

## Perspectives :

In populous, water-limited regions, humans have profoundly altered the river and floodplain environment to satisfy society's demands for water, power, navigation and safety. River management also profoundly alters riparian forests, which respond to changes in disturbance regimes and sediment dynamics. In this study, we assessed forest and floodplain development along the lower Rhône River, one of the most heavily modified rivers in Mediterranean-climate regions. The Rhône channel was engineered for navigation prior to 1900, and since then has been dammed and diverted at 18 sites for hydropower and irrigation. In the context of these ongoing stressors, regional, state and national agencies have organized processes for assessing the cumulative ecological impacts and for integrating ecosystem protection within large-scale basin planning initiatives (e.g. Plan Rhône, <http://www.planrhone.fr/>). Therefore, understanding the status and future trends of the riparian forest is critical for assessing impacts and prioritizing conservation and restoration actions along the Rhône River.

## Plus-value pour les praticiens :

- A major goal of riparian forest management and restoration should be to promote a diversity of forest stand ages, in particular the youngest pioneer stands.
- Several restoration approaches can be combined to achieve this goal, including removing dikes to allow channel migration, altering flow regimes to promote sediment deposition, and clearing patches of forest to allow for natural regeneration.
- Riparian forest composition and structure on similar, less-impacted rivers can serve as a reference system for restoring the old Rhône River.
- Understanding forest trajectories under climate change and different river management scenarios is critical to setting realistic restoration objectives.
- These forest inventories can also be used to model carbon stocks and evaluate carbon credits associated with proposed river management actions.

## Références :

Stella, J.C., P. Rodríguez-González, S. Dufour, J. Bendix. 2013. Riparian vegetation research in Mediterranean-climate regions: common patterns, ecological processes, and considerations for management. *Hydrobiologia* 719:291–315. DOI: 10.1007/s10750-012-1304-9

Stella, J.C., H. Piégay, J.D. Riddle, C. Gruel\*, B. Rapple\*. Riparian forest impacts and dynamics on large rivers managed for multiple uses; insights from the Sacramento (California, USA) and Rhône (France). *Proceedings of the Second Integrative Sciences and Sustainable Development of Rivers (IS Rivers) Conference, Lyon, France, 22–26 June 2015.*

Stella, J.C., J. Riddle, H. Piégay, M. Gagnage, M-L. Trémélo. 2013. Climate and local geomorphic interactions drive patterns of riparian forest decline along a Mediterranean Basin river. *Geomorphology*. DOI: 10.1016/j.geomorph.2013.01.013

## Composition et structure de la ripisylve dans les casiers Girardon des Vieux-Rhône

### Résumé :

The Rhône River was heavily channelized in the 19th century for navigation and dammed in many places since the 1950's, with major reductions in peak flows and channel mobility. We conducted extensive forest inventories and sampled fine sediment depth in regulated reaches within the riparian zone of the old Rhône, and compared pre- versus post-dam forest development and linked patterns of floodplain development. The pre- versus post-dam surfaces at each site had distinct geomorphic and floristic characteristics. There was very little post-dam recruitment of poplar and willow, which are pioneer species that rely on dynamic geomorphic conditions. Post-dam floodplains supported vigorous recruitment by *Acer negundo* (box elder), which is non-native and invasive in Europe.

### Objectifs du projet et mise en contexte :

The riparian forest ecosystem along the Rhône River has been greatly altered by human impacts, particularly dams and flow regulation in the 20<sup>th</sup> century, river navigation structures installed in the 19<sup>th</sup> century, and widespread land conversion to agriculture for centuries prior. These cumulative impacts have resulted in a severe reduction in riparian forest extent and confinement to highly altered river margins, primarily along reaches of the former main channel (vieux-Rhône) that are bypassed by excavated canals and hydroelectric works, and which are subject to reduced flood frequency and altered seasonal discharge patterns. Going forward, ongoing regional climate warming and drying also present challenges for riparian communities adapted to prior climatic and hydrologic regimes. Recent studies within the greater Rhône basin indicate that native tree riparian species are both responsive to changes in hydrology and climate, and susceptible to non-linear (*i.e.* threshold) decline responses in health and function due to combined change in local and regional drivers. Given the past and potential future impacts to the riparian zone along the Rhône, a better understanding of its current state and expected trajectory is necessary to better manage this important resource for both its human and ecosystem values.

