

Multi-taxon dynamics of an ecological succession after disturbance: Study of a quarry network

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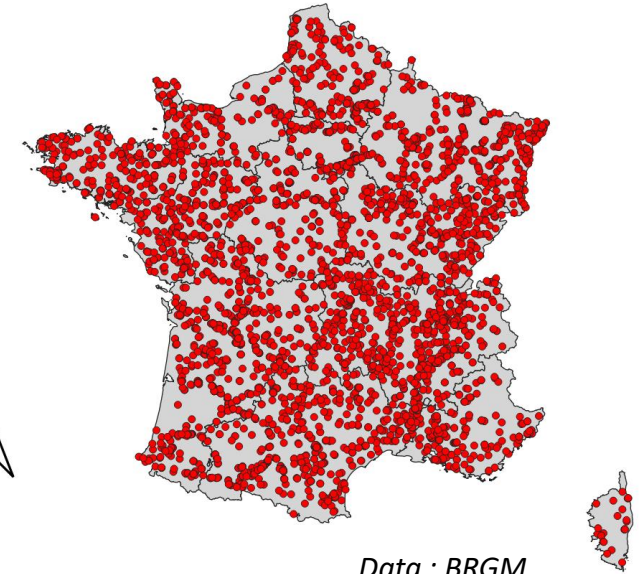
SFE²

Lyon

October 2024



Quarry in mainland France



Data : BRGM

More than 45,300 species are threatened with extinction

That is still 28% of all assessed species.

