Restoring habitat heterogeneity, use conceptual models, ...???

"Looking for progress in stream restoration"

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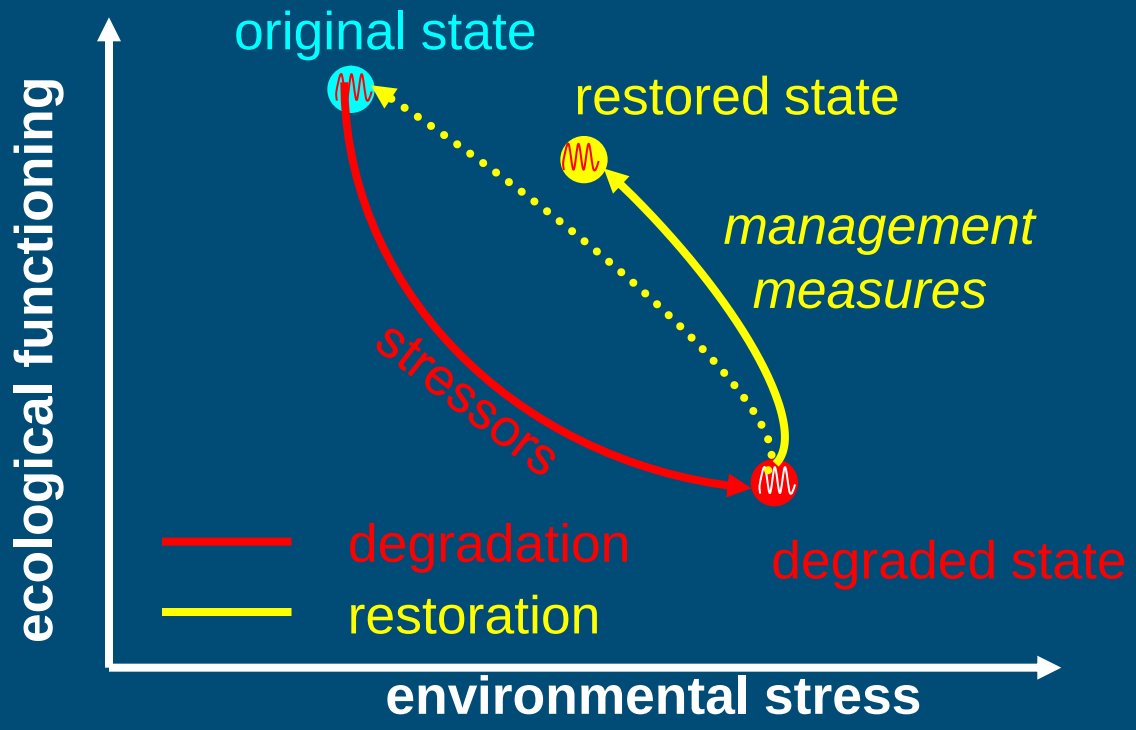
From natural to degraded rivers and back again:

A test on ecology theory and practice

Feld et al 2011

Can restoration learn from degradation?



Despite restoration ≠ degradation?

‘Metadata analysis’ on stream restoration

Method

1000 literature references

370 were taken in review

168 fulfilled our analysis criteria

‘attribute analysis’ => database

Two examples:

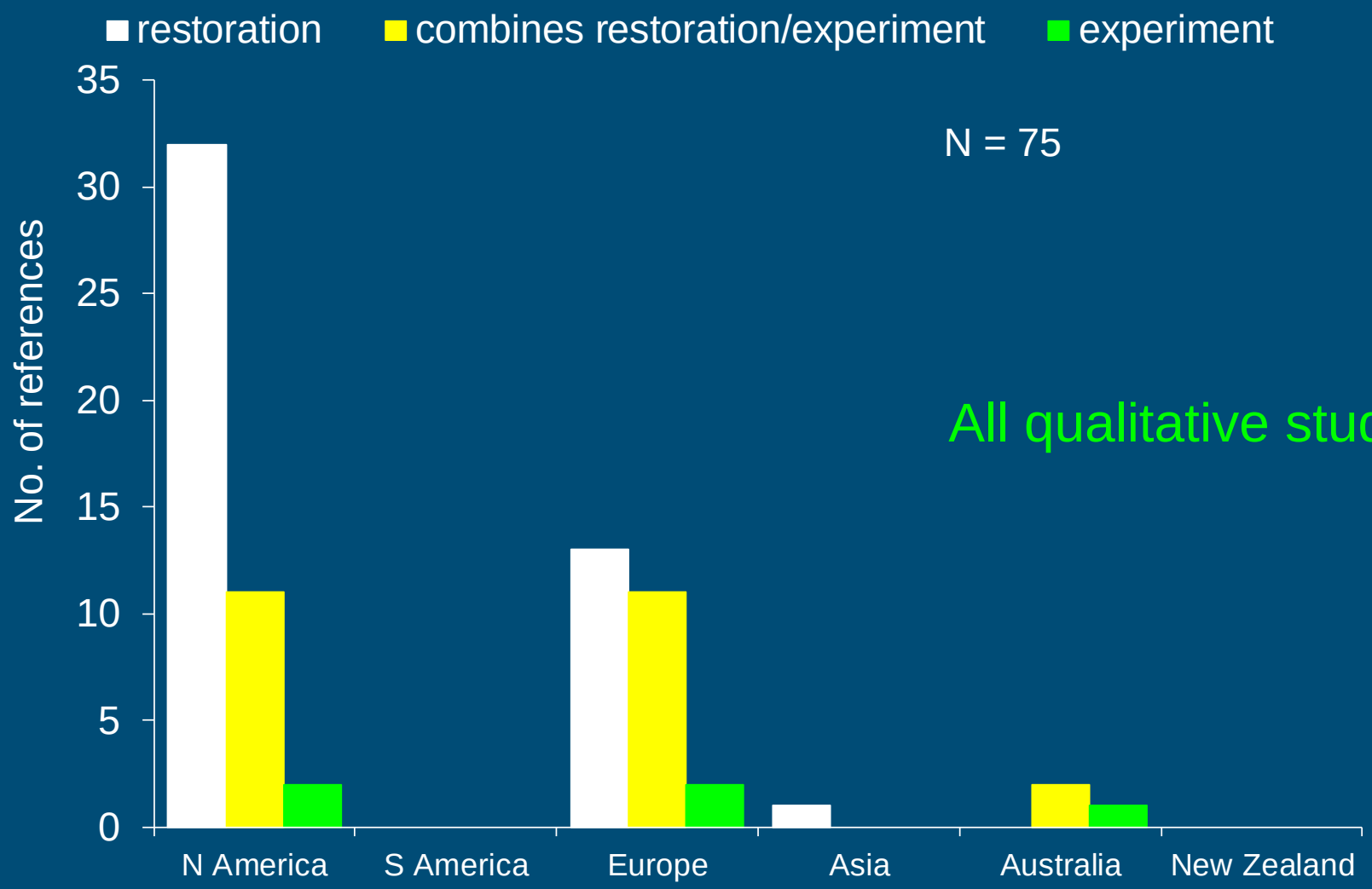
1. Instream habitat enhancement (LWD addition)
2. Riparian buffer strip restoration

