Cottonwood-Willow stand structure on unregulated and regulated reaches of the Verde River, Arizona

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Riparian Areas

- Riparian zones are the interfaces between terrestrial and aquatic ecosystems

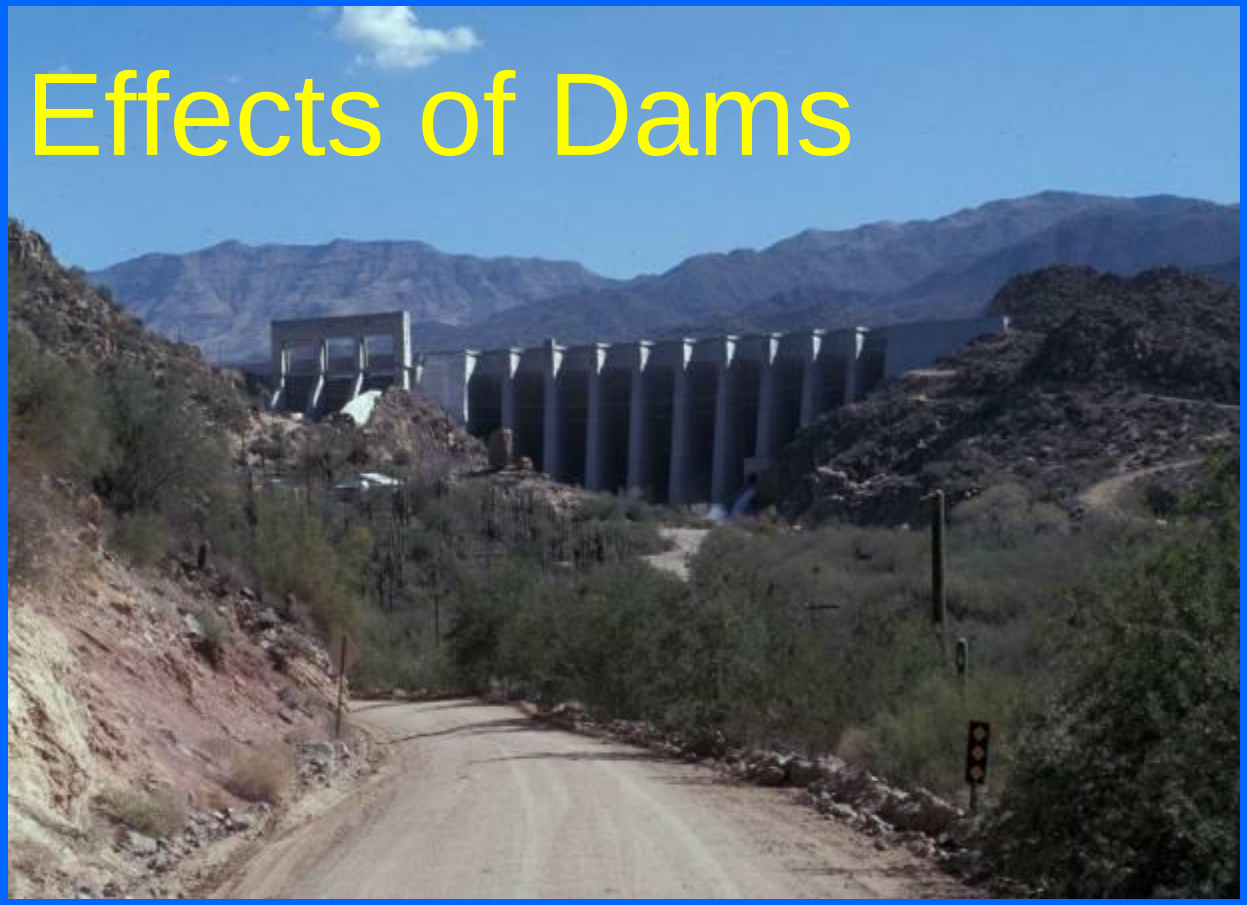
- Dominated by cottonwood *(Populus fremontii)* and willow (*Salix gooddingii)*

- Disturbance adapted - regeneration tied to floods

Riparian Areas

- Floods create bare moist germination beds necessary for pioneer species recruitment
- New cohorts of cottonwoods and willows come up with each appropriate flood event (magnitude and timing are important)
- River migration and aggradation creates lateral age zonation of stands across the floodplain

