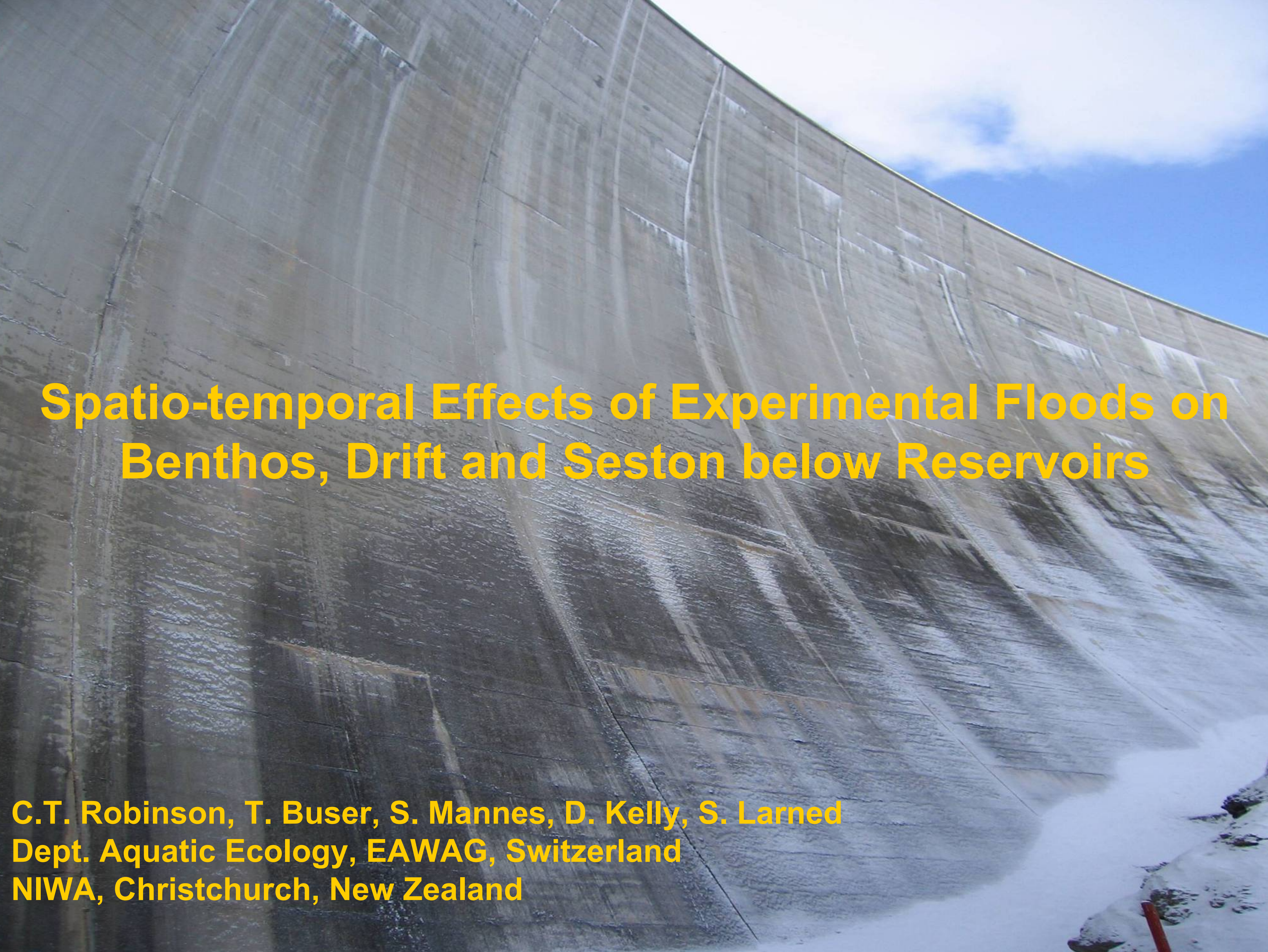
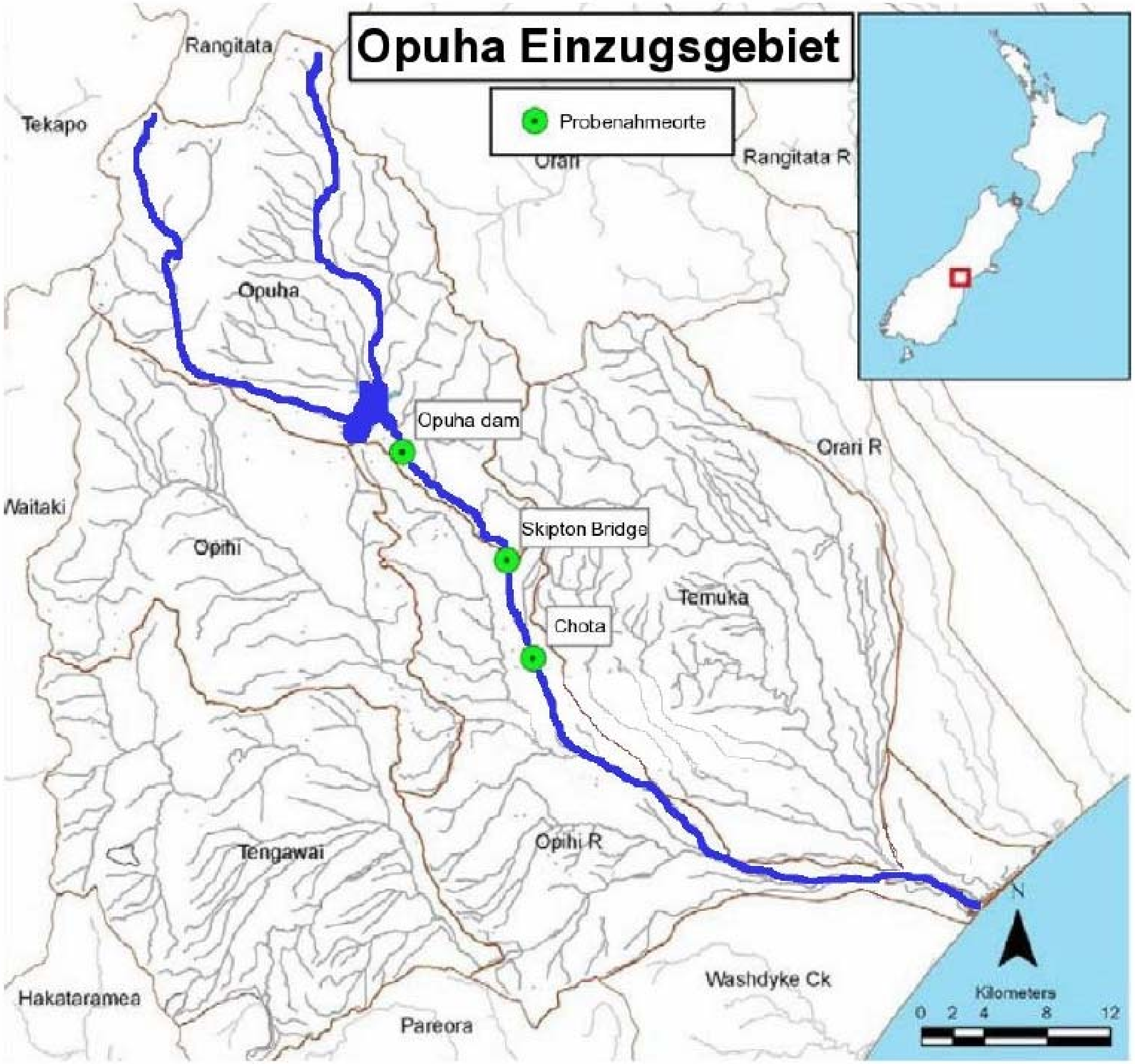


Spatio-temporal Effects of Experimental Floods on Benthos, Drift and Seston below Reservoirs

