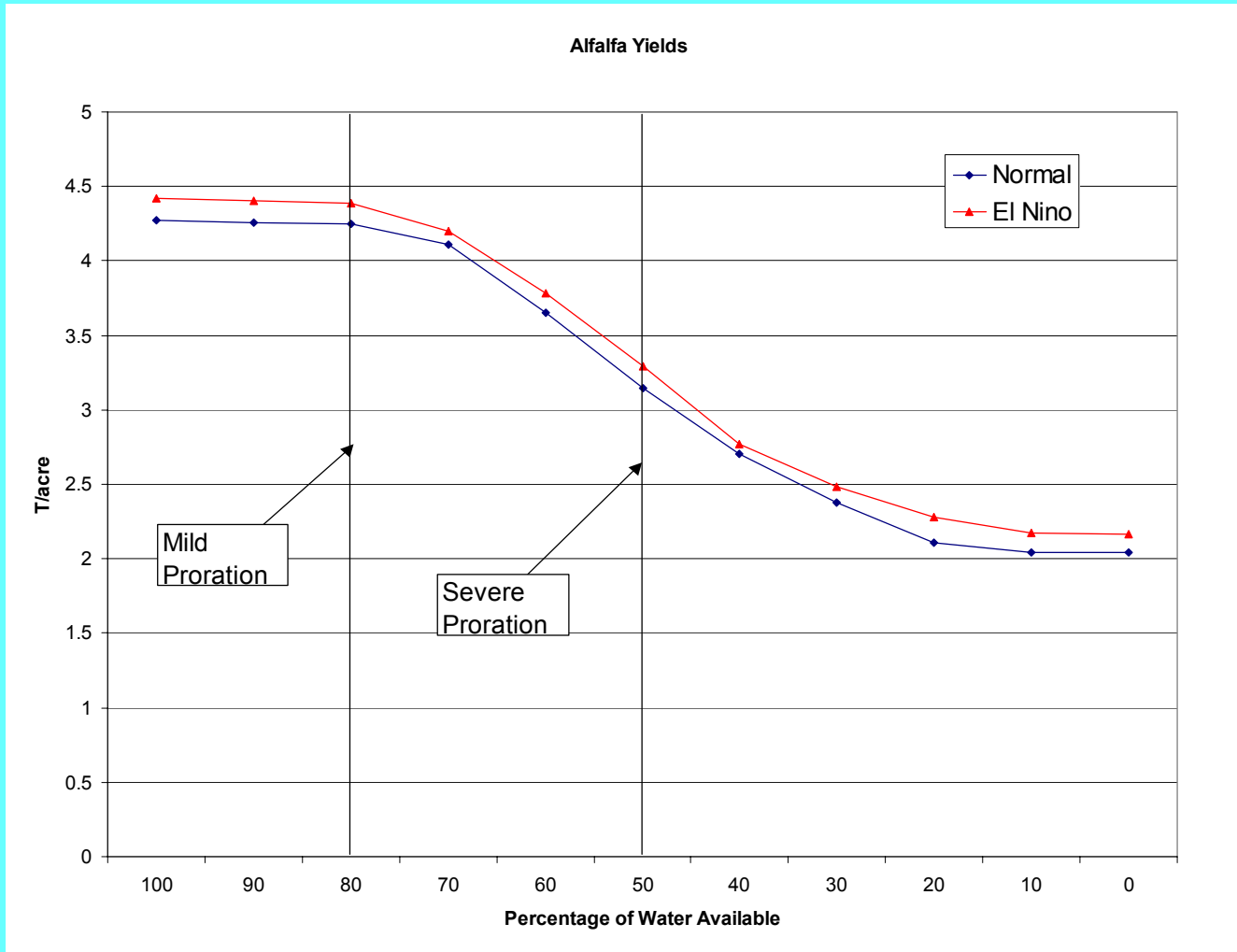
TWSA Cumulative Distribution, El Niño Climate Only, 1926-1994