Effects of Dams



- Alter flow regime
  - magnitude, frequency, duration, and timing of floods

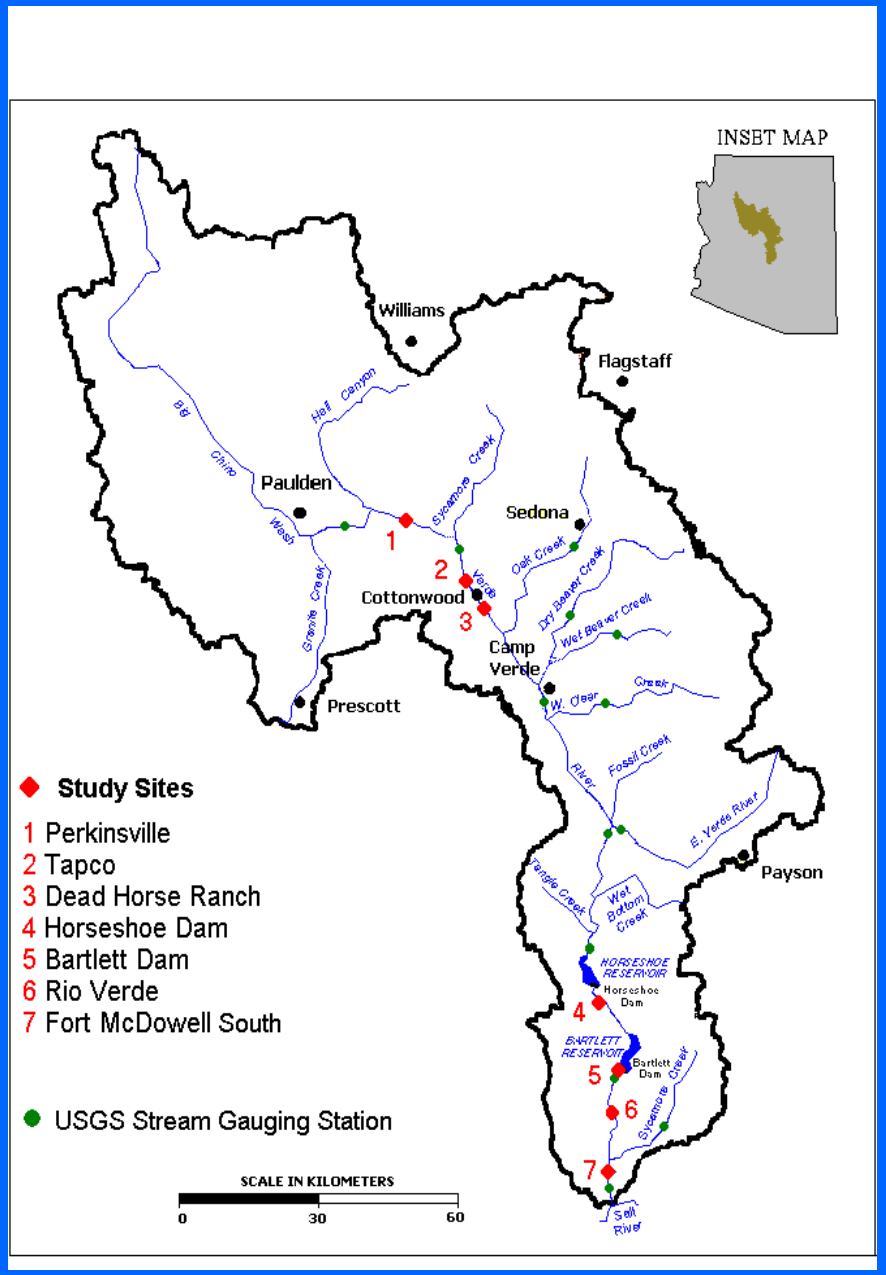
- Native vegetation often not adapted to new flow regime
- Decreased germination and survival of cottonwood and willow
- Saltcedar spreads into below dam areas

Objectives

- How does the operation of Bartlett Dam alter the flow regime of the Verde River?
- How does the structure of cottonwood-willow stands differ between above and below dam reaches?
  - *Populus fremontii*
  - *Salix gooddingii* and *S. exigua*
  - *Tamarix ramosissima*

Study Sites and Methods

- Hydrology
  - USGS Gauges at Tangle and Bartlett (1945 to 2000)
- Vegetation
  - Upper Basin: Unregulated
    - Three sites (1,170 to 1,100 m)
  - Lower Basin: Regulated
    - Four sites (580 to 440 m)
  - 9 cottonwood-willow plots per site
    - Sapling (1 to 10 year)
    - Mature (11 to 55 year)
    - Old-growth (55+ year)



Methods

- Stem density and basal area for all trees within plot
- Differences within age classes between reach types: Mann-Whitney test