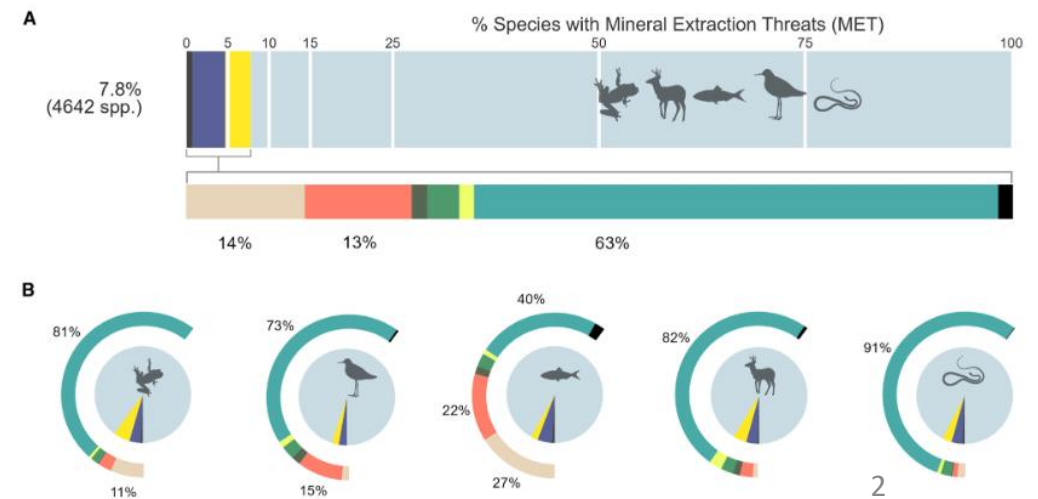


UICN

Land degradation is one of the major causes of biodiversity decline

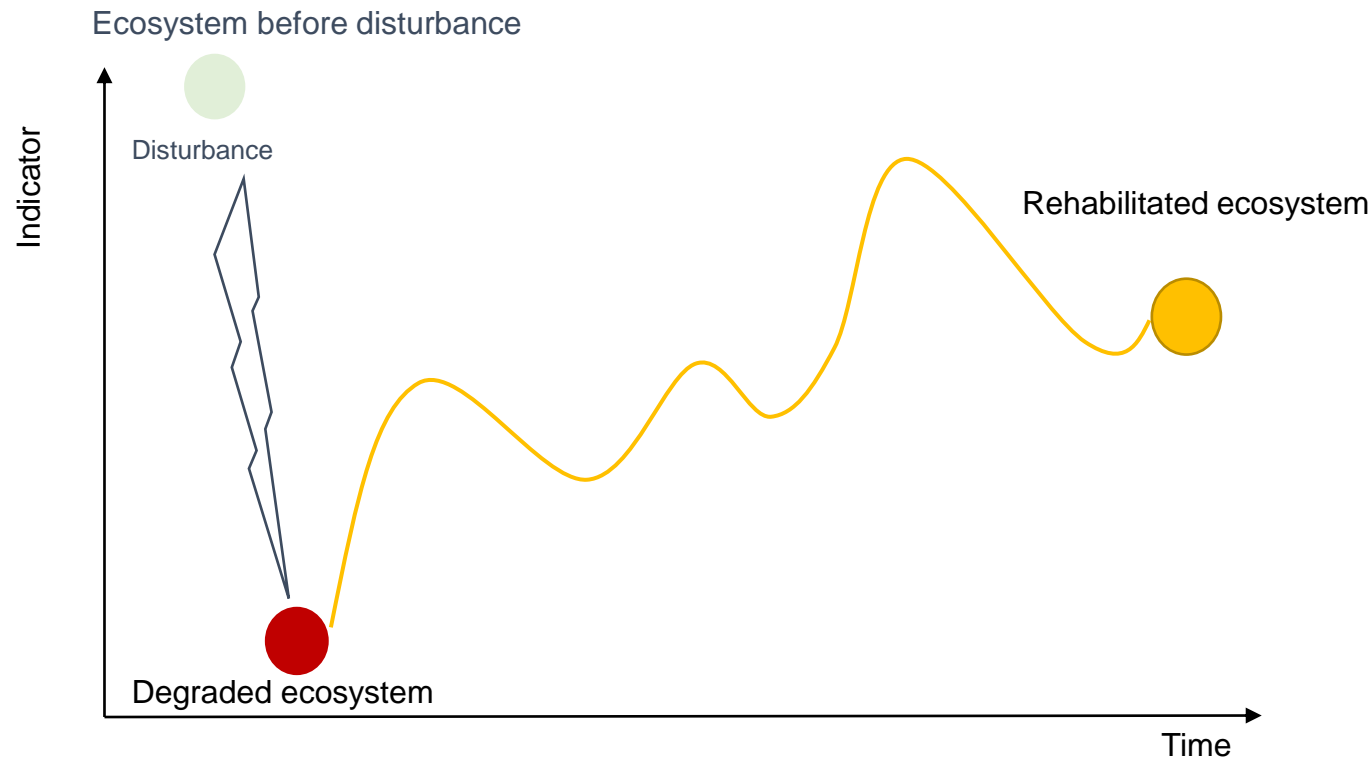


Pressure from mineral extraction is strong

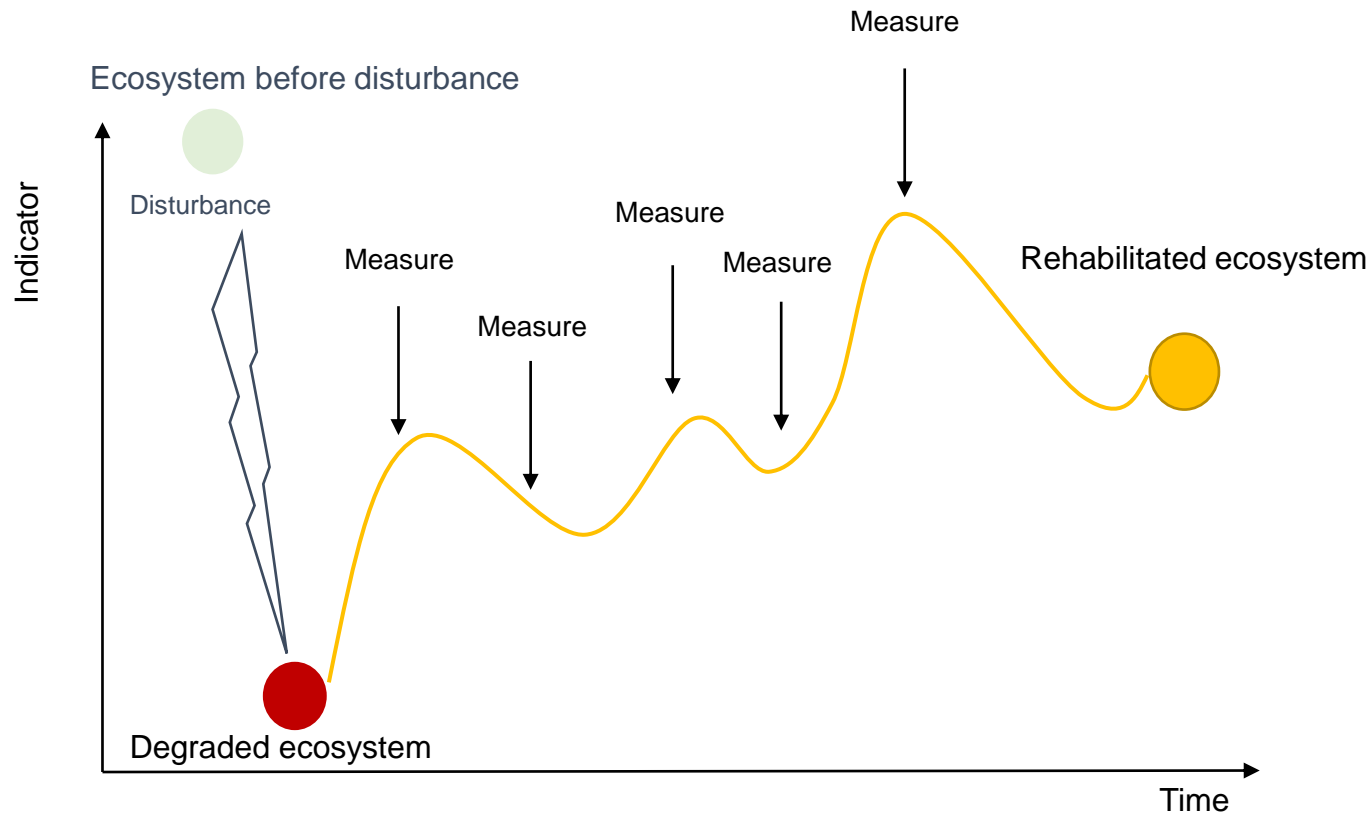


What happen after a disturbance ?

