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Functional composition of gravel bar plant communities along the Rhône River: implications for management and restoration operations

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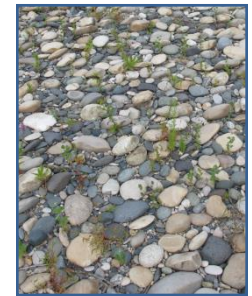
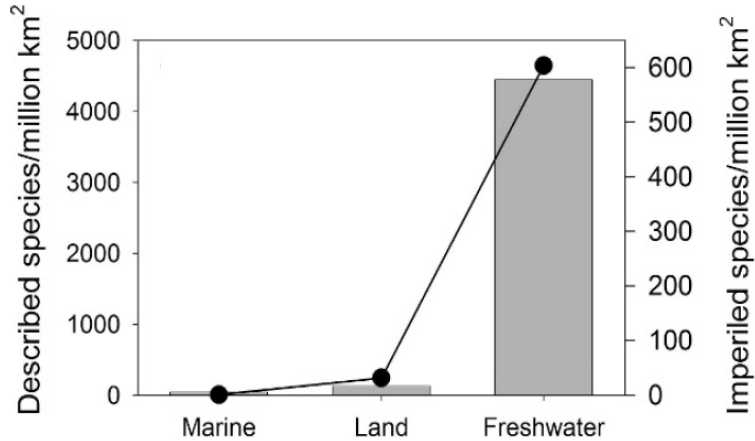
***Functional composition of
gravel bar plant communities
along the Rhône River:
implications for management
and restoration operations***

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Riparian biodiversity

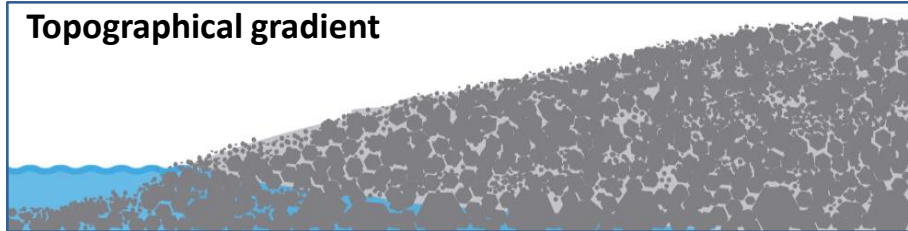
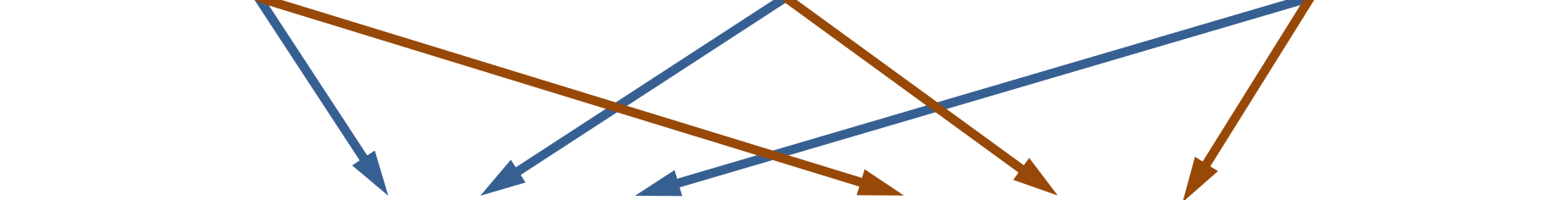
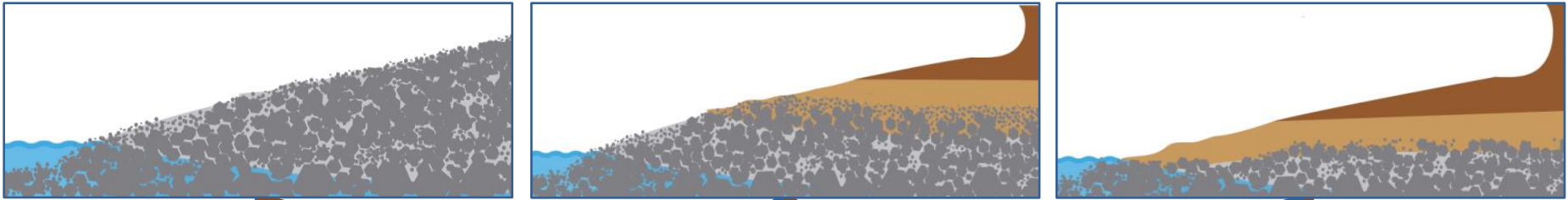


Riparian communities from the upper to the lower part of the banks

Poff et al. 1997, Strayer & Dudgeon 2010, González et al. 2016, Naiman and & Decamps 1997, Sabo et al. 2005



Environmental gradients



Merritt et al. 2010, Dawson et al. 2017, Bejarano et al. 2017

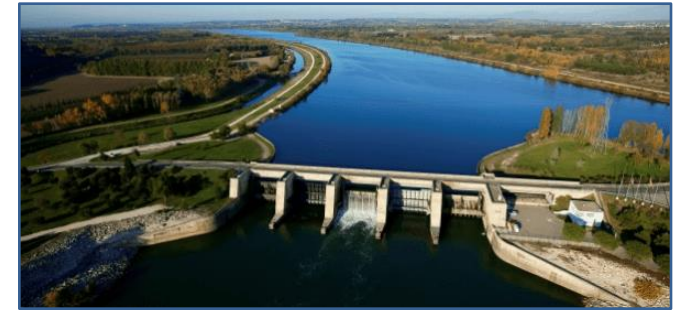


Xiong et al. 2001, Kyle and Leishman 2009



Environmental changes and human activity

- Civil engineering widely used
 - Control flood risk
 - Prevent channel migration



➔ Added-value of restoration operations ?

- Maintenance/clearing operations
 - Prevent vegetation encroachment
 - Maintain wide channels



➔ Related effect on pioneer communities ?



Nilsson et al. 2005, Feld et al. 2011, Poff et al. 2007, Poff and Zimmerman 2010, Liébault and Piégay 2002, Comiti et al. 2011



Research questions

Study the effect of topographical and pedological gradients on the functional composition of gravel bar plant communities

- How environmental gradients shape riparian plant functional composition along a highly degraded large River?
- How human activity, through maintenance and restoration operations, mediate the response of plant functional composition to environmental gradients?