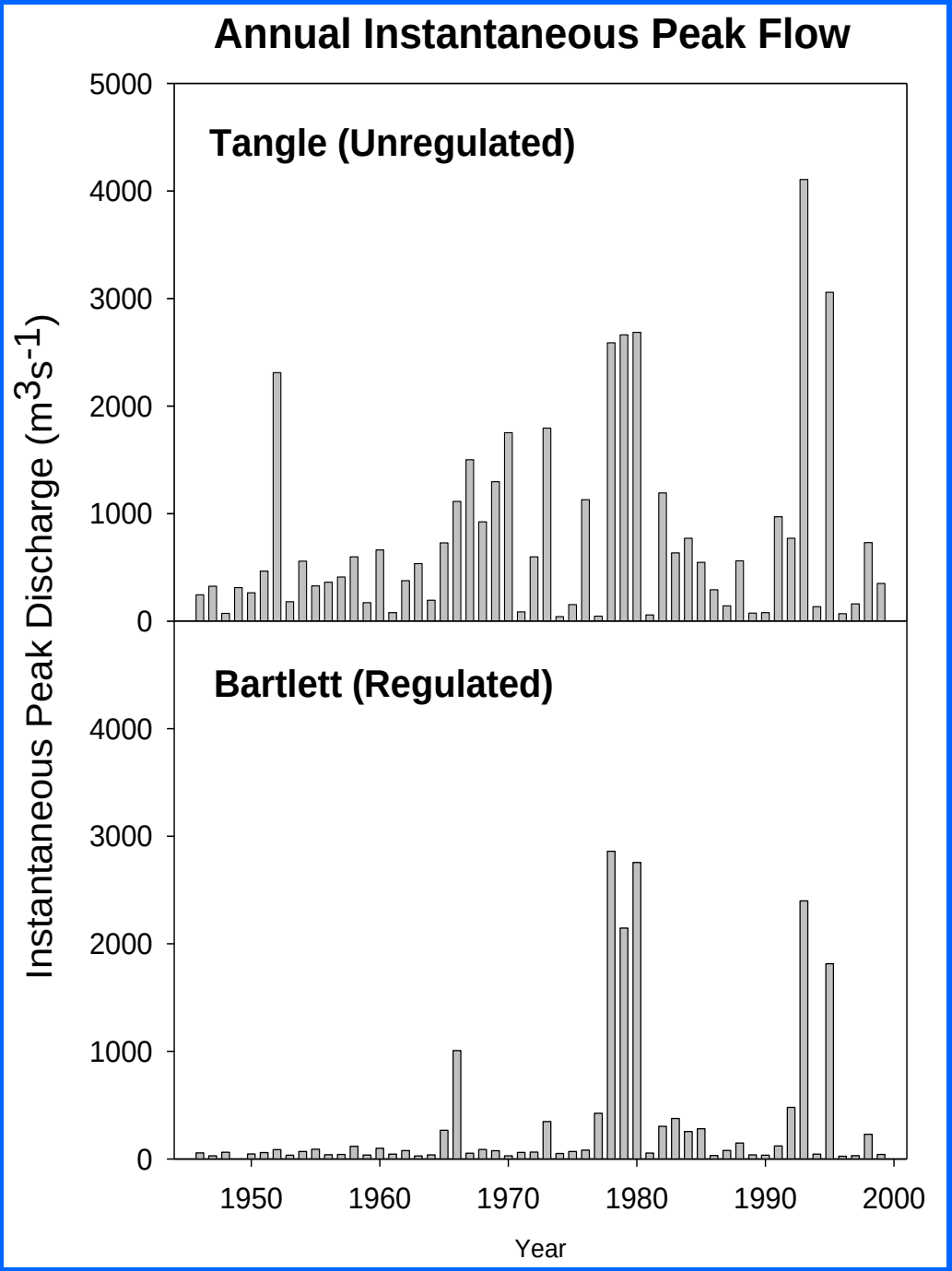
- Sapling – 5, 4m^2 plots within 100m^2
- Mature - 100m^2
- Old-Growth - 400m^2

Results - Hydrology

How has operation of Bartlett Dam altered the flow regime of the Verde River?

Annual Instantaneous Peak Flows

- Average annual instantaneous peak flow decreased by 56%
  - moderate-sized floods captured by dam
- Spring (Dec-April) peak flows shifted 1 month weeks from early February to early March
- Large floods
  - 20% decrease
  - No timing shift

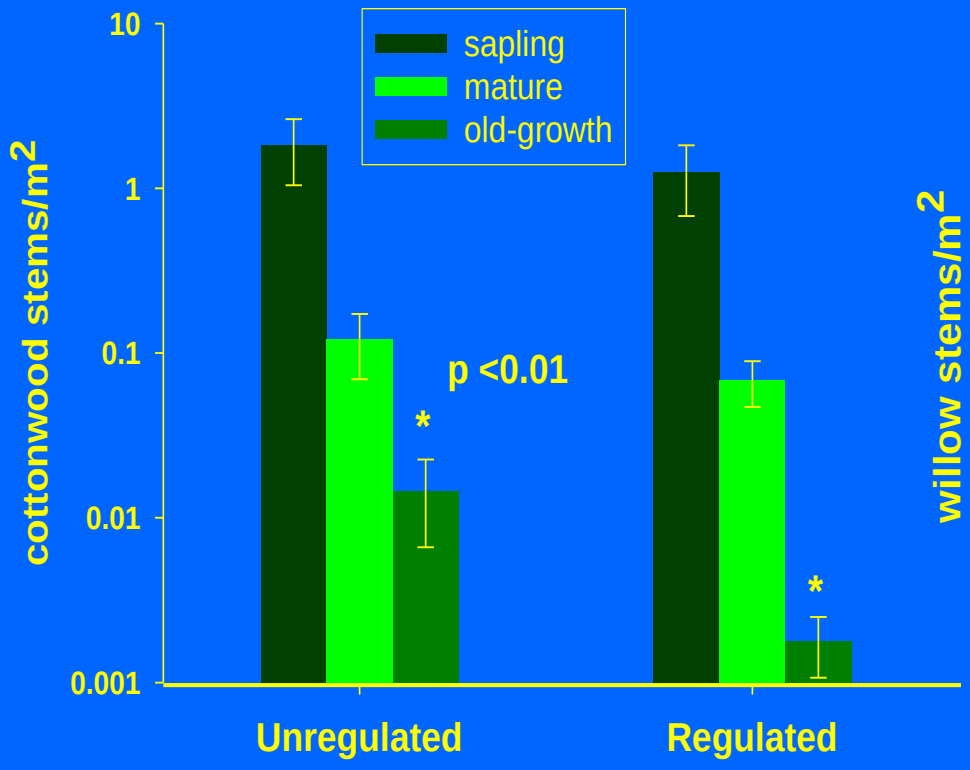


Results - Vegetation

How does woody vegetation structure within cottonwood-willow stands differ between reach types?