After a disturbance the succession/rehabilitation process isn't always linear



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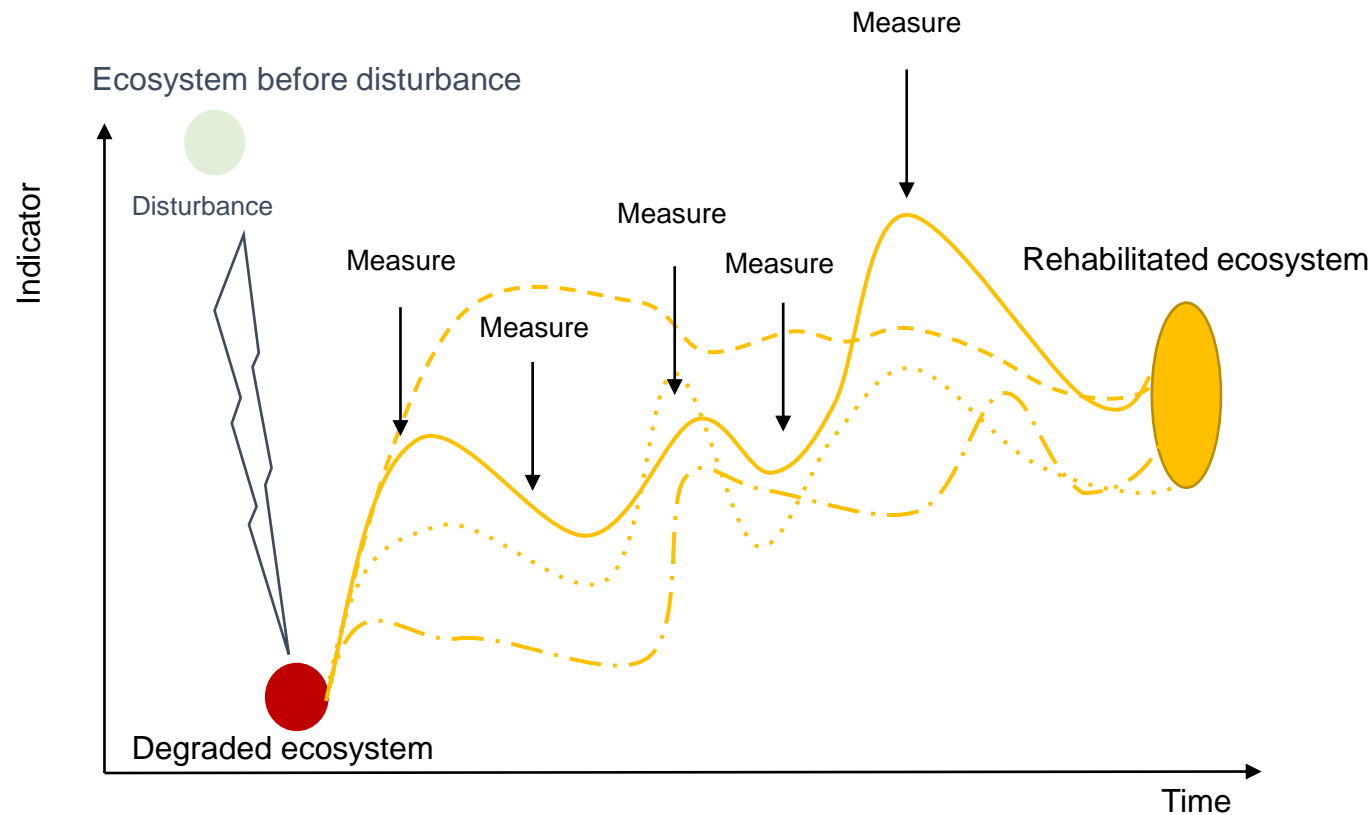


After a disturbance the succession/rehabilitation process isn't always linear

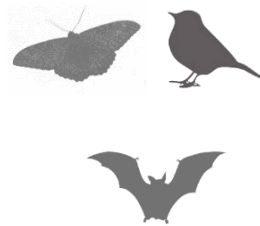
Risk of over- or under-assessment of rehabilitation progress

To take this risk into account : Need for long-term monitoring

The benefits of multi-site monitoring :



Each site will follow a particular trajectory, but is it possible to identify general patterns?

Part 1 : Effect of a disturbanceMain hypothesis :

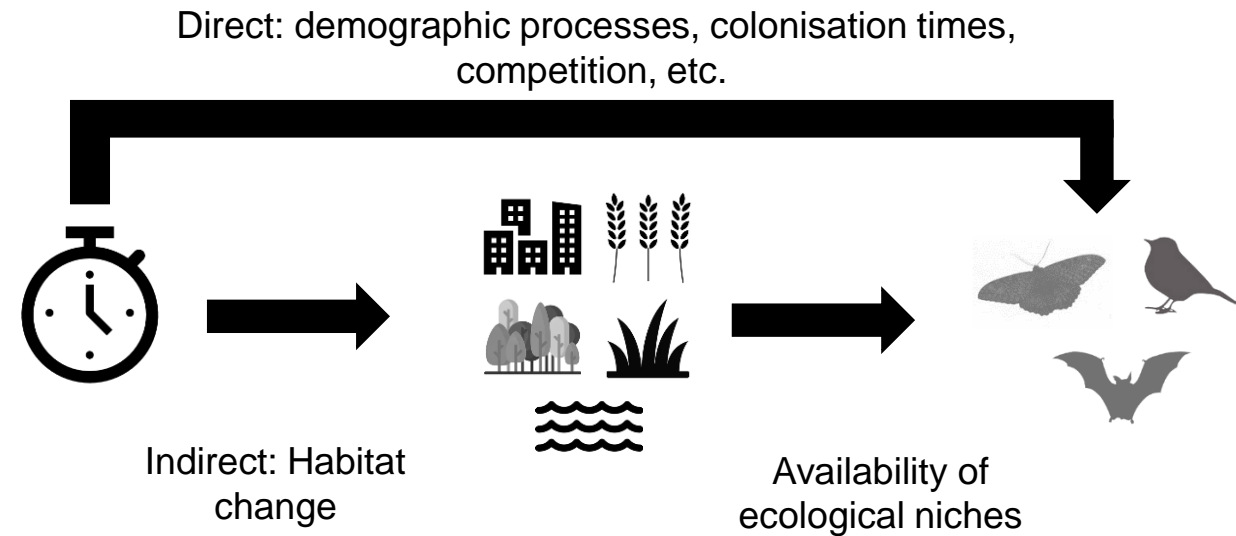
A disturbance will caused a decline in the biodiversity indicators (Richness, Pielou Eveness, Specialisation, Community composition) followed by an increase during succession.