Case study: the Rhône River

- A large River
 - total length = 810 km
 - watershed area = 96 500 km²
 - mean flow = 1 700 m³/s
- A highly degraded system
 - rectification phase in the 19th century
 - derivation phase in the 20th century
- Riparian zones intensively managed
- Ambitious ecological restoration program



Study area and sampling design

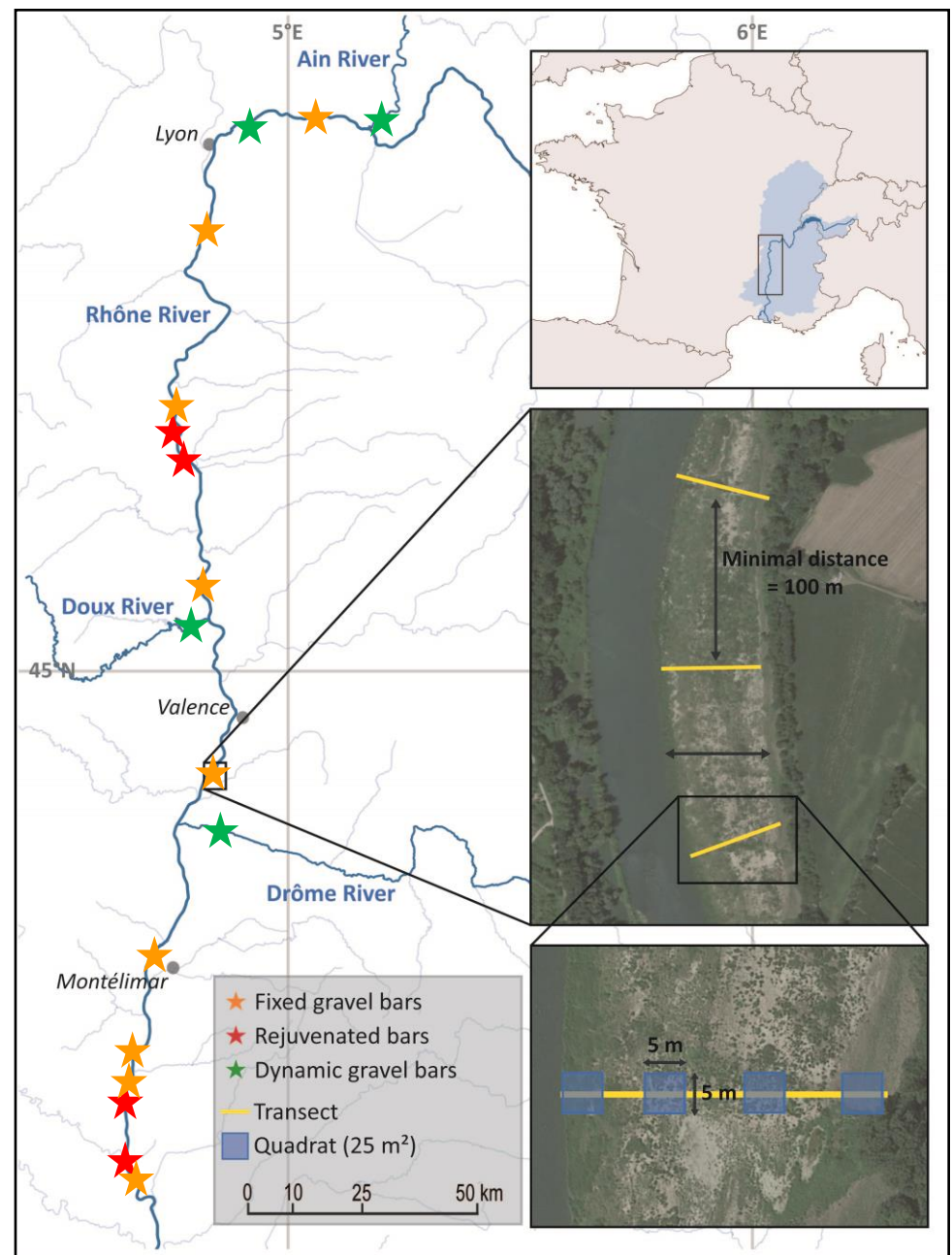
★ Fixed = 9, Qdts = 108, Sp = 203



★ Rejuvenated = 4, Qdts = 48, Sp = 198

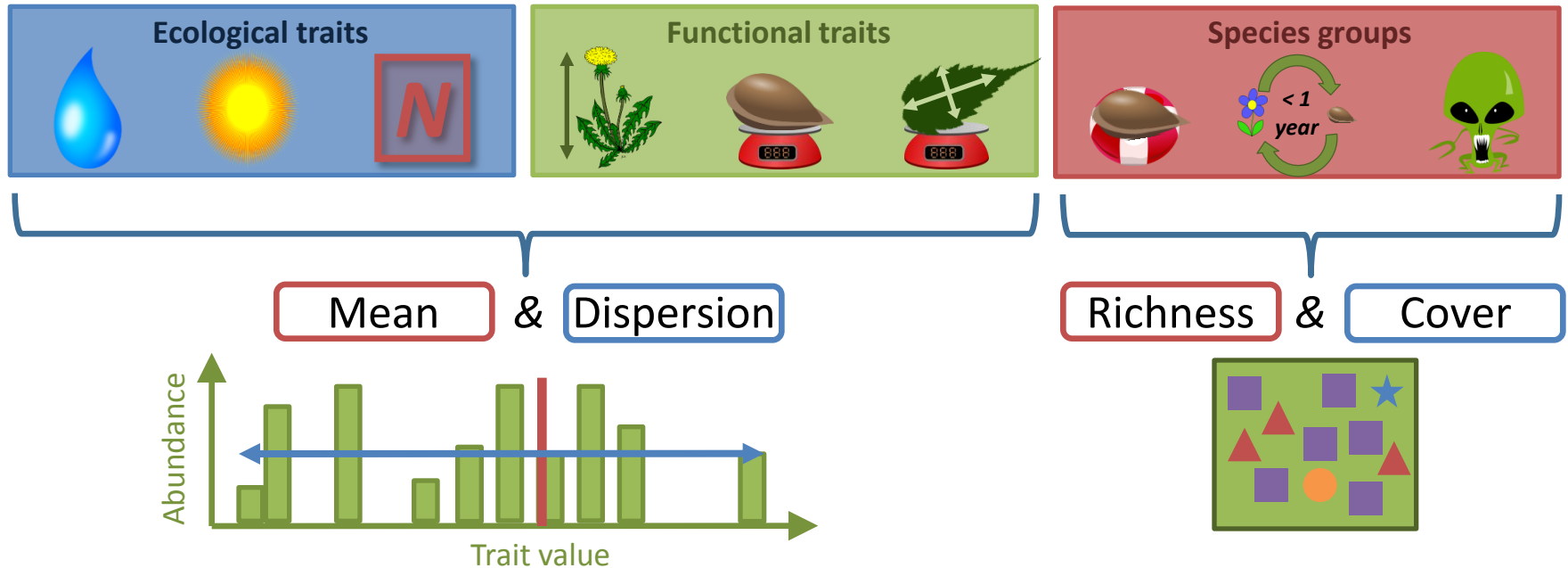


★ Dynamic = 4, Qdts = 48, Sp = 175