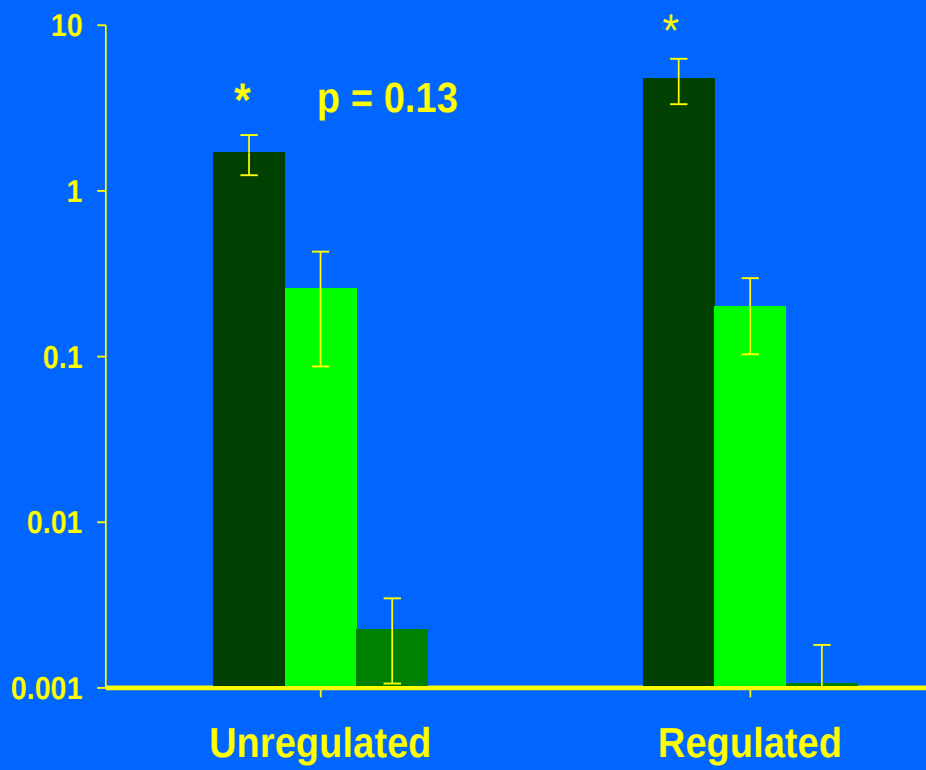
Cottonwood Stem Density
(*P. fremontii*)

- No difference in stem density between reaches in sapling and mature stands

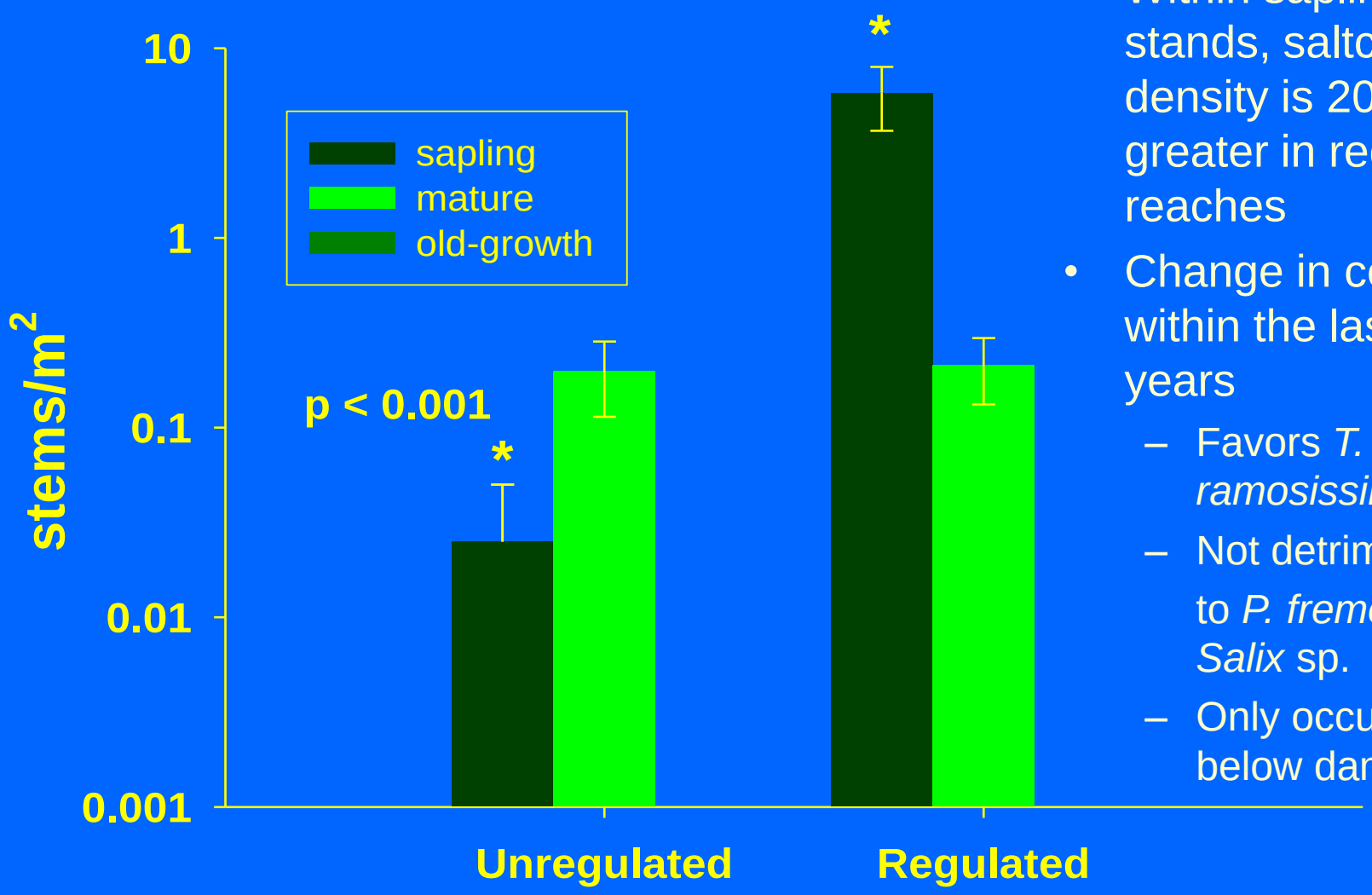


Willow Stem Density
(*S. gooddingii and S. exigua*)

