

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

“Looking for progress in stream restoration”



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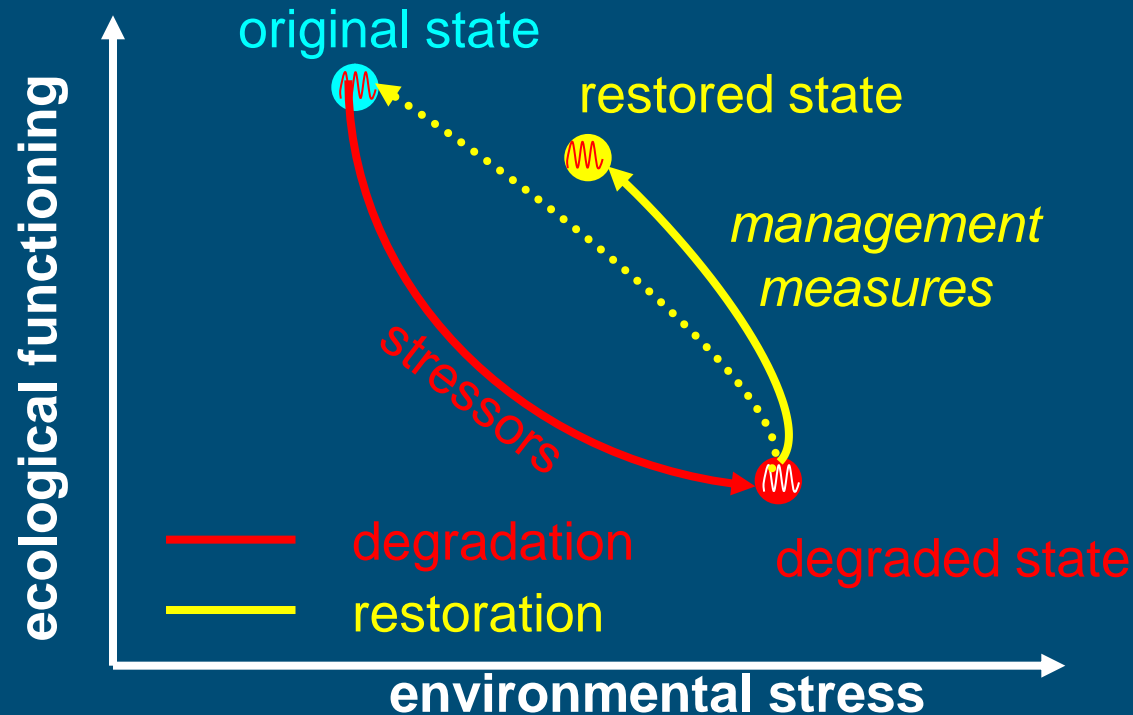


# From natural to degraded rivers and back again:

## A test on ecology theory and practice

Feld et al 2011

Can restoration learn from degradation?



Despite restoration  $\neq$  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