Trait-based approach

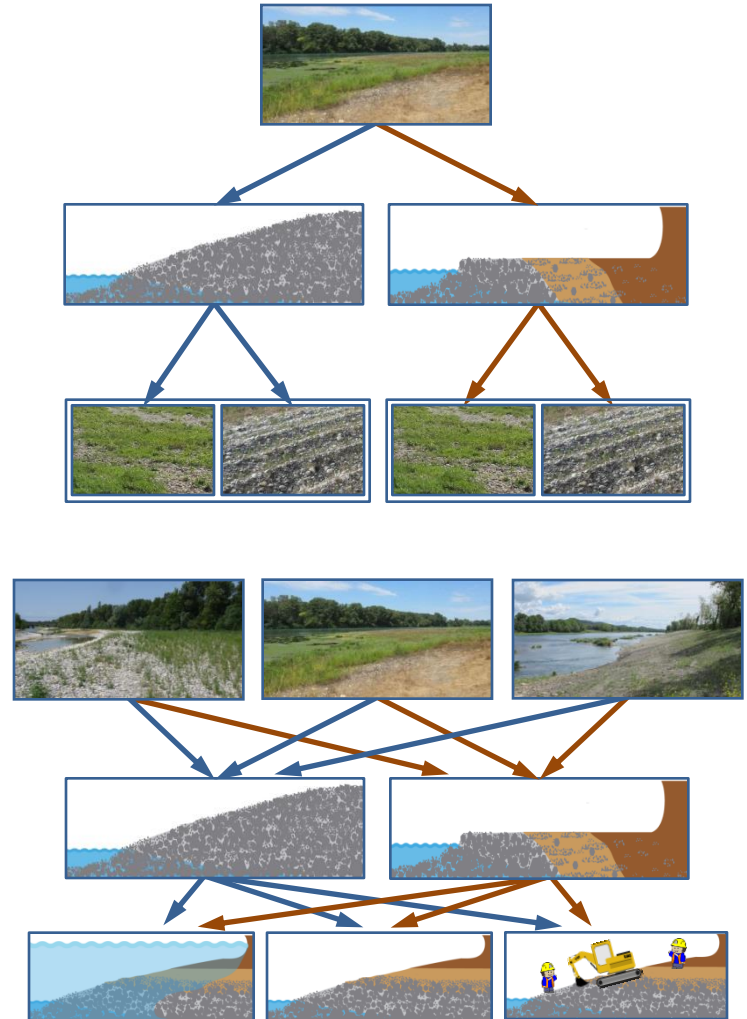
- Three groups of plant traits:



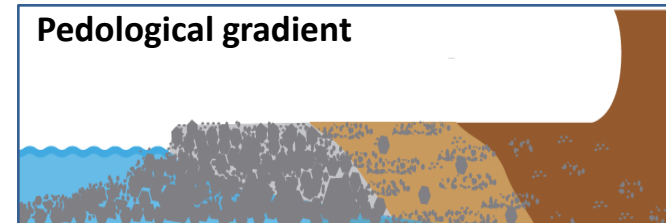
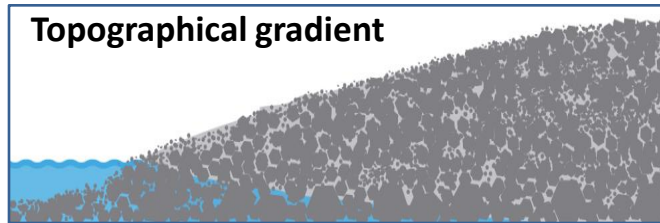
- Modeling framework: LMMs / GLMMs + multimodel inference

Analytical strategy

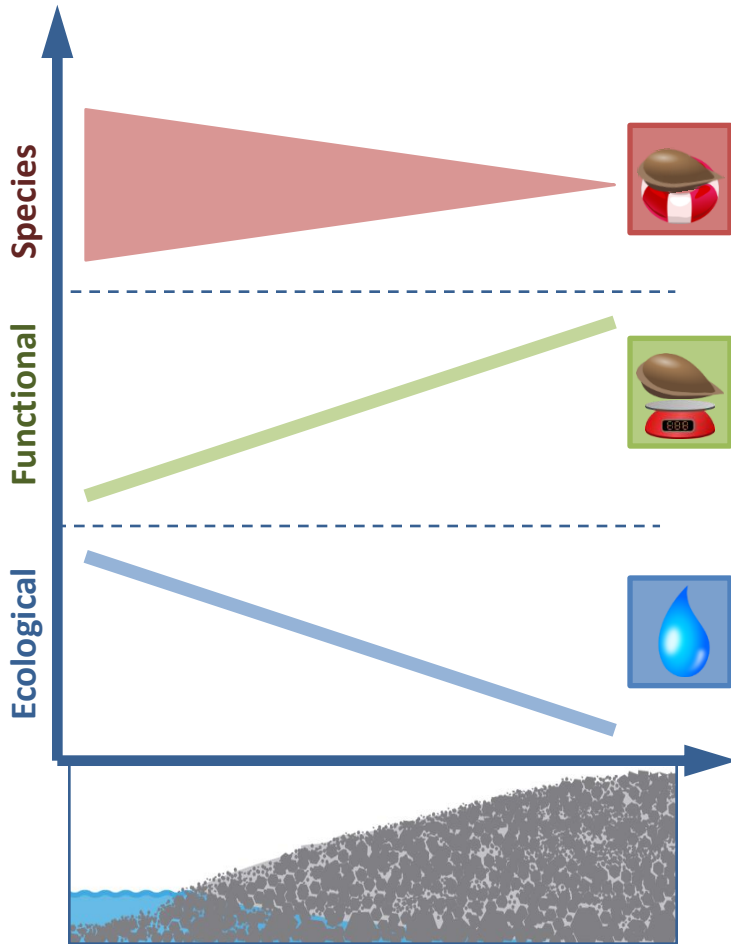
- How do environmental gradients shape plant communities along the Rhône River?
- How do maintenance operations mediate their response to environmental gradients?
- How is the response consistent among fixed, rejuvenated and dynamic bars?



