

APPLICATION AND EVALUATION OF THE HEC-RAS - RIPARIAN VEGETATION SIMULATION MODULE TO THE SACRAMENTO RIVER

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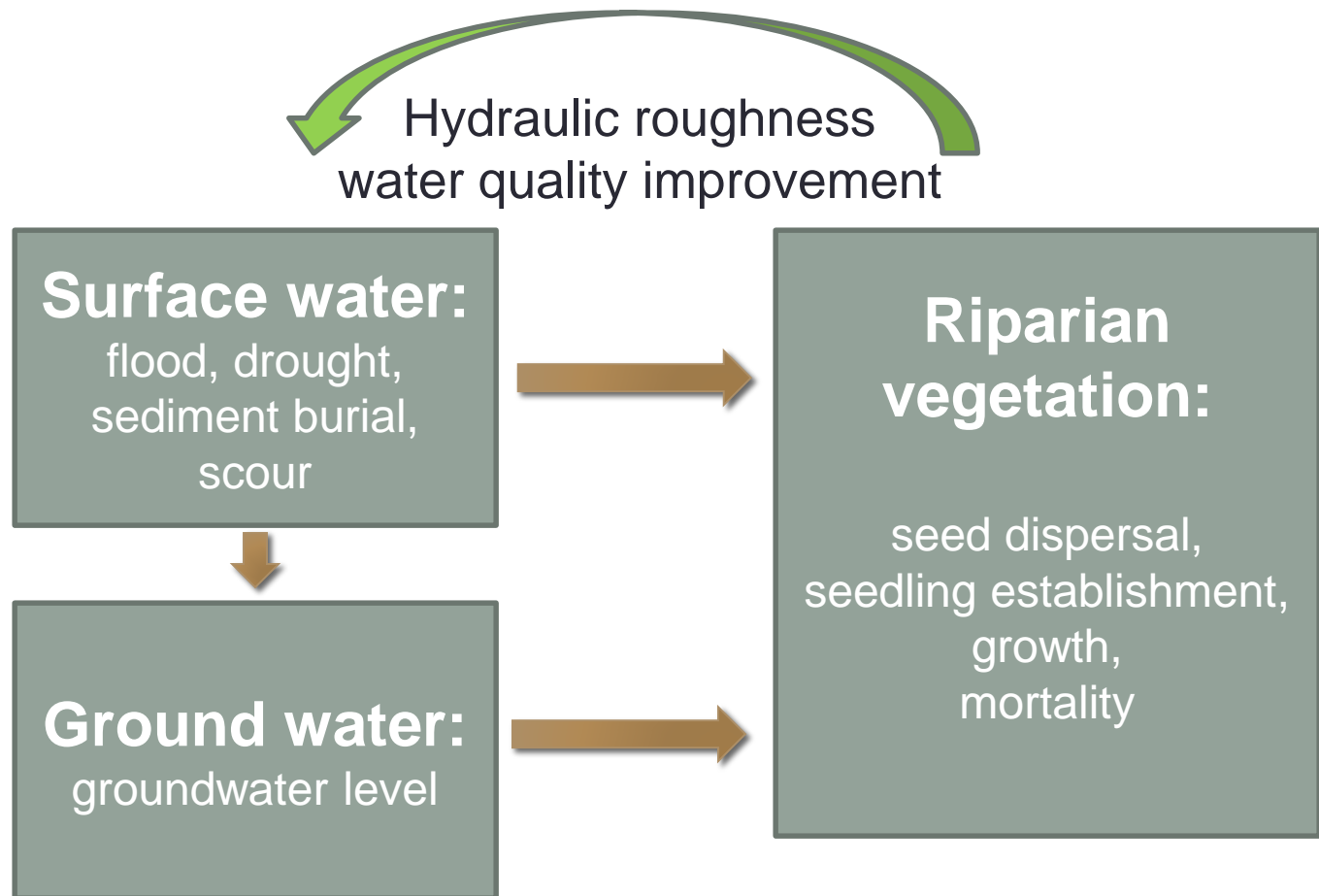
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Outline