- Sapling willow stands show a trend toward higher density in regulated reaches

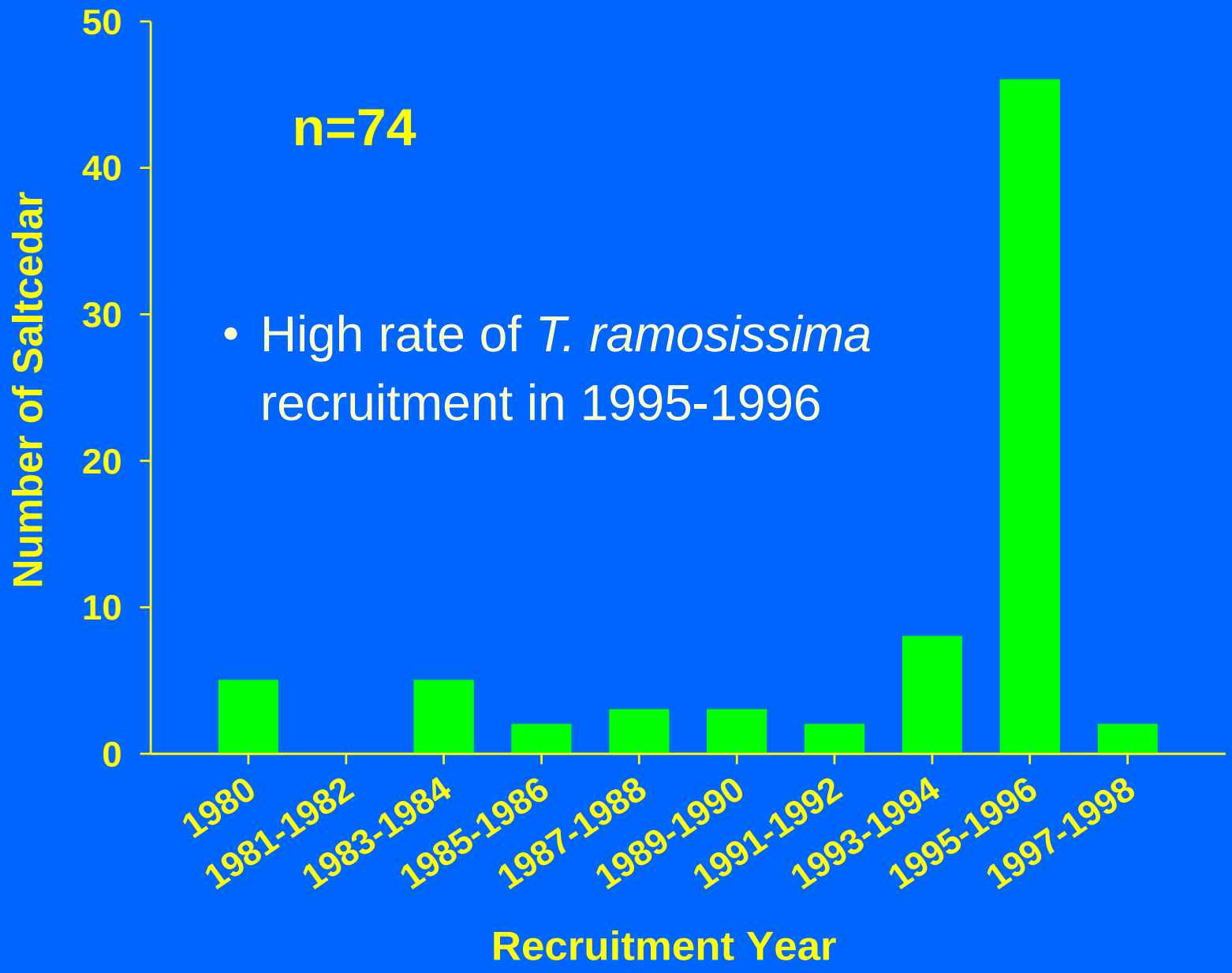


Saltcedar (Tamarix ramosissima) Stem Density within Cottonwood-Willow Stands

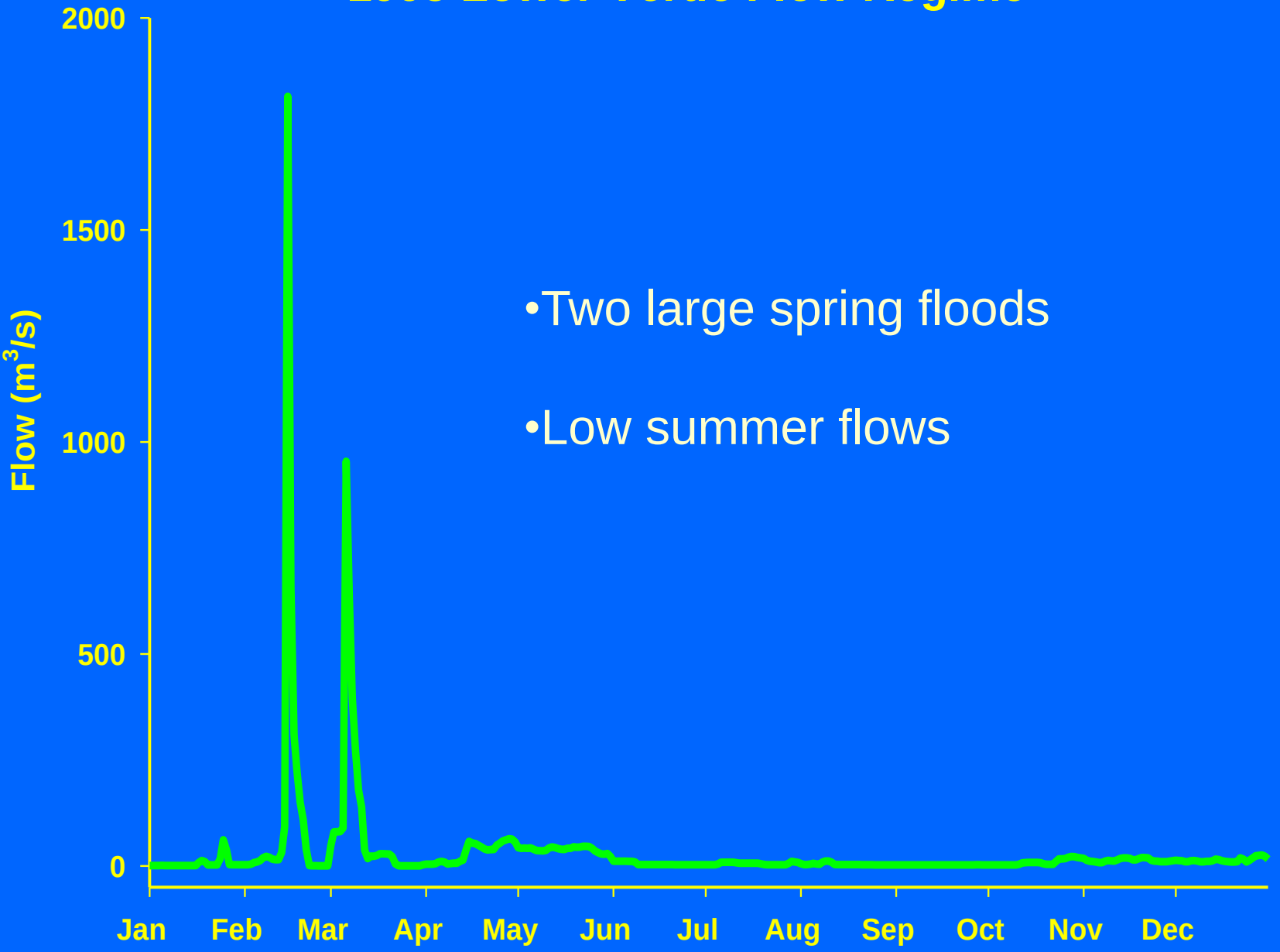


- Within sapling cw-w stands, saltcedar density is 200 fold greater in regulated reaches
- Change in conditions within the last 10 years
  - Favors *T. ramosissima*
  - Not detrimental to *P. fremontii* or *Salix* sp.
  - Only occurred below dam