Instream habitat enhancement

Example 1: Large Woody Debris (LWD) addition

Instream habitat enhancement

Geographic information distribution

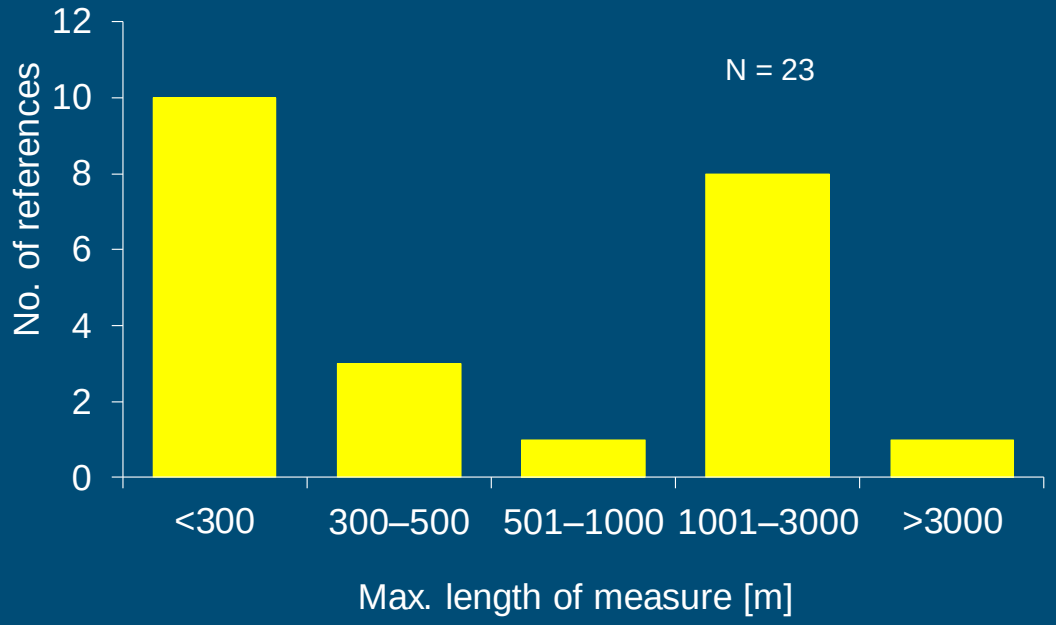


N = 75

All qualitative study results

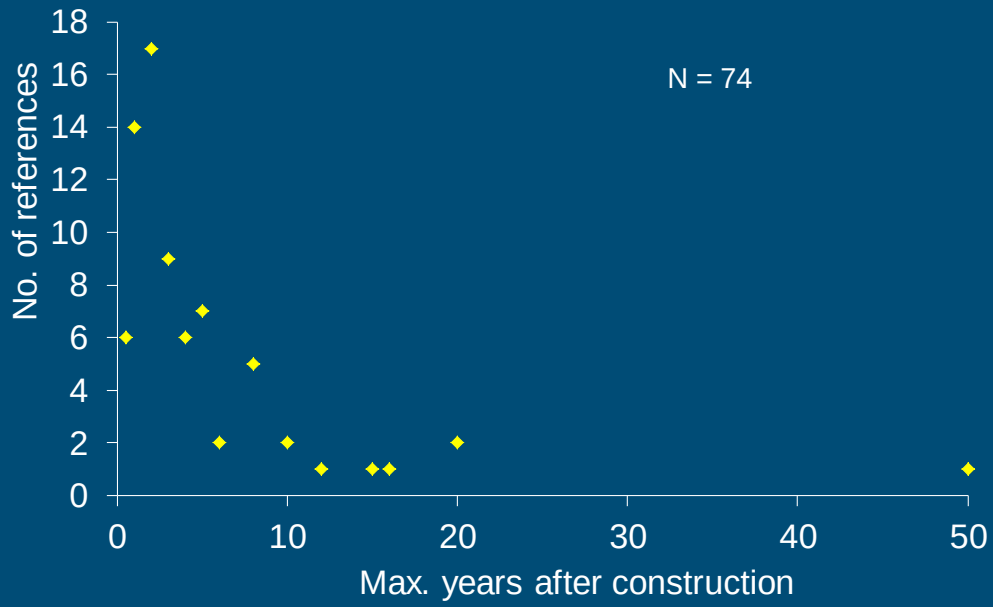
Instream habitat enhancement

Spatial and temporal scale



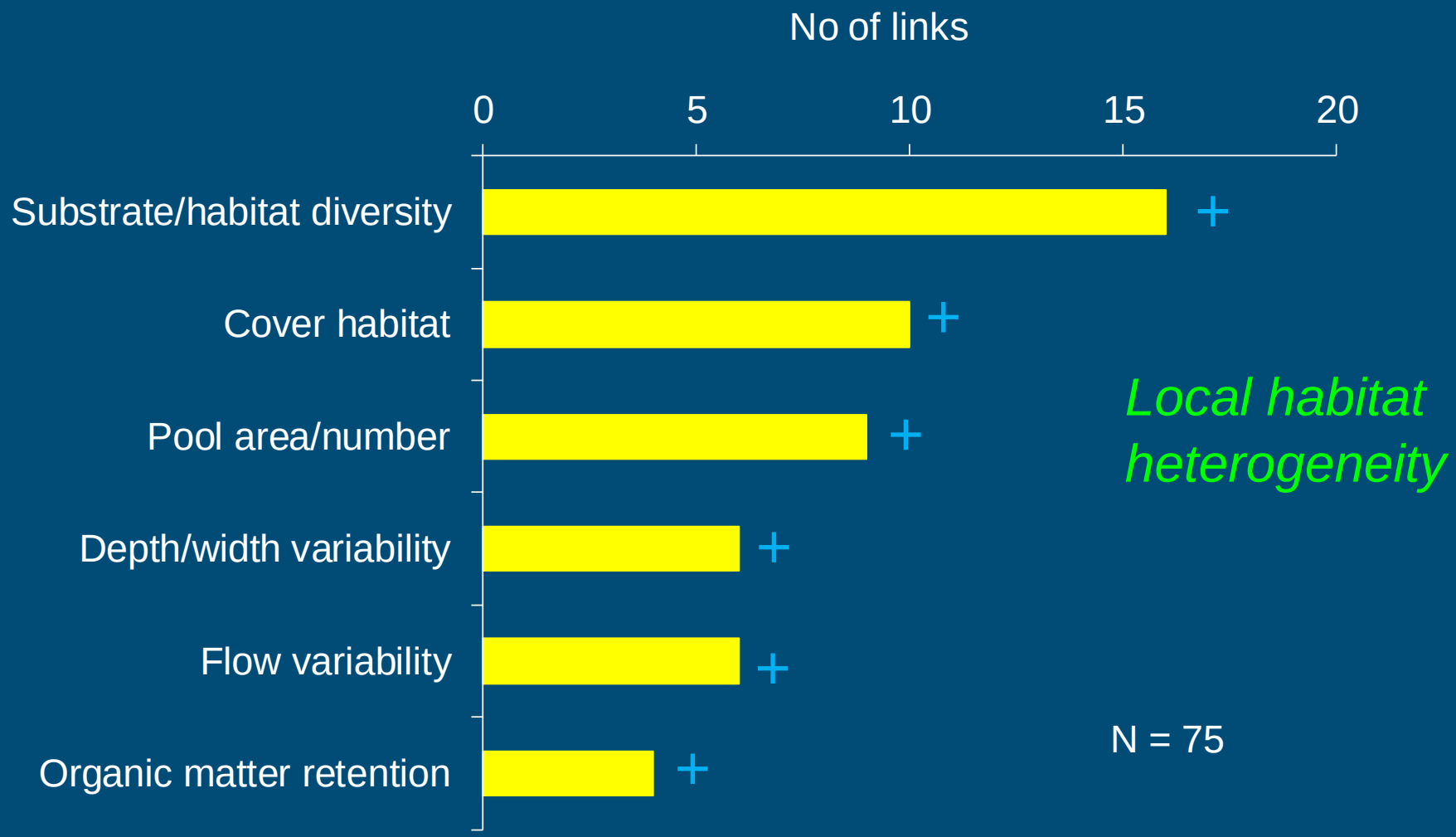
Often short stretches

Short monitored recovery time