CropSyst Model

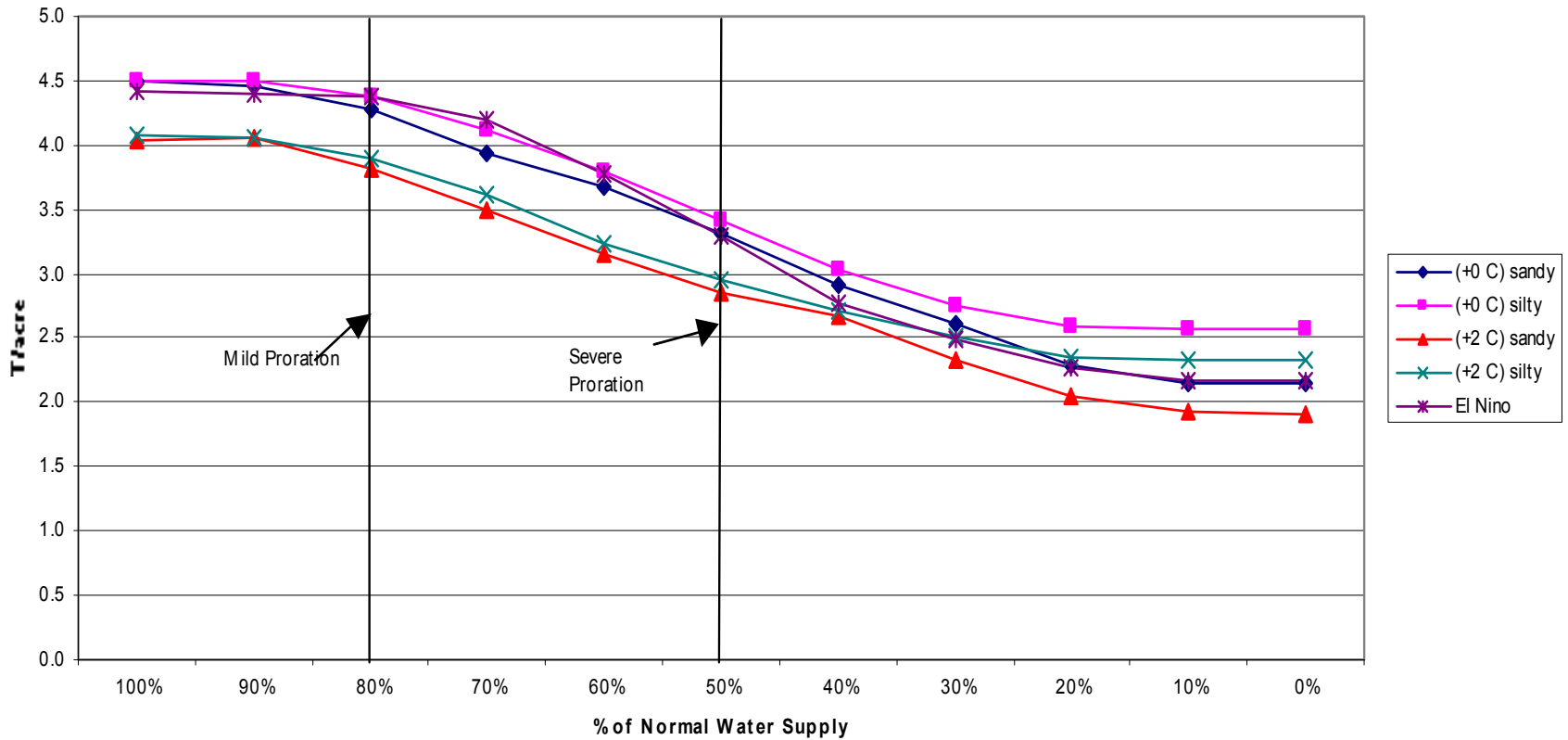
- Multi-year, multi-crop, daily time-step
- Soil-water budget, soil-plant nitrogen budget
- Crop canopy and root growth
- Production, yield, residue production
- Management options: cultivar selection, crop rotation, irrigation, fertilization, tillage operations, and residue management