Lower Verde Saltcedar Recruitment

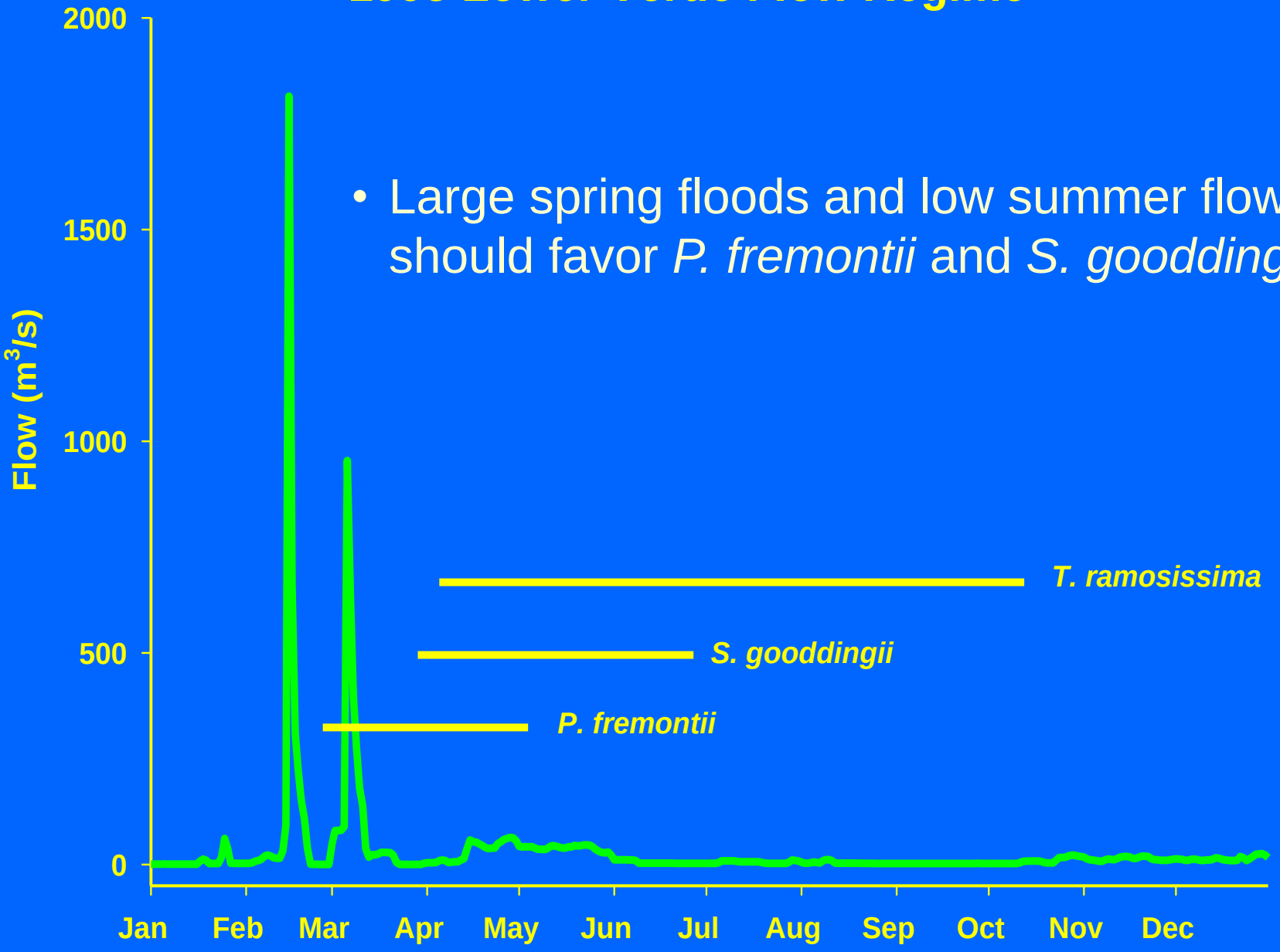


1995 Lower Verde Flow Regime



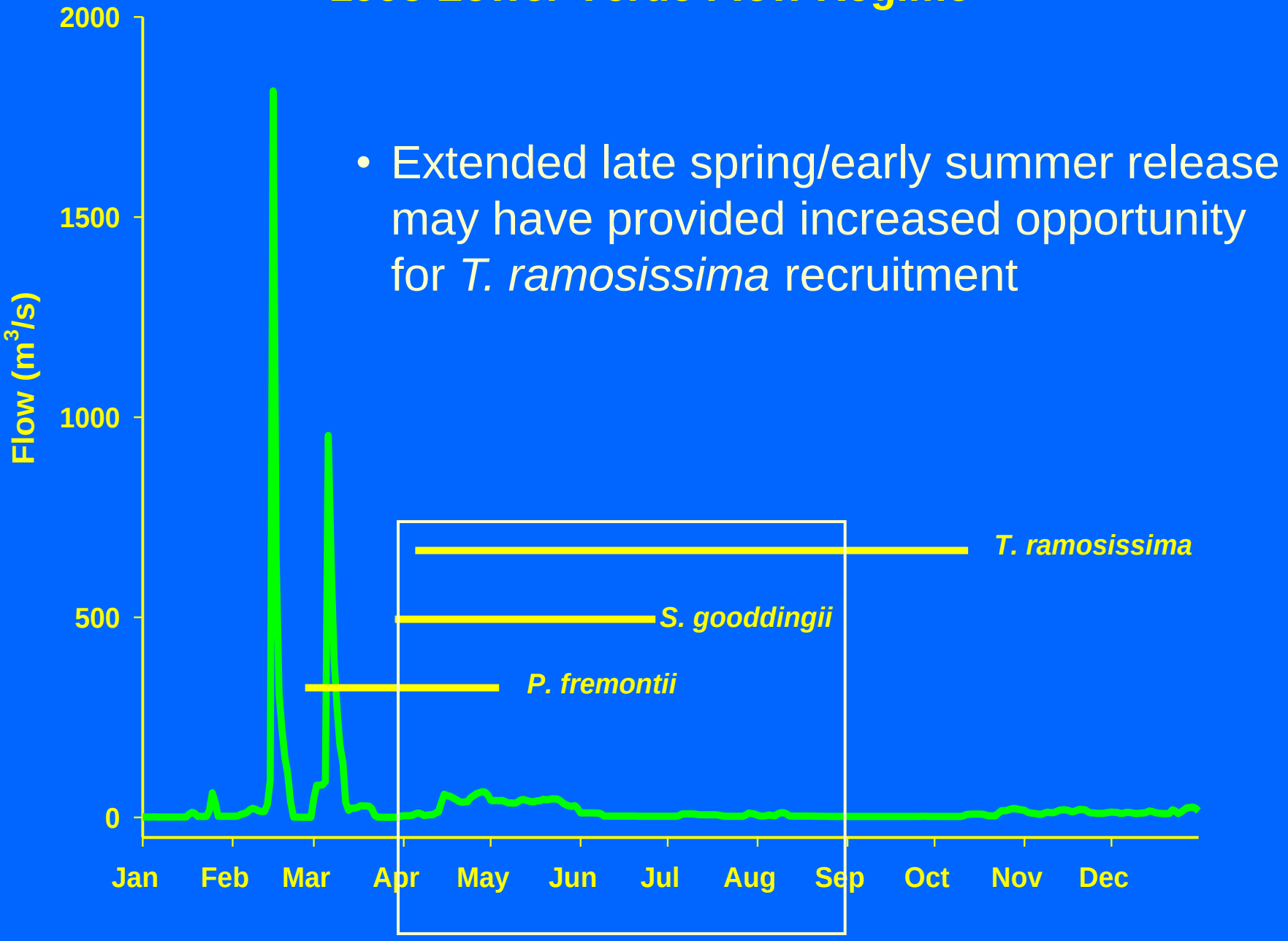
- Two large spring floods
- Low summer flows