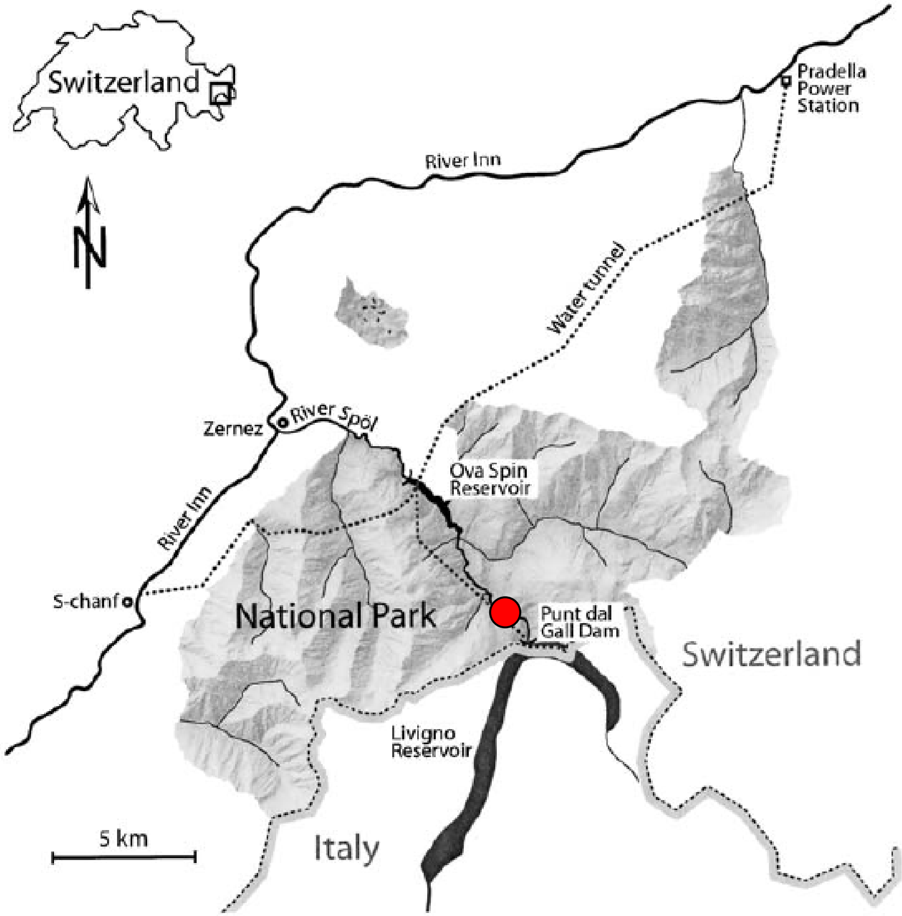
C.T. Robinson, T. Buser, S. Mannes, D. Kelly, S. Larned
Dept. Aquatic Ecology, EAWAG, Switzerland
NIWA, Christchurch, New Zealand

The Spöl, Swiss National Park, CH

The Opuha, South Island, NZ


Opuha Einzugsgebiet
Probenahmeorte
Rangitata
Tekapo
Orari
Rangitata R
Opuha
Opuha dam
Orari R
Waitaki
Skipton Bridge
Opihi
Temuka
Chota
Tengawai
Opihi R
Washdyke Ck
Hakataramea
Pareora
Kilometers
0 2 4 8 12

The Spöl, CH


Switzerland
N
River Inn
Pradella
Power
Station
Water tunnel
Zernez
River Spöl
Ova Spin
Reservoir
River Inn
S-chanf
National Park
Punt dal
Gall Dam
Switzerland
Livigno
Reservoir
5 km
Italy

I: SPATIAL RESPONSE PATTERNS

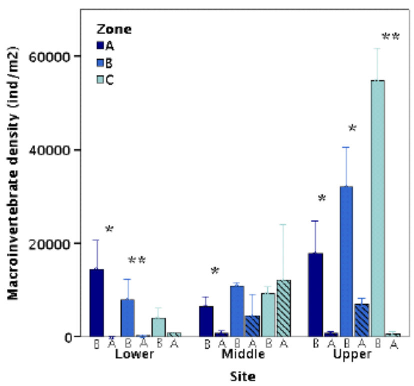
QUESTION:

-What is the spatial effect (local, longitudinal) of floods on stream benthos (macroinvertebrates, periphyton)?

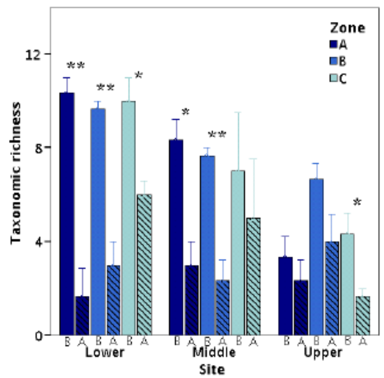
METHODS:

-Benthic samples collected before and after a flood at 3 locations downstream of the reservoir and in different coarse-scale habitat types at each location. Study river was the Spöl.

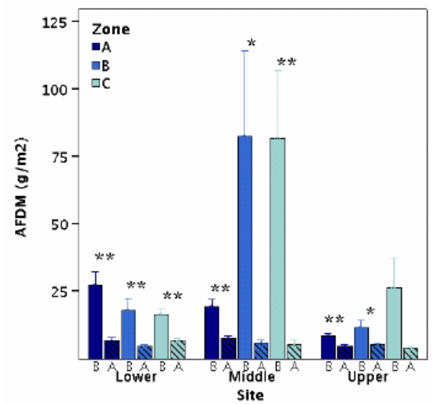
I: Spatial Response Patterns to Floods



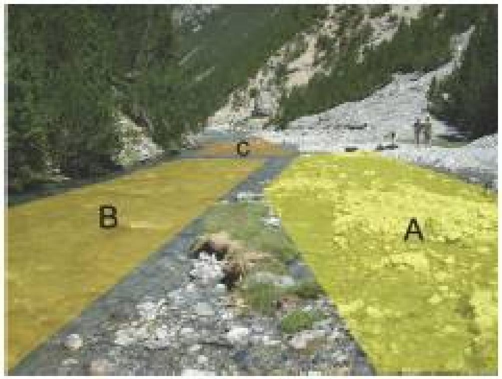
(a) Macroinvertebrate density.



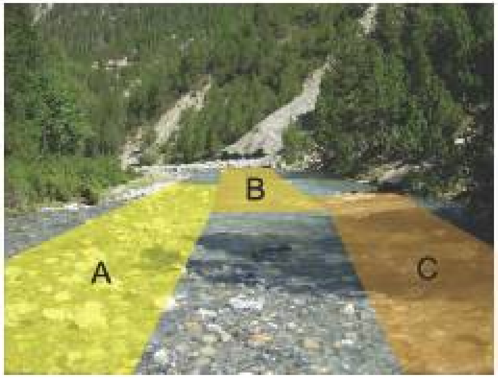
(b) Macroinvertebrate richness.



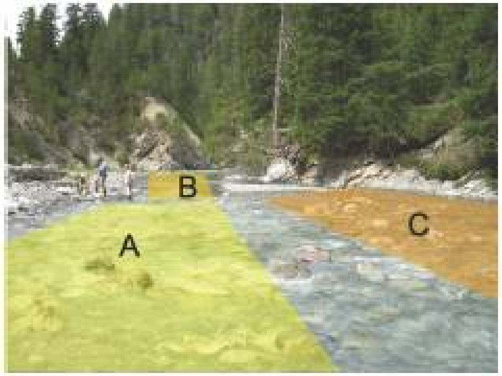
(c) Changes in ash-free drymass.



(a) Upper site



(b) Middle site



(c) Lower site

The response in benthic algae and macro-invertebrates was similar between zones (coarse-scale habitats) and between longitudinal sites.

II: TEMPORAL RESPONSE PATTERNS

QUESTIONS:

-Do drift and seston exhibit different response patterns to flooding?

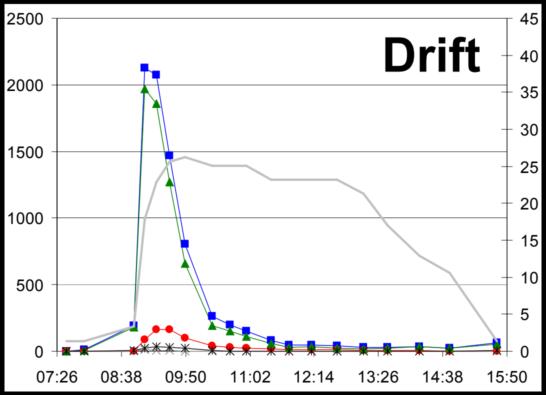
-Do both parameters show hysteresis?

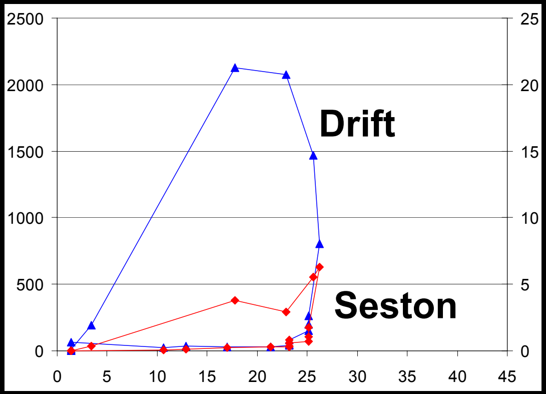
-Is there a longitudinal pattern in seston and drift during a flood?