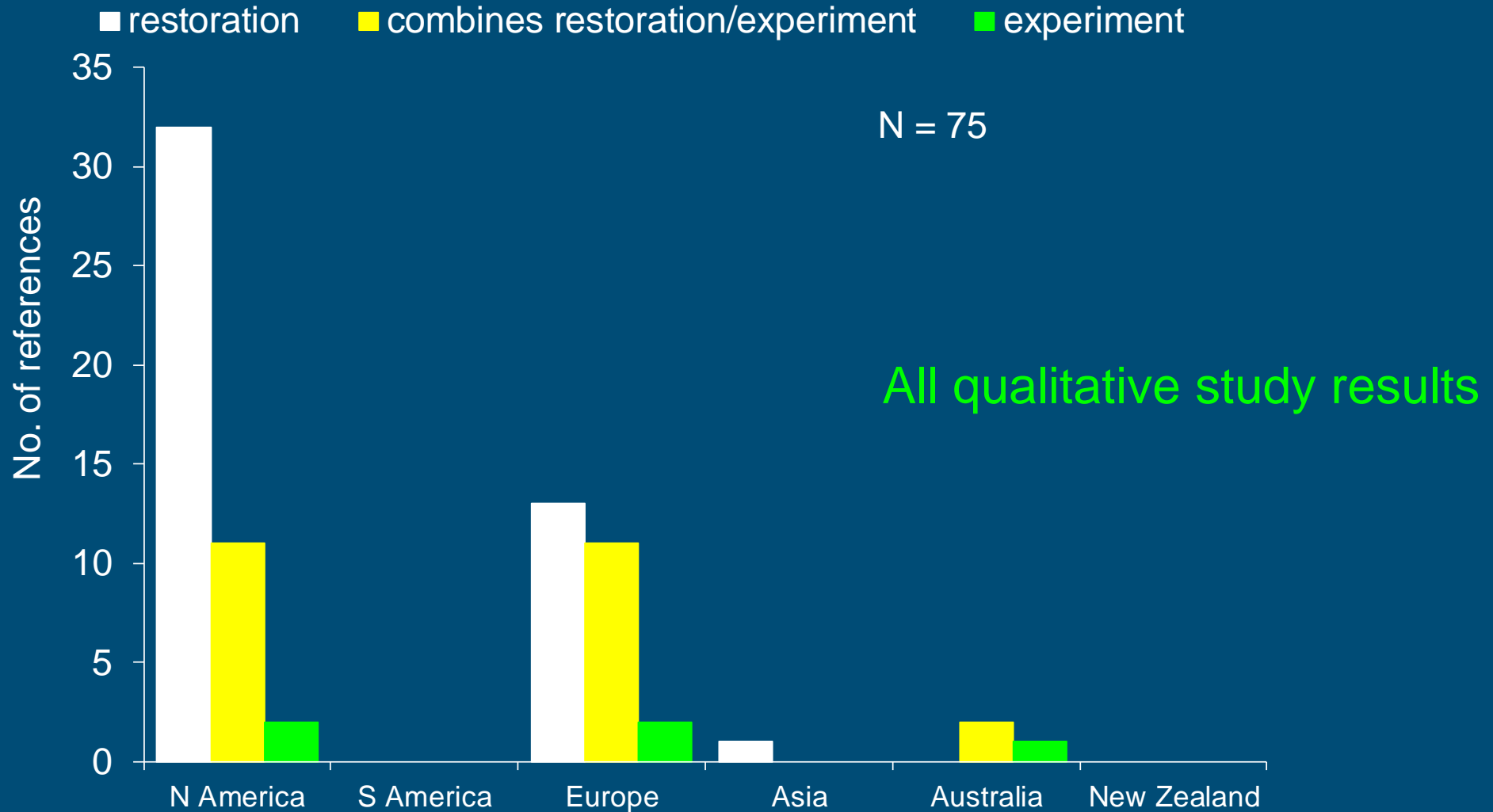
# Instream habitat enhancement

## Example 1: Large Woody Debris (LWD) addition



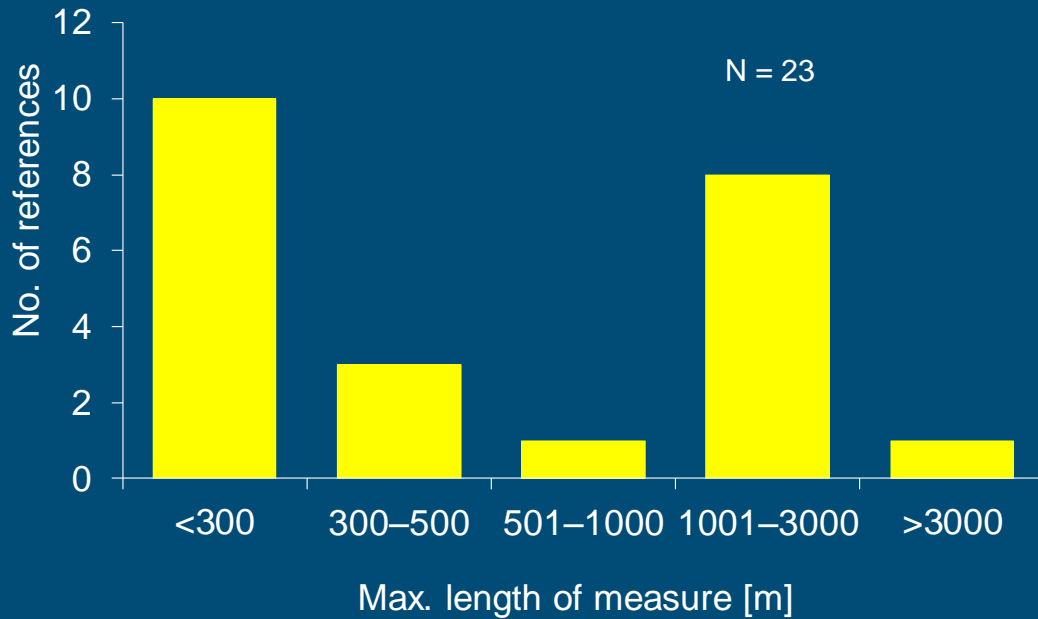
# Instream habitat enhancement

## Geographic information distribution



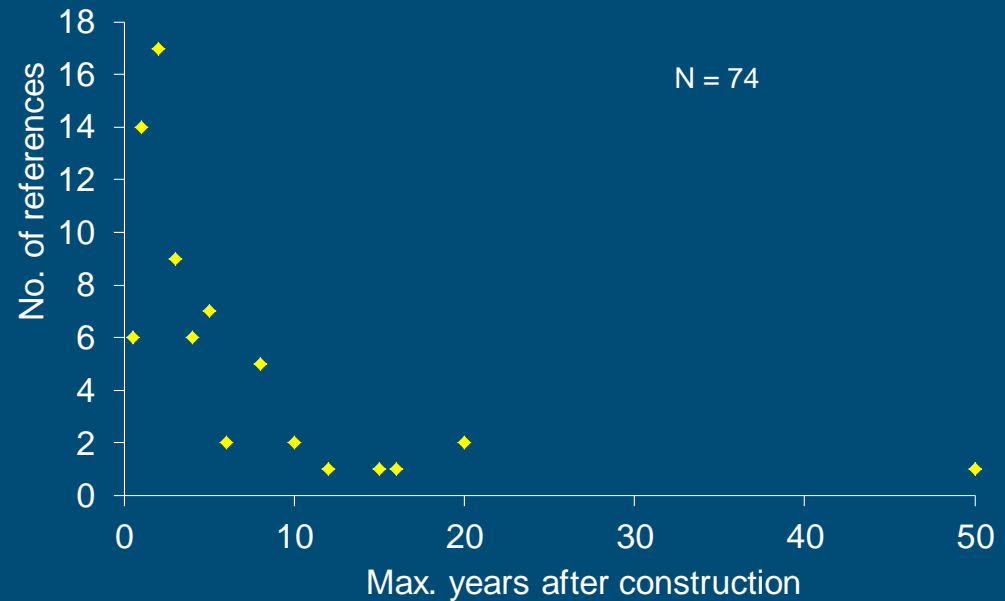
