

# Do Restored Riparian Understories Converge With Reference Systems After Three Decades?

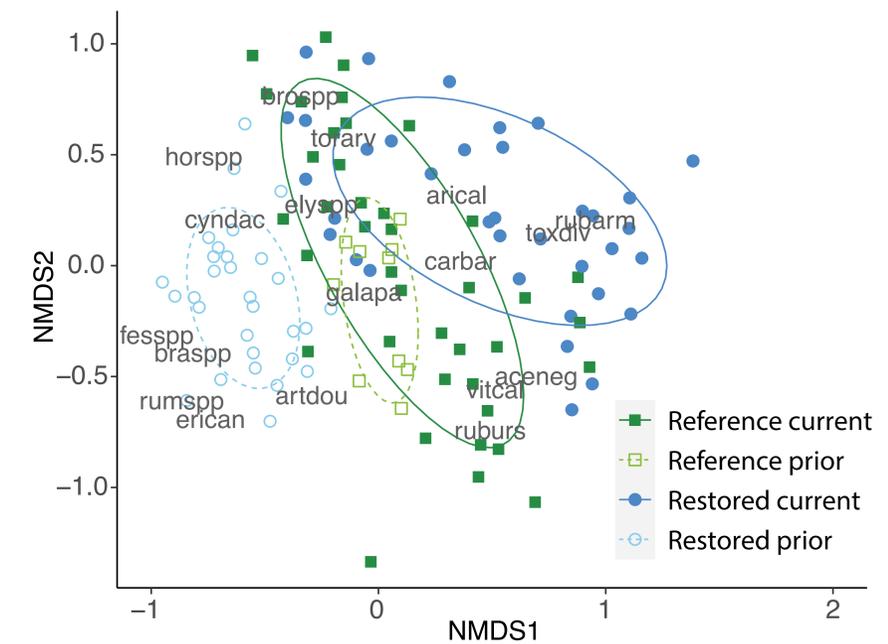
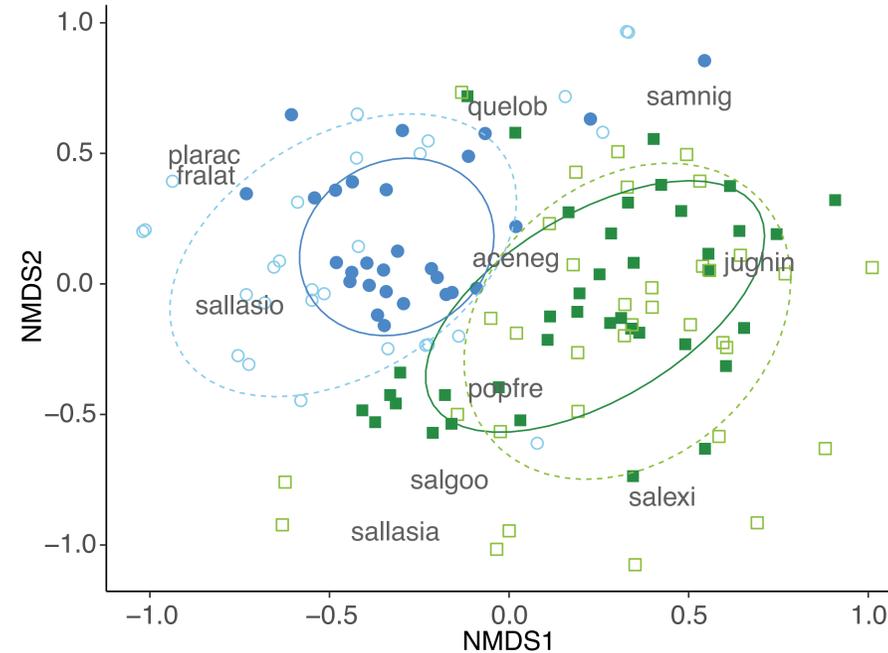
Brook Constantz<sup>1</sup>, Karen Holl<sup>1</sup>, John Stella<sup>2</sup>

<sup>1</sup>University of California, Santa Cruz, <sup>2</sup>State University of New York College of Environmental Science and Forestry

## Sacramento River floodplain restoration

- Restoration began in 1989 under SB1086 to restore 3,000 hectares of riparian forests along the Sacramento River.
- Previous surveys between 2006 and 2012 found differences in composition between restored and reference overstories and understories.
- Repeat study 2021-2023 were conducted to evaluate if the forests have converged in terms of species composition and tree density.