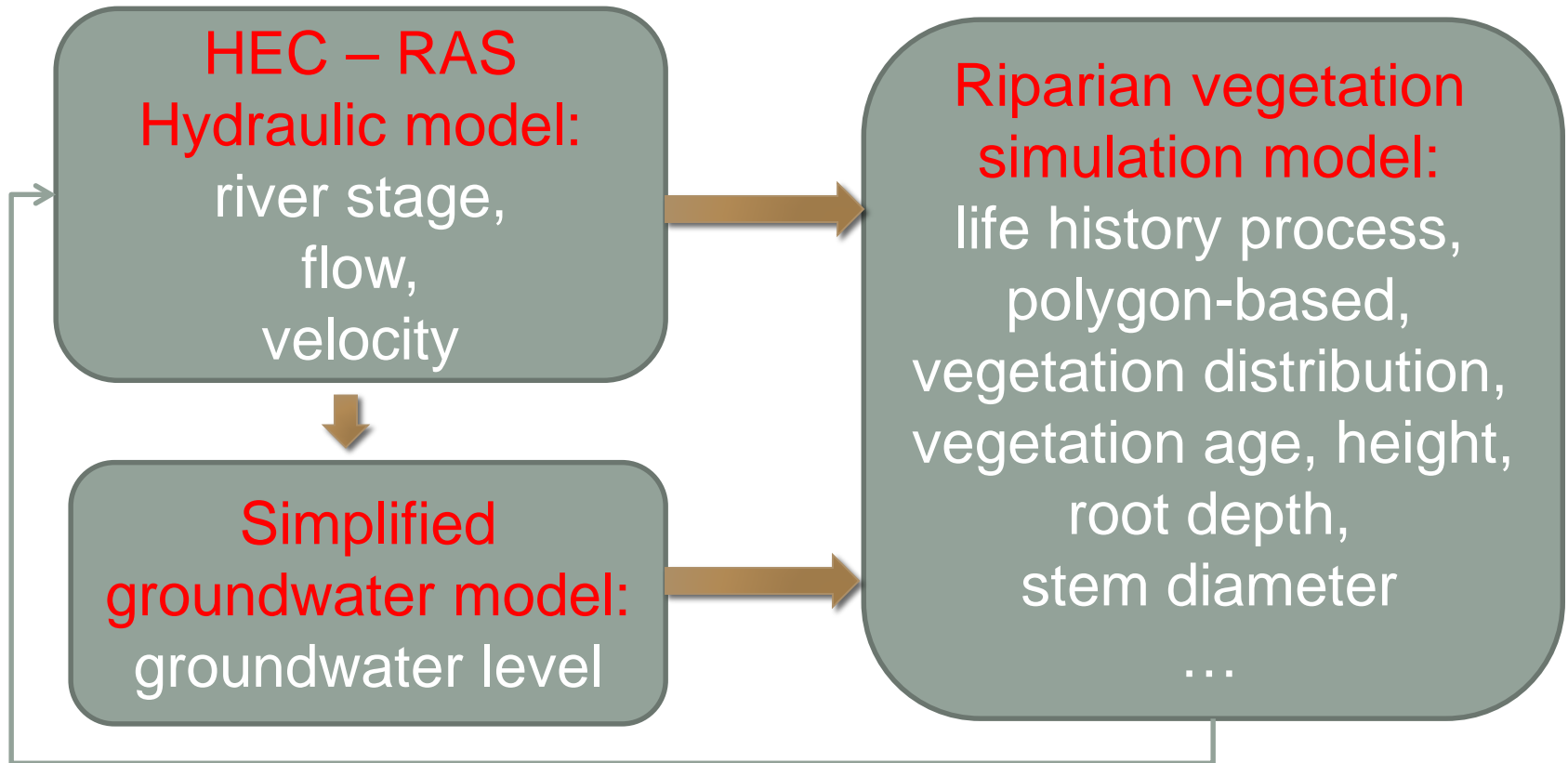
1. Overview of the HEC-RAS – Riparian Vegetation Simulation Module (RVSM)
2. Riparian Vegetation Simulation Module (RVSM)
3. Application of HEC-RAS – RVSM model to a reach of Sacramento River
4. Next step