Prorationing and average yields: Alfalfa



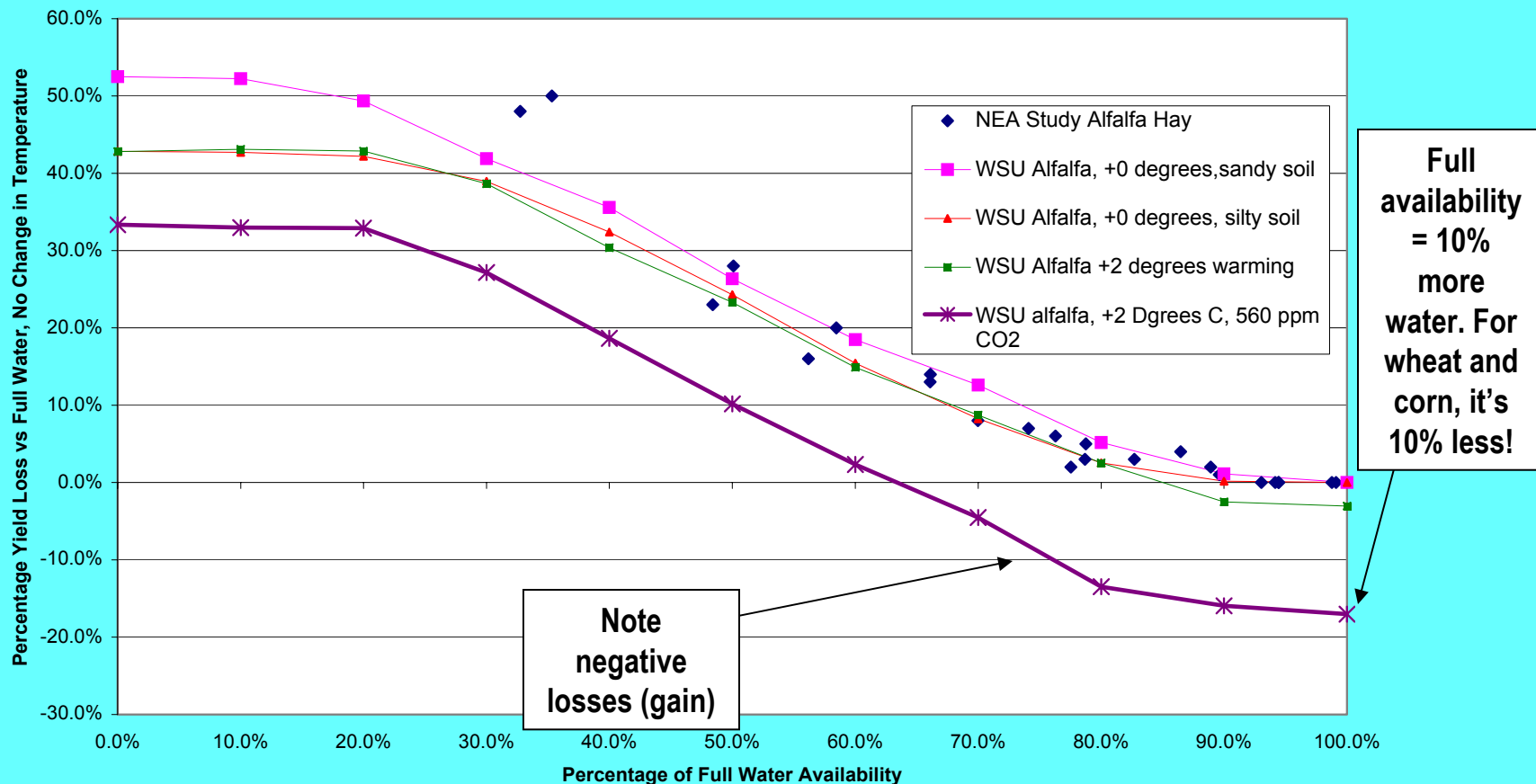
Alfalfa yields with future climate

Yields of Alfalfa, Current Climate, El Nino, and Climate Warming