This research investigated the current state of the riparian forest that has colonized former river engineering structures along the old Rhône River. We quantified the species composition, size distribution and condition of the riparian forest; these are a first step necessary in considering management, conservation and restoration actions within the riparian corridor. The research conducted riparian forest inventories based on protocols developed by the Office National des Forêts within bypassed reaches of the downstream Rhône River valley (Rhône aval).

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## Méthodologies :

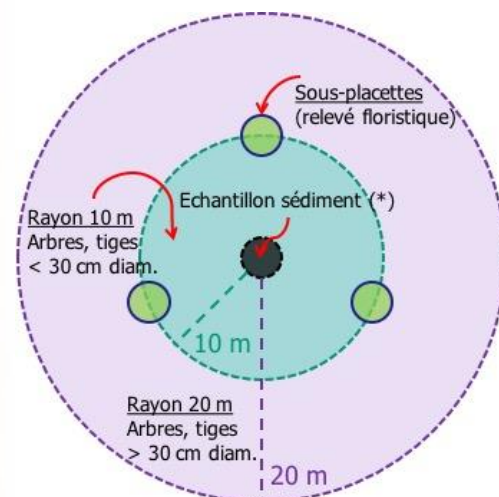
Our specific research objectives were to:

1. Quantify the spatial extent, density, species composition, and size/age distribution of the riparian forest associated with the former river engineering structures of the Rhône River.
2. Document local environmental factors such as overbank fine sedimentation thickness that are linked to the vegetation distribution, composition, and structure.
3. Compare forest composition and structure characteristics to reference areas within the river corridor, including rivers with similar climate, geography and species pools (e.g. Sacramento River, California, USA).
4. Discuss the implications of the research and recommendations for the management of the riparian forests established within the Girardon structures along the Rhône River.

Vegetation surveys were conducted at four sites along the Rhône River where navigation and hydropower canals bypass reaches of the former main stem river: Pierre-Bénite, Péage-de-Roussillon, Donzère-Mondragon, and Montélimar. These sites span a large range of climate, hydrology, riparian conditions, and engineering and other human modifications found along the lower Rhône, and are among the largest sites recommended for restoration actions. Data collection consisted of vegetation inventories conducted in circular plots (see below) in conjunction with sampling fine sediment depth. Field work occurred in spring/summer 2014 and was performed by a team that included graduate students and research assistants under the direction of Drs. Stella and Piégay.

Details of the sampling included:

- 88 plots (500 m<sup>2</sup>) surveyed in four river sectors
- Sampled tree composition, diameter and health index
- Sampling scheme adapted the French national inventory protocol for riparian areas
- Plots stratified by management period
  - pre-dam (1950's - 1970's)
  - post-dam (current)
- Measured fine sediment depth and texture; calculated sedimentation rate
- Measured coarse woody debris both standing (snags) and on the ground



### Echantillonnage

- Placettes de 500 m<sup>2</sup>
- Composition, taille, santé des arbres
- Epaisseur de sédiments fins (→ toit de gravier)



(Photo: Gruel, 2014)