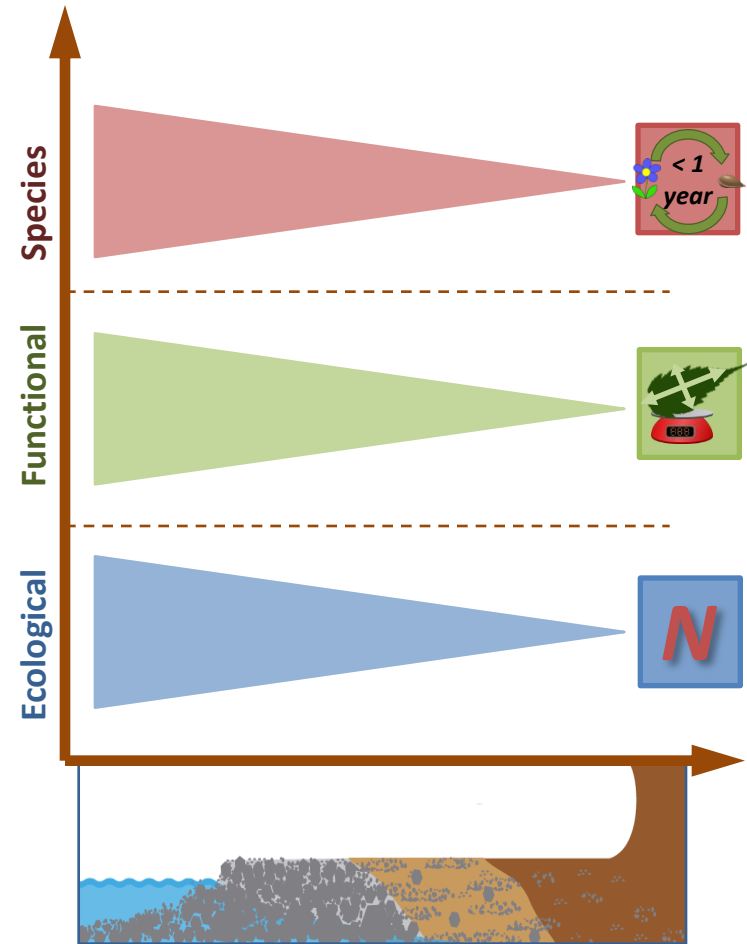
Effect of environmental gradients



Effect of environmental gradients



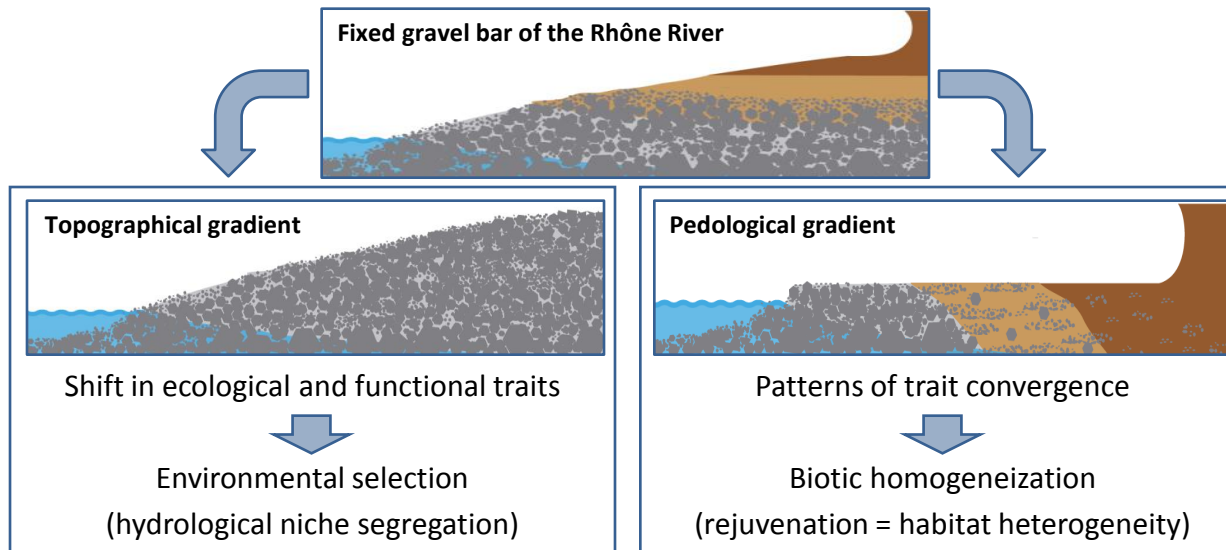
Topographical gradient