1. Overview of HEC-RAS – Riparian Vegetation Simulation Module (RVSM)

Interactions among surface water, groundwater and riparian vegetation



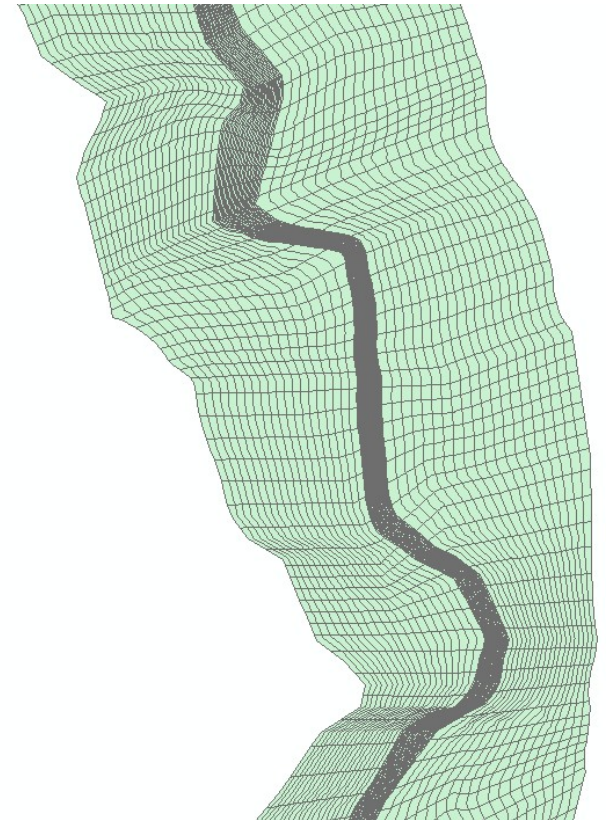
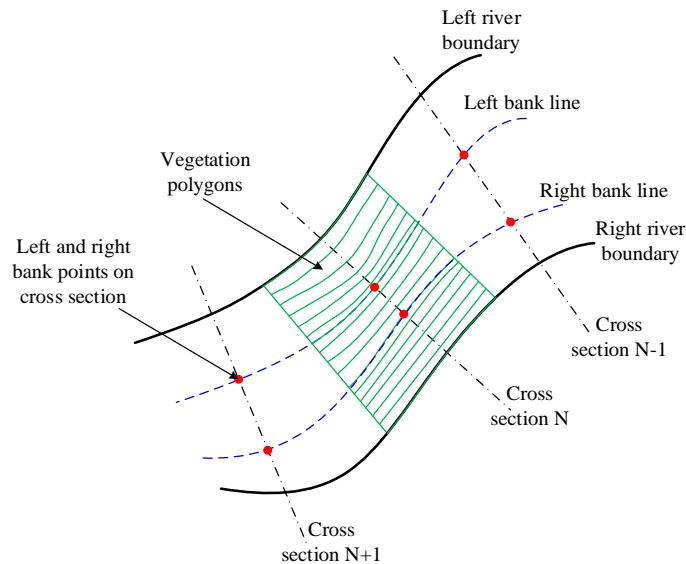
1. Overview of HEC-RAS – RVSM model system



Computed roughness coefficients
based on vegetation property and hydraulic conditions

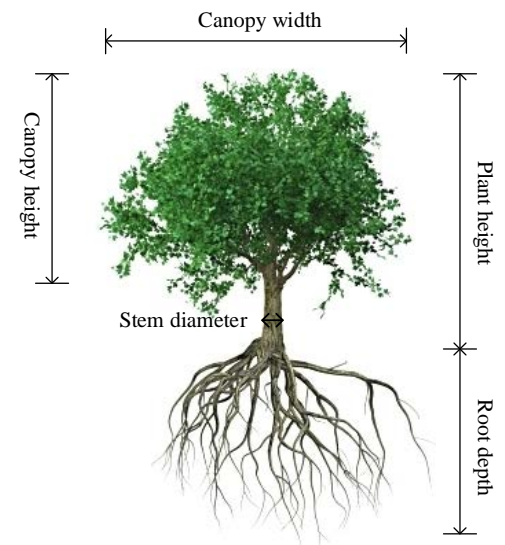
2. Riparian Vegetation Simulation Module (RVSM)

- Originally developed by USBR
- Modified to a 2D polygon based model
- Polygon is the basic computation grid



2. Riparian Vegetation Simulation Module (RVSM)

- Multiple vegetation types could be simulated
- Entire life cycles of vegetation are simulated
 - seed germination
 - seedling establishment
 - plant growth and mortality
- Many properties of vegetation are simulated
 - plant height, root depth, canopy width, stem diameter, etc