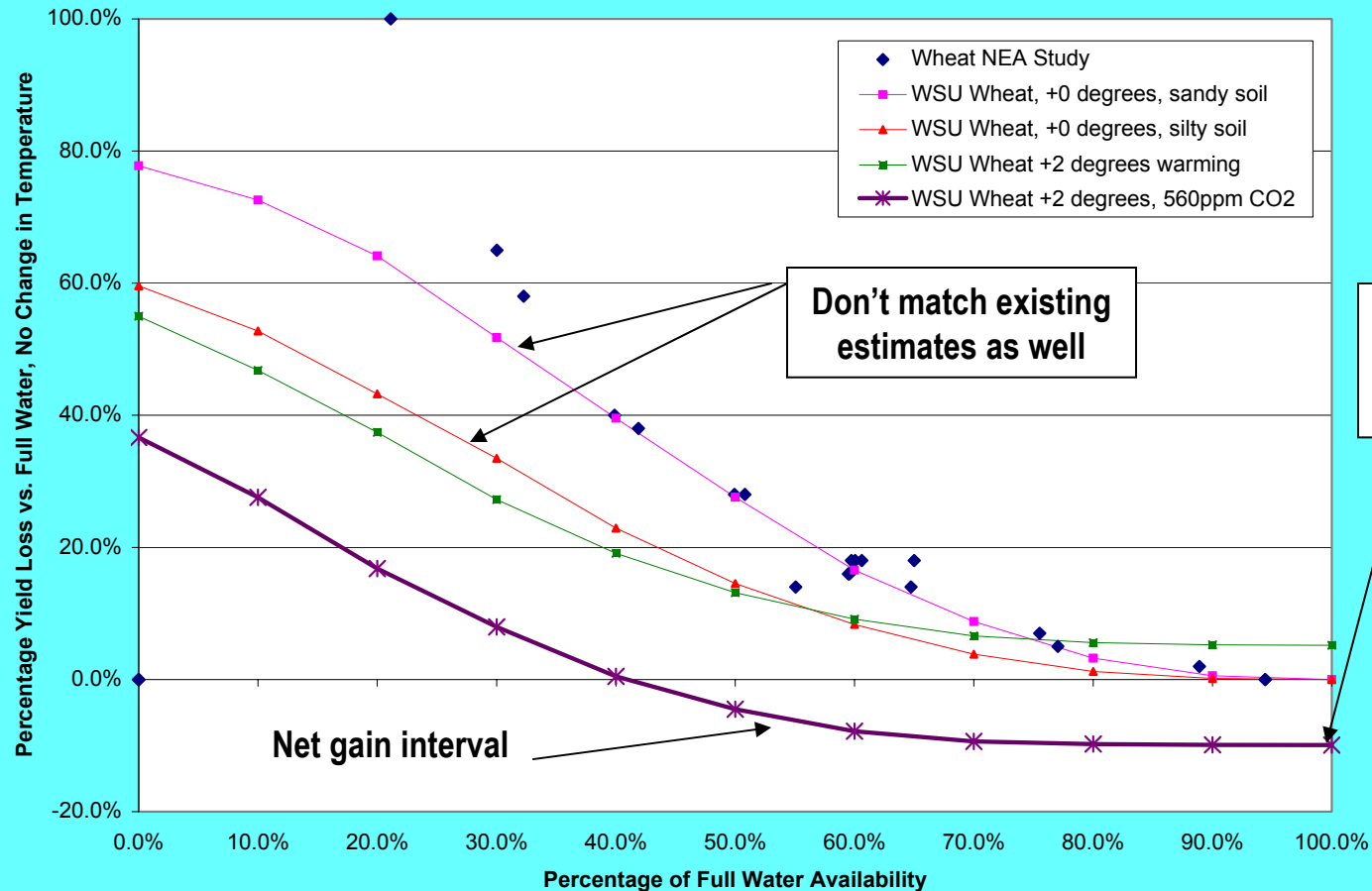
Alfalfa yields with future climate

Percentage Yield Loss vs Water Availability, Alfalfa Hay



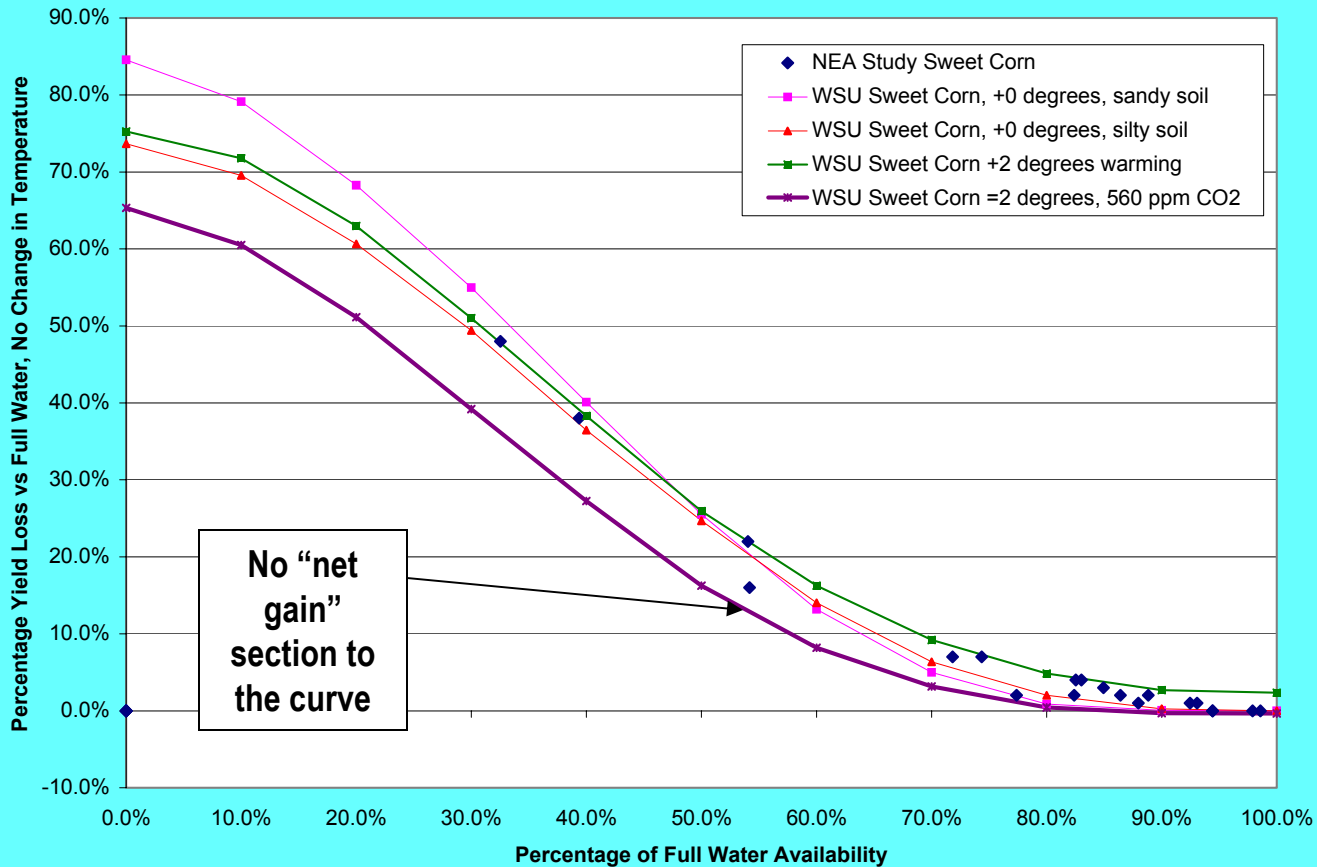
Irrigated wheat yields with future climate