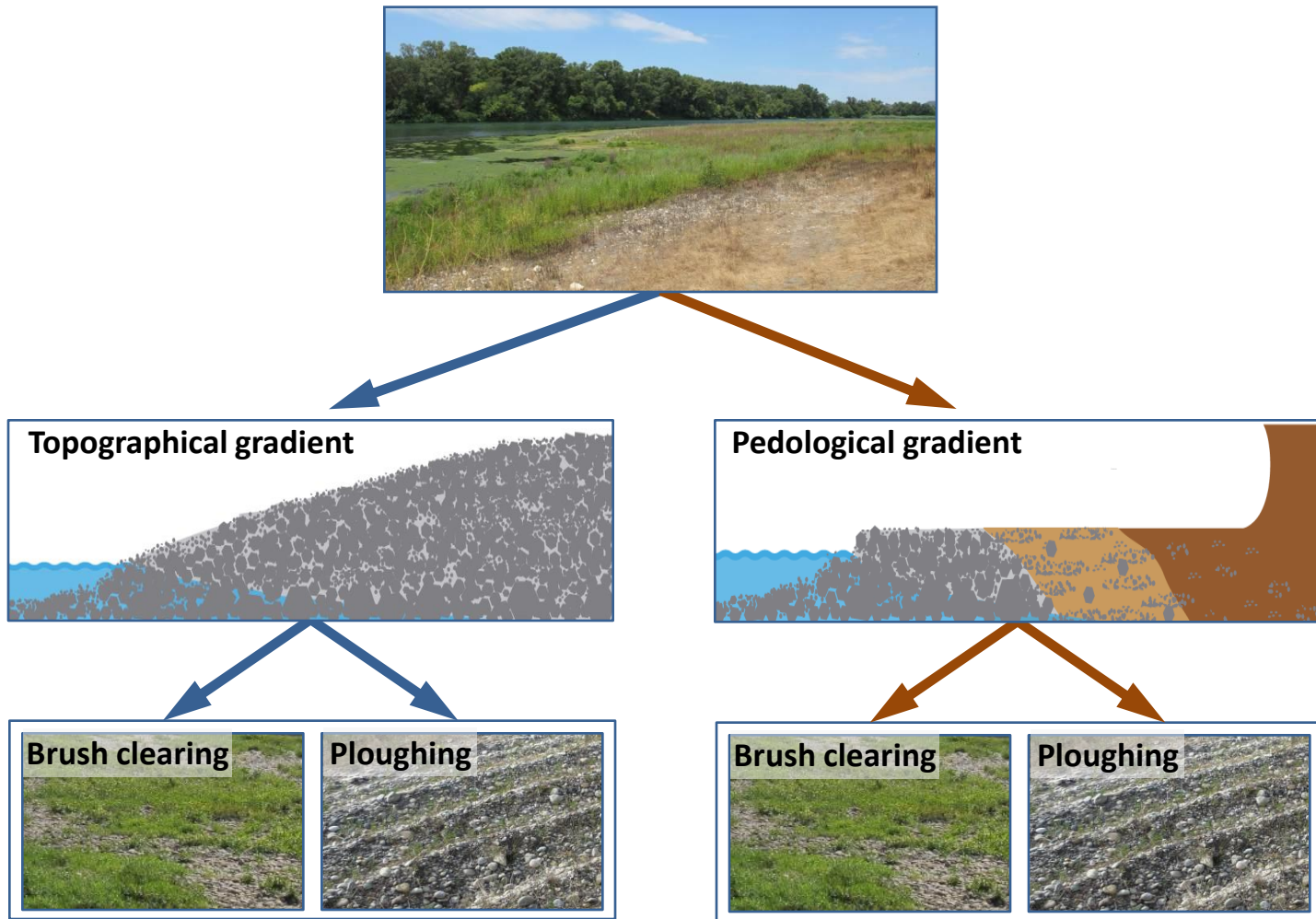
Pedological gradient



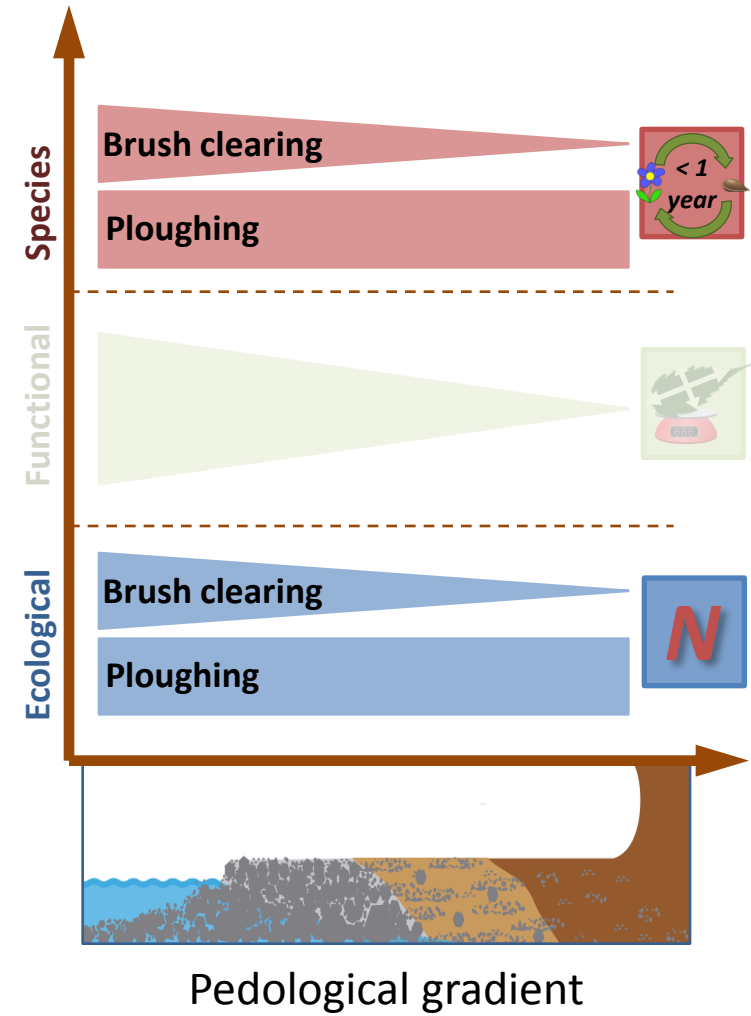
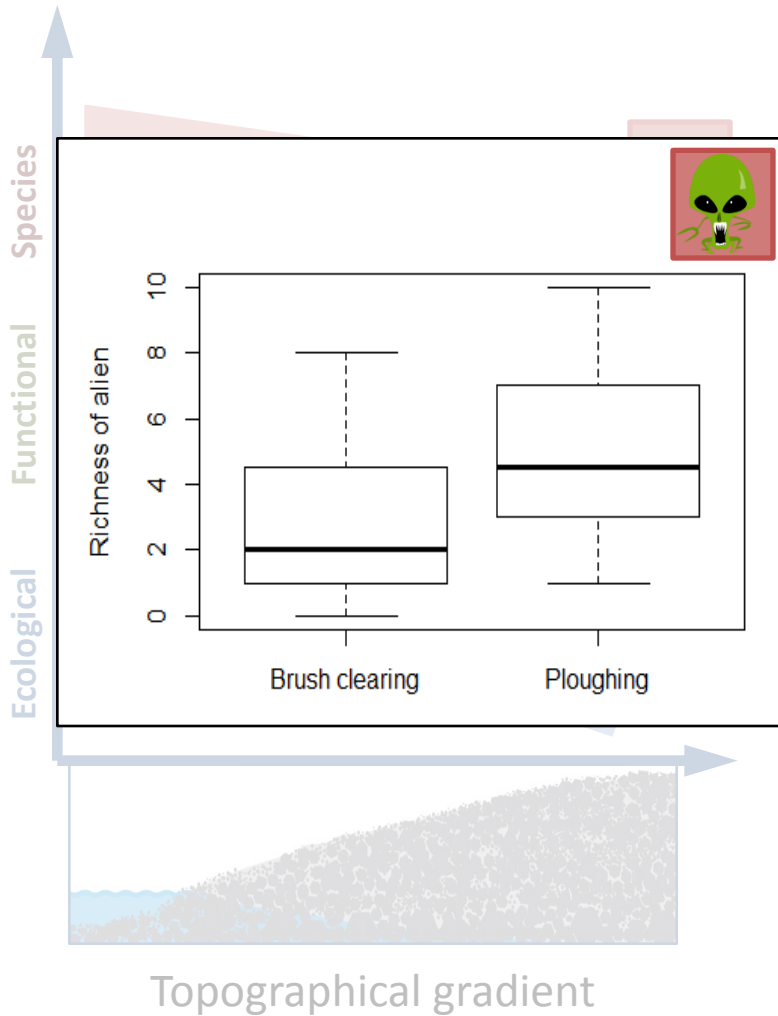
Effect of environmental gradients