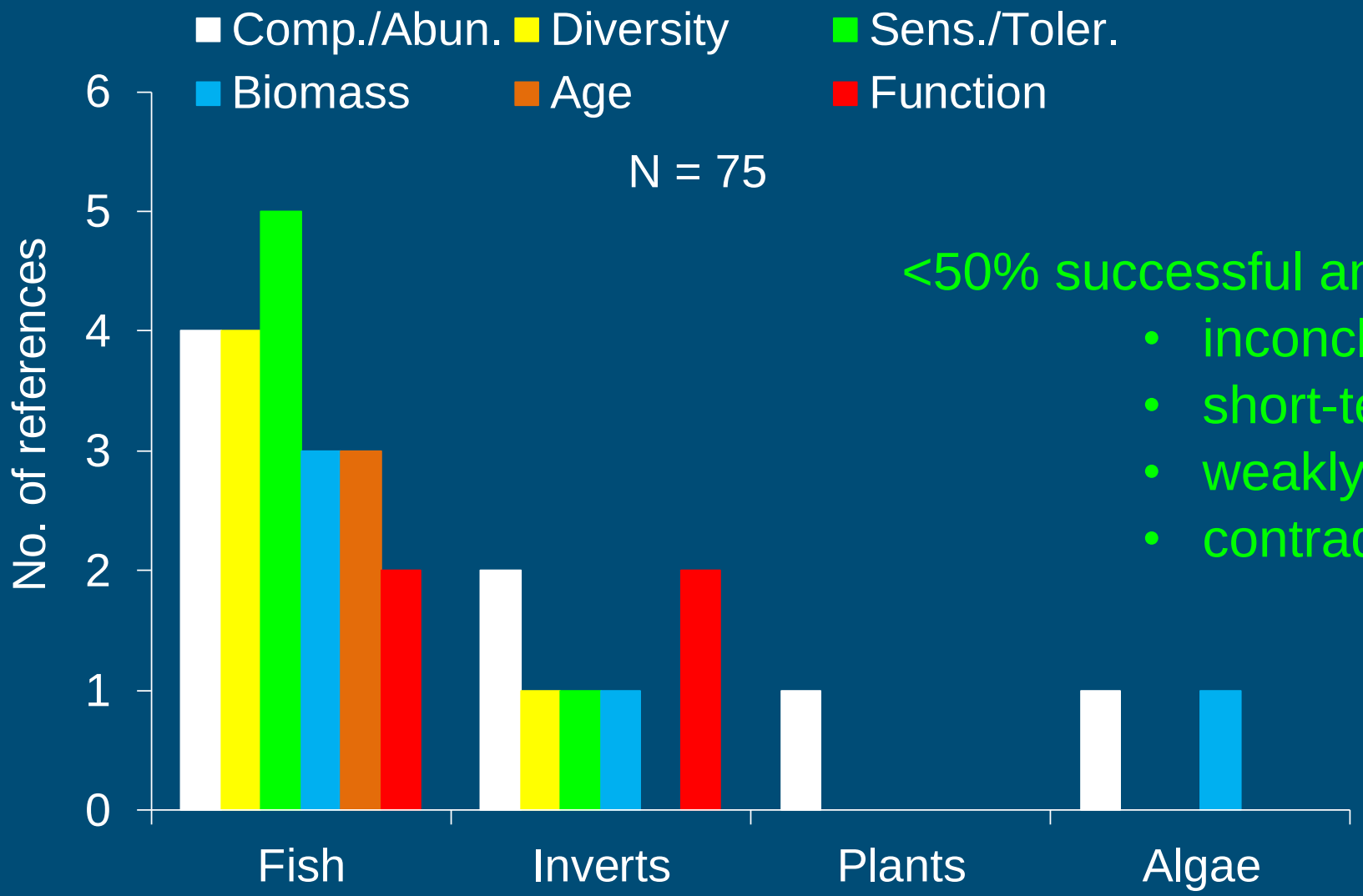
Instream habitat enhancement

Abiotic effects



Instream habitat enhancement

Biotic effects



<50% successful and these:

- inconclusive
- short-term
- weakly replicated
- contradicting

Instream habitat enhancement

Conclusions

Proven success factors:

- length restored stretch needs to be > 1.5 km (for fish)
- must be combined with riparian planting

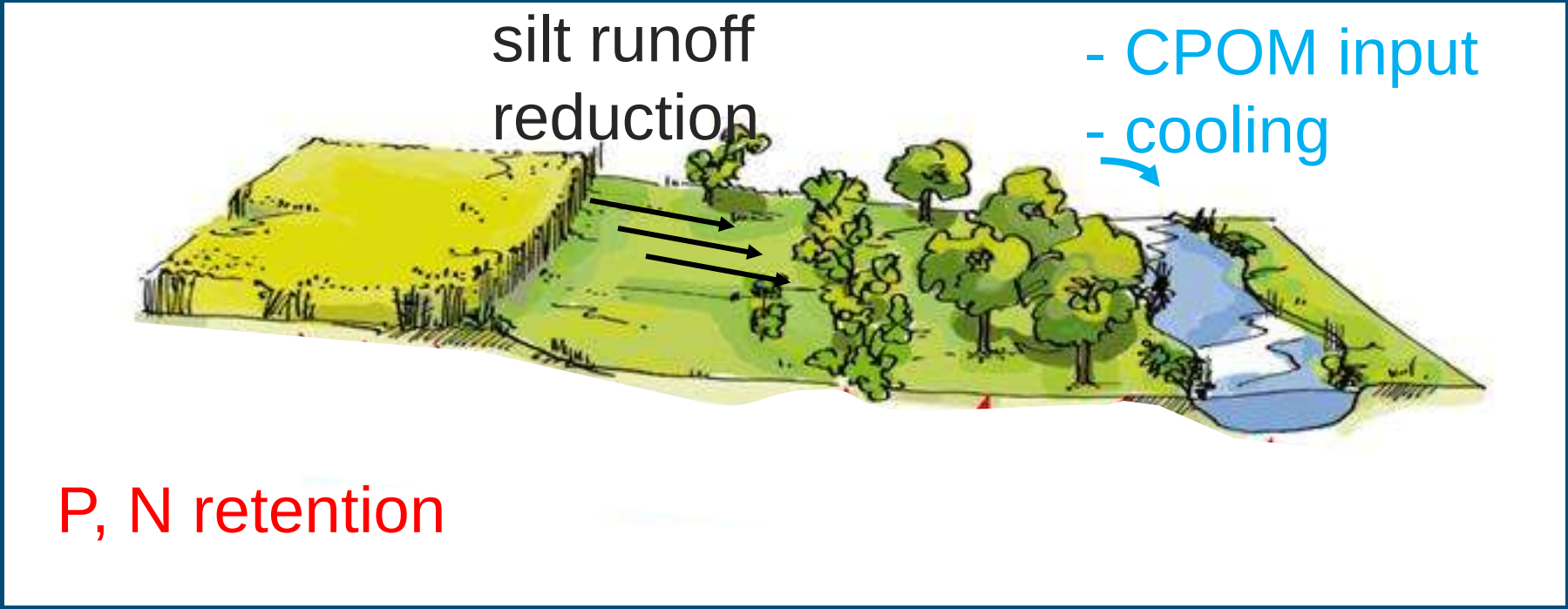
Limiting factors:

- inappropriate scaling of restoration
- inappropriate timing of and indicators in monitoring
- inappropriate implementation of ‘full’ restoration and presence multistressors (catchment deterioration / land use)
- confounding effects natural variability (monitoring design?)

Metadata analysis on stream restoration

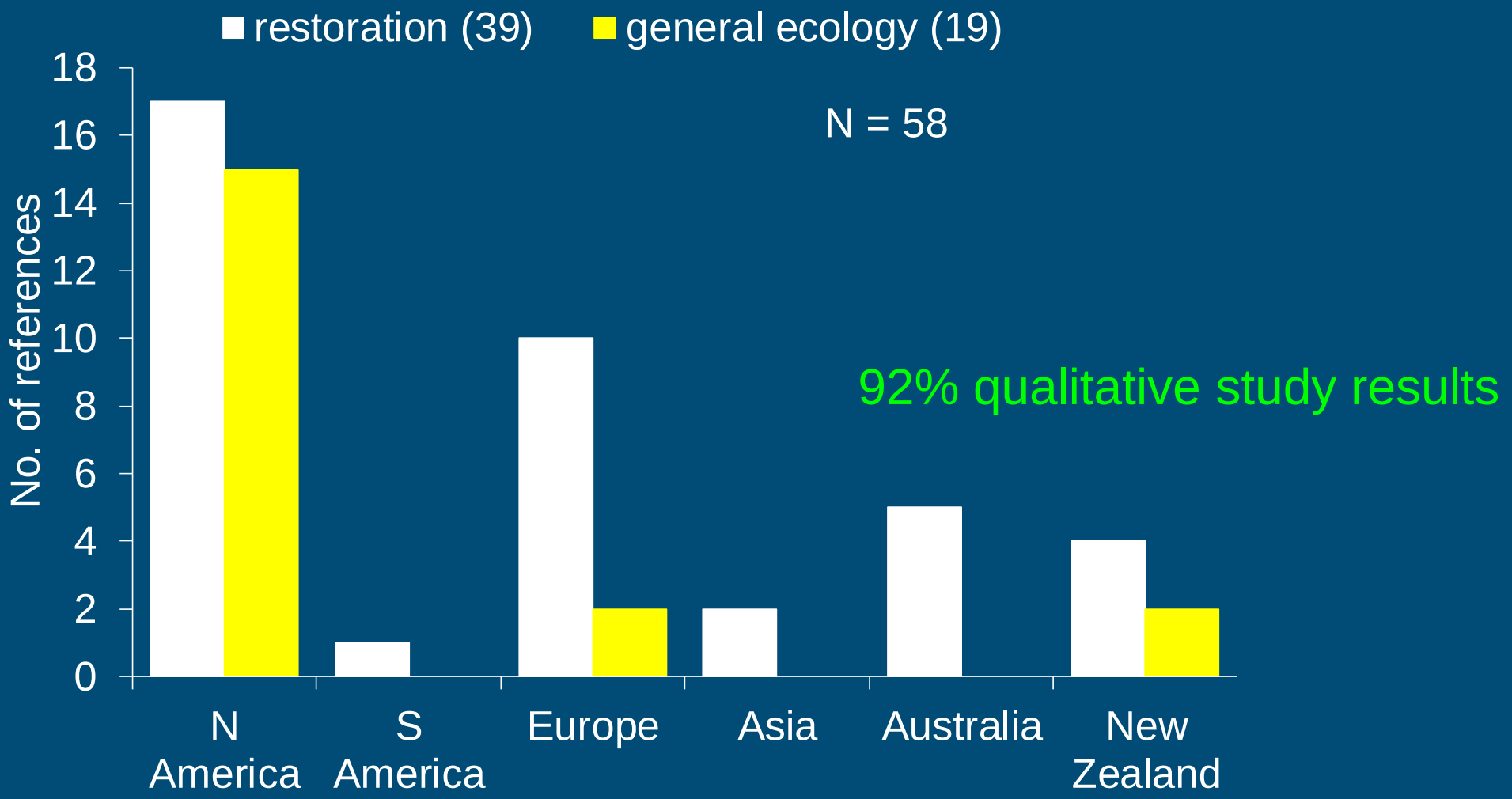
Example 2: Riparian buffer strip restoration