2. RVSM Inputs and Outputs

- Inputs

GIS vegetation mapping used to assign initial condition

A set of vegetation parameters for each vegetation type

- Outputs

Spatial distribution of each vegetation type at any given time

Vegetation properties at certain polygons

Statistical results

Vegetation area, seedling elevation etc

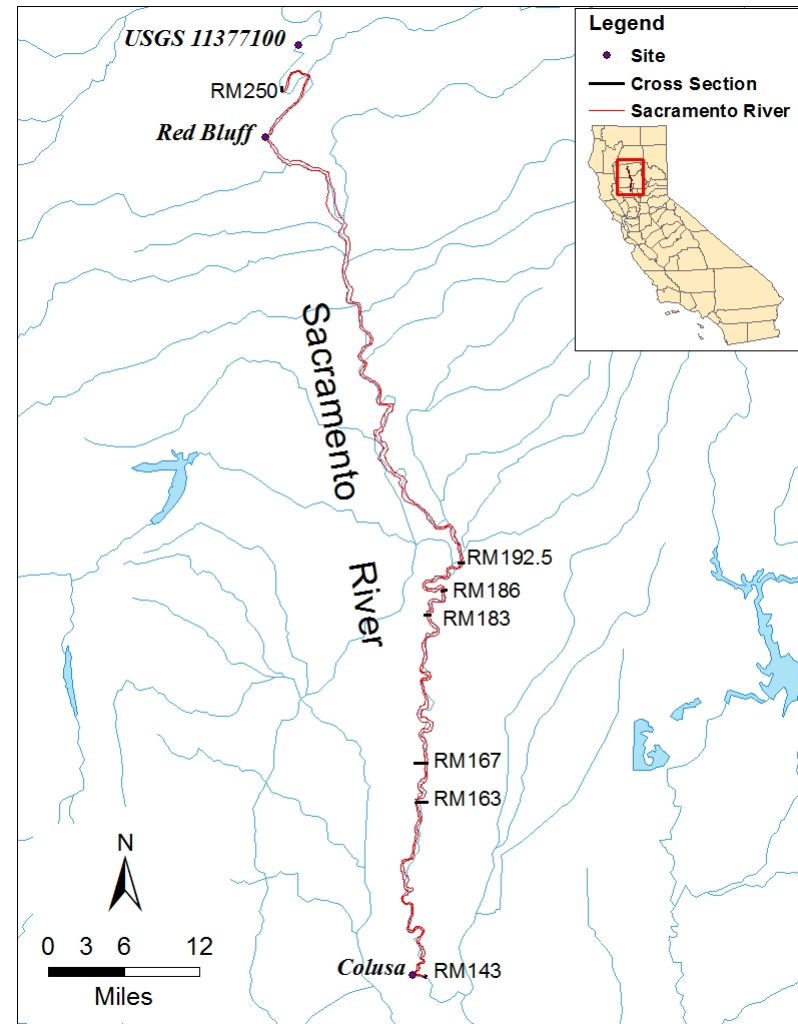
3. Application to Sacramento River reach

- **Study area**

- from Red Bluff to Colusa
- 107 miles
- Ecological management zone
- Abundant field surveyed vegetation data

- **Purpose of this application**

- Test model's capability of predicting interaction between flow and vegetation
- Predict vegetation area change
- Examine the reason for vegetation area change based on model result



3. Application to Sacramento River reach

- 342 original cross sections interpolated to 1063 cross sections
- 106300 vegetation computational polygons
- Simulation period from 10/1/1999 to 10/1/2007