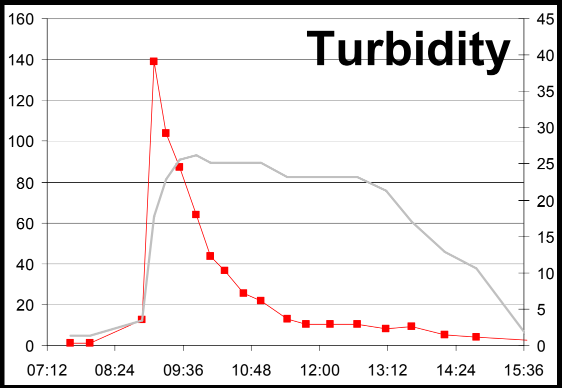
METHODS:

-Collection of drift and seston during the flood. Study rivers were Spöl and Opuha.

II: Temporal Patterns in Drift and Seston during a Flood







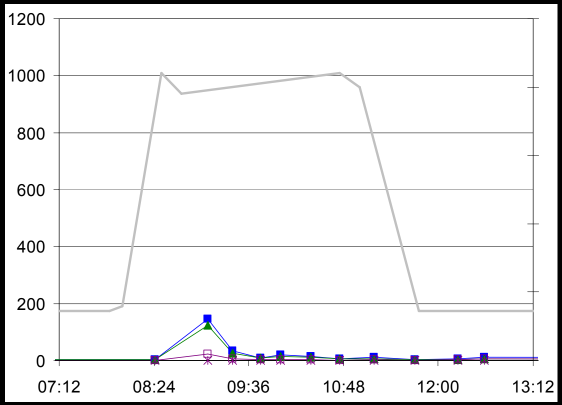
Macroinvertebrate drift increased and peaked before seston, and all taxa showed similar early response patterns.

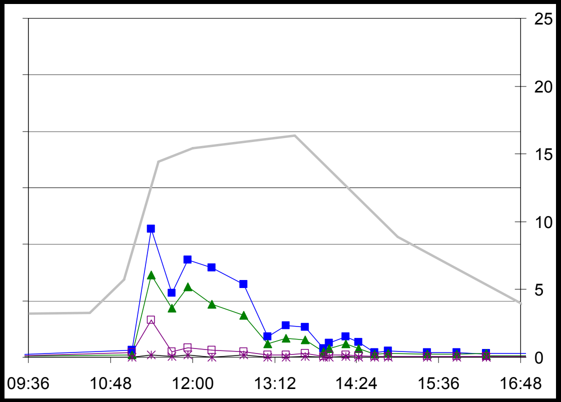
Seston (organic and inorganic fractions) peaked with peak flow.

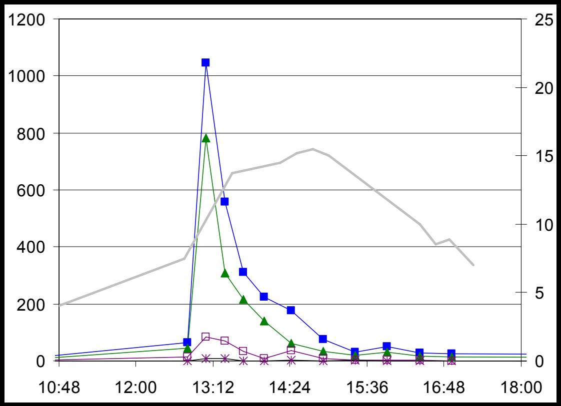
Seston typically showed two peaks, one associated with loose surface material and another when the bed sediments were mobilized.

Both drift and seston demonstrated hysteresis.

II: Longitudinal Dynamics of Drift during Flood





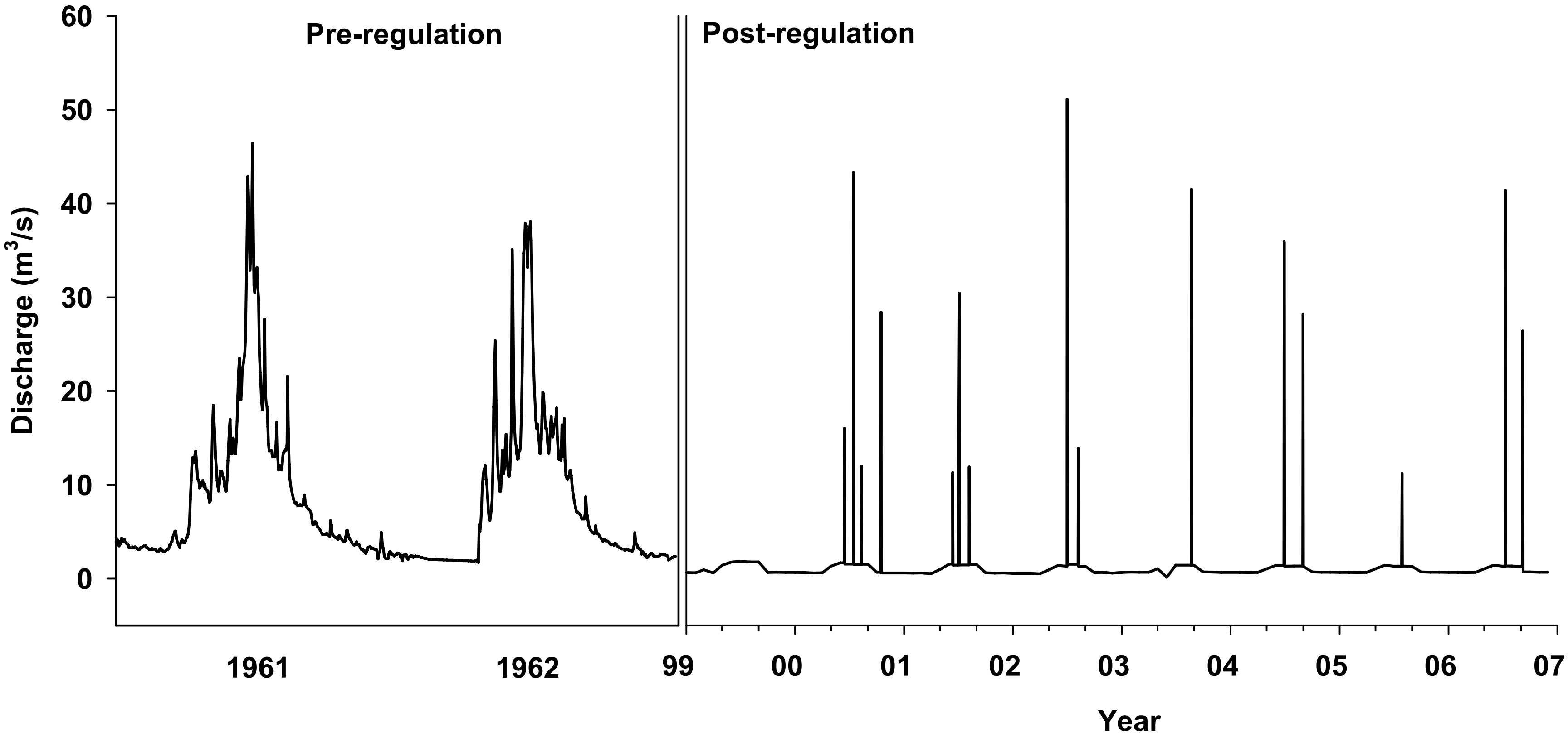


As shown for the Opuha, macroinvertebrate drift increased downstream as the number of organisms accumulated with distance downstream.

Peak flows were attenuated downstream, thus showing that drift (along with seston, not shown) shows a longitudinal response pattern associated with the cumulative number of organisms in the drift as the flood proceeds downriver.