Percentage Yield Loss vs Percentage of Available Water, Irrigated Wheat



Corn yields with future climate

Percentage of Yield Loss vs Water Availability, Irrigated Sweet Corn

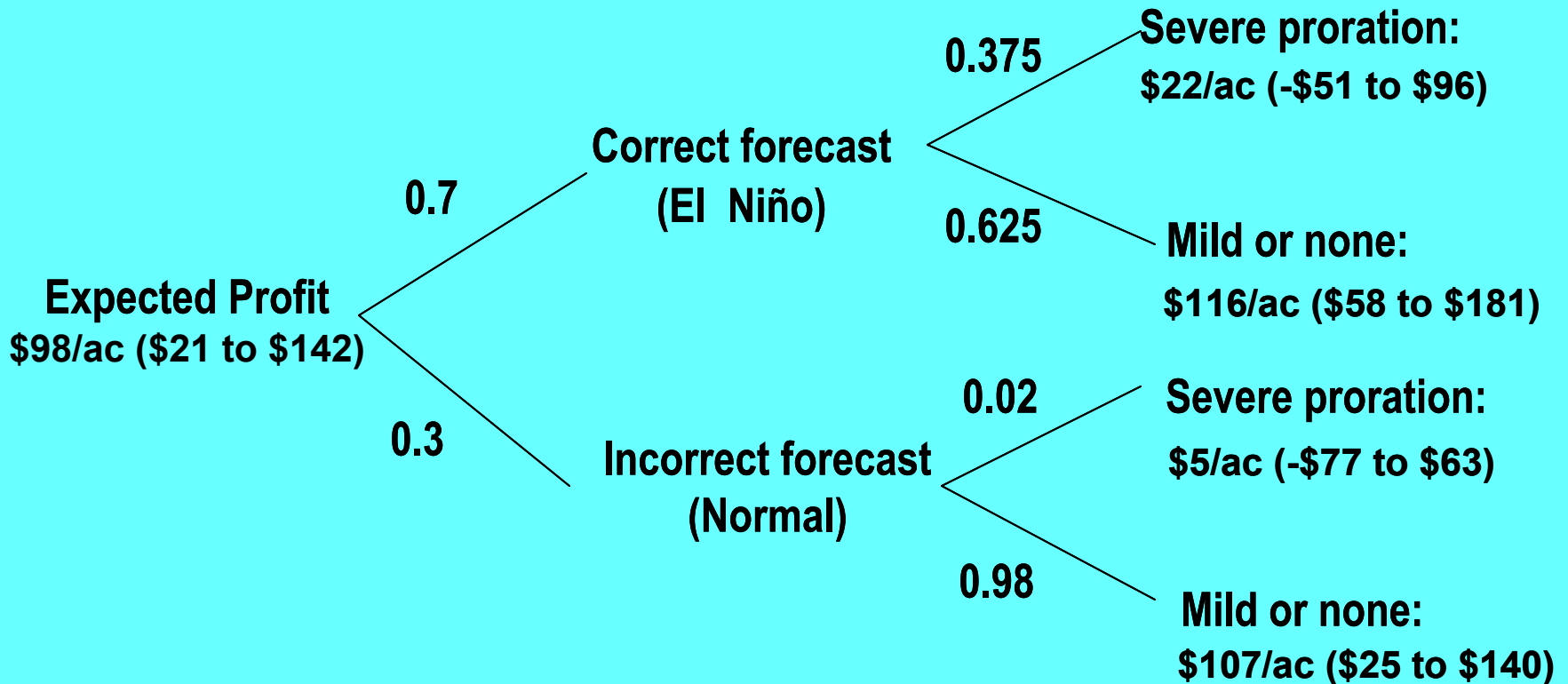


Yakima Valley Farm Production Model

- Flexible crop cost/prices /yields
- 30 crops available for analysis
- Single crops or up to four crops in rotation
- Intercropping analysis
- Automated sensitivity and uncertainty analysis
- 20-year analysis period
- Discounted cash flow

Expected profitability

Expected profit for Alfalfa with 70% confidence in forecast of El Niño:



Water transfers in anticipation?