Positive ecosystem services of buffer strips



Riparian buffer strip restoration

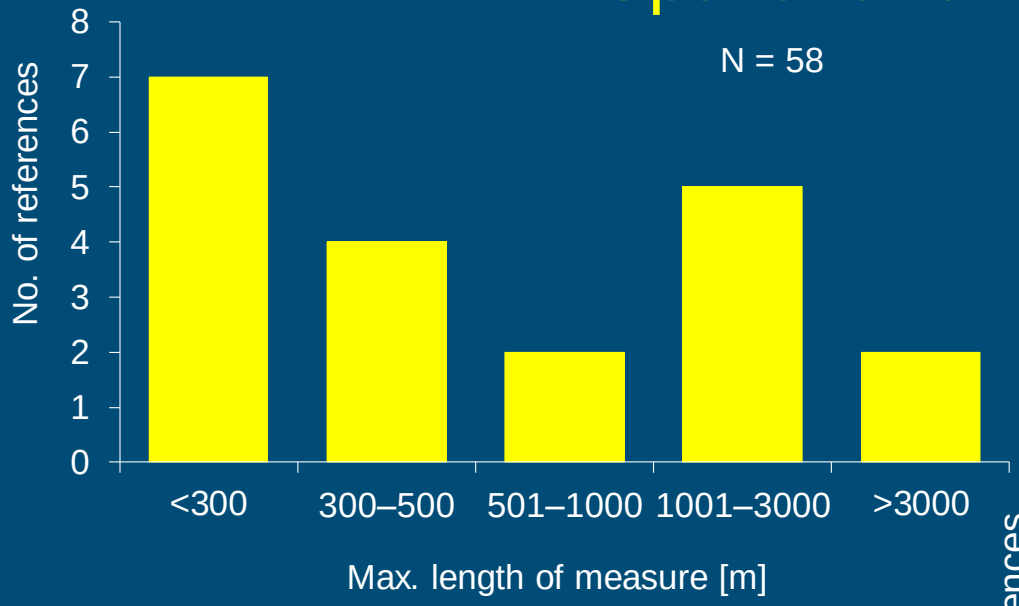
Geographic information distribution



92% qualitative study results

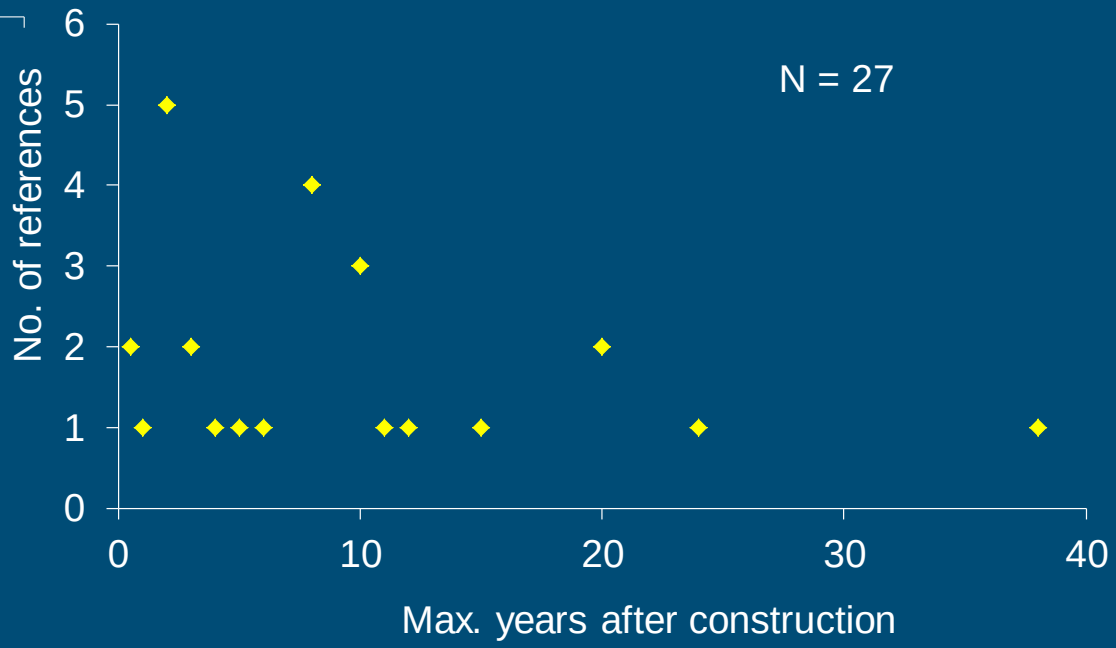
Riparian buffer strip restoration

Spatial and temporal scale



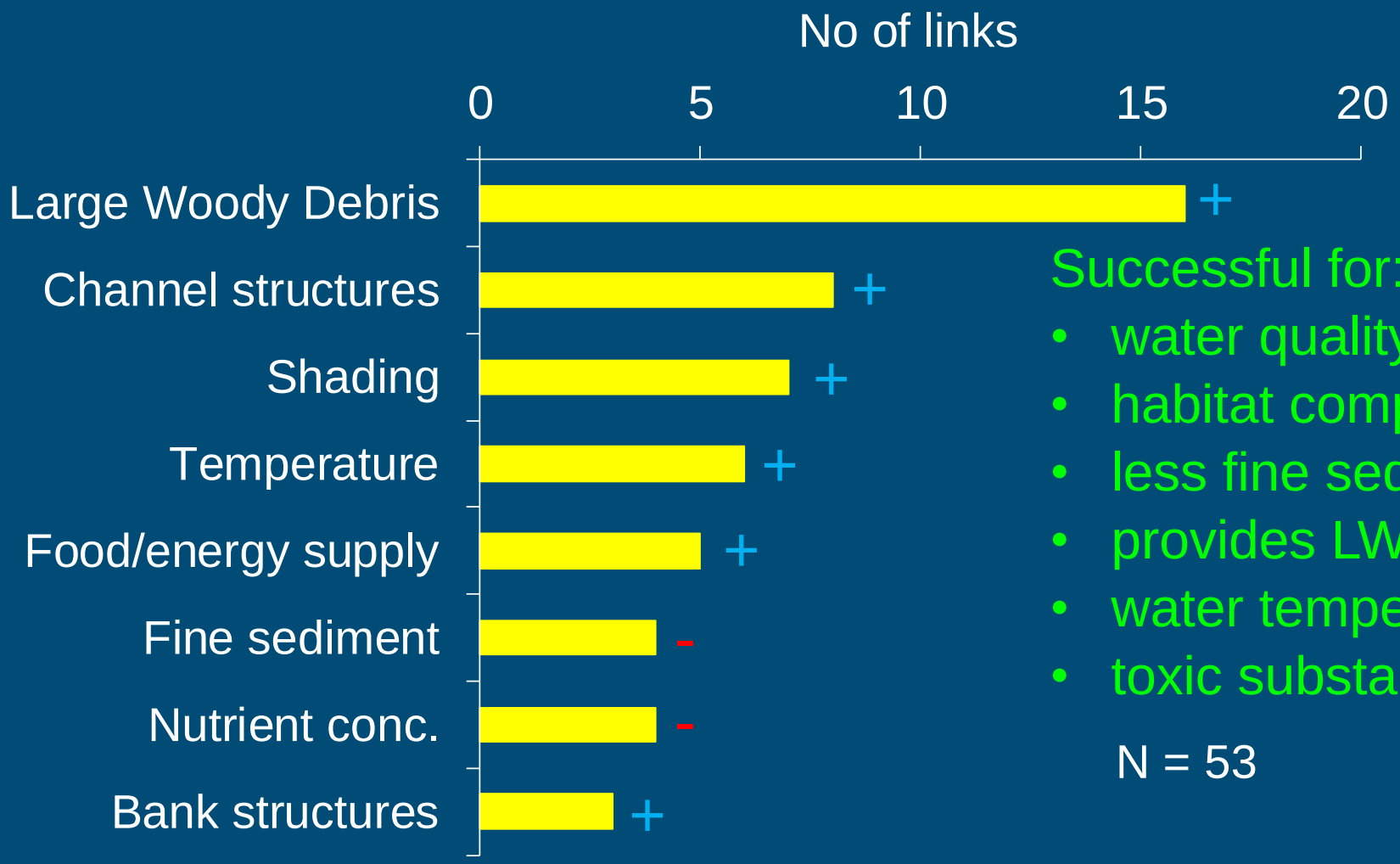
Often short stretches

Short monitored recovery time



Riparian buffer strip restoration

Abiotic effects



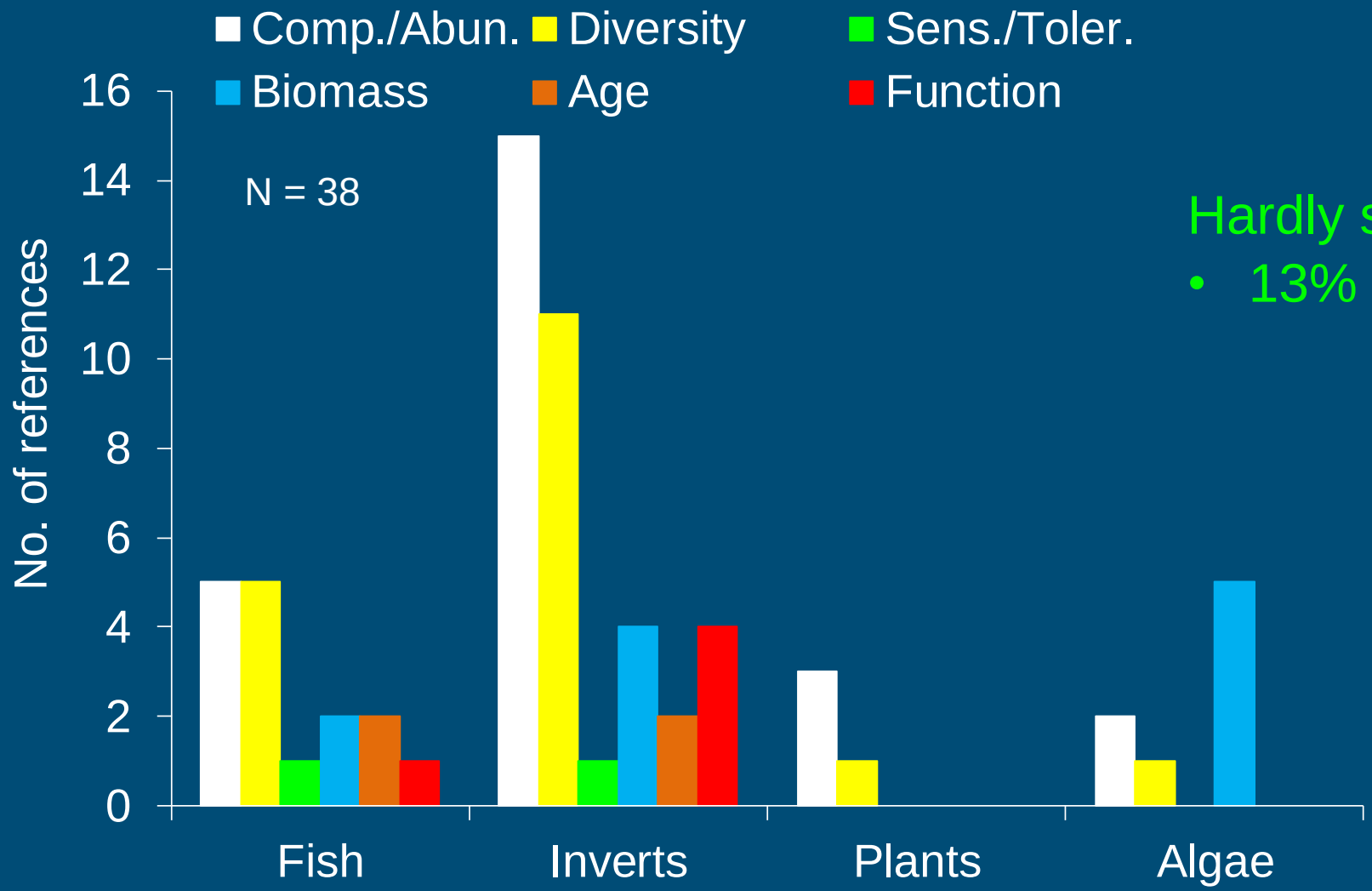
Successful for:

- water quality
- habitat complexity
- less fine sediments
- provides LWD
- water temperature
- toxic substances

N = 53

Riparian buffer strip restoration

Biotic effects



Hardly successful

- 13% effect

Riparian buffer strip restoration

Conclusions

Proven success factors:

- abiotic processes

Limiting factors:

- full grown tree stands need 30-40 yrs
- catchment / land use pressures (fine sediments)
- buffer size, age and gaps
- time to recover

Lessons from stream restoration

Conclusions

Proven success factors:

- abiotic processes more often
- biology in < 5-10% of all cases

Limiting factors:

- spatial scale: must be large enough (catchment)
- temporal scale: time needed for recovery
- multistressors: mostly one or a few stressor were tackled
- distance from source populations: dispersal limitations / connectivity

What more can we learn (from the past)?