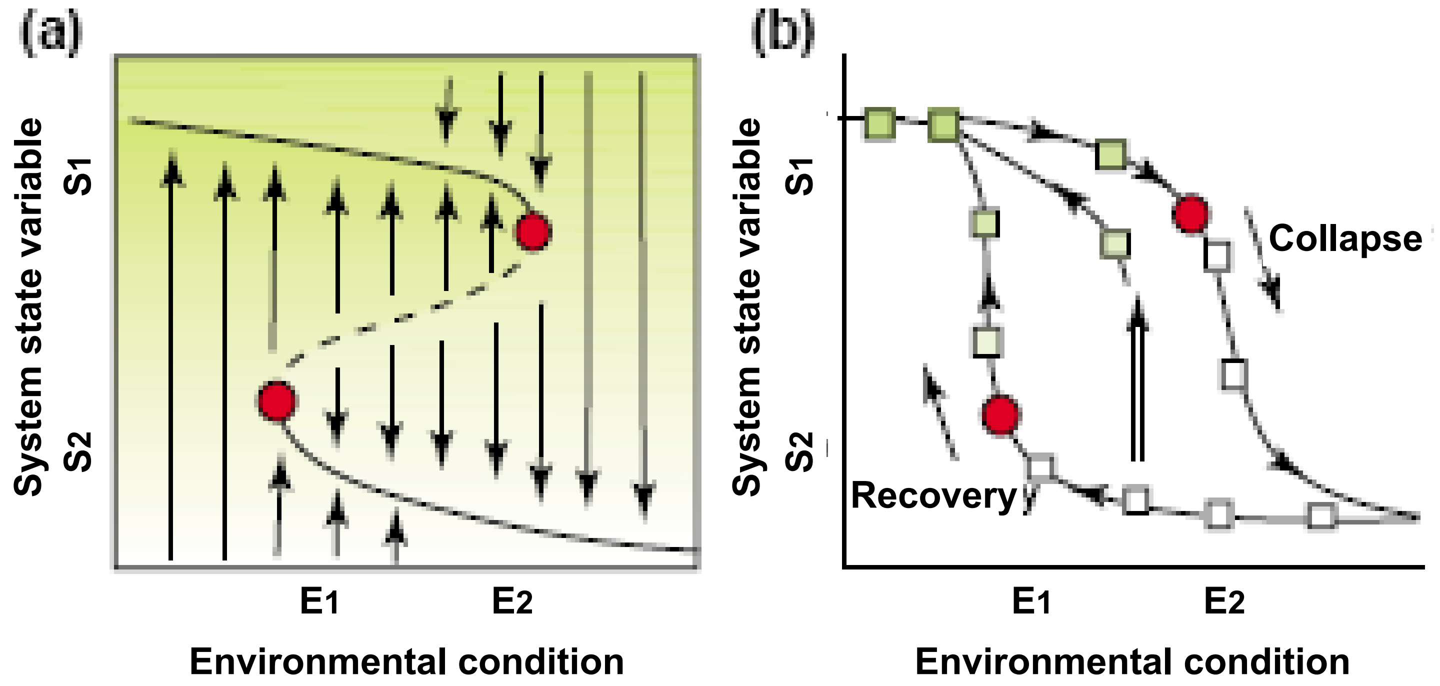
III: Long-term Flood Effects

The Spöl: 1997-2007


Pre-regulation
Post-regulation
Discharge (m³/s)
60
50
40
30
20
10
0
1961
1962
99
00
01
02
03
04
05
06
07
Year

I: Catastrophic Shifts and Alternate States

Scheffer et al. 2001 (Nature)



Suding et al. 2004 (TREE)

II: Rising variance: indicator of ecological transition

Carpenter u. Brock 2006 (Ecology Letters)

General Hypotheses:

1) Reduction in periphyton biomass and BOM

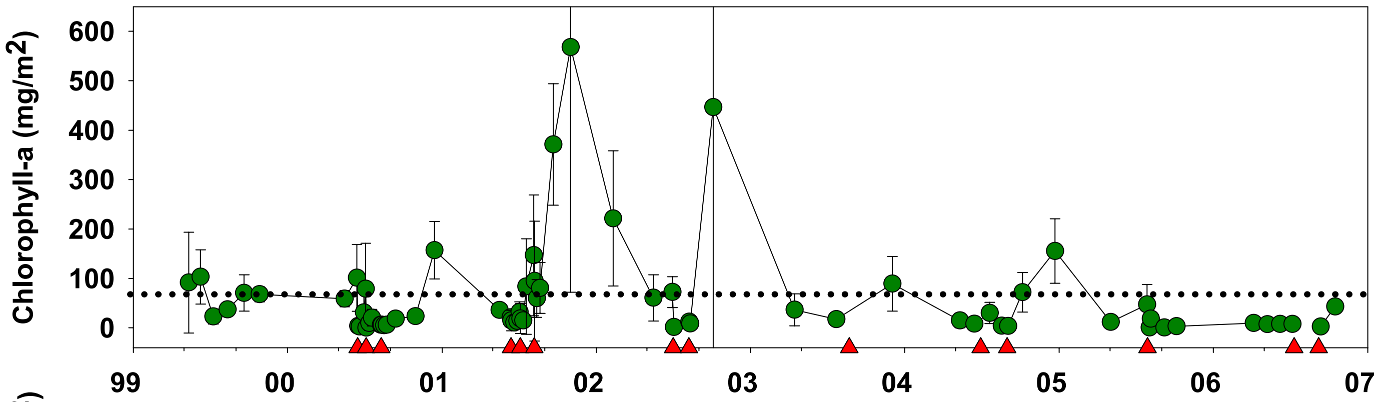
2) Initial reduction in richness, density, biomass

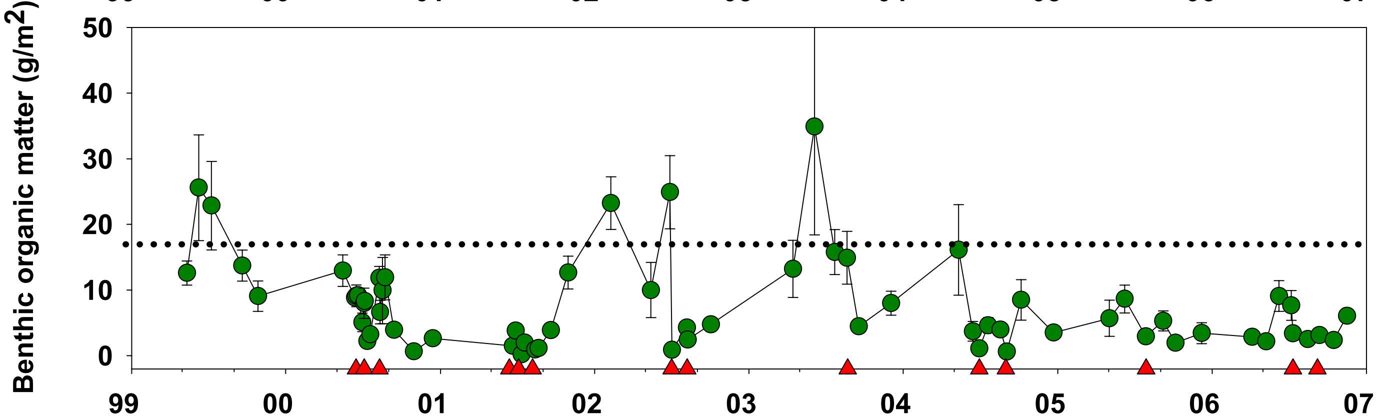
3) Increase in variance during transition

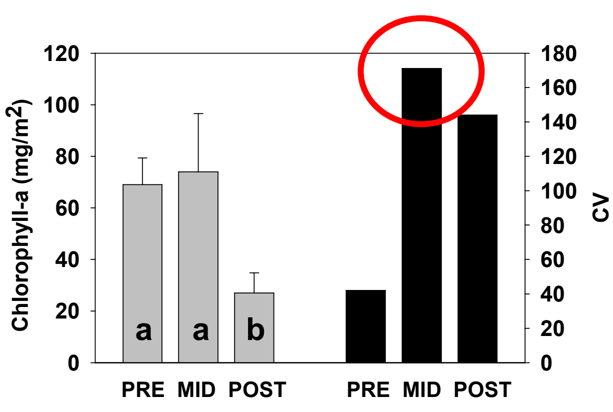
4) Differential response by different taxa