## Overstory and understory vegetation 27-32 years after restoration



## What is the long-term trajectory of riparian vegetation?

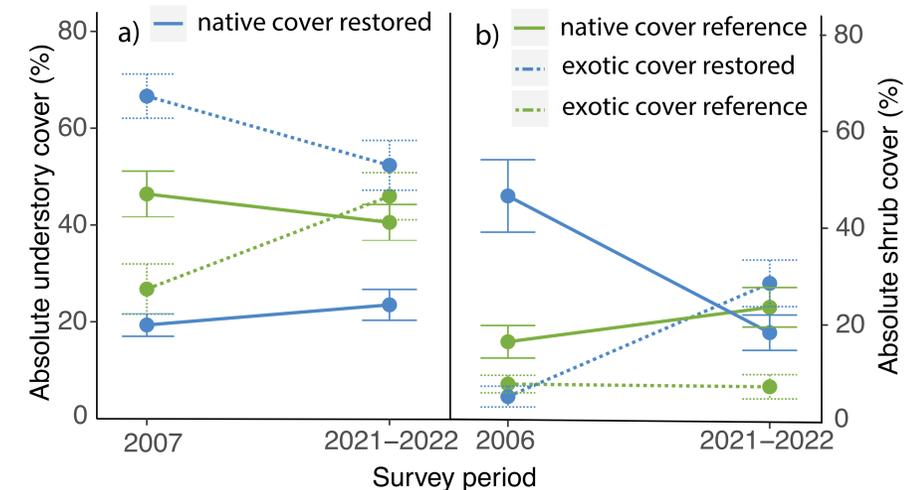
- H1: The overall species composition of the restored overstory is not converging with that of reference forests.
- H2: Restored and reference forest understories will show greater similarity in native cover compared to the previous survey, driven by a loss of native cover in reference forests.
- H3: *Rubus armeniacus* is the driving factor influencing native understory cover.

**Overstory basal area ordination.** Most restored forests originally had all floodplain species planted and have thus undergone change through the attrition of early successional species, while reference forests have recruited different late successional species.

**Understory cover ordination.** Restored forests have more native and exotic shrubs than reference forests and would have converged if not for *Rubus armeniacus*.

## 76 forest plots were resampled for species abundance

- Ten restored forests and their nearby reference forests resurveyed.
- All vegetation was sampled within 76 forest plots (20 x 30 meters).
- All trees above 2.5 cm diameter were measured.
- Shrub cover was measured along five 10 m transects.
- Understory cover was measured inside ten 1 m quadrats.

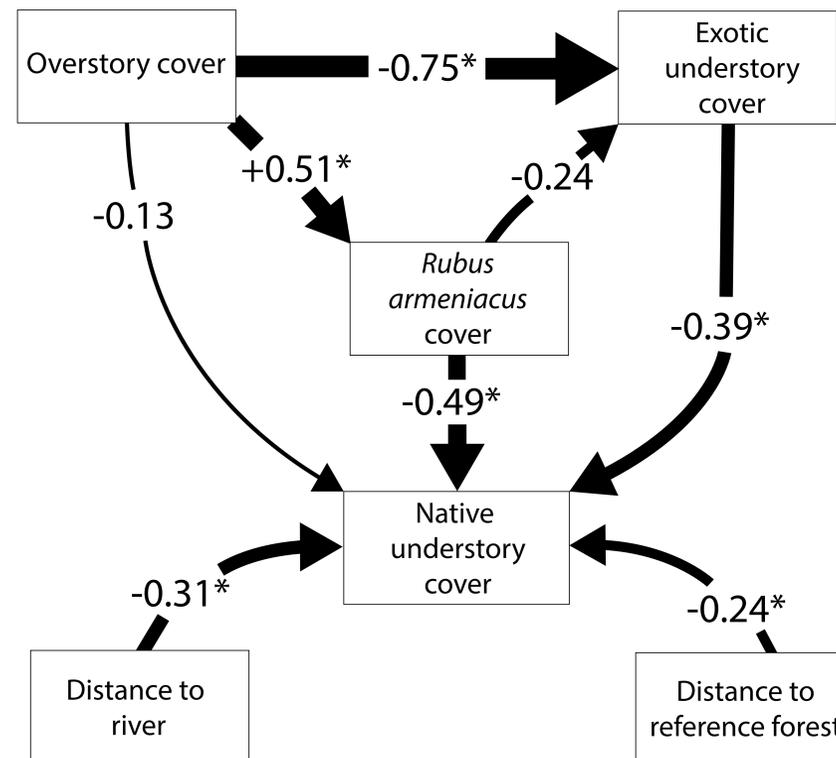


**Absolute understory cover.** Both (a) quadrats and (b) shrub transects had exotic and native species measured. Reference forest understories had a increase in exotic understory cover, while restored forests had a decline in native shrub cover and an increase in exotic shrub cover.



**Site photos.** Left: restored forests and right: reference forests.

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**Understory path analysis.** Although overstory cover reduces most exotic plant cover, it increases the *Rubus armeniacus* cover which has since spread through much of the restored forests.

## Conclusions

- The overstory composition of restored forests has narrowed and remains entirely native but is distinct from reference forests.
- The understory in both types of forests is on a trajectory to converge, driven by a gain of exotic cover in reference forests.
- Restored forests have woodier understories, whereas reference forests have more graminoids and forbs.
- Shading out exotic species is not effective against shade tolerant species like *Rubus armeniacus*, which is preventing convergence.