Different effects depending on the taxa monitored

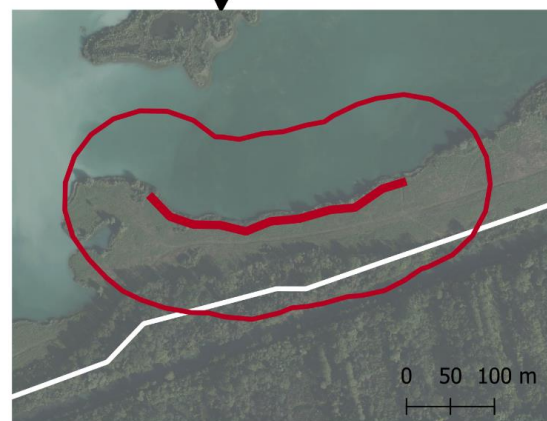
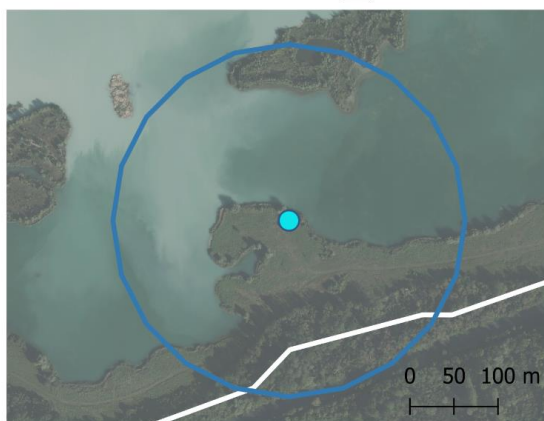
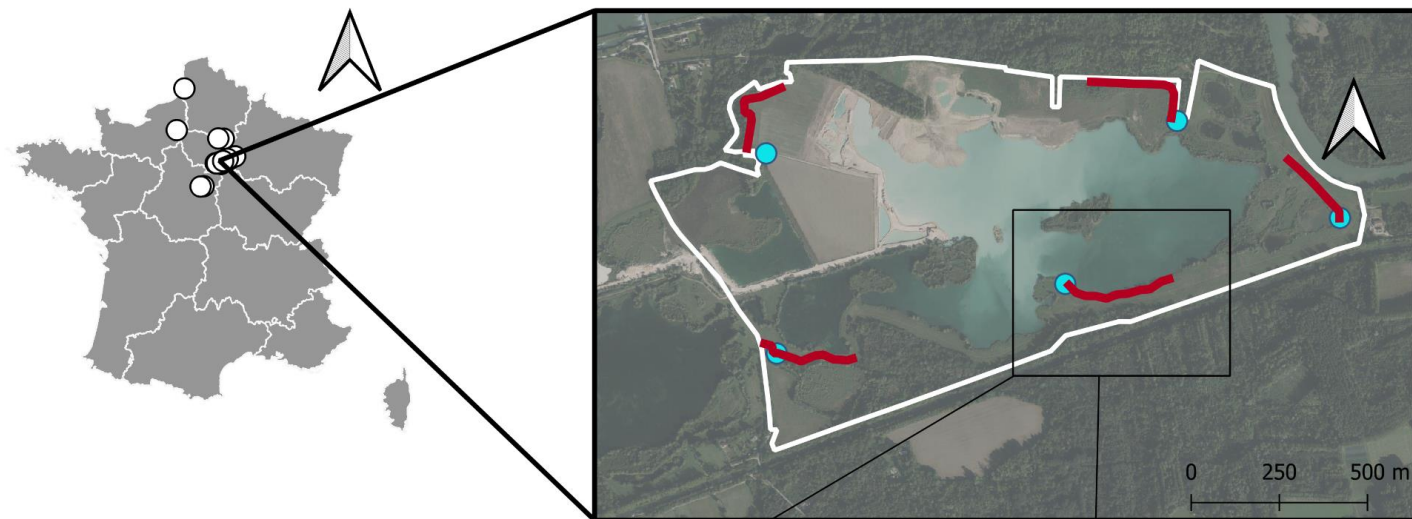
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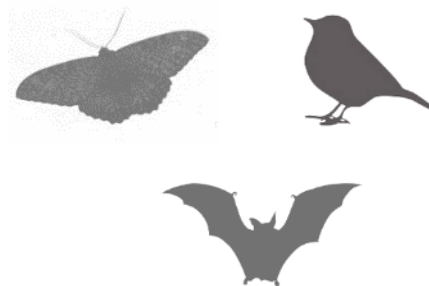
Different effects depending on the taxa monitored

Part 2: Direct and indirect effect of time after disturbance ?Main hypothesis :

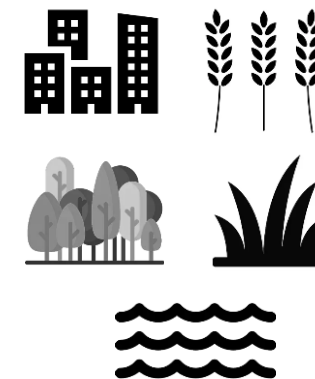
Time after exploitation will caused both a direct effect on biodiversity and an indirect effect through habitat change



3 taxonomic groups



5 local habitat class



4 indicators :

- Richness
- Pielou Evenness
- Specialisation index
- Species composition

- Birds and bats monitoring points
- Butterfly transects
- Buffer 200m
- Buffer 100m
- Quarry sites

→ 38 quarries; 1707 monitoring point realised; 90691 observation

Life cycle stage

Part 1 : Effect of a disturbance

General linear mixed modelling
Categorical time variable

[Community structure indice] ~ Life_cycle_stage +
local habitat variables + day +
weather variables + year + random effect.