Conceptual models: history

Cause-Effect Chains

Driver/Pressor

Impact

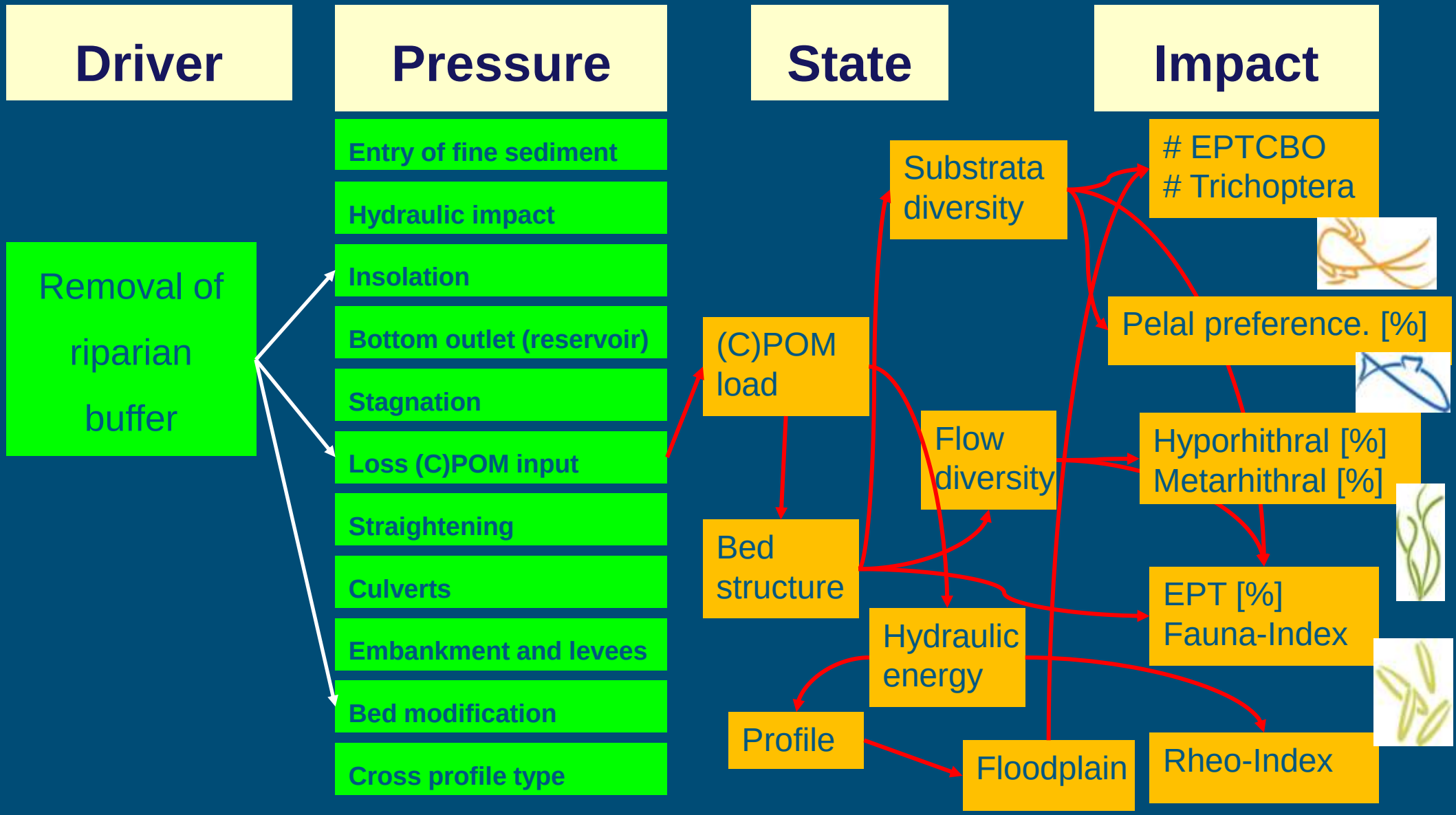
Response

eutrophication

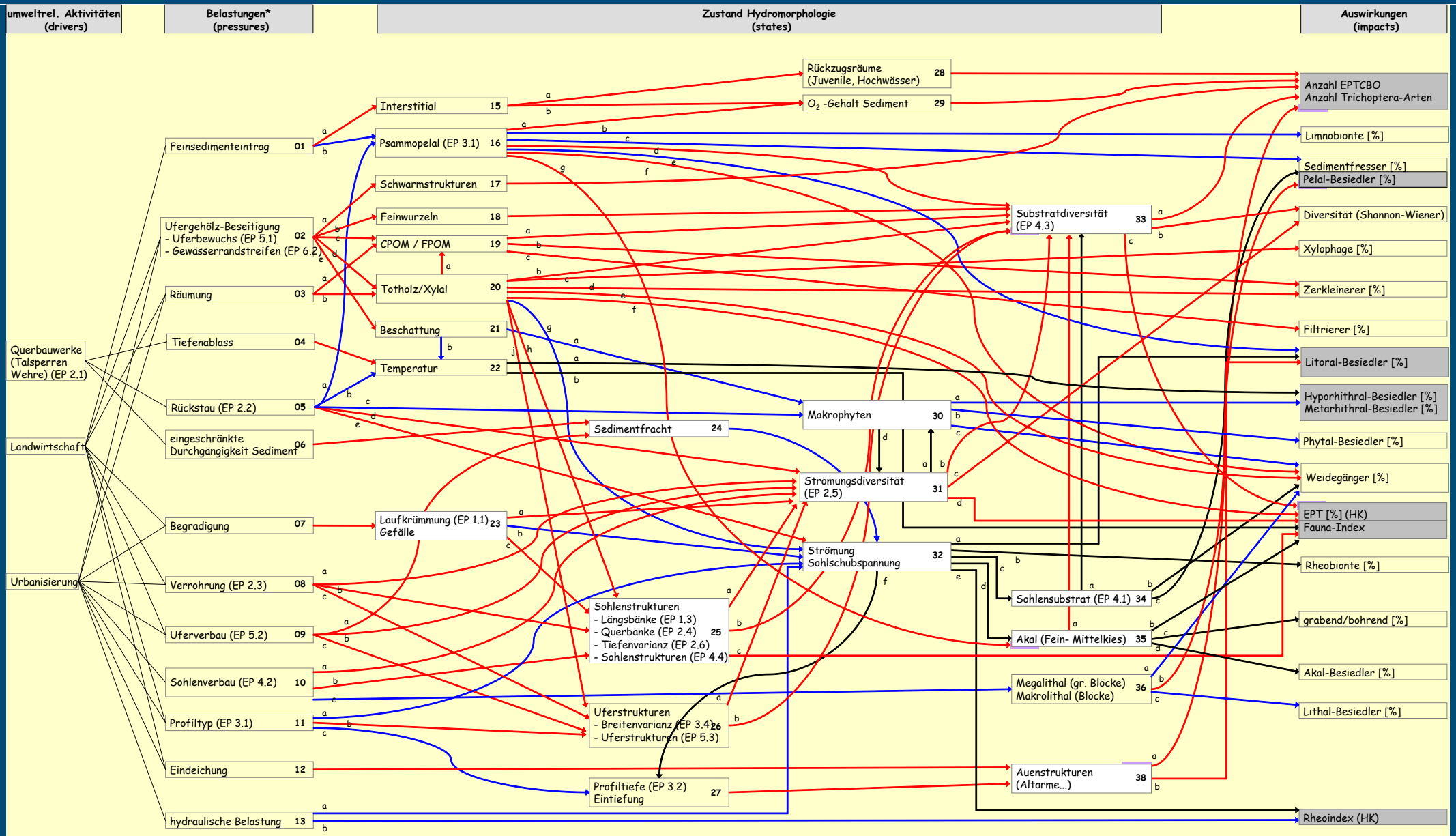
hydromorphological degradation

Module DIN 38410		good
Saprobic Index (SI)	2.21	good
Module Morphology		bad
Fauna Index type 15	-1.0	bad
[%] Littoral prefer.	16.6	bad
[%] Gath. collectors	38.0	poor
[%] Trichoptera	4.4	mod.
[%] Rheophilic taxa	5.9	bad
[%] Pelal prefer.	5.4	poor

Example: existing knowledge hydromorphology



Example: reality of interactions



Conceptual models: including restoration

Response-Recovery Chain

Impact/Response

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pre

Restoration

local scale

post

Recovery

Module DIN 38410		good
Saprobic Index (SI)	2.21	good
Module Morphology		good
Fauna Index type 15	+1.6	good
[%] Littoral prefer.	3.6	good
[%] Gath. collectors	8.0	high
[%] Trichoptera	24.4	high.
[%] Rheophilic taxa	56.9	good
[%] Pelal prefer.	1.4	high