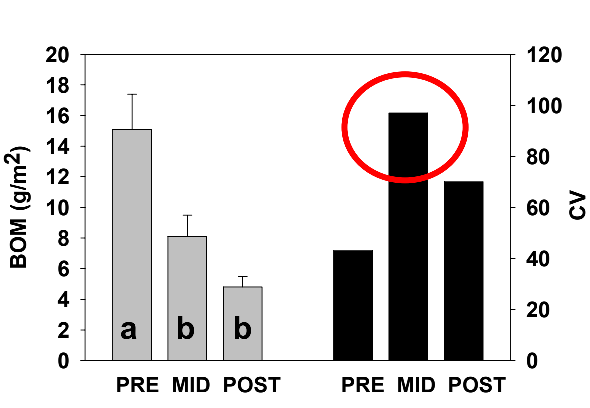
Ecol. Appl. 18: 511-526

H1,3: Periphyton and Benthic Organic Matter

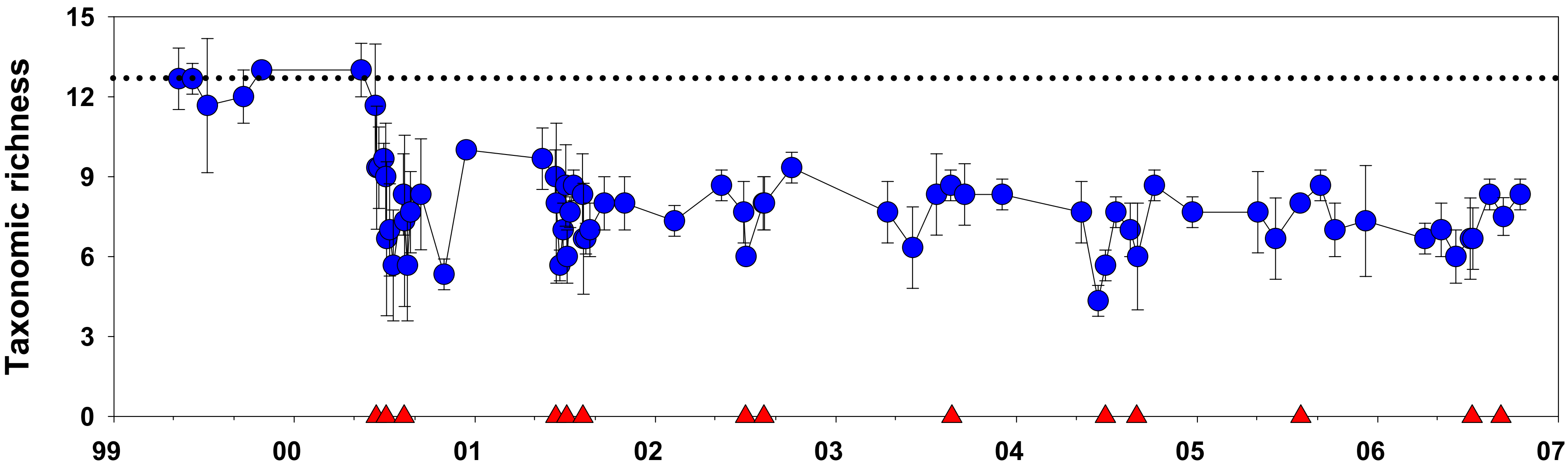


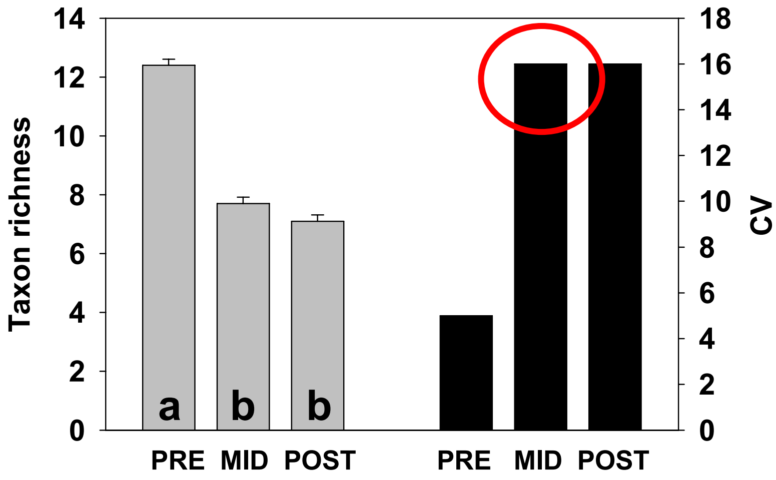




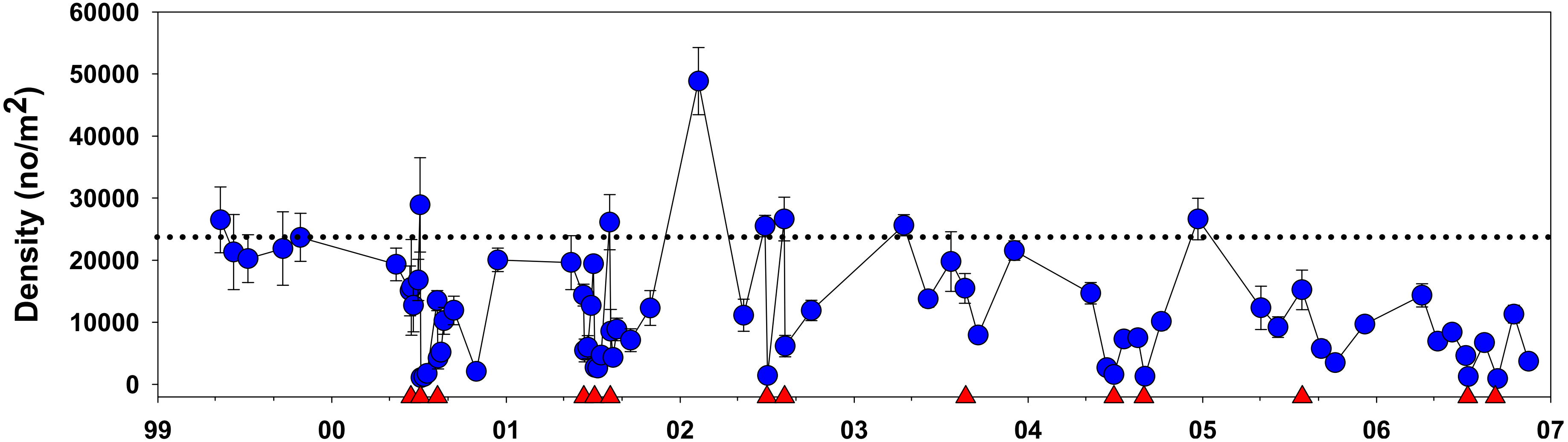


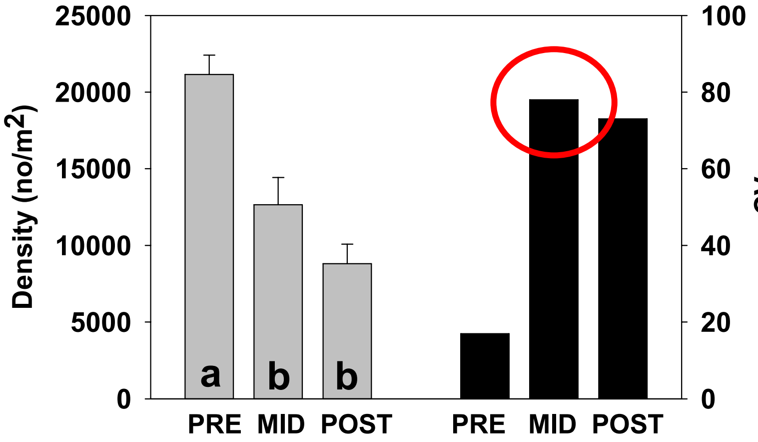
H2,3: Macroinvertebrate Richness