Before
exploitation

During
exploitation

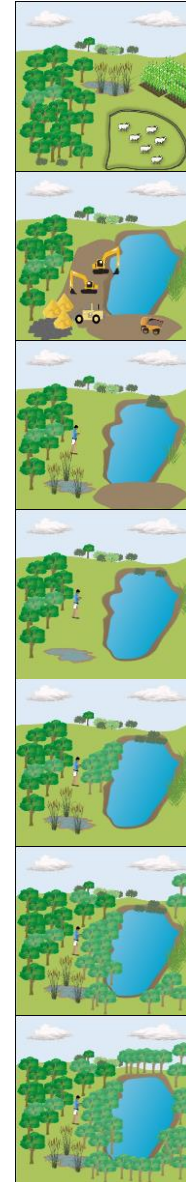
0-5 years after
rehabilitation

6-10 years after
rehabilitation

11-15 years after
rehabilitation

16-20 years after
rehabilitation

+20 years after
rehabilitation



Part 1 : Effect of a disturbance

General linear mixed modelling
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Life cycle stage

Before exploitation

During exploitation

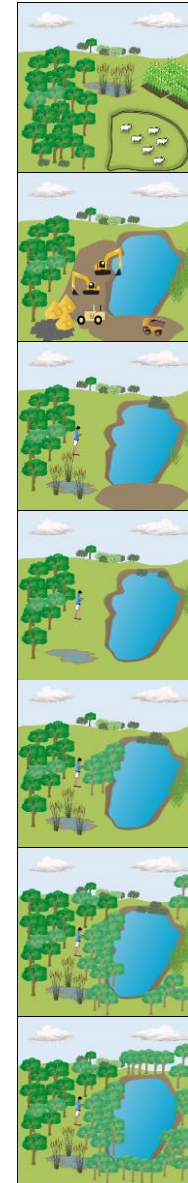
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0

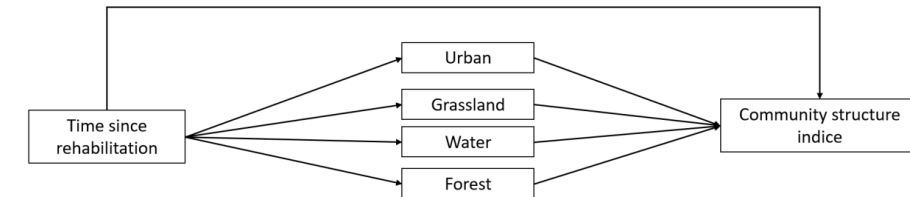
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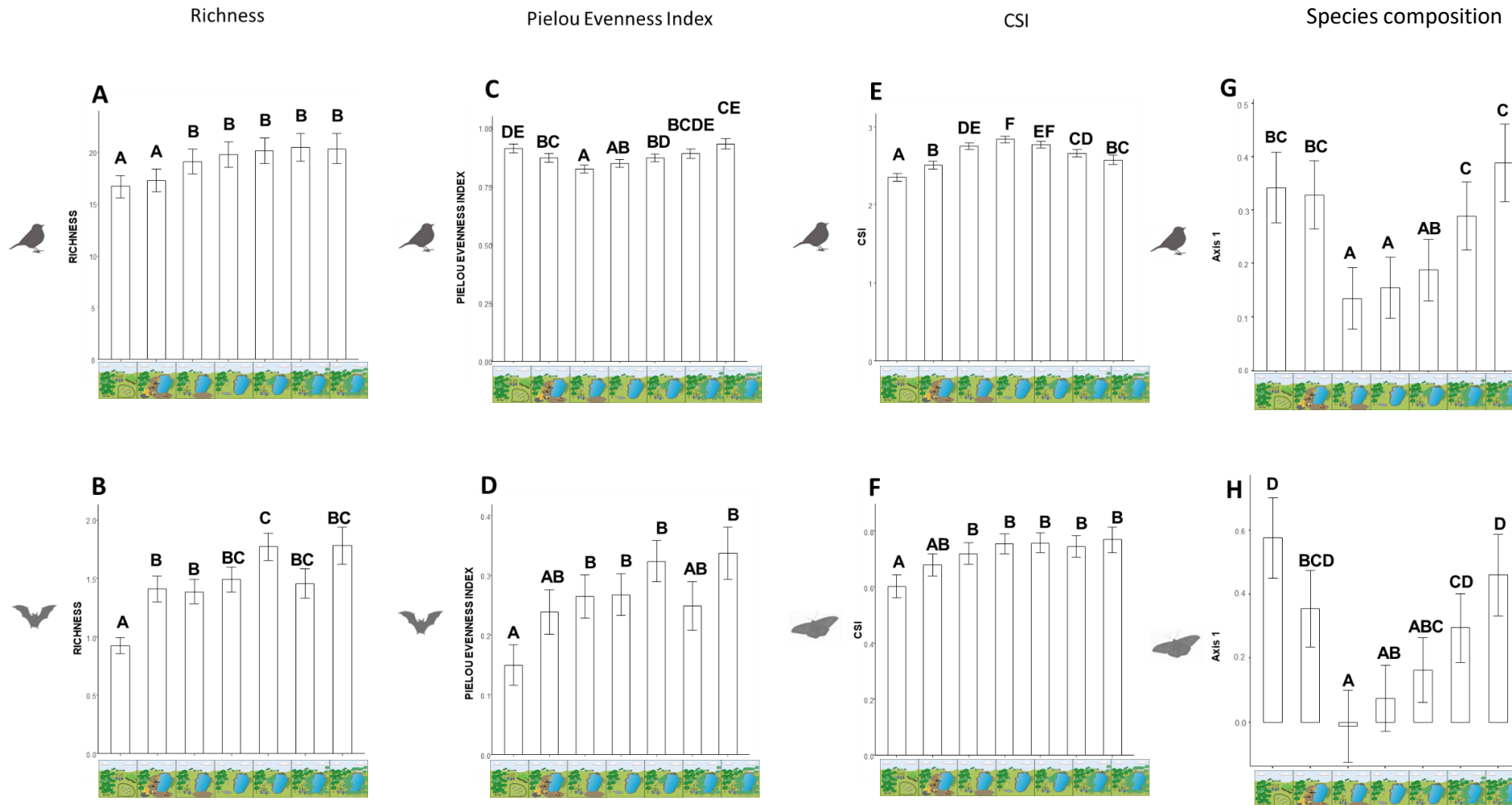
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Years since rehabilitation