# Instream habitat enhancement

## Spatial and temporal scale



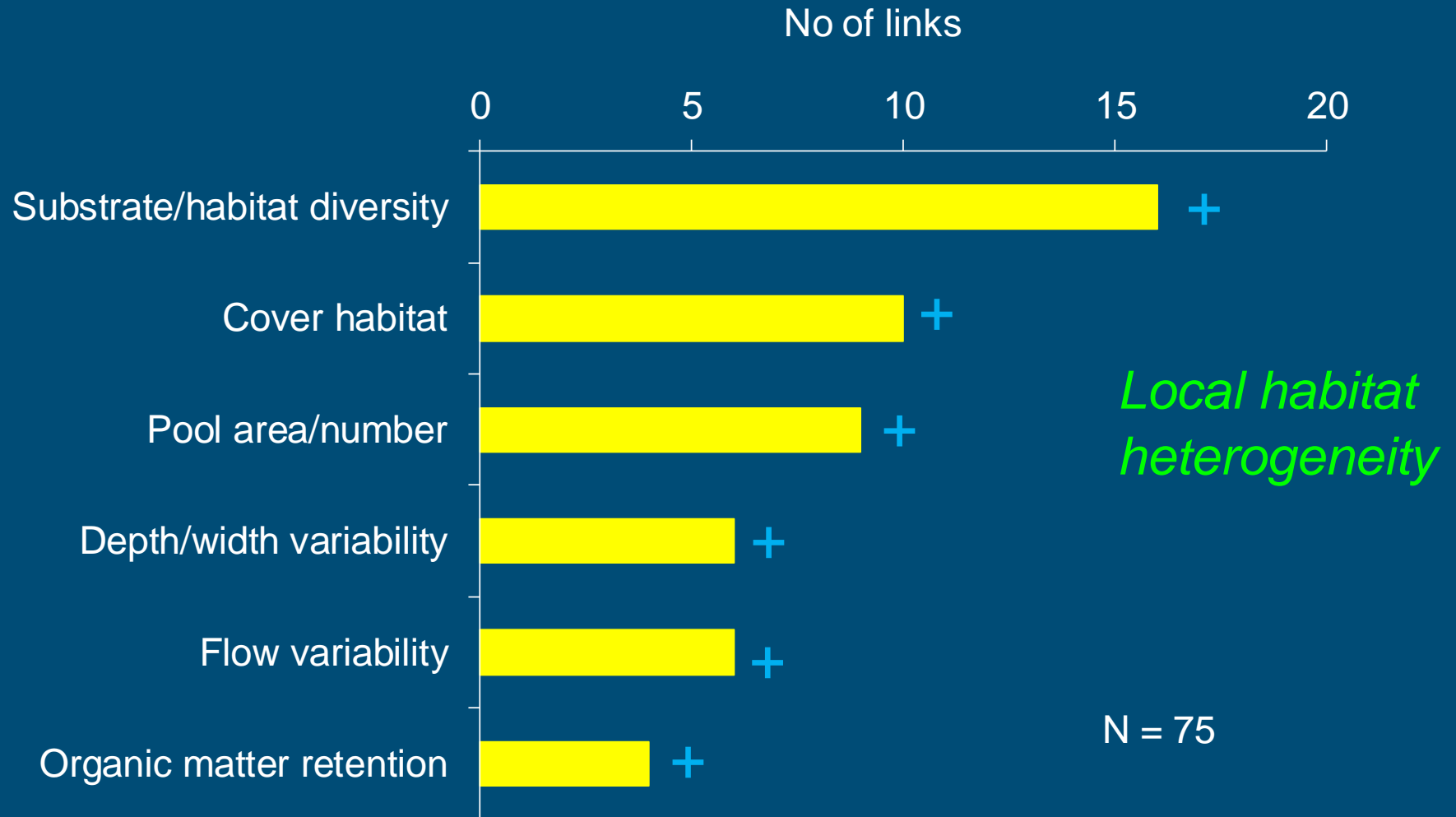
*Often short stretches*

*Short monitored recovery time*



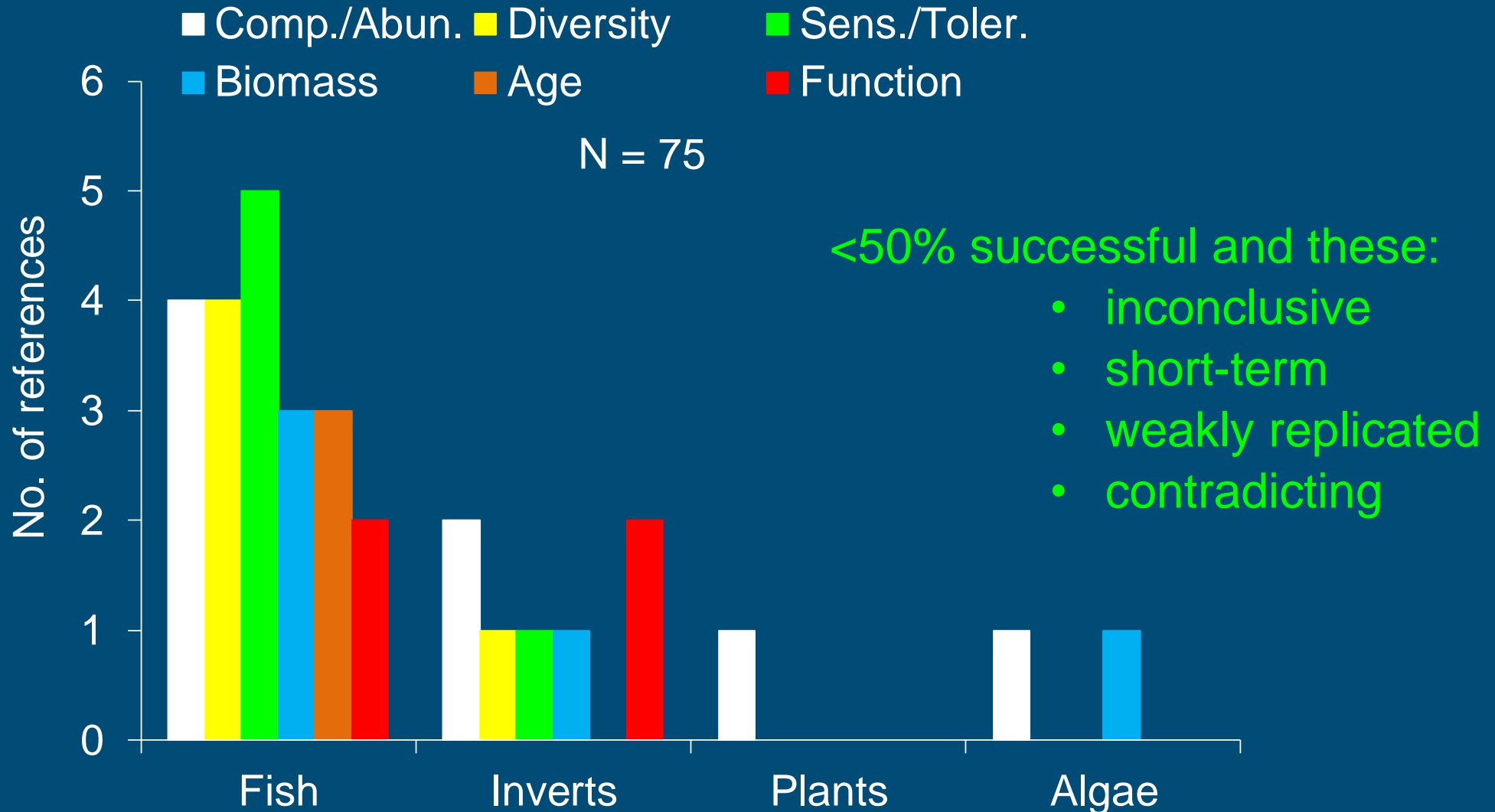
# Instream habitat enhancement

## Abiotic effects



# Instream habitat enhancement

## Biotic effects



# Instream habitat enhancement