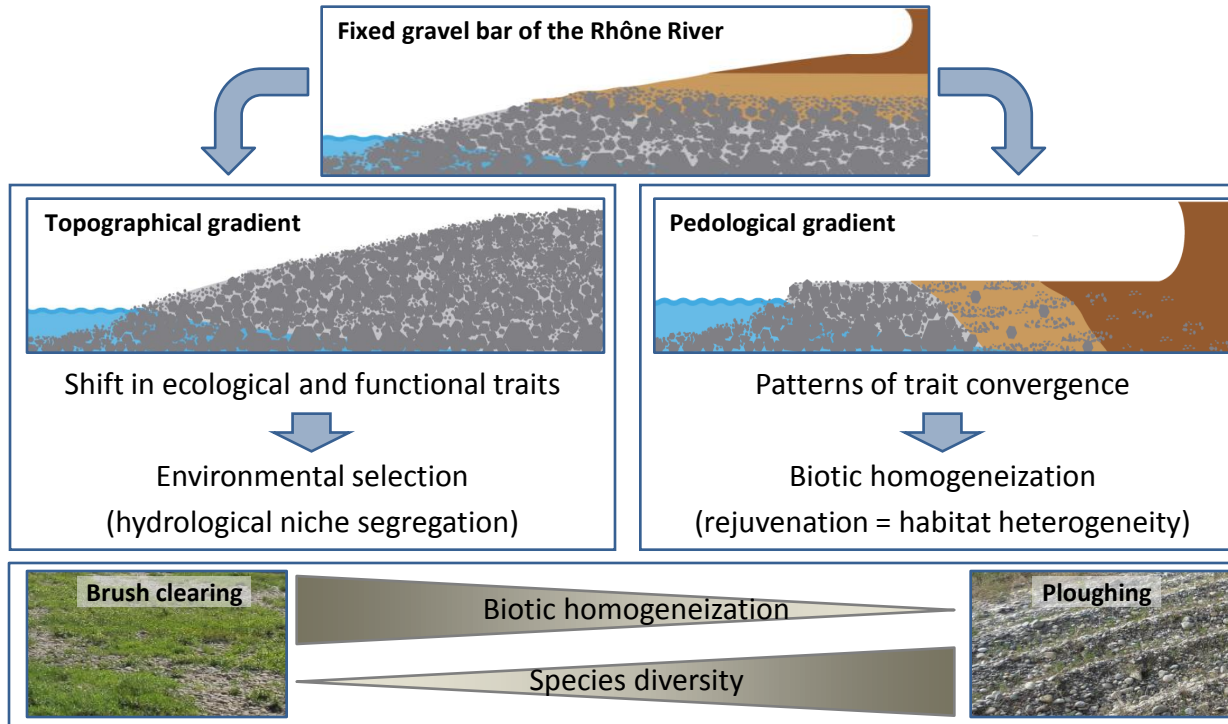
Effect of maintenance operations



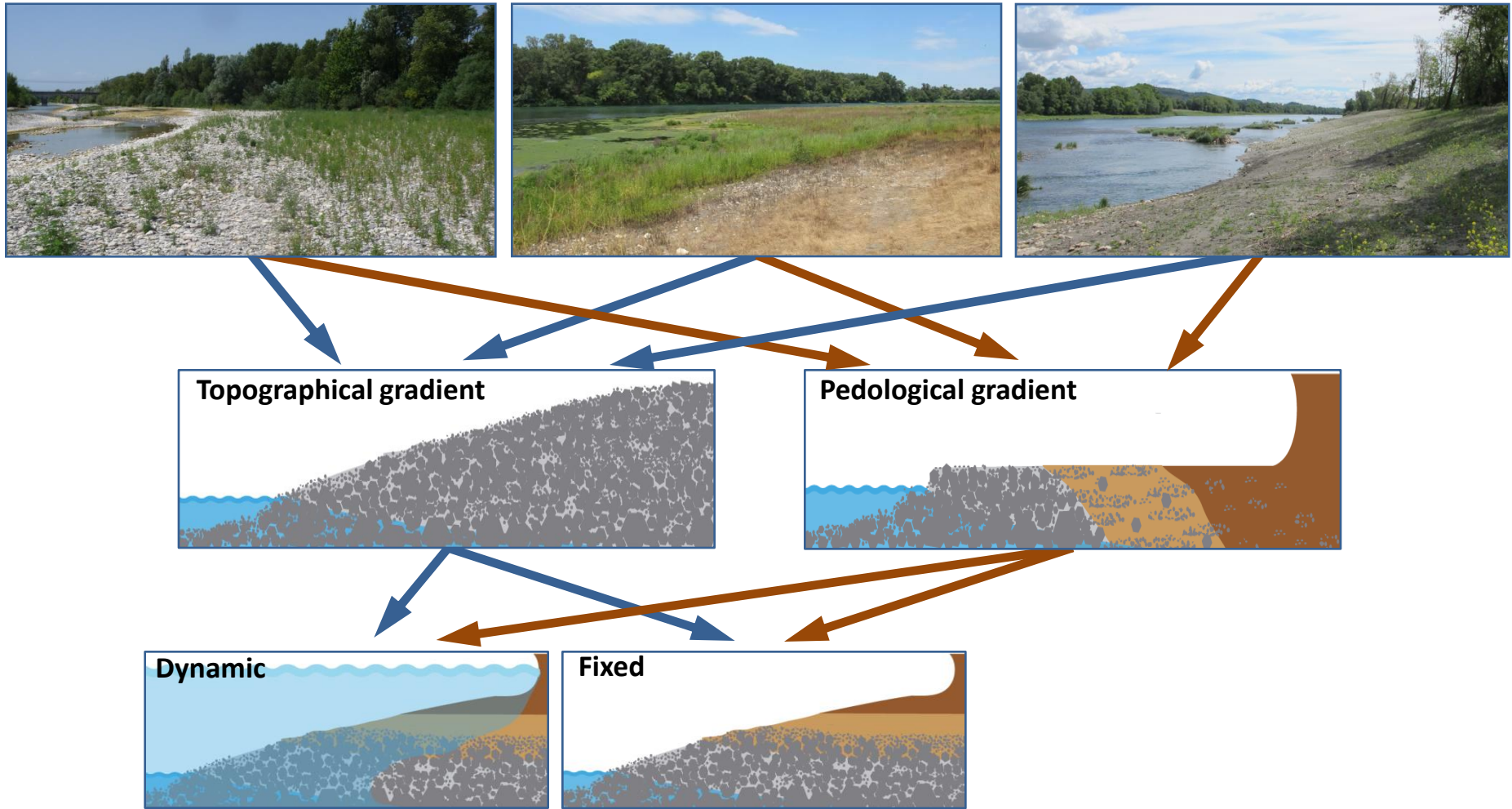
Effect of maintenance operations



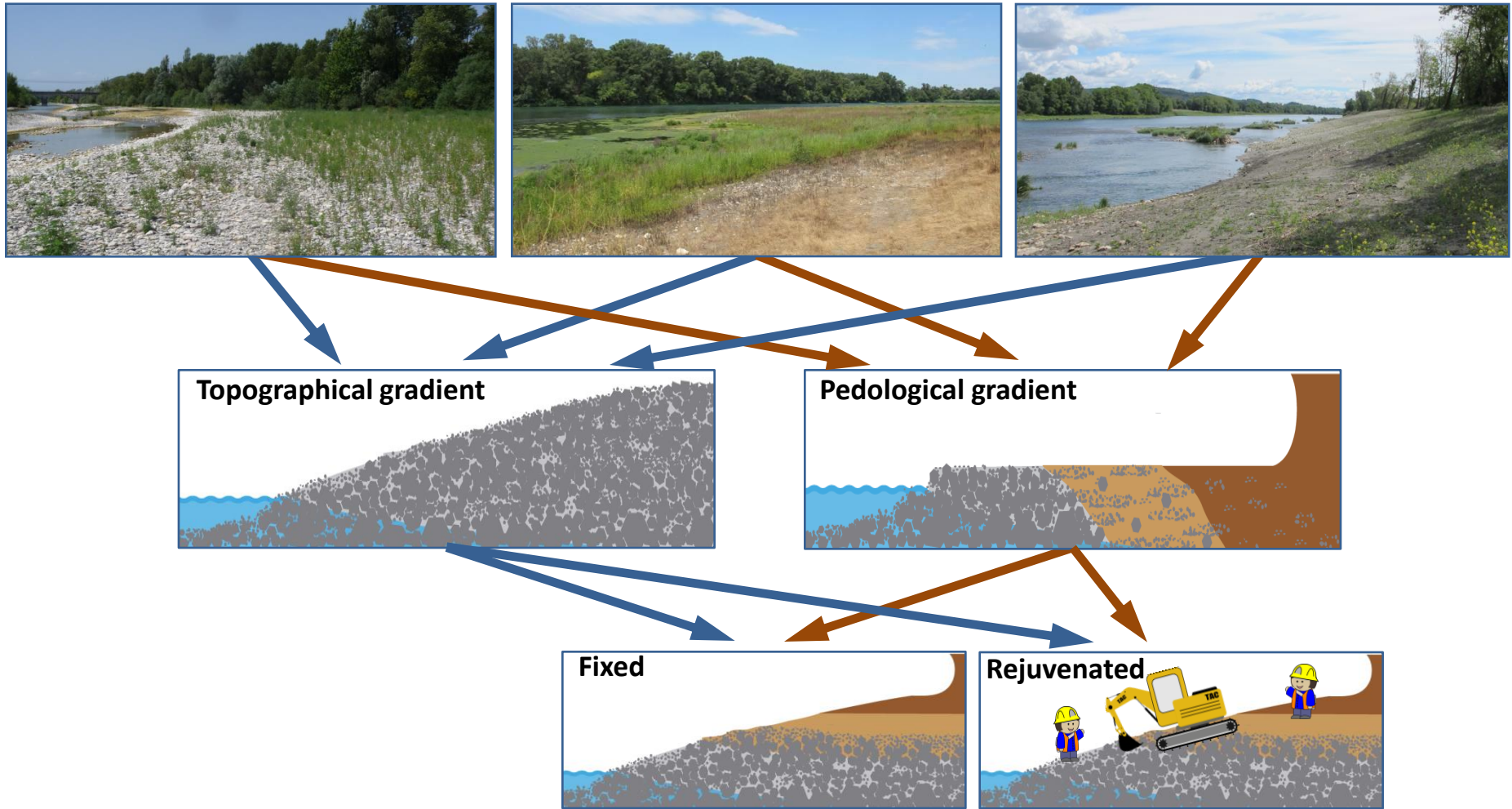