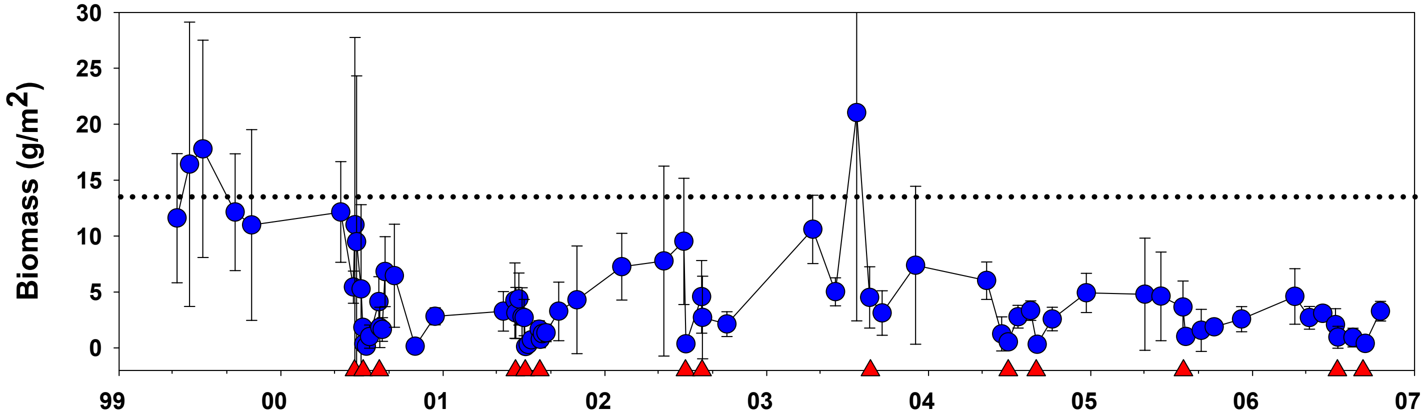


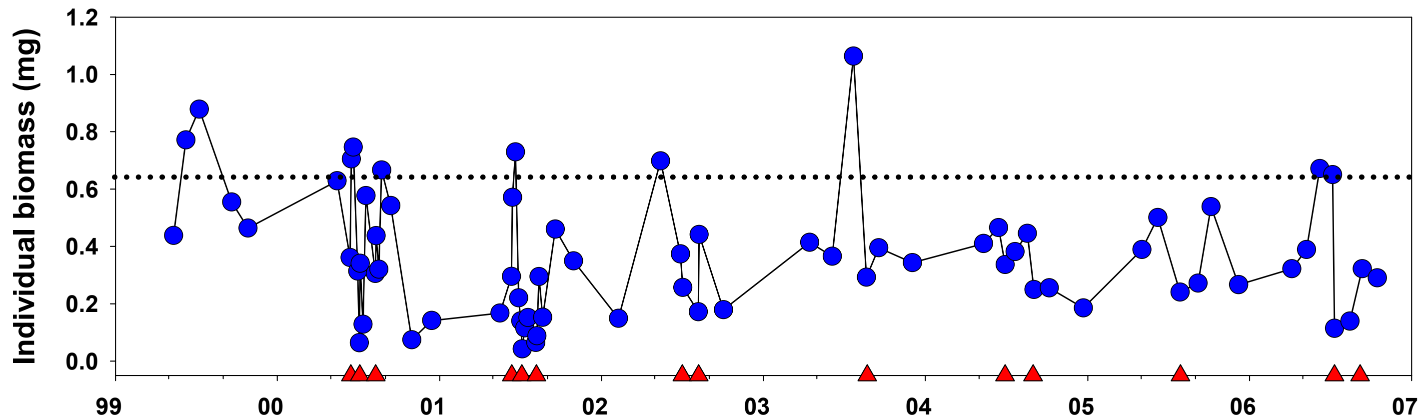
H2,3: Macroinvertebrate Density

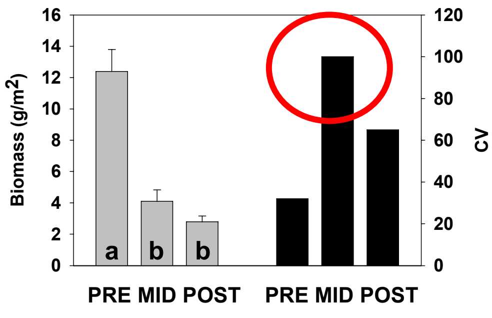


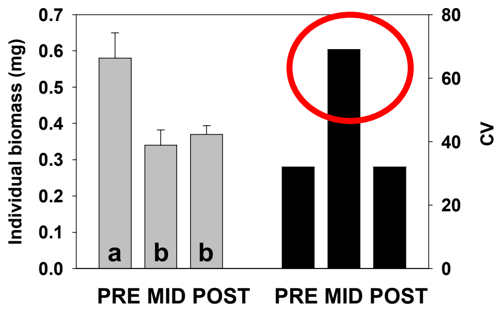


H2,3: Macroinvertebrate Biomass

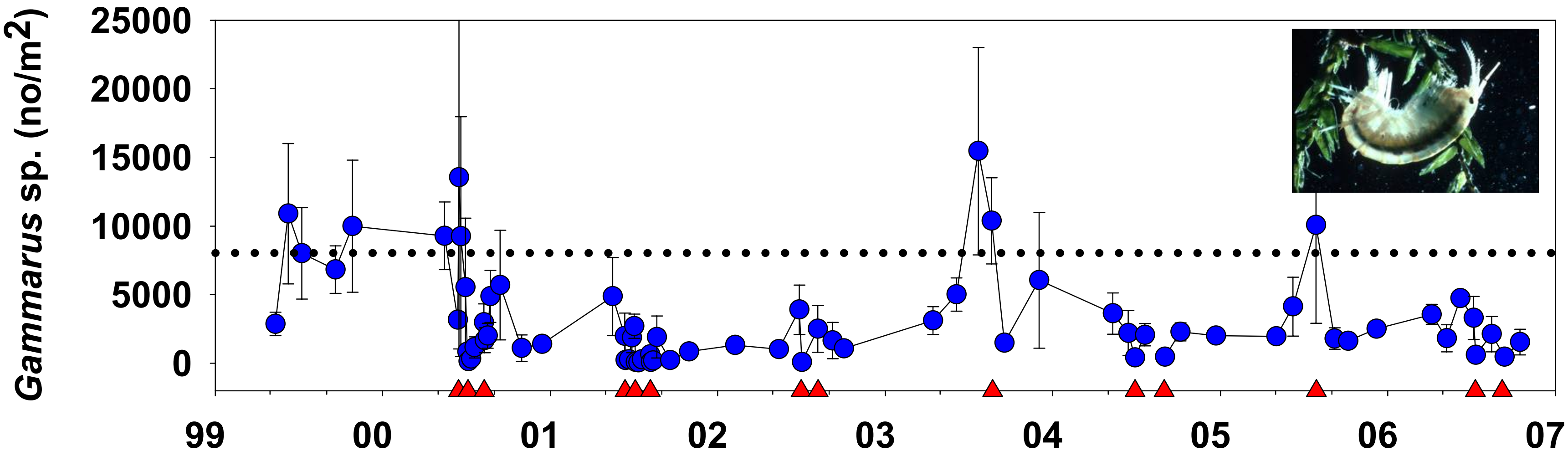