## Conclusions

### *Proven success factors:*

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

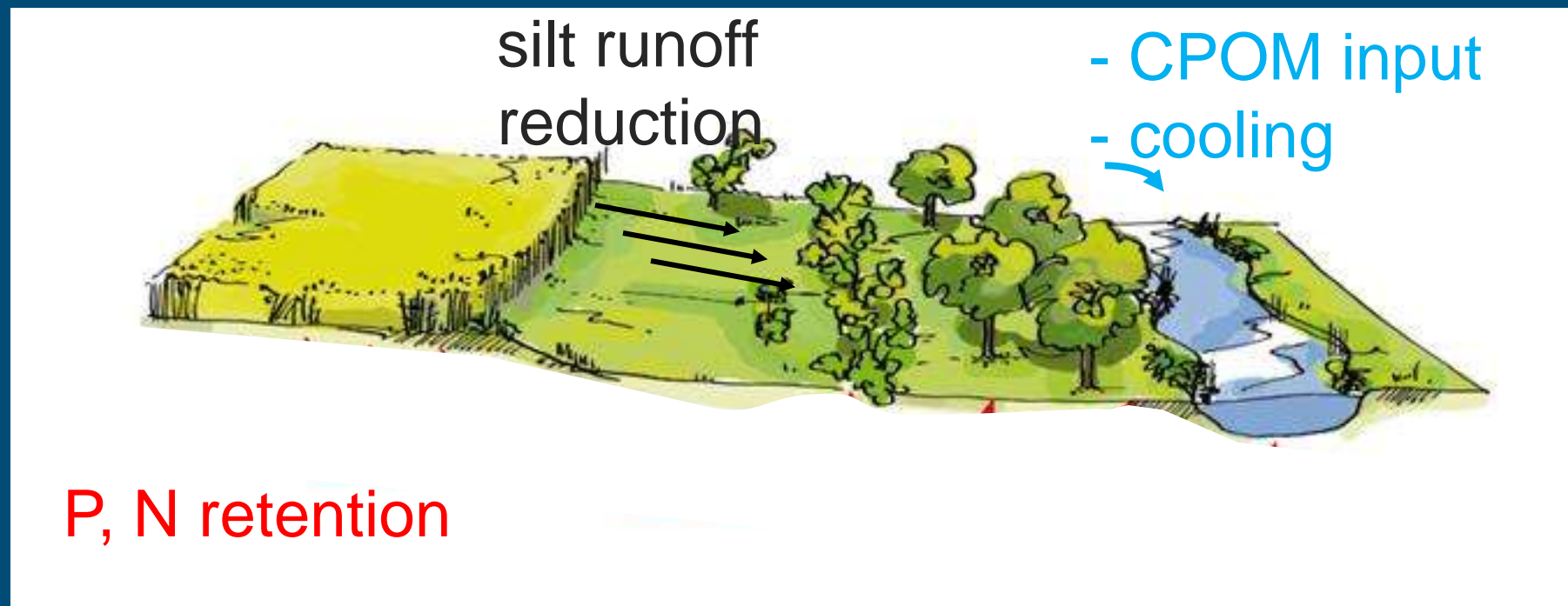
### *Limiting factors:*

- 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

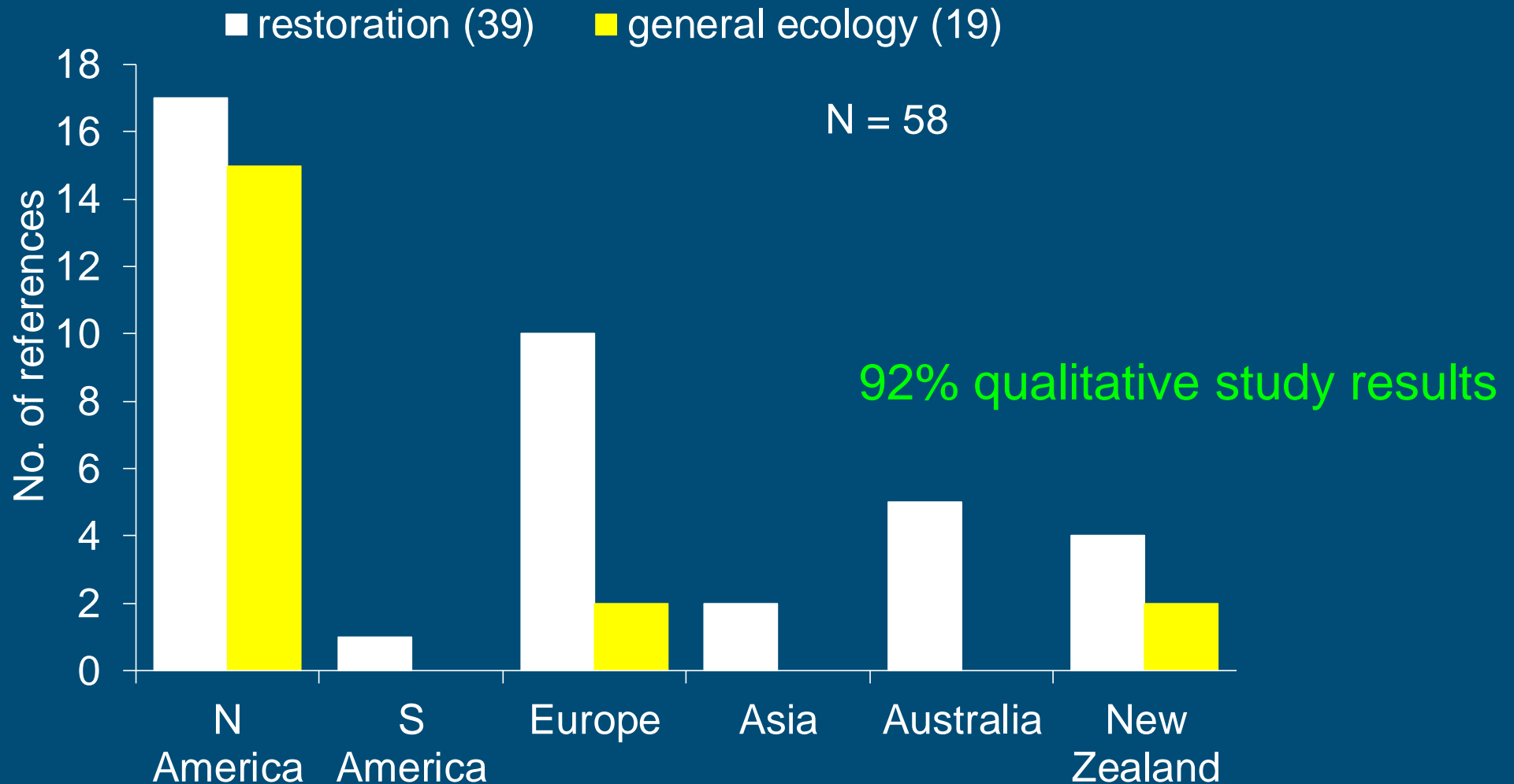
## Example 2: Riparian buffer strip restoration