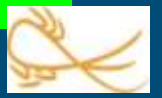
catchment scale

Pressure reduction

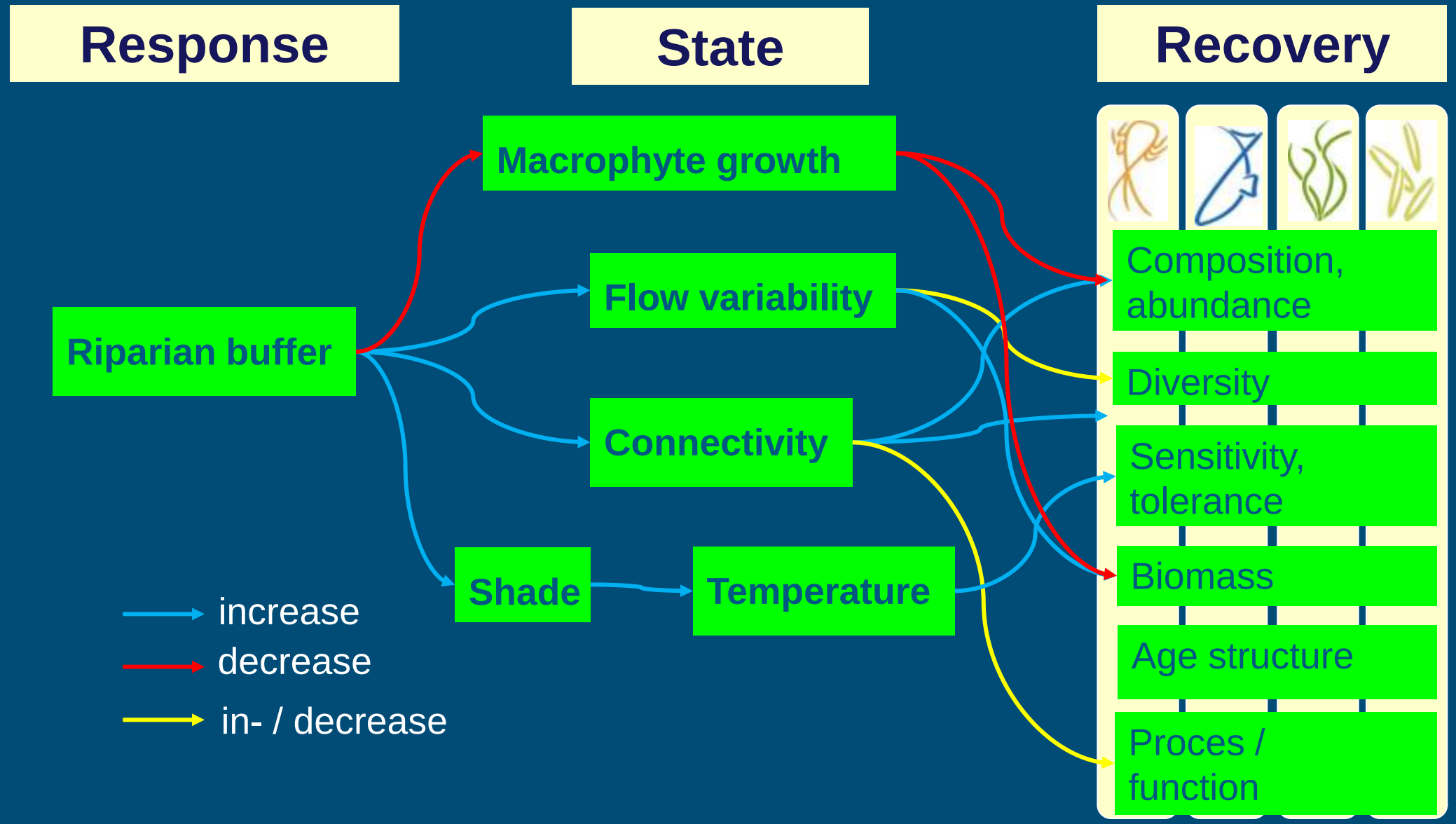
Example: hydromorphology

Driver	Pressure reduction	Response	Recovery
Installing riparian buffer	Entry of sediments Hydraulic impact Shading Flow variation Erosion-sedimentation (C)POM input Meandering Connectivity Dry-wet gradients Bed variation Cross profile variability	What do we know?	# EPTCBO # Trichoptera Pelal pref. [%] Hyporhithral [%] Metarhithral [%] EPT [%] Fauna-Index Rheo-Index

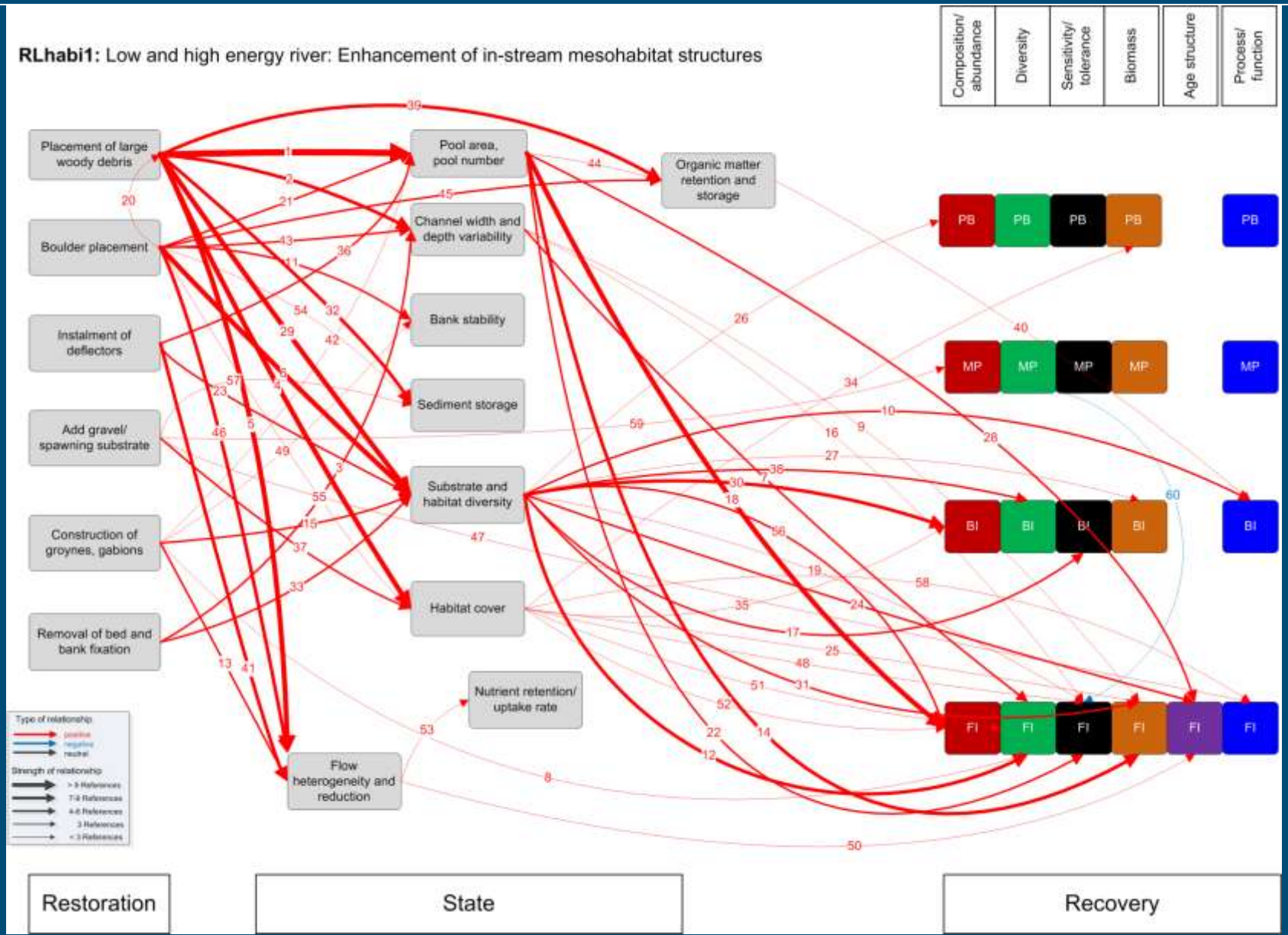
What can we use from degradation knowledge?




Example: hydromorphology



Example: hydromorphology



Stream restoration: the future?

Conclusions

- Degradation ≠ Restoration
- Knowledge progress is limited and is mainly qualitative descriptive
- Little quantified knowledge available on recovery processes
- (Some) knowledge can be extracted from degradation processes

Needs

- Well designed BACI monitoring of restoration (few stressors)
- Monitoring over a long time after
- Quantified knowledge on thresholds