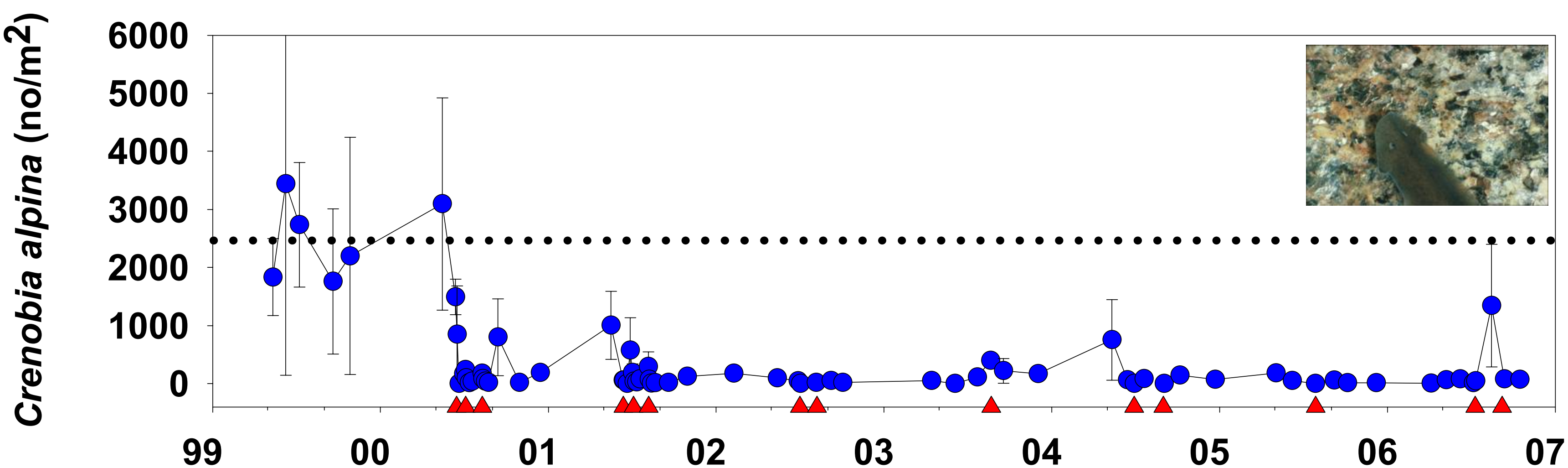




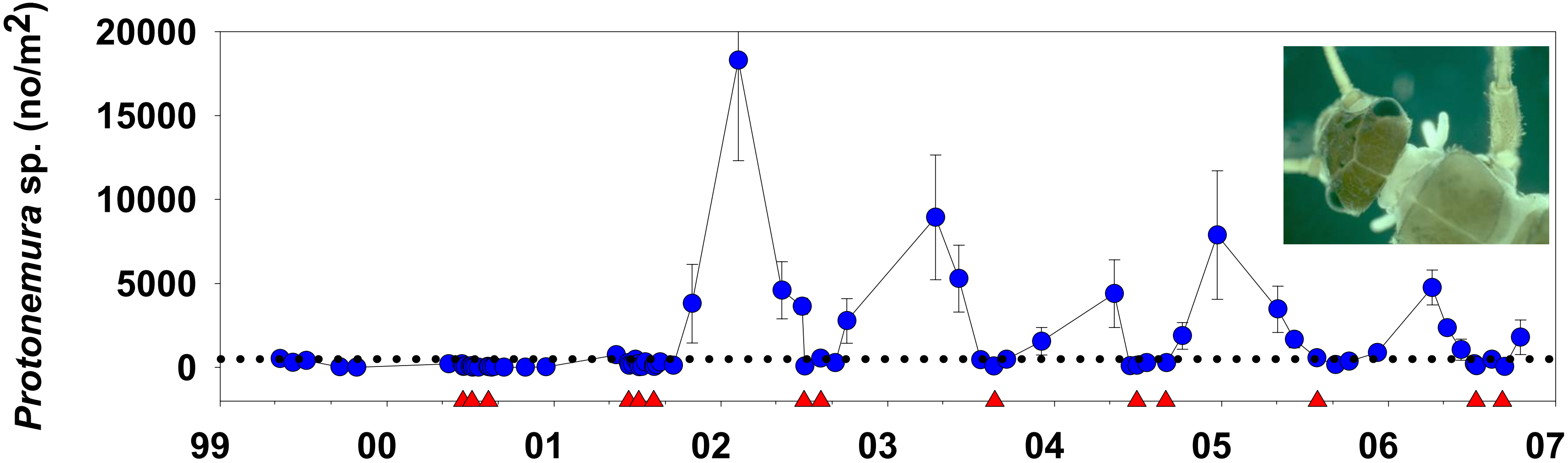


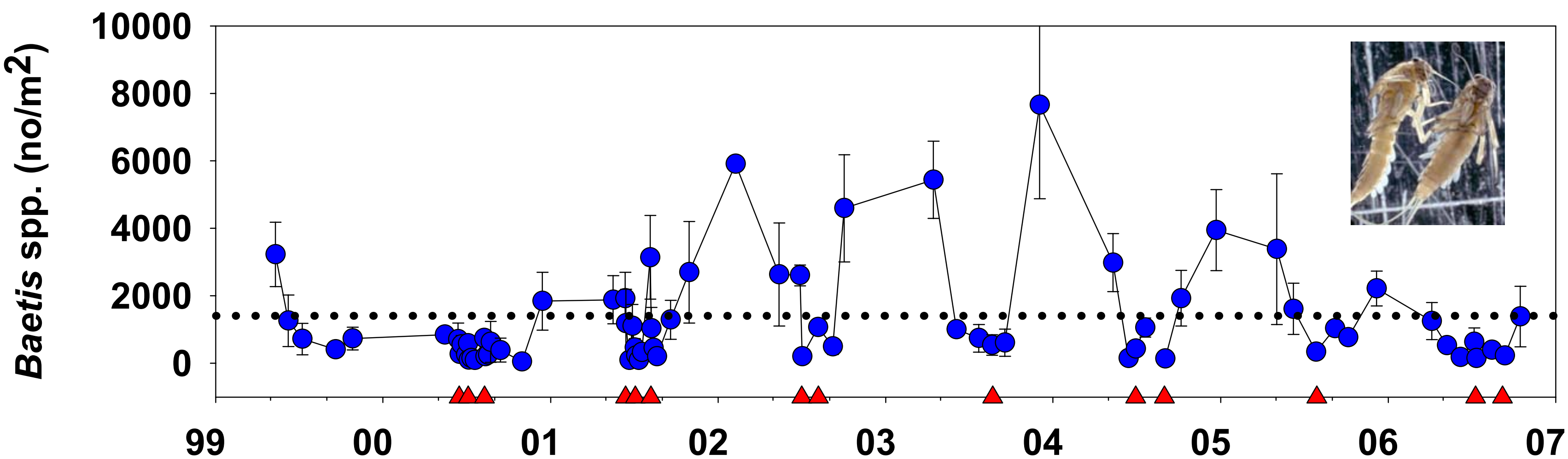
H4: Taxon Specific Pattern I- A loss in abundance



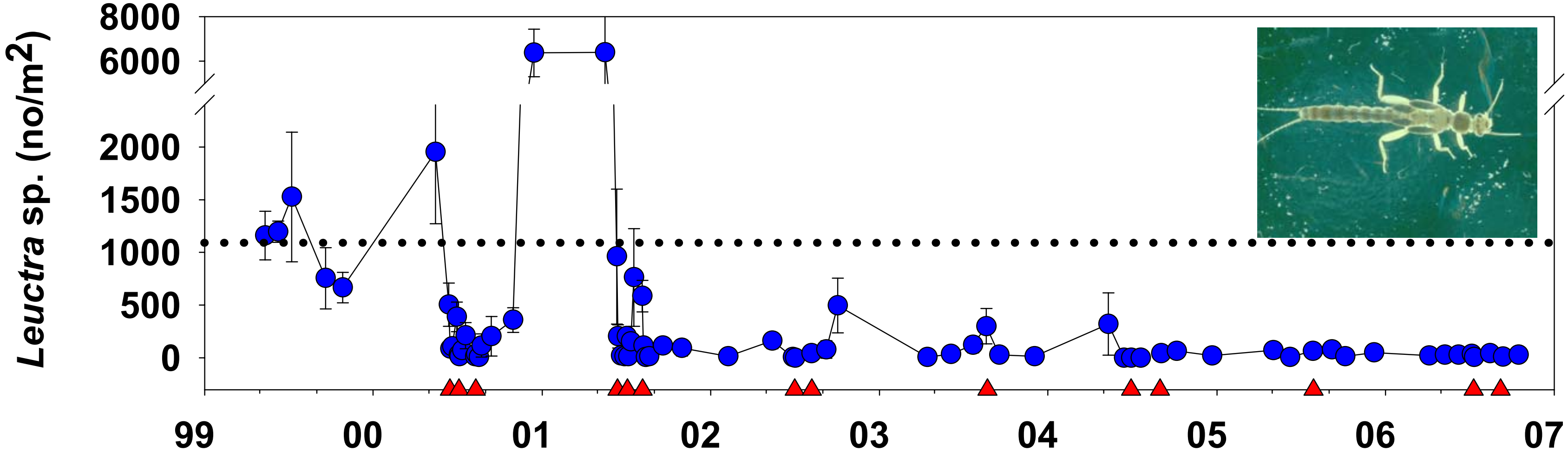


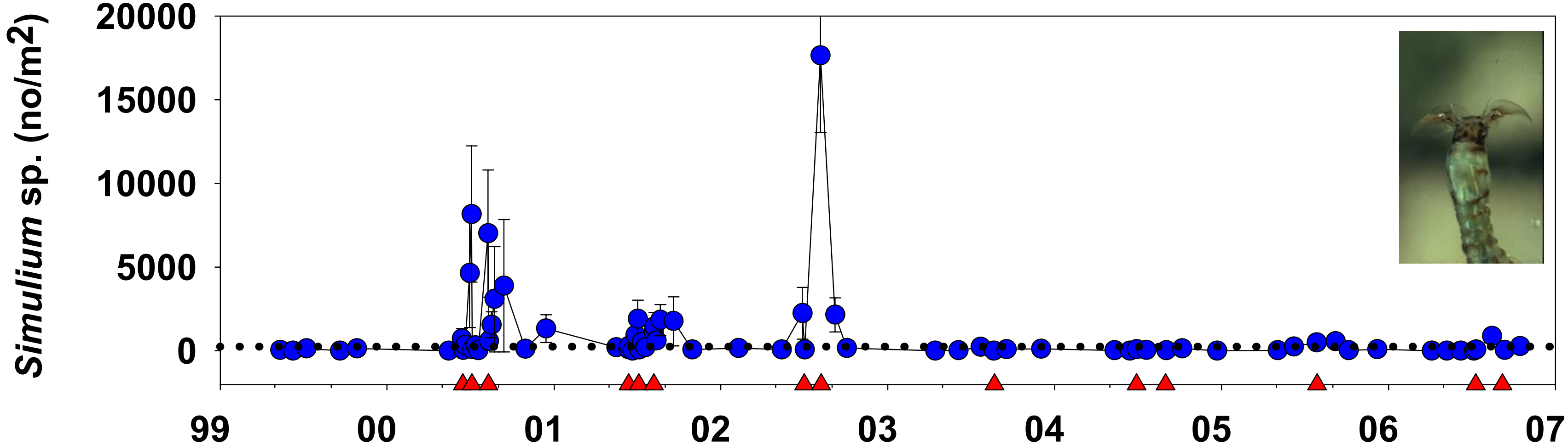
H4: Taxon Specific Pattern II- An increase in abundance