Effect of maintenance operations



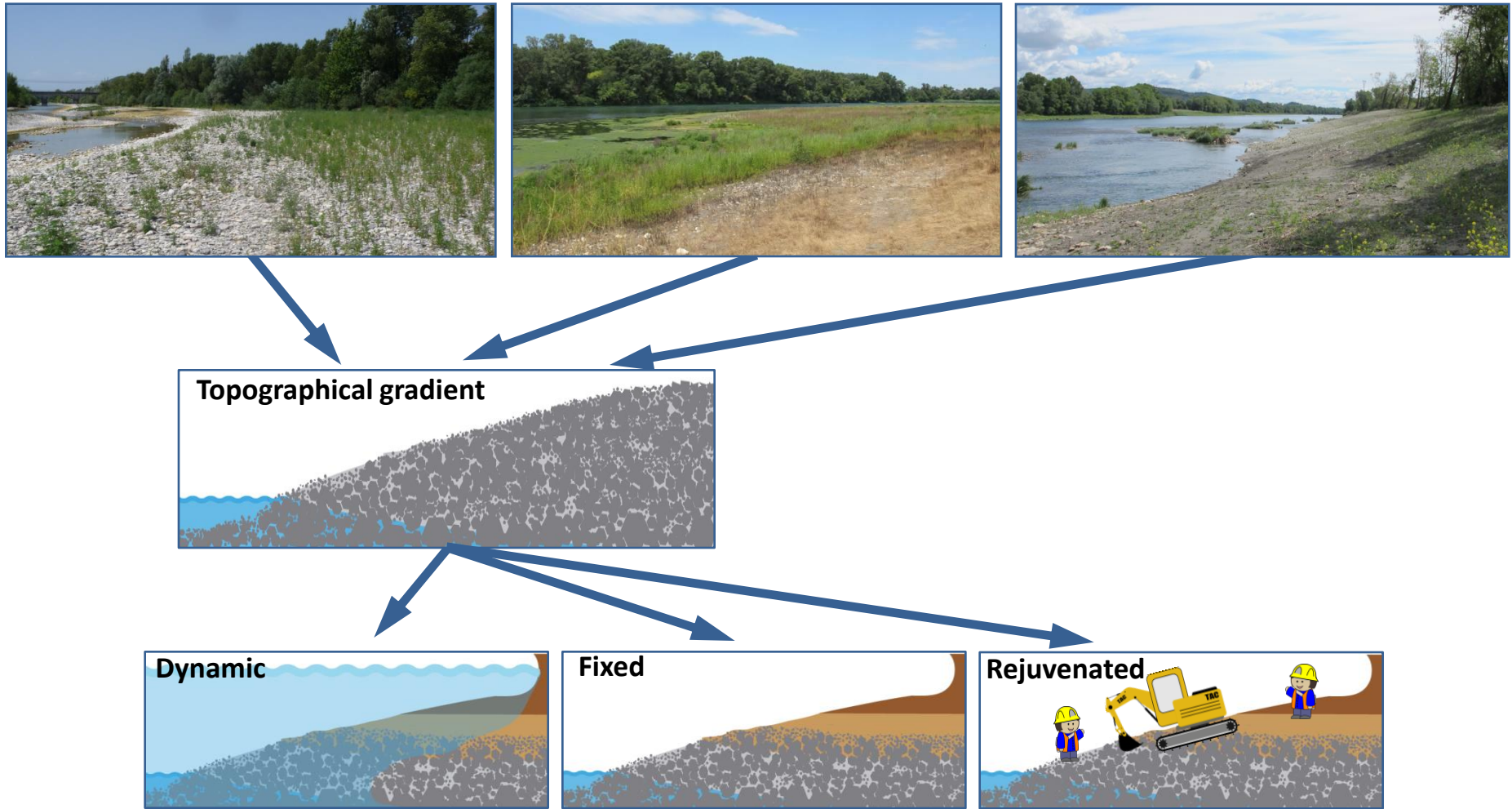
Effect of restoration operations



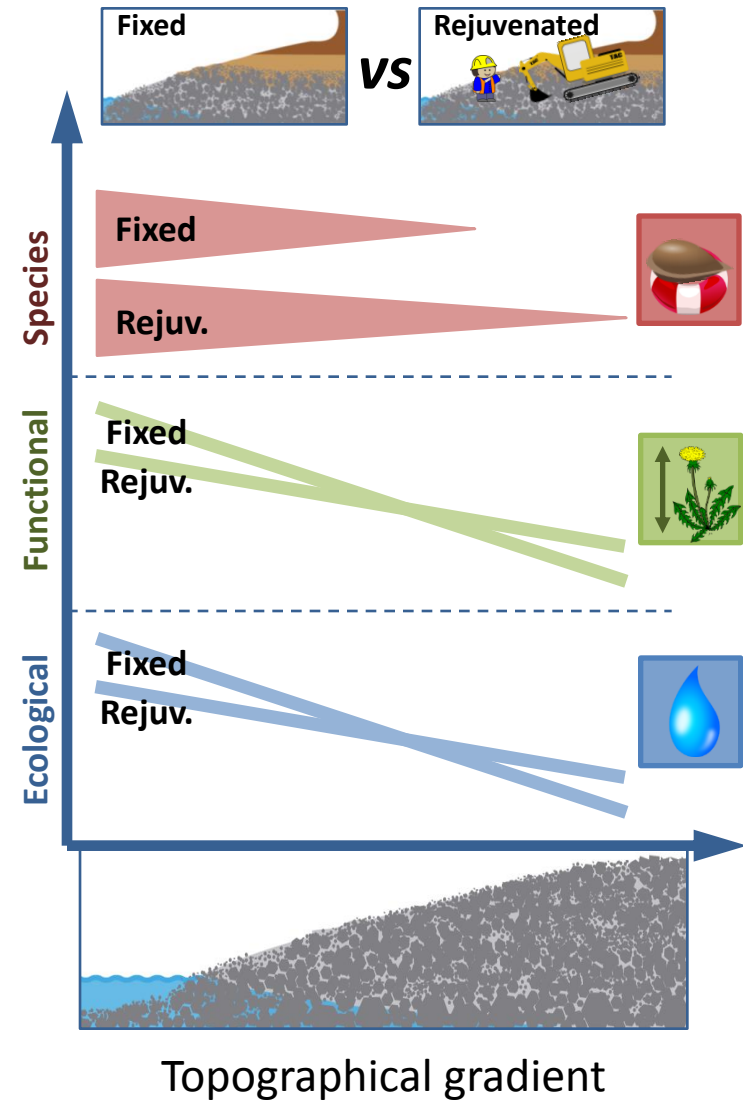
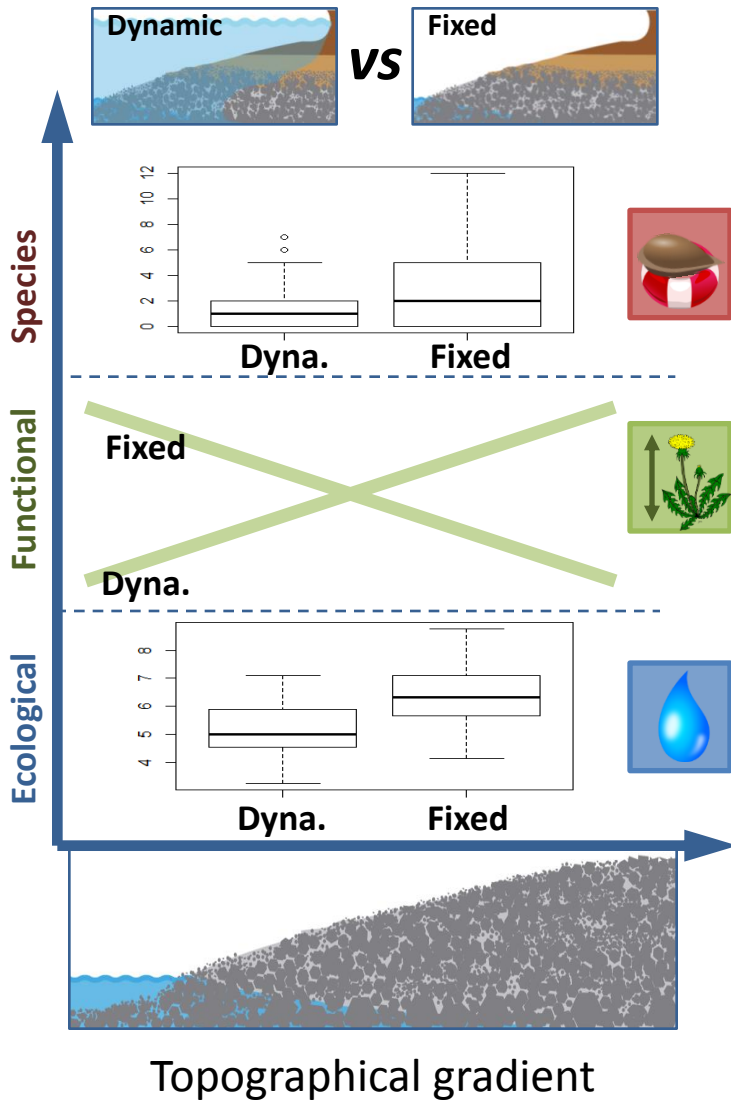
Effect of restoration operations