### Positive ecosystem services of buffer strips



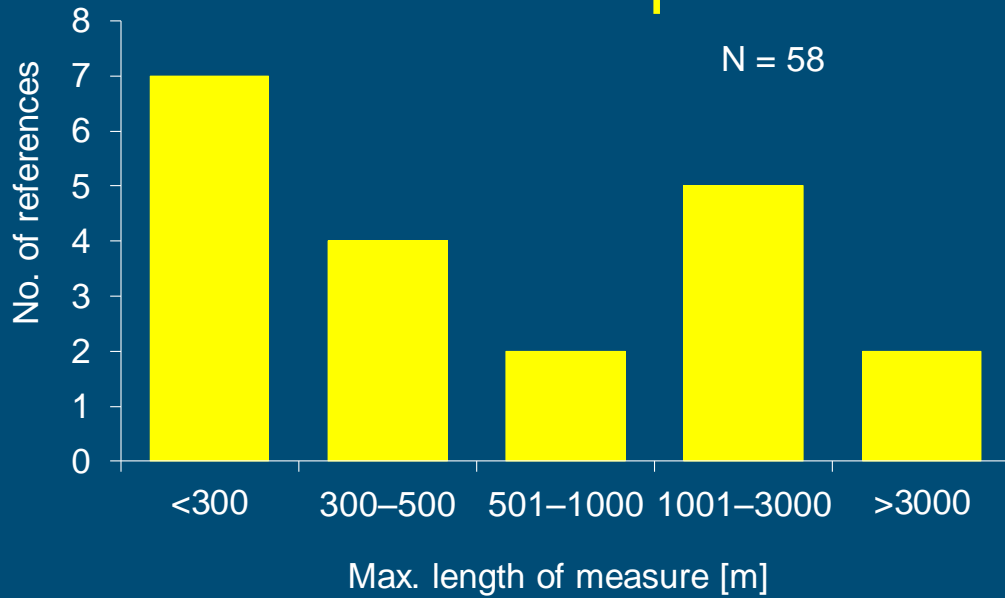
# Riparian buffer strip restoration

## Geographic information distribution



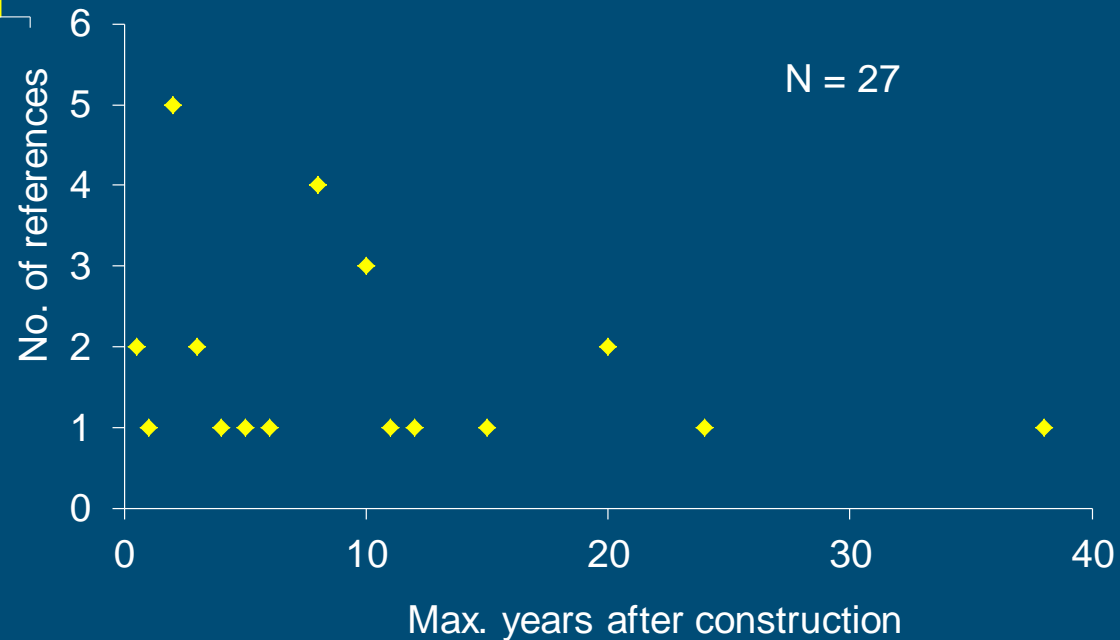
# Riparian buffer strip restoration

## Spatial and temporal scale



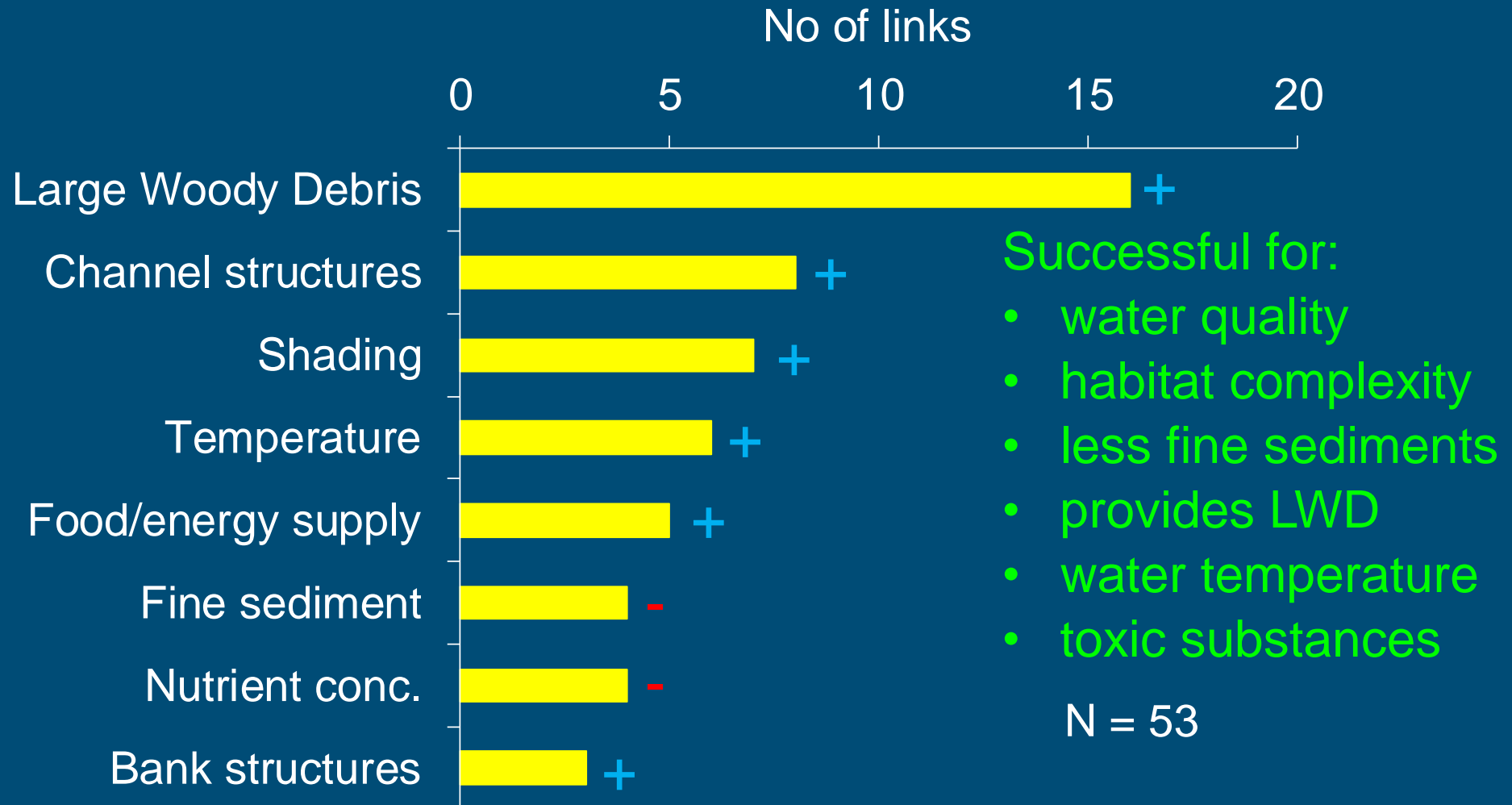
*Often short stretches*

*Short monitored recovery time*



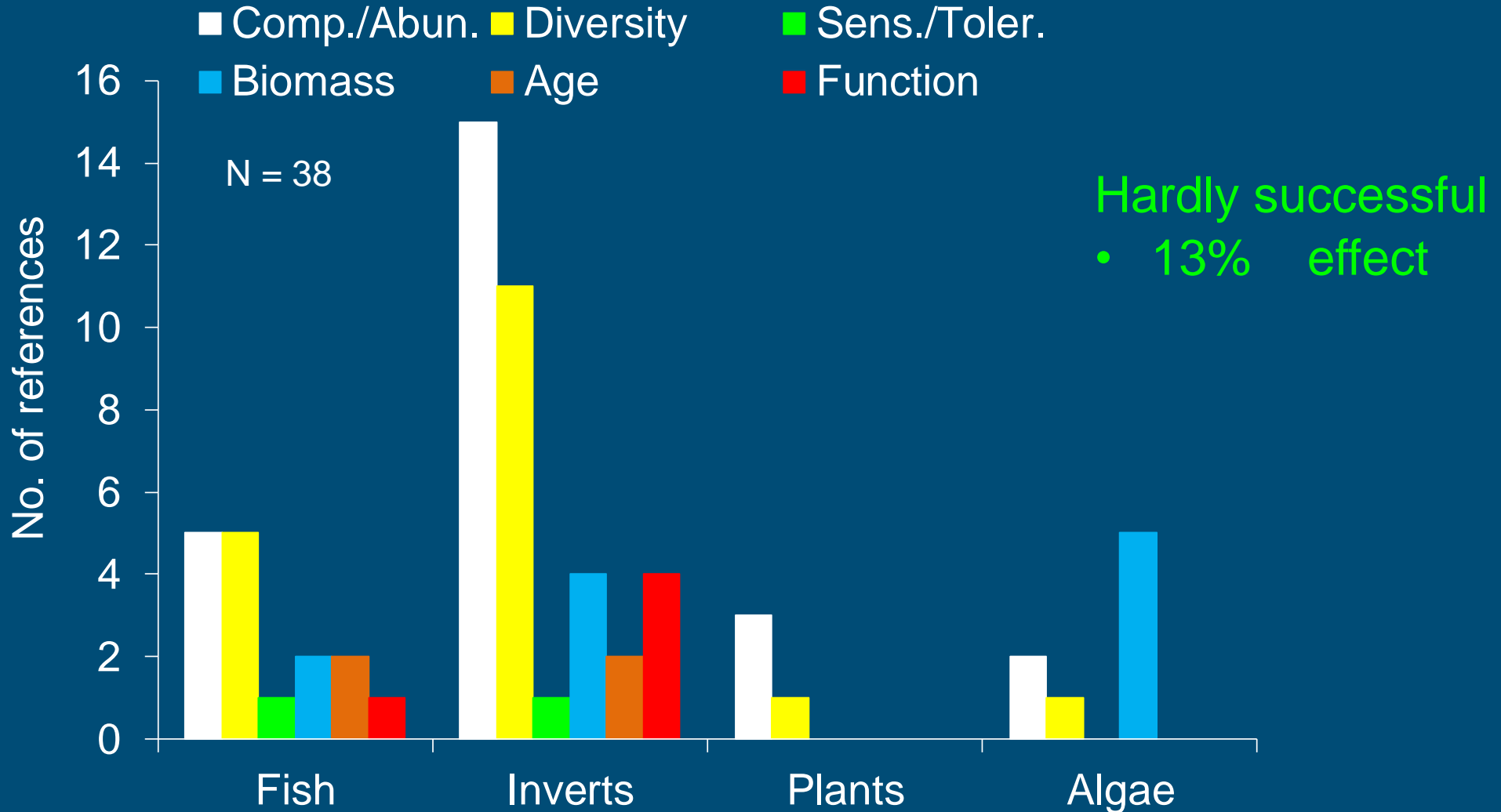
# Riparian buffer strip restoration

## Abiotic effects



# Riparian buffer strip restoration

## Biotic effects



# 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



eutrophication