Part 2: Direct or indirect effect of time after a disturbance ?

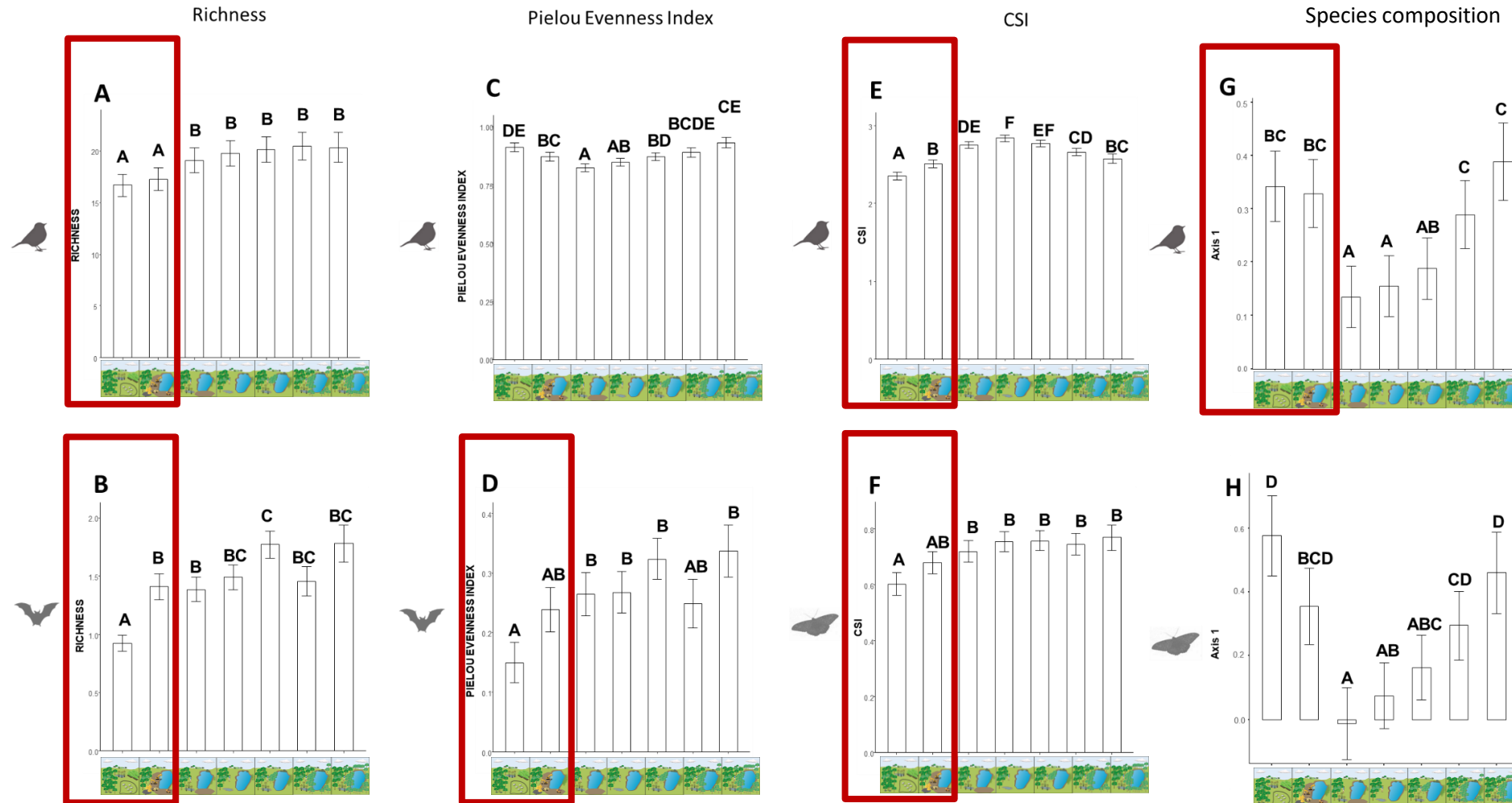
Structural equation modelling for two time periods
Continuous time variable