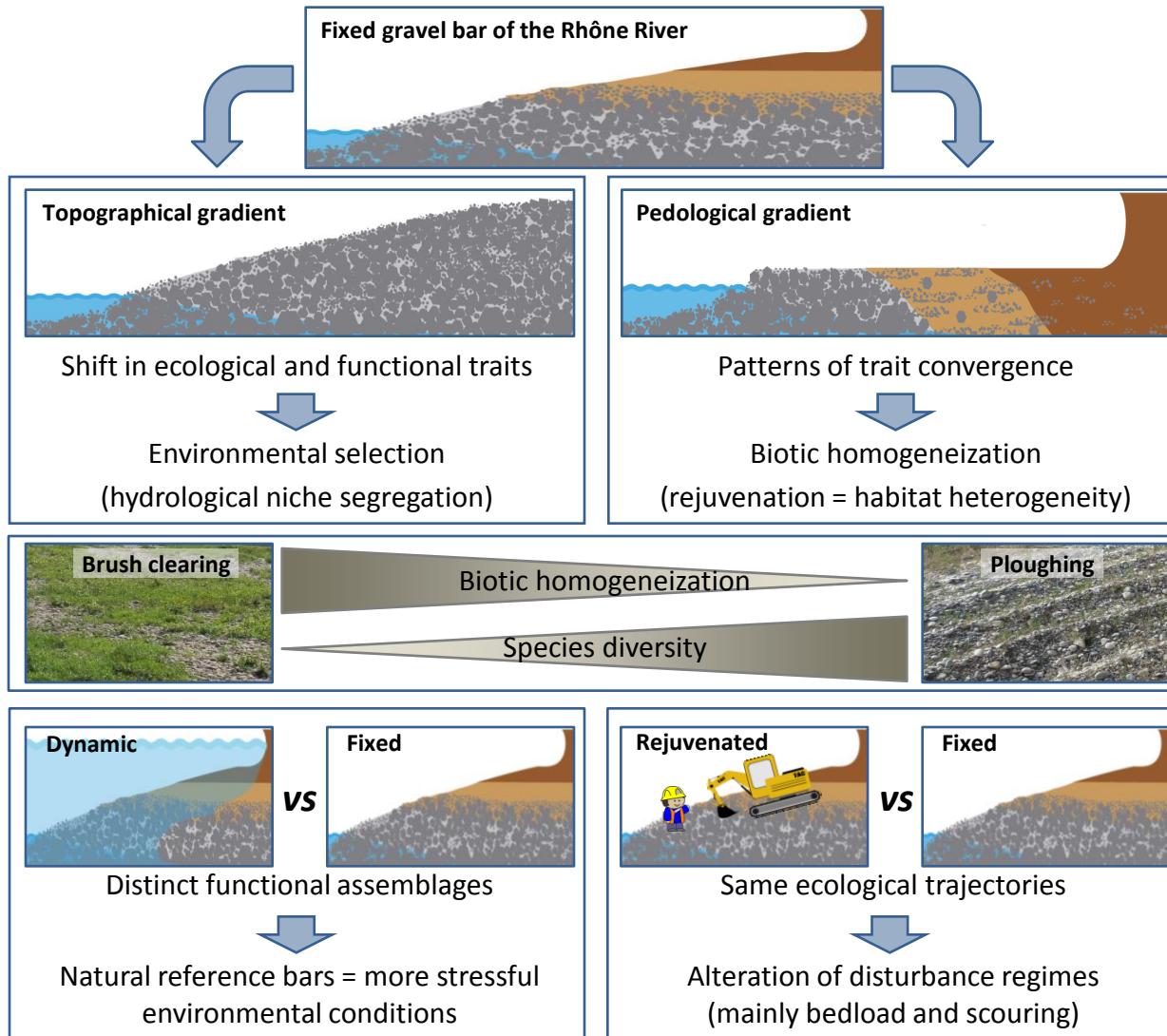
Effect of restoration operations



Effect of restoration operations



Effect of restoration operations



Take-home messages...

- Both gradients have strong effect on plant functional composition;
- Co-occurrence of species is higher on highly disturbed sites;
- Rejuvenation processes avoid biotic homogenization and promote habitat heterogeneity;
- Human activities mediate environmental gradients:
 - ploughing promote pioneer communities but also alien species;
 - dynamic gravel bars are more stressful environments;
 - rejuvenated surfaces follow the ecological trajectories of fixed ones.
- Effective ecological restoration strategies should imply:
 - reactivation of bedload transport and supply + greater variability of the minimum flow;
 - engineering operations that better mimic landform and soil properties of dynamic gravel bars.



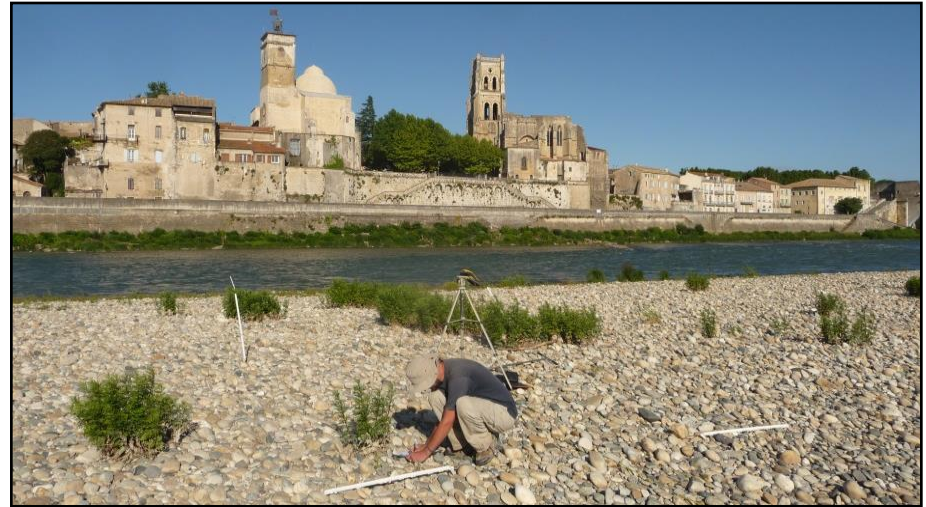
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