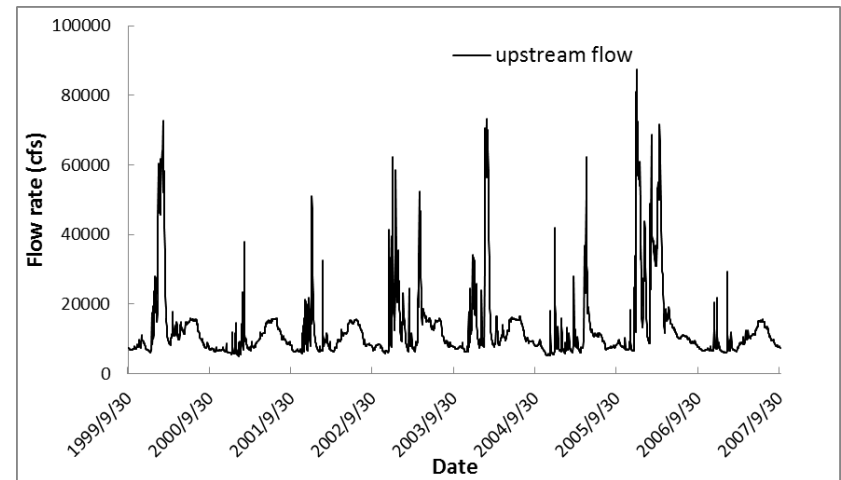
HEC – RAS model

Groundwater model

Vegetation model

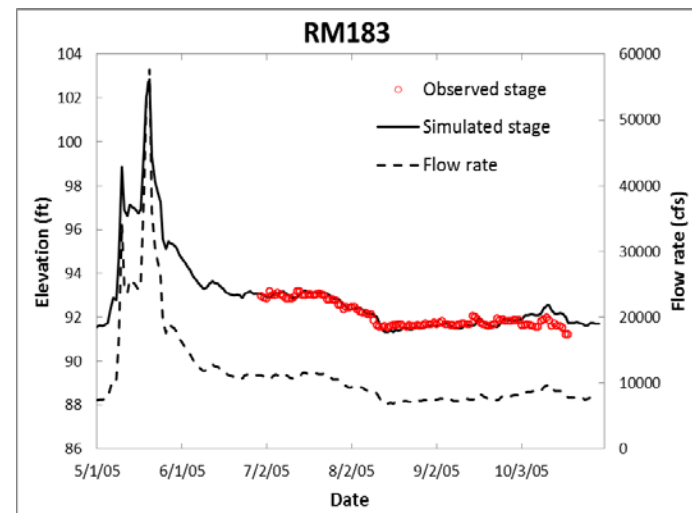
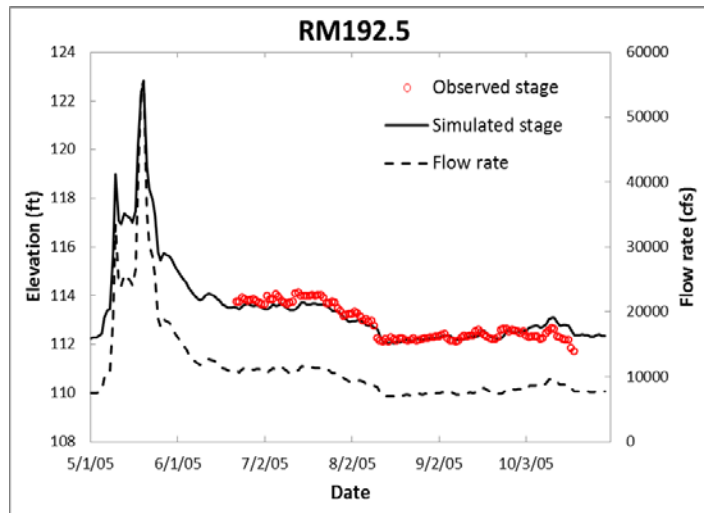
3.1. Sacramento River HEC-RAS model

- Upstream flow boundary
- Downstream rating curve
- Manning roughness in main channel is 0.02 – 0.04; on floodplain is 0.029 to 0.2.