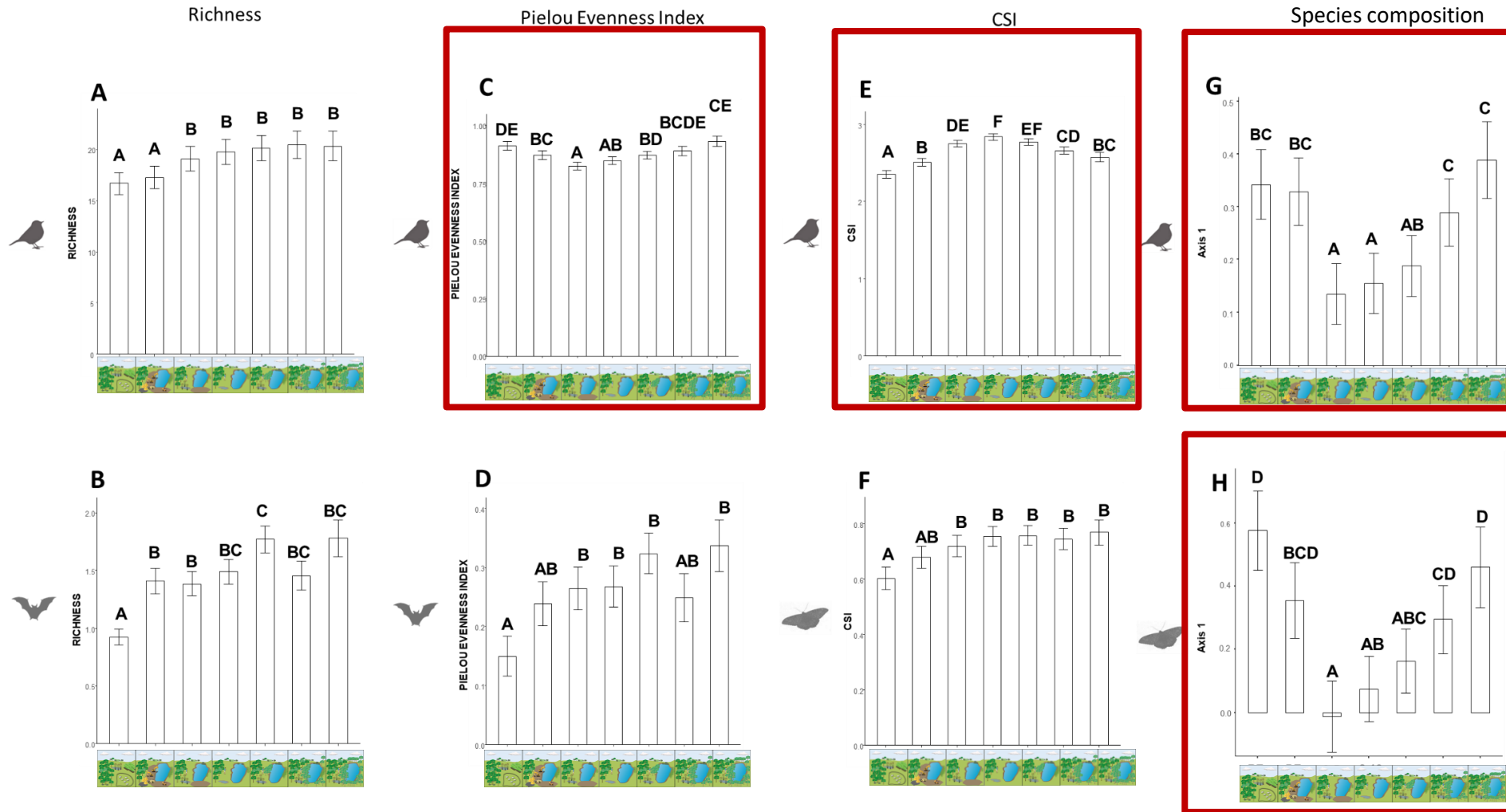


Differences between taxa → Differences in habitat affinity

Differences between metrics → Defining a rehabilitation success is complex.

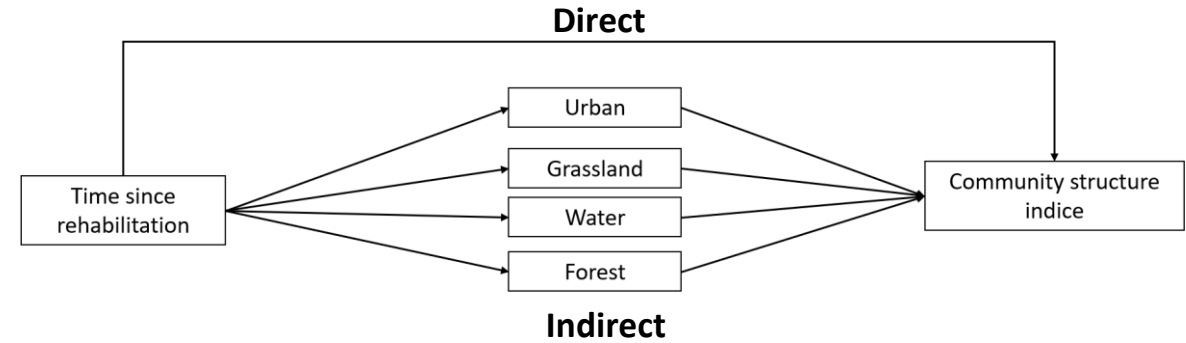


No always a negative impact of quarrying on our metrics → Quarries fit into landscapes that are already under heavy pressure
 The start of exploitation → New pioneer habitat





