

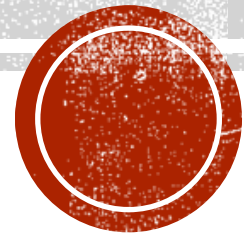
BENTHOS-DRIFT RELATIONSHIPS AS PROXIES FOR THE DETECTION OF THE MOST SUITABLE BIOINDICATOR TAXA IN FLOWING WATERS — A PILOT-STUDY WITHIN A MEDITERRANEAN KARST RIVER

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Benthos-drift relationships as proxies for the detection of the most suitable bioindicator taxa in flowing waters – a pilot-study within a Mediterranean karst river



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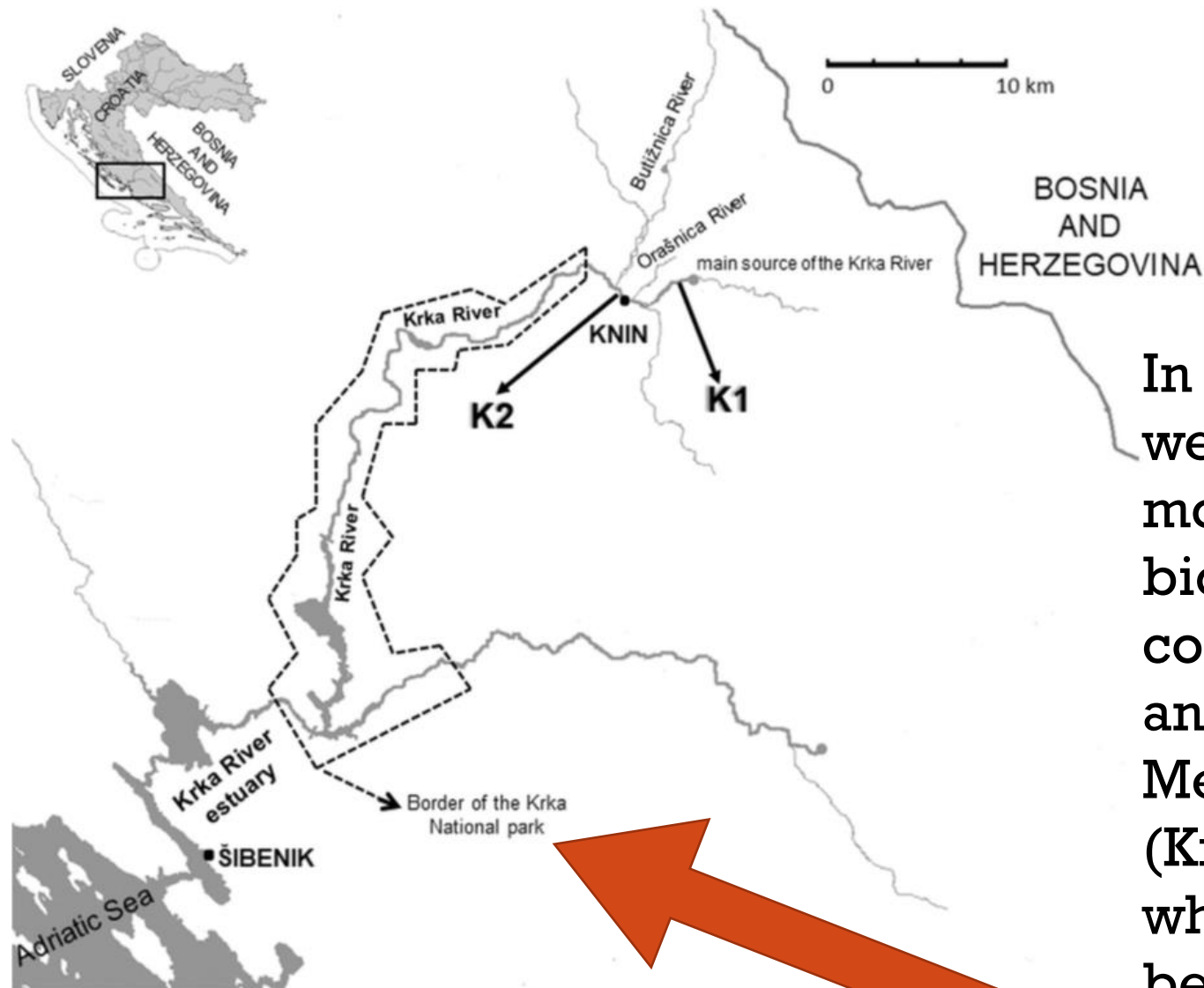
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Protected landscape
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Physico-chemical parameters
Metal contamination