H4: Pattern III- An increase then loss in abundance





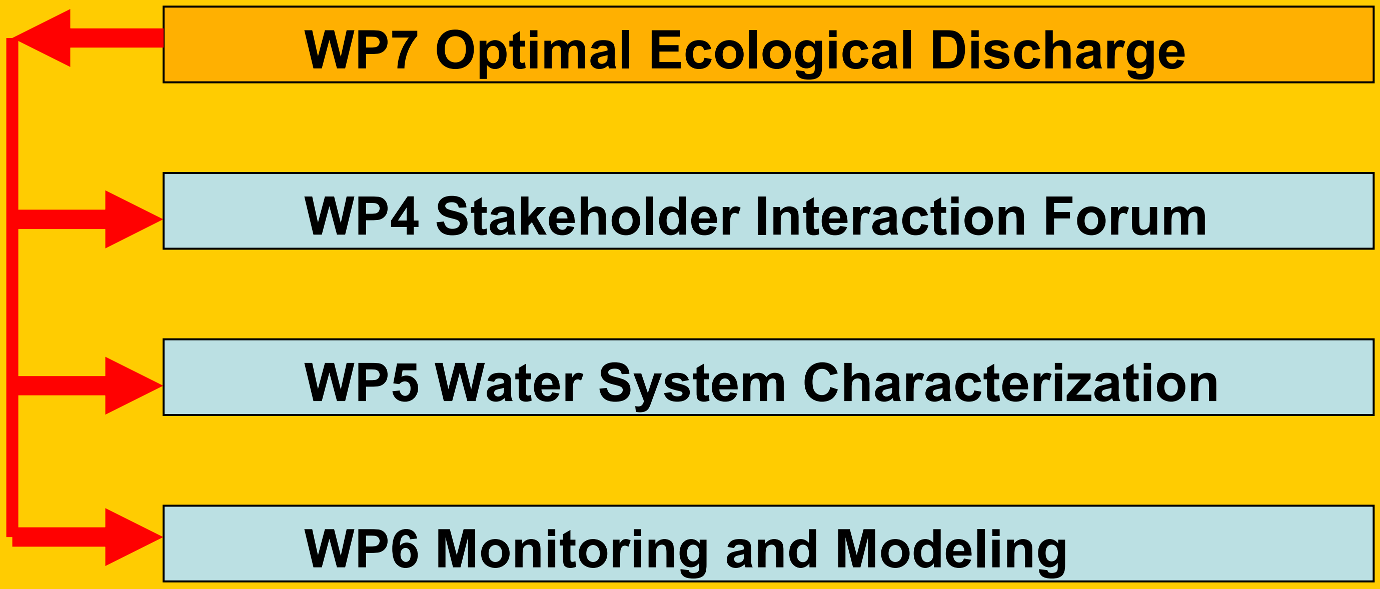
Water Management Strategies against Water Scarcity in the Alps

Optimal Ecological Discharge: WP7

Flow regulation and abstraction are the main water problems in the pilot sites (Noce/Adige, IT; Spöl, CH)

www.alpwaterscarce.eu

Link to other WPs



Objectives

-This WP contributes to the project objectives by defining and applying hydrological and ecological indicators related to optimal ecological discharge under changing flow regimes imposed by management issues (such as hydropower production) and climate change.

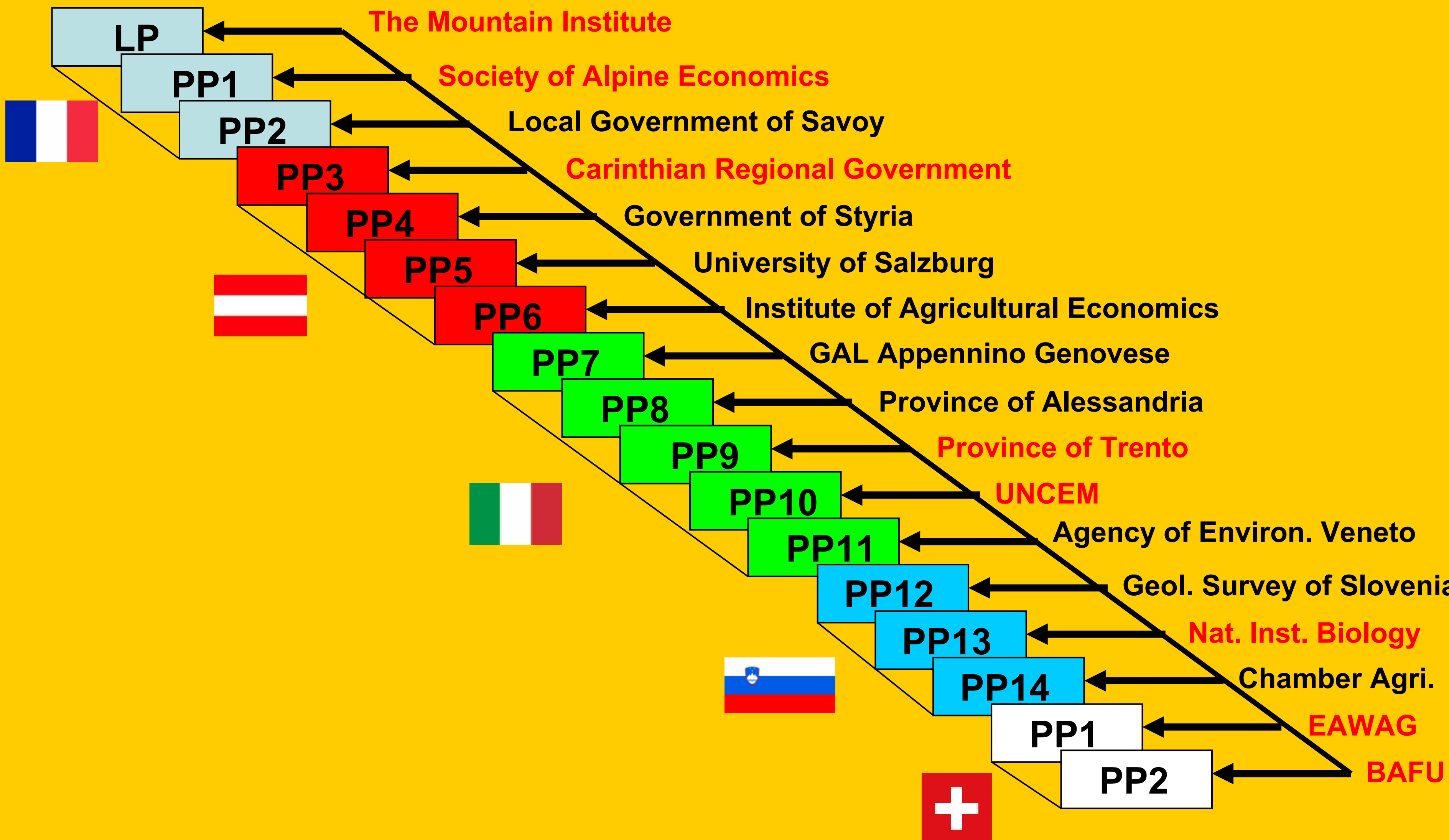
-It also assesses the resistance and resilience of ecosystems to water scarcity.

-Ecological effects on ecosystem goods and services, as well as mitigation and adaptation strategies such as water re-use, are to be suggested.

WP7 Main Actions

7.1 -Aquatic indicators of optimal flows
7.2 -Assess drought effects
7.3 -Experiments on optimal flows
7.4 -Water re-use considerations

Partners involved




Flaming Gorge Dam, Utah, USA
Thanks-