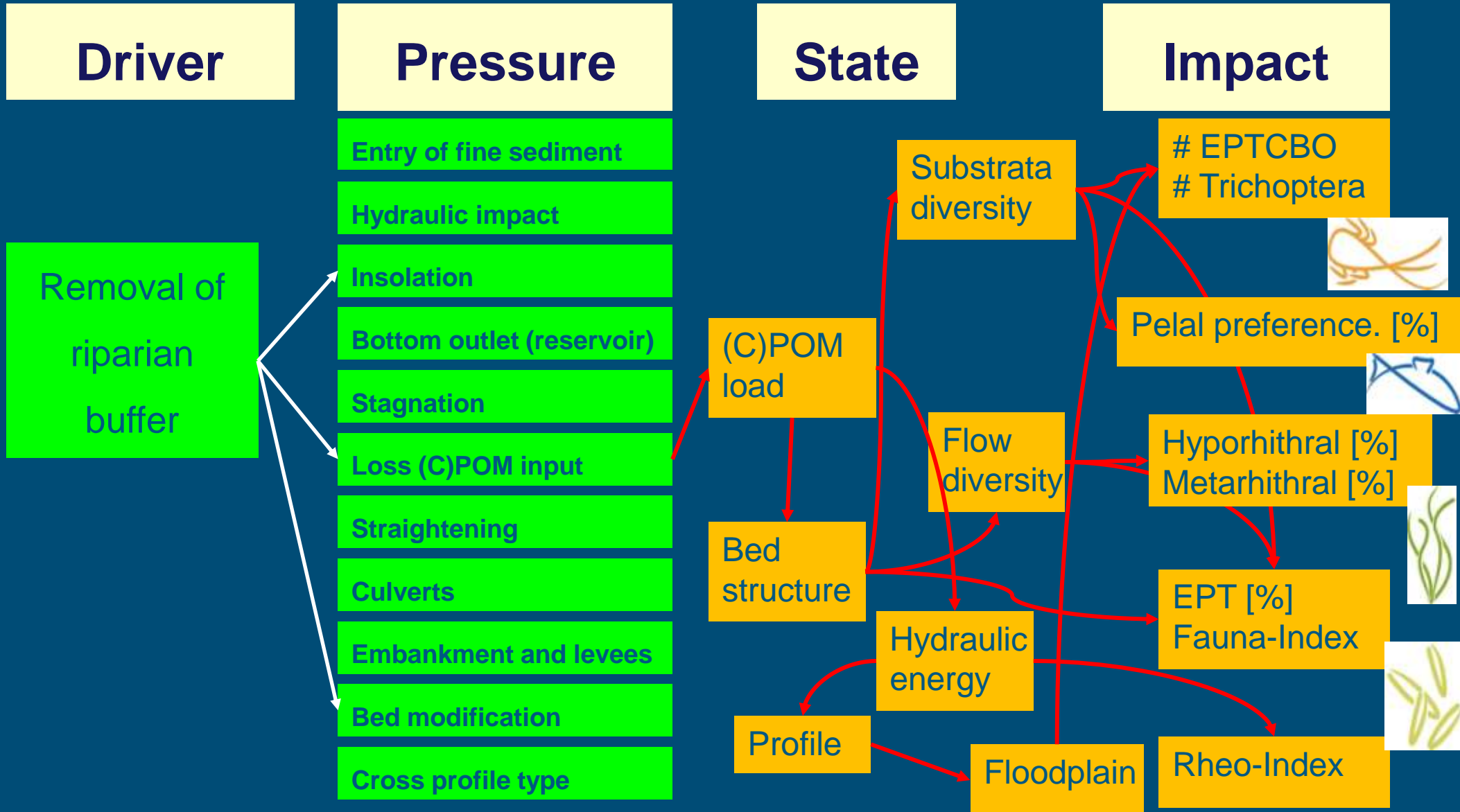
Response



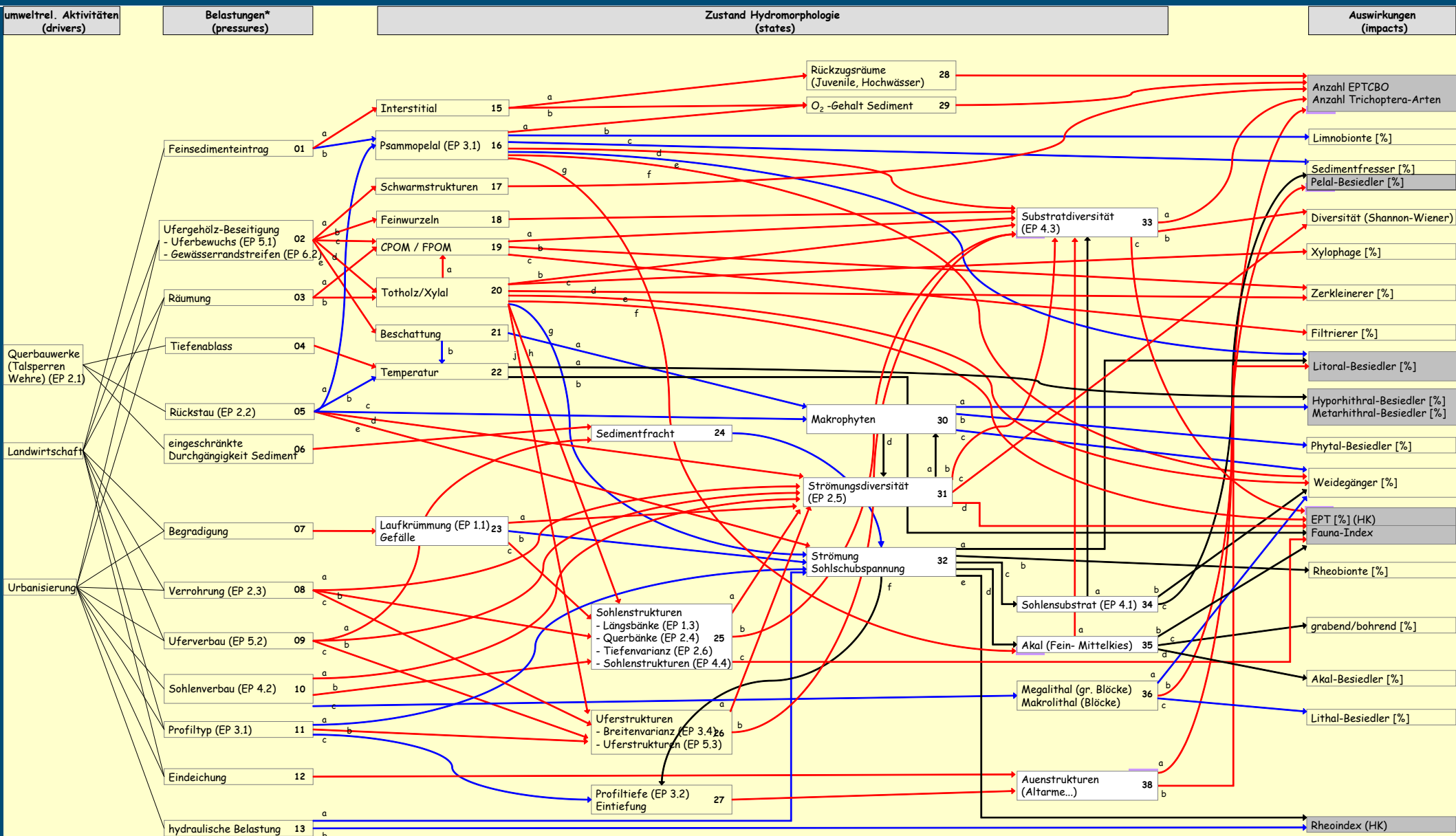
hydromorphological degradation

|                      |      |      |
|----------------------|------|------|
| 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

Restoration

Recovery



pre



post



|                      |      |      |
|----------------------|------|------|
| Module DIN 38410     |      | good |
| Saprobic Index (SI)  | 2.21 | good |
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catchment scale

|                      |      |       |
|----------------------|------|-------|
| 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  |

Pressure reduction



# Example: hydromorphology

**Driver**

**Pressure  
reduction**

**Response**

**Recovery**

Installing  
riparian  
buffer

Entry of sediments

Hydraulic impact

Shading

Flow variation

Erosion/sedimentation

TPOM input

Meandering

Connectivity

Dry-wet gradients

Bed variation

Cross profile variability

# EPTCBO  
# Trichoptera



Pelal pref. [%]



Hyporhithral [%]  
Metarhithral [%]