ABSTRACT

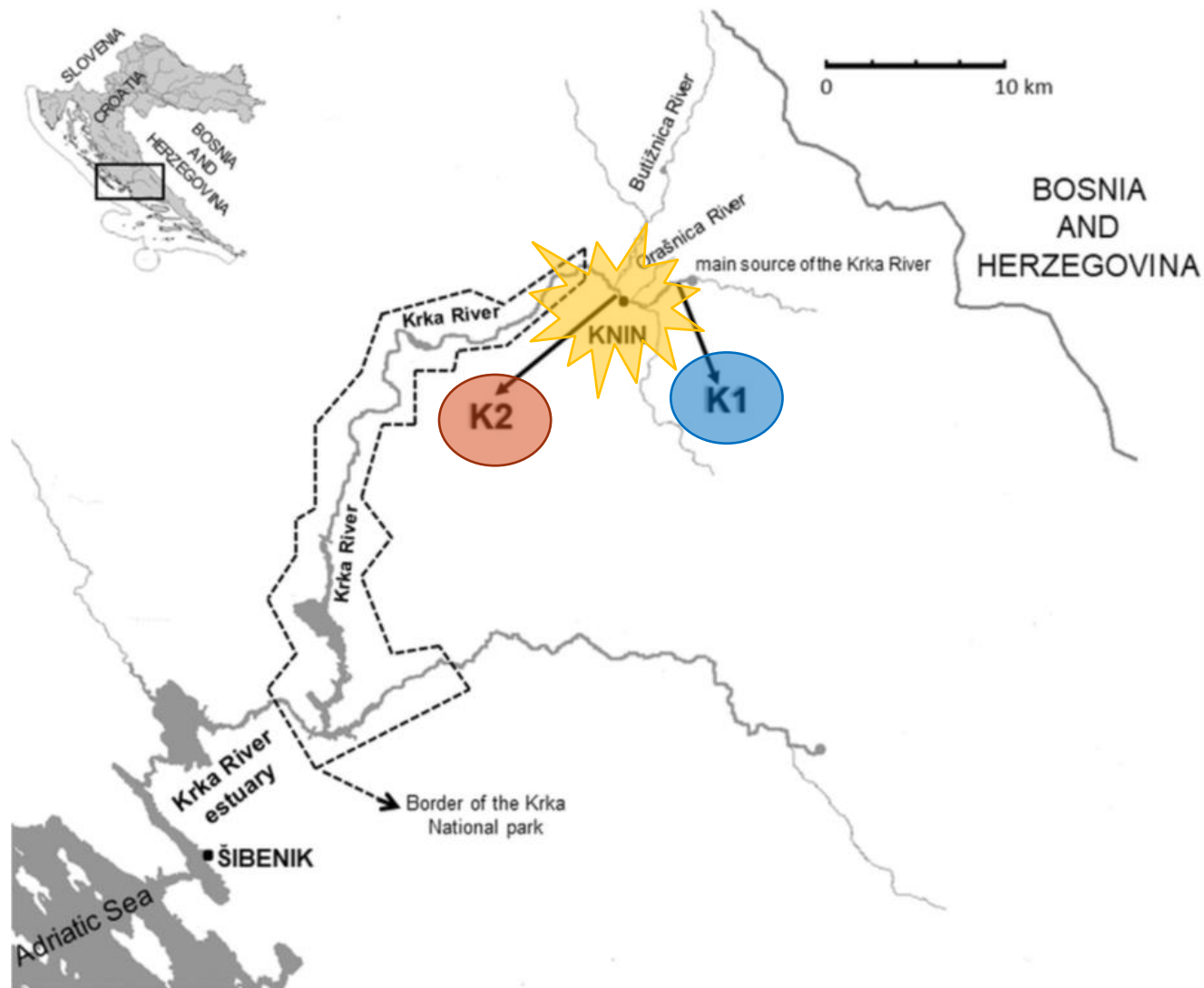
Mediterranean karst aquifers are sensitive systems vulnerable to contamination, exhibiting high rates of diversity and endemism. In the present pilot-study, we aimed to detect the most suitable bioindicators of contaminant accumulation and mobilization within a Mediterranean karst river (Krka River, Croatia), whose lowermost sections belong to a designated protection area (national park). To meet our goal, we sampled water, drift and benthos (macroinvertebrates and periphytic microfauna) at the two Krka River sites, located upstream and downstream from town Knin and its urban influences. We compared: 1) environmental conditions (water physico-chemical parameters, trace- and macro-element concentrations); 2) abundance and diversity of periphyton and macroinvertebrate taxa constituting benthos; and 3) macroinvertebrate benthos-drift relationships between the two sites. Despite higher values of all measured physico-chemical parameters, and most trace- and macro-element concentrations at the urban-influenced site, the





In the present pilot-study, we **aimed to** detect the most suitable bioindicators of contaminant accumulation and mobilization within a Mediterranean karst river (Krka River, Croatia), whose lowermost sections belong to a **designated protection area** (national park).