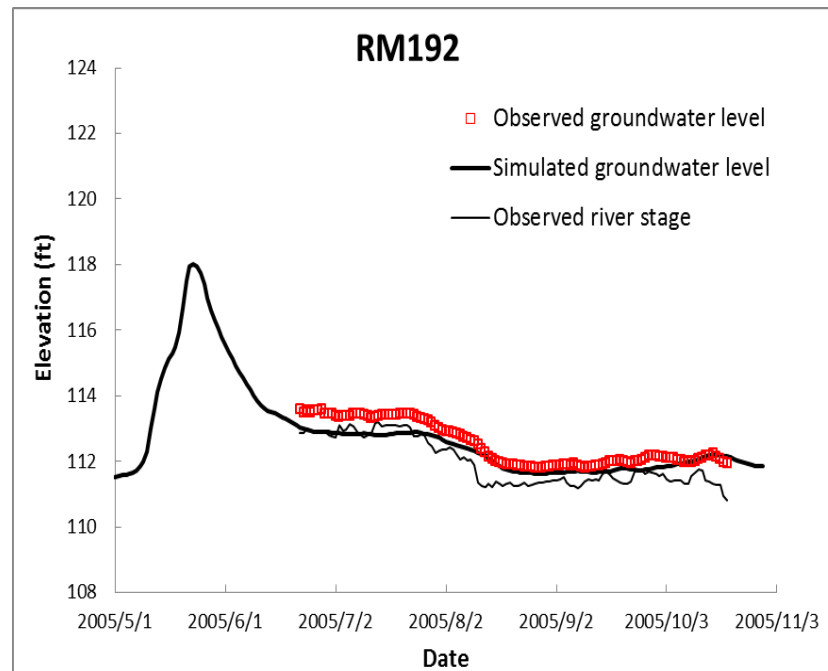
3.1. Sacramento River HEC-RAS model

- Observed river stage at RM192.5 and RM183 was compared with simulated river stage. The error is about 0.3 ft.



3.2. Sacramento River groundwater model

- Observed groundwater level at RM 192 was compared with simulated groundwater level.



3.3. Sacramento River vegetation model

- Five vegetation types were simulated
 - Fremont's cottonwood, mixed forest, riparian shrub
 - invasive species and grass
- Vegetation GIS mapping in 1999 was used to assign initial conditions
- Vegetation GIS mapping in 2007 was used to calibrate the vegetation model

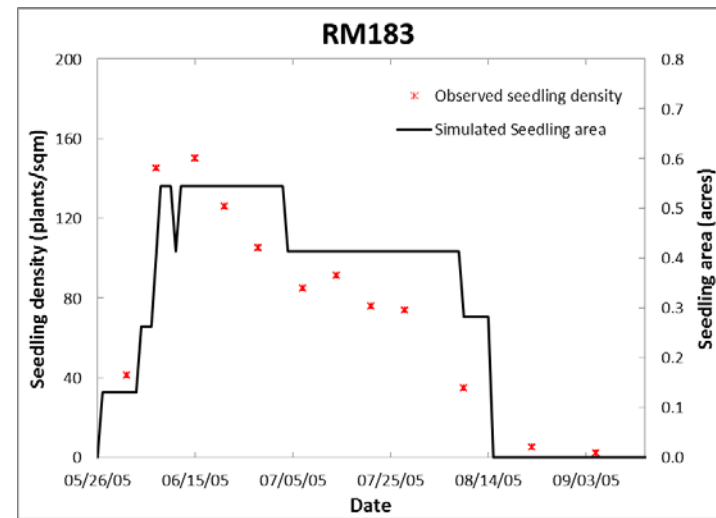
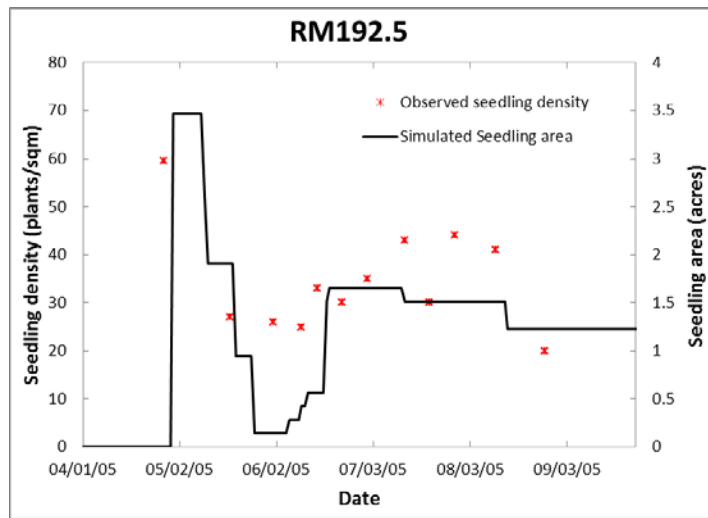
3.3. Sacramento River vegetation model

Calibrated in three aspects

- Cottonwood seedling density and elevation at two point bars of RM192.5 and RM183 monitored in 2005 and 2006 were used to calibrate cottonwood seedling establishment.
- Two GIS Vegetation mappings in 1999 and 2007 were used to calibrate the vegetation area change over 8 years
- Predicted cottonwood spatial distribution was compared with GIS mapped cottonwood spatial distribution