- Water supply conditions can be anticipated (with some uncertainty)
- Water might be transferred or leased before the season
- Values of transfers or leases could be calculated based on expected value or some safer, risk-averse standard

Example: water transfer from junior rights holders (50% prorationing)

Water transfer at 70% confidence of El Niño, median crop prices and yields:

Expected net value to recipient per acre

<u>Expected cost</u>	Sweet Corn	Potatoes	Alfalfa	Dry Beans	Concord G.	Cabernet G
Sweet Corn (\$324)	--	\$161	\$28	\$45	\$213	\$381
Potatoes (\$185)	\$3	--	\$28	\$45	\$213	\$381
Alfalfa (\$88)	\$3	\$161	--	\$45	\$213	\$381
Dry Beans (\$38)	\$3	\$161	\$28	--	\$213	\$381
Concord Grapes (*)	(*)	(*)	(*)	(*)	--	(*)
Cabernet Grapes (*)	(*)	(*)	(*)	(*)	(*)	--

*It is assumed that water rights applied to high-value perennial crops would not be exchanged due to large cost implied by lost future profits .

Example: water transfer from senior rights holders

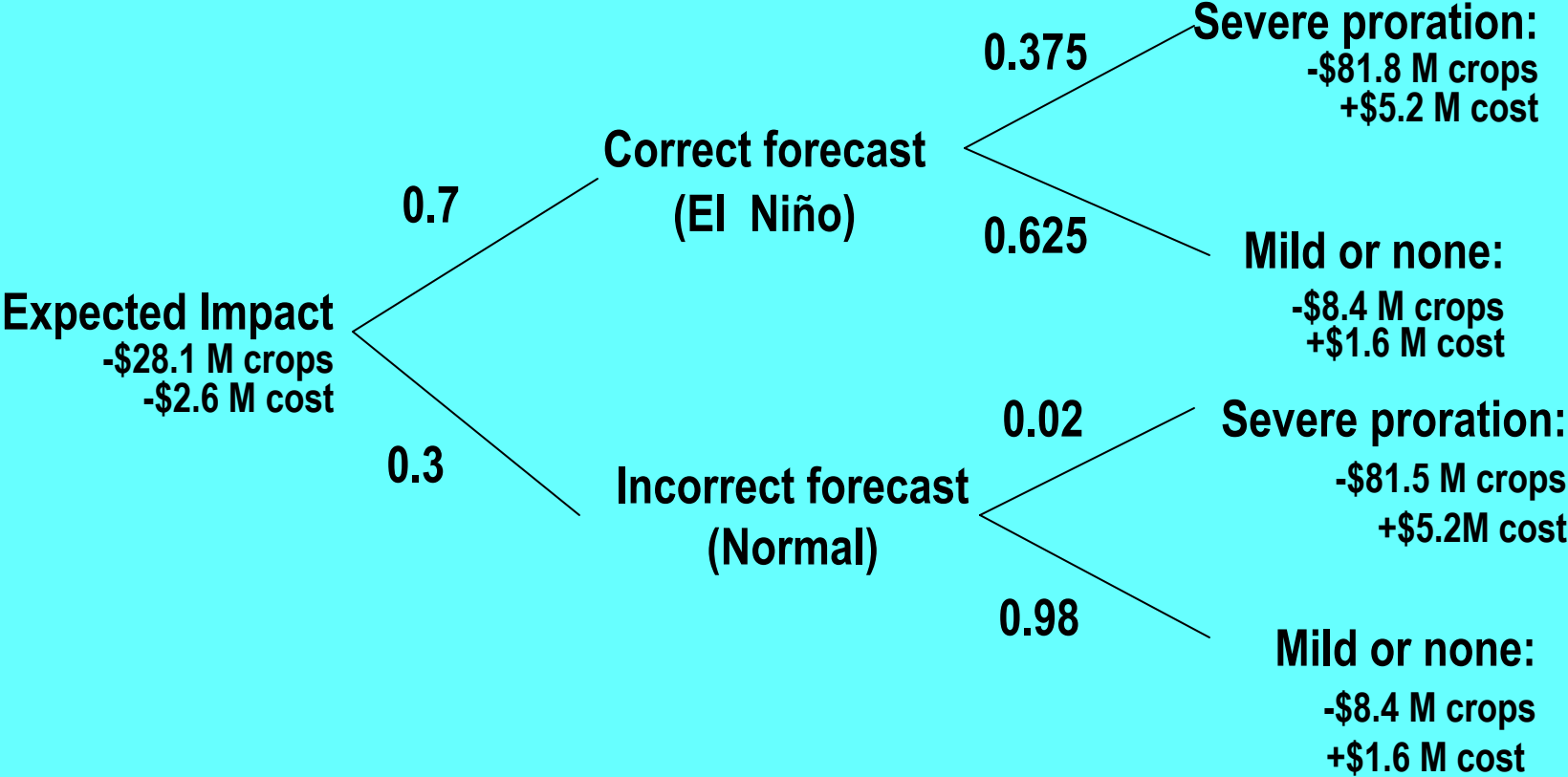
Water transfer at 70% confidence of El Niño, median crop prices and yields:

<u>Expected cost</u>	<u>Expected net value to recipient per acre</u>					
	Sweet Corn	Potatoes	Alfalfa	Dry Beans	Concord G.	Cabernet G
Sweet Corn (\$327)	--	\$161	\$28	\$45	\$213	\$381
Potatoes (\$346)	\$3	--	\$28	\$45	\$213	\$381
Alfalfa (\$116)	\$3	\$161	--	\$45	\$213	\$381
Dry Beans (\$8)	\$3	\$161	\$28	--	\$213	\$381
Concord Grapes (*)	(*)	(*)	(*)	(*)	--	(*)
Cabernet Grapes (*)	(*)	(*)	(*)	(*)	(*)	--

*It is assumed that water rights applied to high-value perennial crops would not be exchanged due to large cost implied by lost future profits .

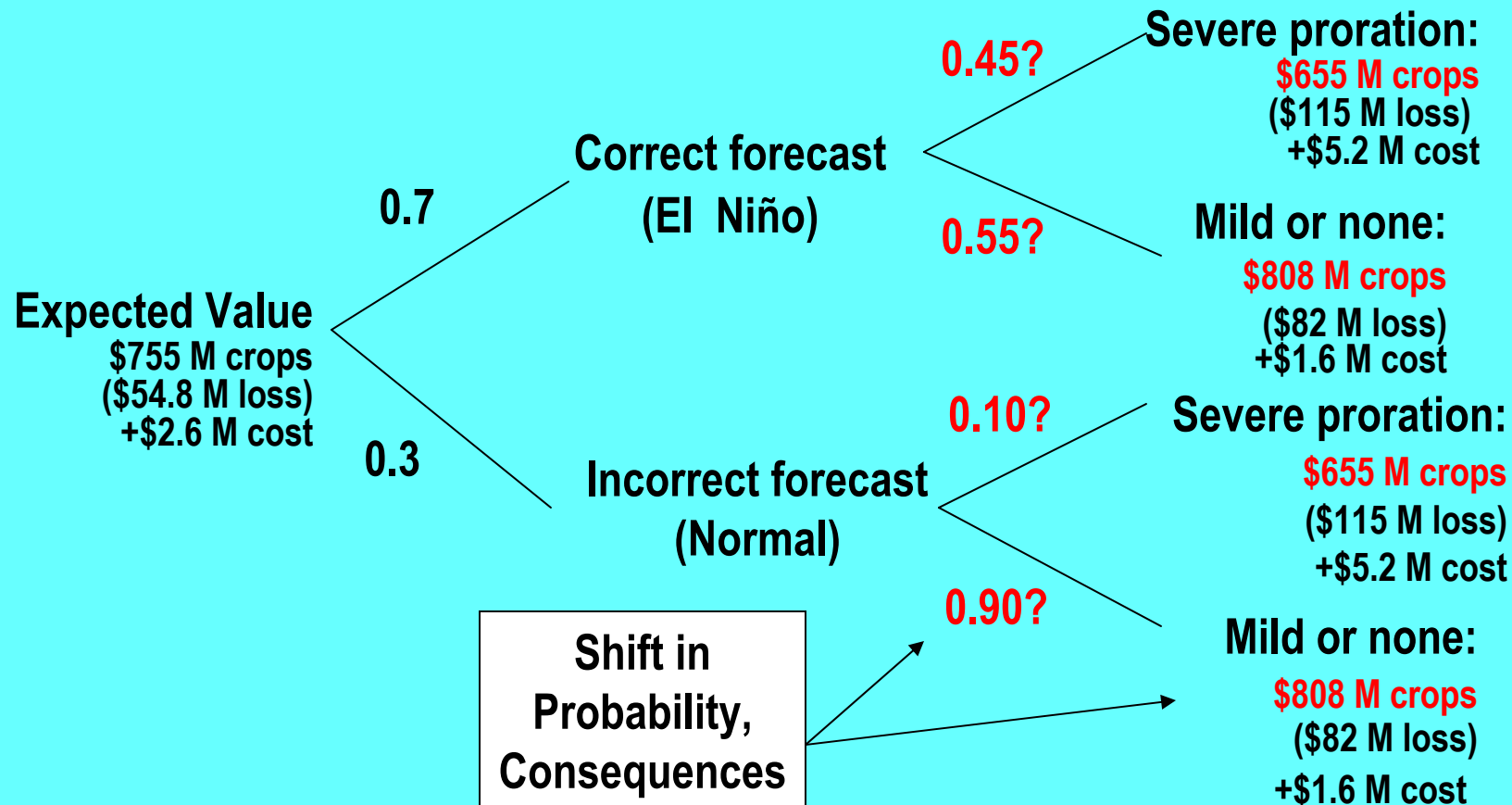
Expected Value of Losses from El Niño

Expected losses with 70% confidence in forecast of El Niño:



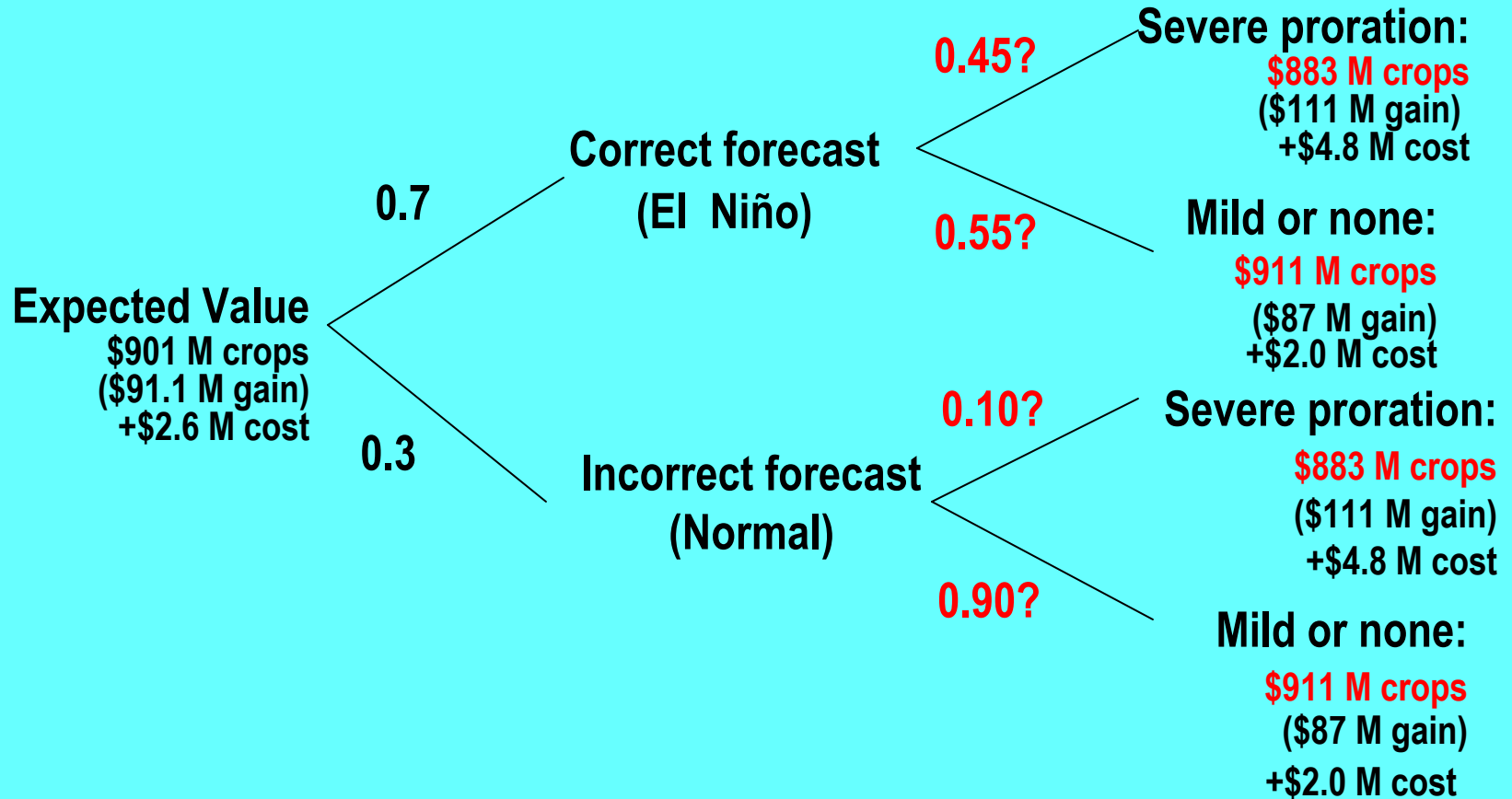
Preliminary Scenario Impacts from 2°C Warming, No CO₂ Effects

Expected losses with 70% confidence in forecast of El Niño:



Preliminary Scenario Impacts from 2°C Warming, 560ppm CO₂

Expected losses with 70% confidence in forecast of El Niño:



Institutional issues

- Washington water rights are subject to:
 - Beneficial use
 - No impairment to existing or senior rights
 - Water is available for appropriation
 - Not detrimental to public welfare
- Drought allows trade (need more flexibility)
 - Flow < 75% of normal, undue hardship
 - Fallowing required for temporary transfer of right

Findings

- El Niño years (and future climates) are at higher risk for low water availability
- These conditions can be predicted with some skill and risk can be managed
- Farmers do have some profitable options to respond by trading water

Acknowledgements

- Human Dimensions Program, NOAA Office of Global Programs
- Bureau of Reclamation, Yakima Project Office
- Environmental Protection Agency