1995 Lower Verde Flow Regime



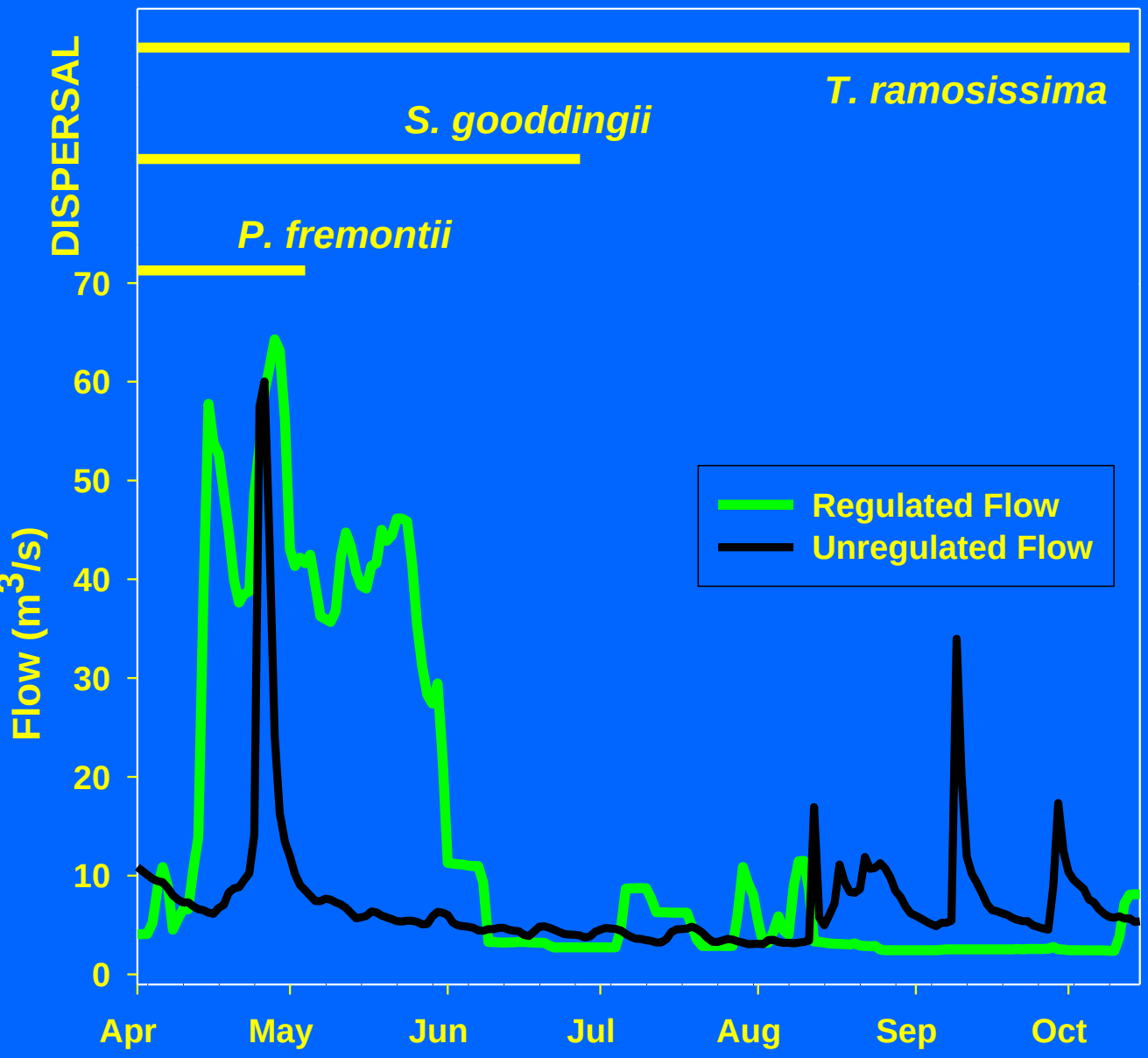
- Large spring floods and low summer flows should favor *P. fremontii* and *S. gooddingii*

1995 Lower Verde Flow Regime



- Extended late spring/early summer release may have provided increased opportunity for *T. ramosissima* recruitment

1995 April – September Flow



- Late spring/early summer release keeps banks inundated
- Flow recession in June provides moist areas for *T. ramosissima* and *S. gooddingii* recruitment

Conclusions

- *T. ramosissima* is denser in below dam reaches
  - Only more abundant in younger *Populus* stands
    - Probably due to release pattern after the 1995 spring flood
- Localized recruitment of *Populus* and *Salix* is not affected
  - Large, relatively unmodified floods still occur periodically
- These results apply at the stand level; at the landscape level, the areal extent of forest may be changing

Management recommendations

- To allow for continued recruitment of woody pioneer species, allow run-of-the-river winter/spring floods whenever possible
- If reduction of *T. ramosissima* is a goal, avoid late spring/early summer flow recession
- To track ongoing changes in vegetation structure, establish a monitoring program

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