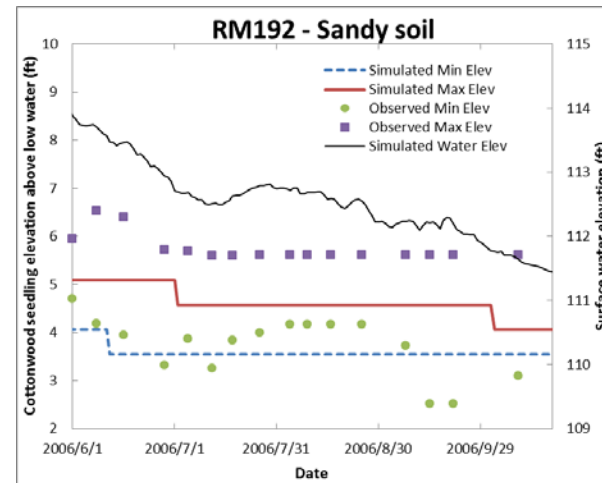
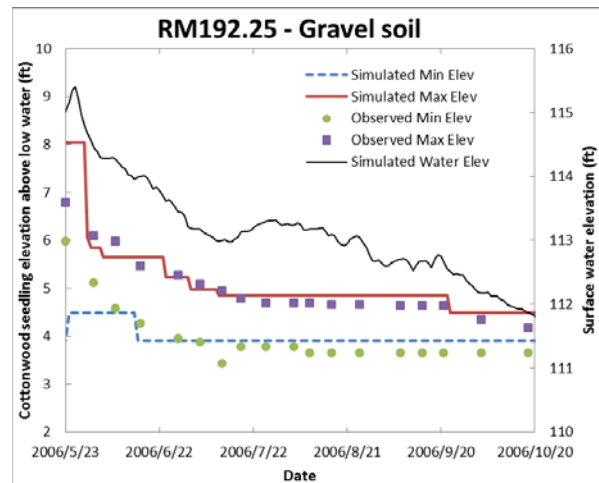
3.3. Sacramento River vegetation model

- Simulated cottonwood seedling areas at RM192.5 and RM183 from May to September in 2005 are compared with observed cottonwood density data



3.3. Sacramento River vegetation model

- Simulated and observed maximum and minimum cottonwood seedling elevation above low water in 2006 on a gravel soil bar and on a sandy soil bar



3.3. Sacramento River vegetation model

- Comparison of simulated and GIS mapped vegetation area change from 1999 to 2007

	Year	Cottonwood	Mixed forest	Riparian shrub	Invasive species	Grass
Area from mapping (acre)	1999	5319	8842	3310	77	3169
	2007	6621	6621	4127	122	4280
	Change ratio	1.35 ↑	0.75 ↓	1.25 ↑	1.59 ↑	1.35 ↑
Area from model (acre)	1999	5308	8827	3275	72	3233
	2007	6028	8246	3891	153	4609
	Change ratio	1.14 ↑	0.93 ↓	1.19 ↑	2.12 ↑	1.42 ↑

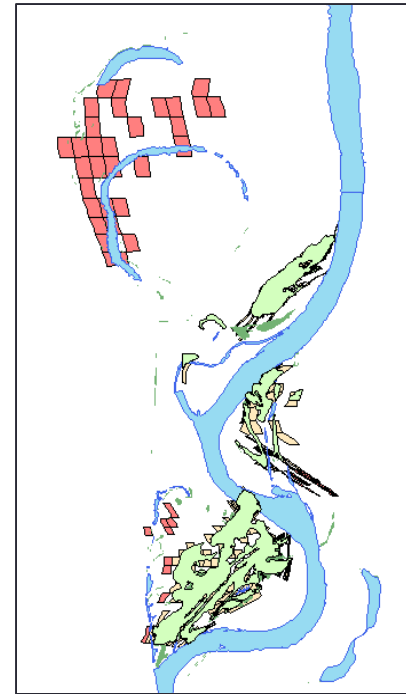
3.3. Sacramento River vegetation model

- Predicted and GIS mapped spatial locations of cottonwood **distribution** from 1999 to 2007