### Calcul des taux de sédimentation

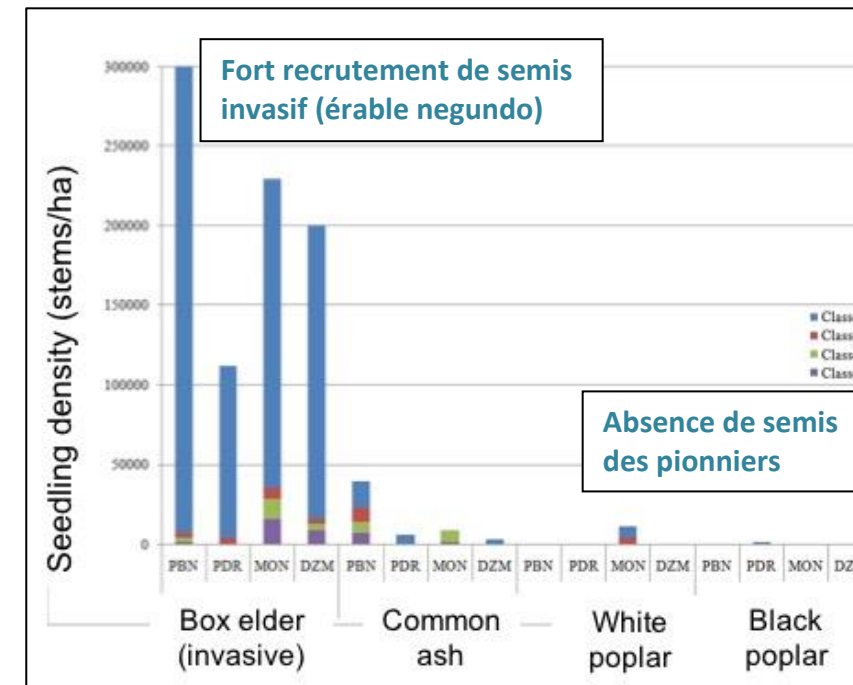
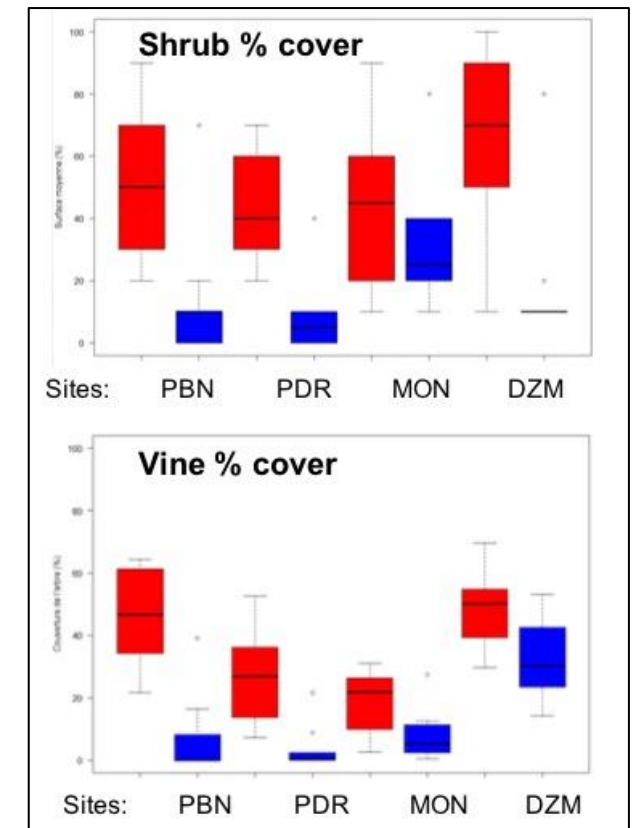
(moyenne sur le long-terme) :

$$\frac{\text{Overbank fine sediment depth [cm]}}{\text{Mean age of deposit [yr]}}$$

## Principaux résultats :

The Rhône river modifications have profoundly affected the riparian zone. Sedimentation patterns varied within and between study reaches, and local controls seem to play a role in influencing fine sediment deposition patterns. There is little diversity in forest habitat ages compared to other large river systems with similar climatic and geomorphic settings (e.g. the Sacramento River, California, USA).

Floodplain areas that transitioned to forest in the pre-dam period were at higher elevation, and supported 30-50% more tree basal area and 20-30% more shrub and vine cover than those that emerged in the post-dam period.



There was very little post-dam recruitment of poplar and willow, which are pioneer species that rely on dynamic geomorphic conditions.

Young floodplains supported vigorous recruitment by *Acer negundo* (box elder), which is non-native and invasive in Europe.

This suggests that anthropogenic control of river processes has favored propagation of this invasive species following flow regulation.

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