EPT [%]  
Fauna-Index

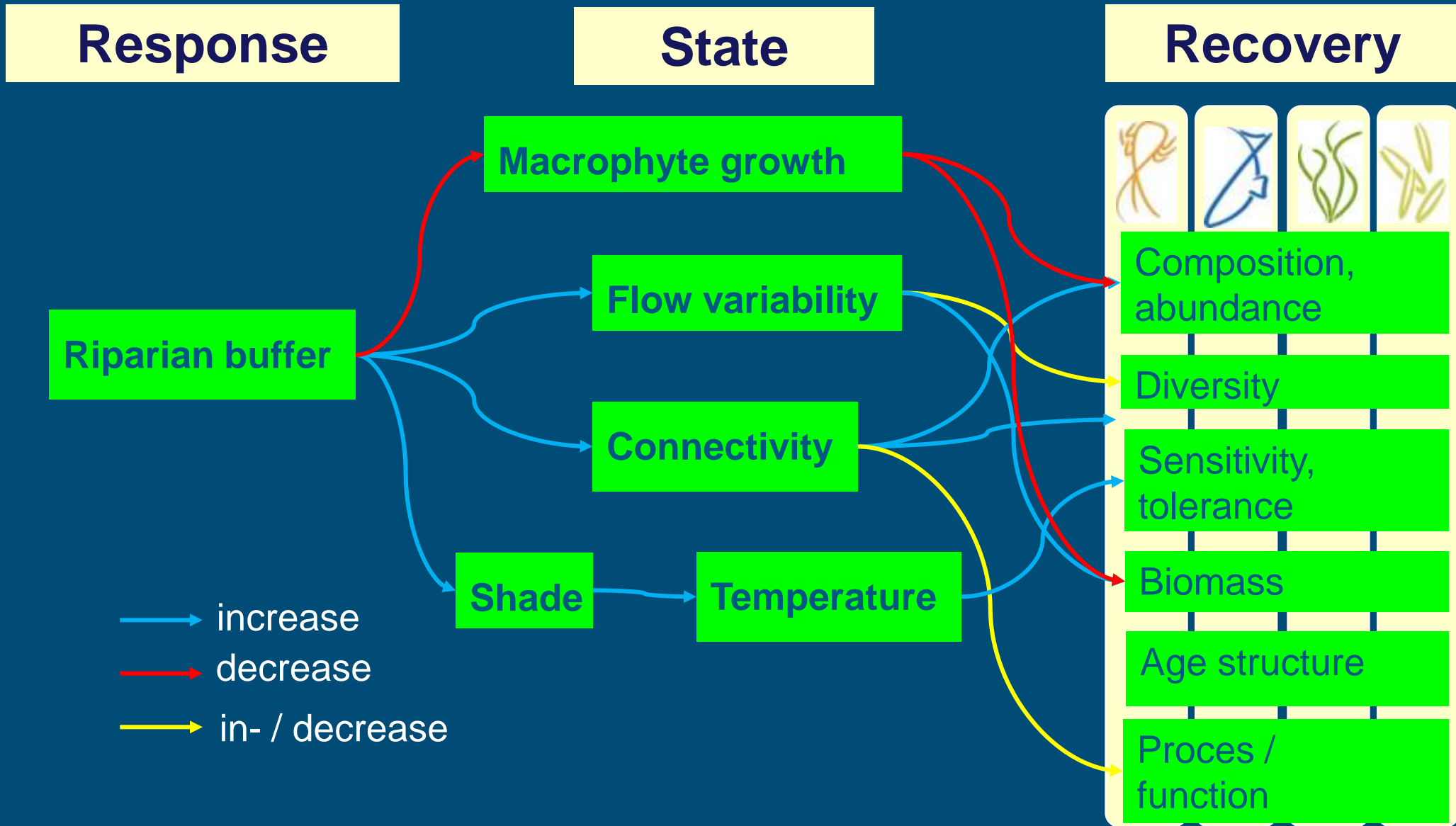
Rheo-Index



What can we use from  
degradation knowledge?

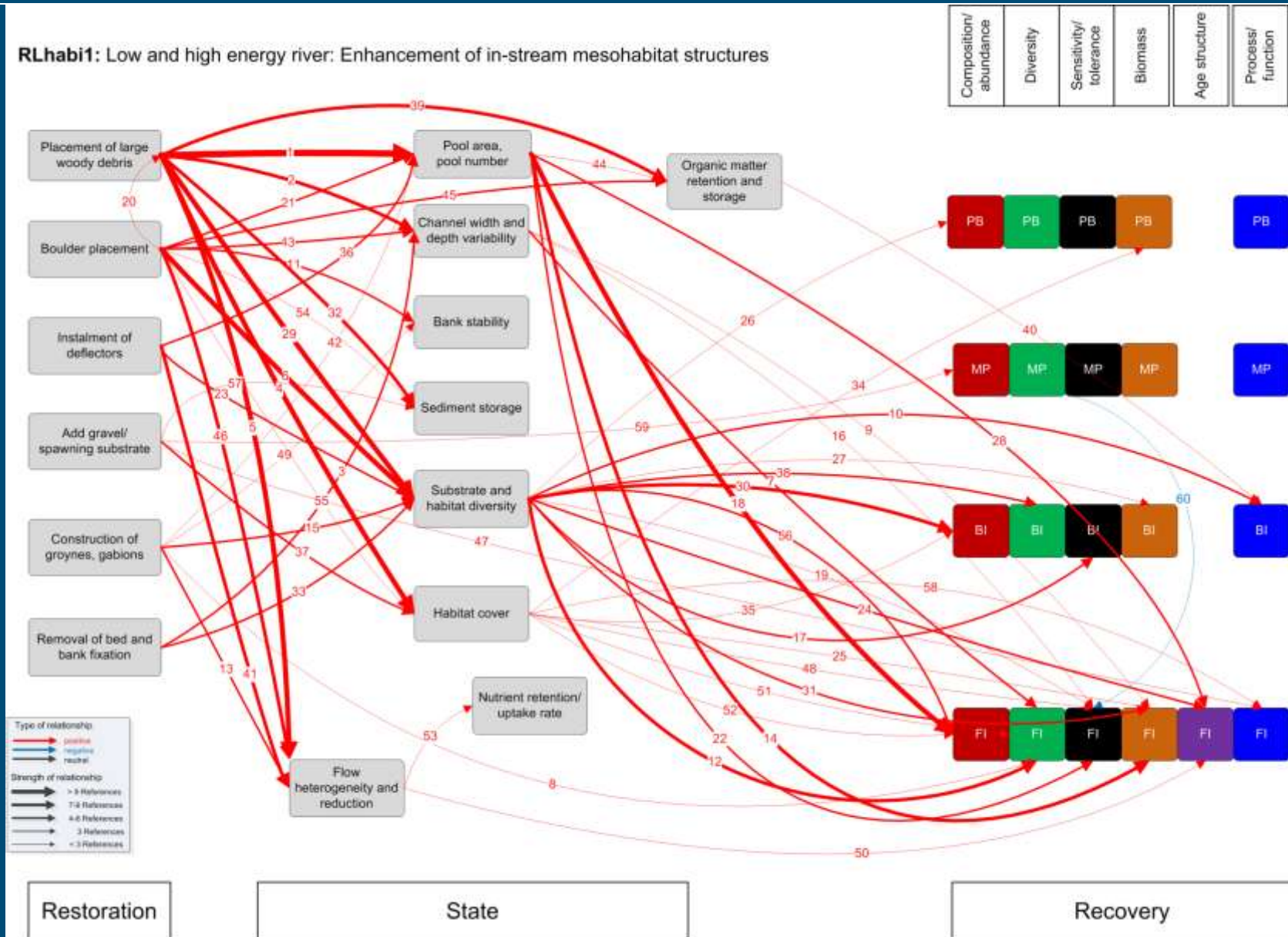
What do we know?

# Example: hydromorphology



# Example: hydromorphology

RLhabi1: Low and high energy river: Enhancement of in-stream mesohabitat structures



# Stream restoration: the future?

## Conclusions

- Degradation  $\neq$  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