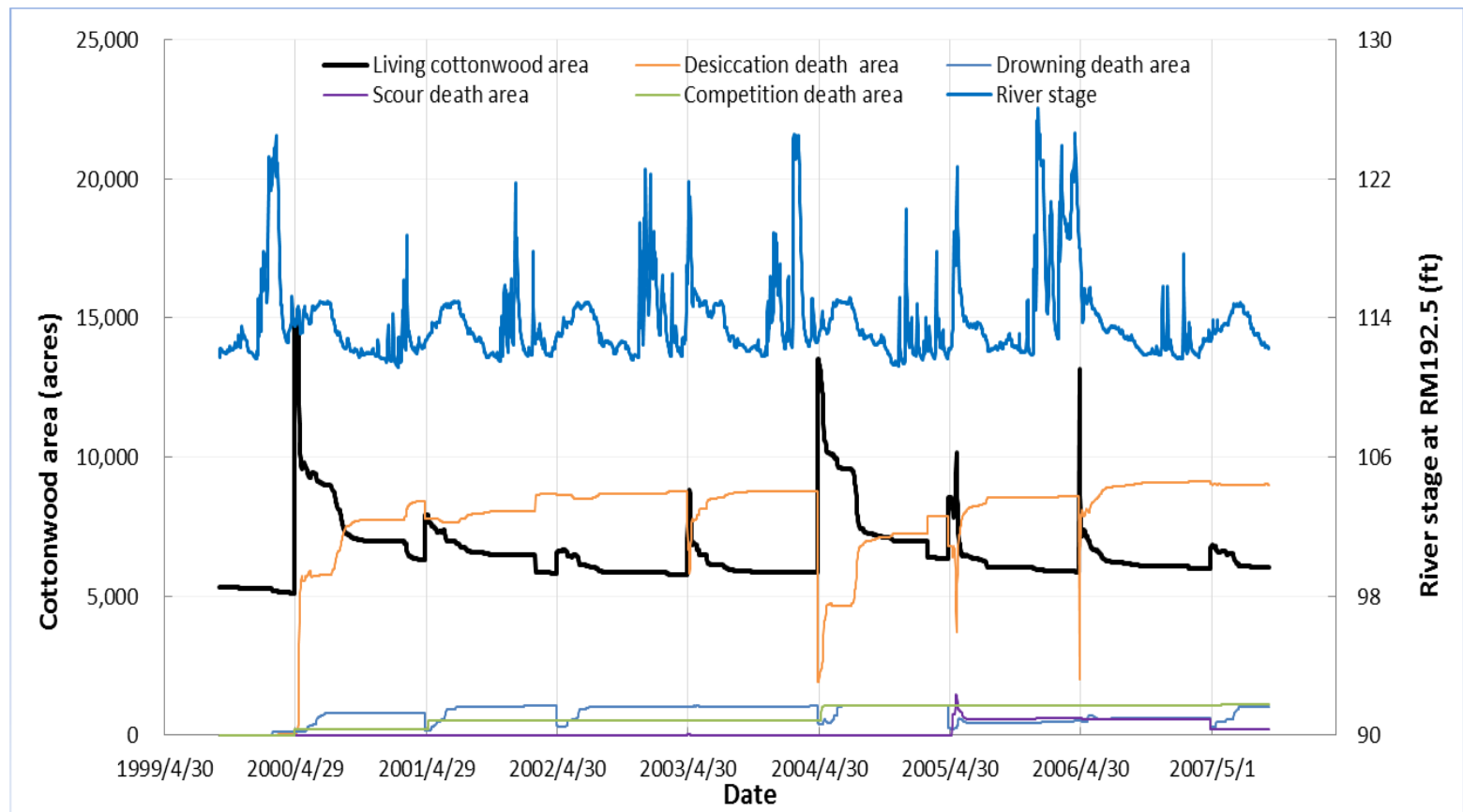
3.3. Sacramento River vegetation model

- The model tends to overestimate the cottonwood establishment around oxbow lakes
- Probably because the simulated water level change in oxbow is too slow, since HEC-RAS does not consider evaporation and infiltration.



3.3. Sacramento River vegetation model

- Modeled relationship between flow regime and cottonwood area



3.4 Summary of Sacramento River application

- ✓ Predict long-term vegetation area change
- ✓ Predict spatial distribution of certain vegetation species
- ✓ Investigate relationship between flow regime and vegetation area
- ✓ Give suggestions on water management and riparian vegetation restoration

4. Next Step

- Further improve and enhance the RVSM
 - Simulating vegetation density, biomass and age-structure
 - Incorporating simplified soil model and nutrient cycling model among water, soil, sediment and plants
 - Simulating the interaction between sediment transport and riparian vegetation
- Integrate the updated RVSM into 1D and 2D HEC-RAS model to simulate vegetation in great detail.

Acknowledgements

- Mark Jensen and Steve Piper of HEC
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QUESTIONS?