Long time changes even years after rehabilitation both positive or negativ

- Direct or indirect effects

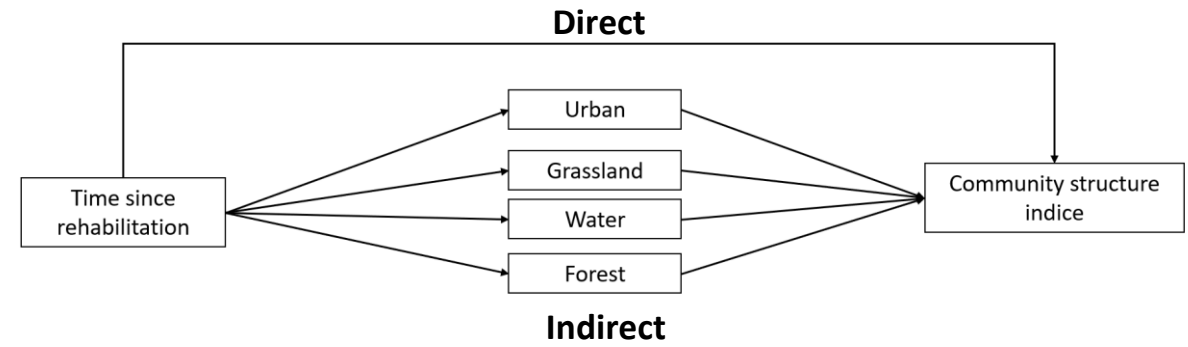


Summary table







	Richness		Pielou evenness index		Specialisation		Species composition	
	Direct	Indirect	Direct	Indirect	Direct	Indirect	Direct	Indirect
 0-10		+		+		+		-
 +10	-	+	+		-		+	

Direct effects only over the period +10 years after rehabilitation → This may be an effect of habitat maturation.

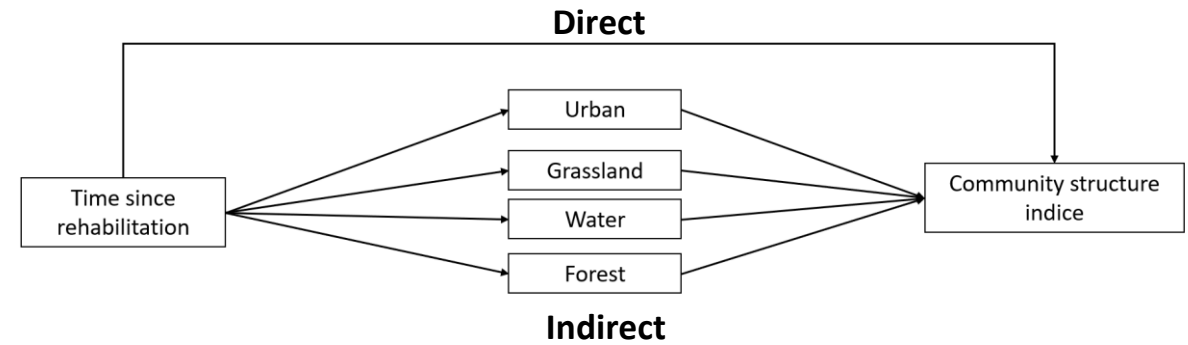
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 0-10				-				
 +10	+		+	-				
 0-10						+		-
 +10						+	+	

- Direct or indirect effects

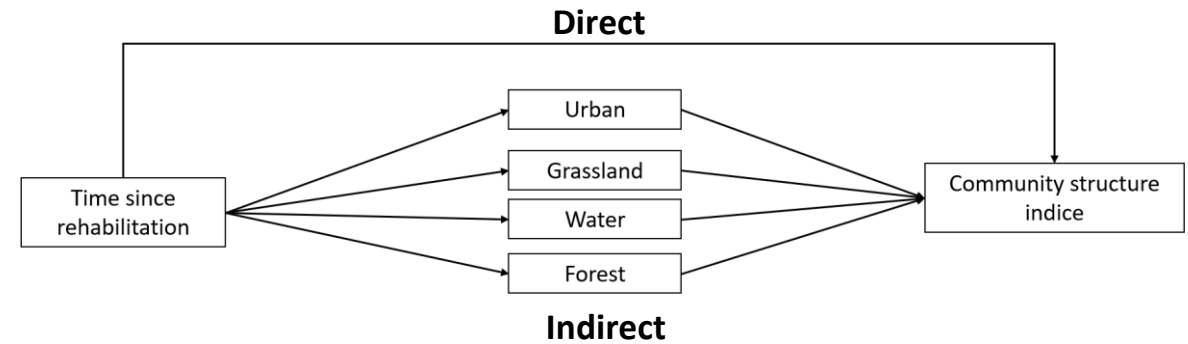


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Differences between taxa

- Direct or indirect effects



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0-10						+		-
+10						+	+	

Differences between taxa

Direct effects only over the period +10 years after rehabilitation →
This may be an effect of habitat maturation.

- The differences in responses between taxa show the importance of clearly defining rehabilitation targets.
- In the first few years after rehabilitation, ecological engineering can modify habitats. (Size of water body, bank slope, number of grassland patch...)
- In a second phase, management efforts could help to promote and/or maintain biotic conditions (e.g. open-land, tree microhabitats...).



What are the post-exploitation uses?

There is a need to take long-term effects of rehabilitation into account and not only the first few years

Thank you !



Aude Ernoult
Pascaline Le Gouar
Marion Parisot
Christian Kerbiriou



MINÉRAUX INDUSTRIELS - FRANCE