Our study sites were located **upstream** and **downstream** from town **Knin** and its urban influences.



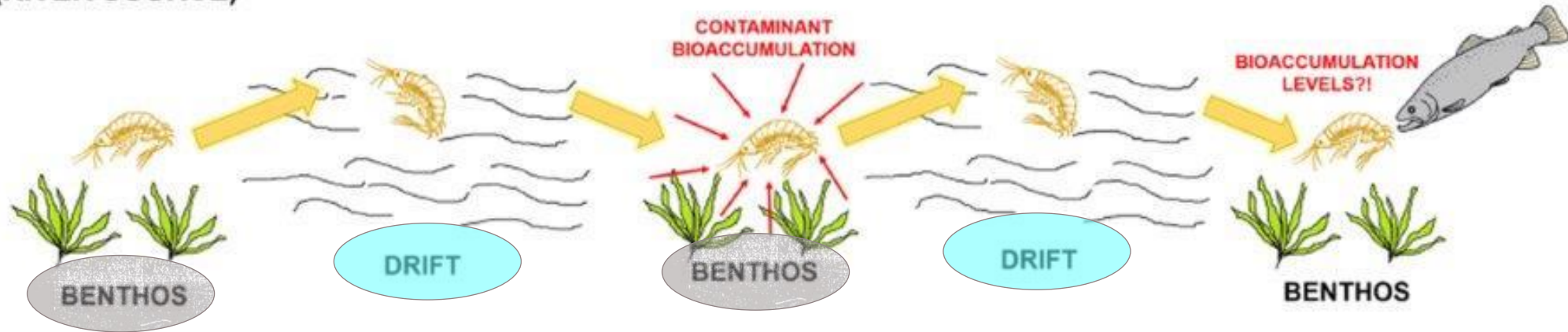
K1 – UPSTREAM SITE

K2 – DOWNSTREAM SITE

- UNCONTAMINATED SITE -
(RIVER SOURCE)

- CONTAMINATED SITE -

- PROTECTED LANDSCAPE -



UPSTREAM

DOWNSTREAM

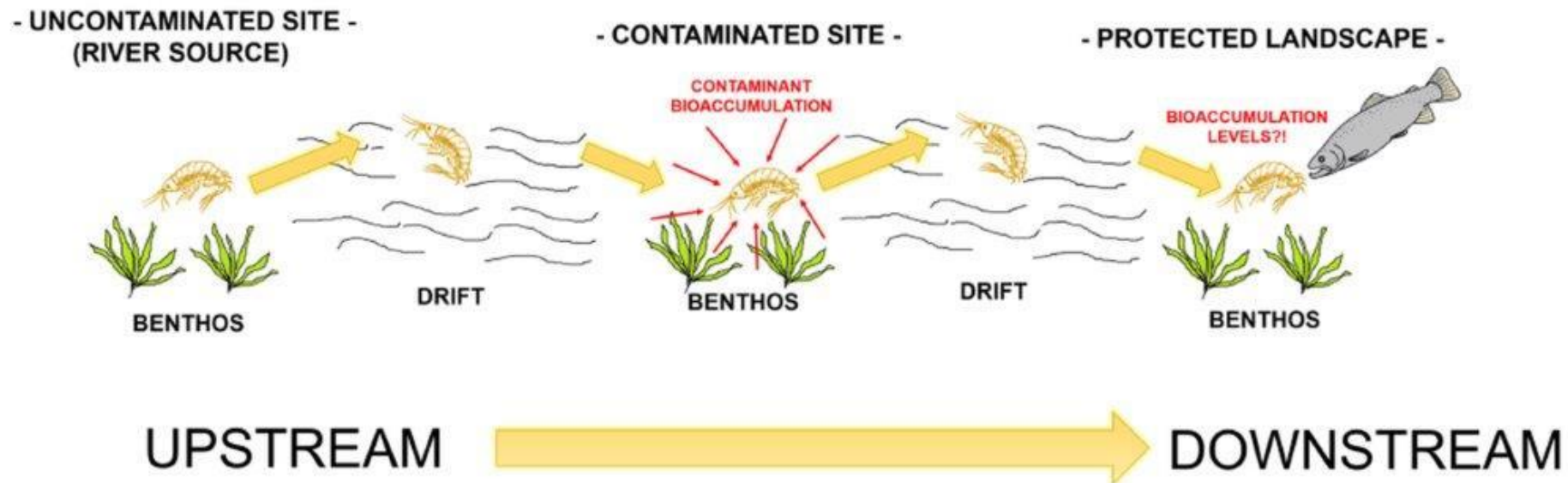
To meet our goal, we sampled water, **benthos** (macroinvertebrates and periphytic microfauna) and **drift** at the two Krka River sites, located upstream and downstream from town Knin and its urban influences.

DRIFT - the downstream dispersal of the organisms driven by flow

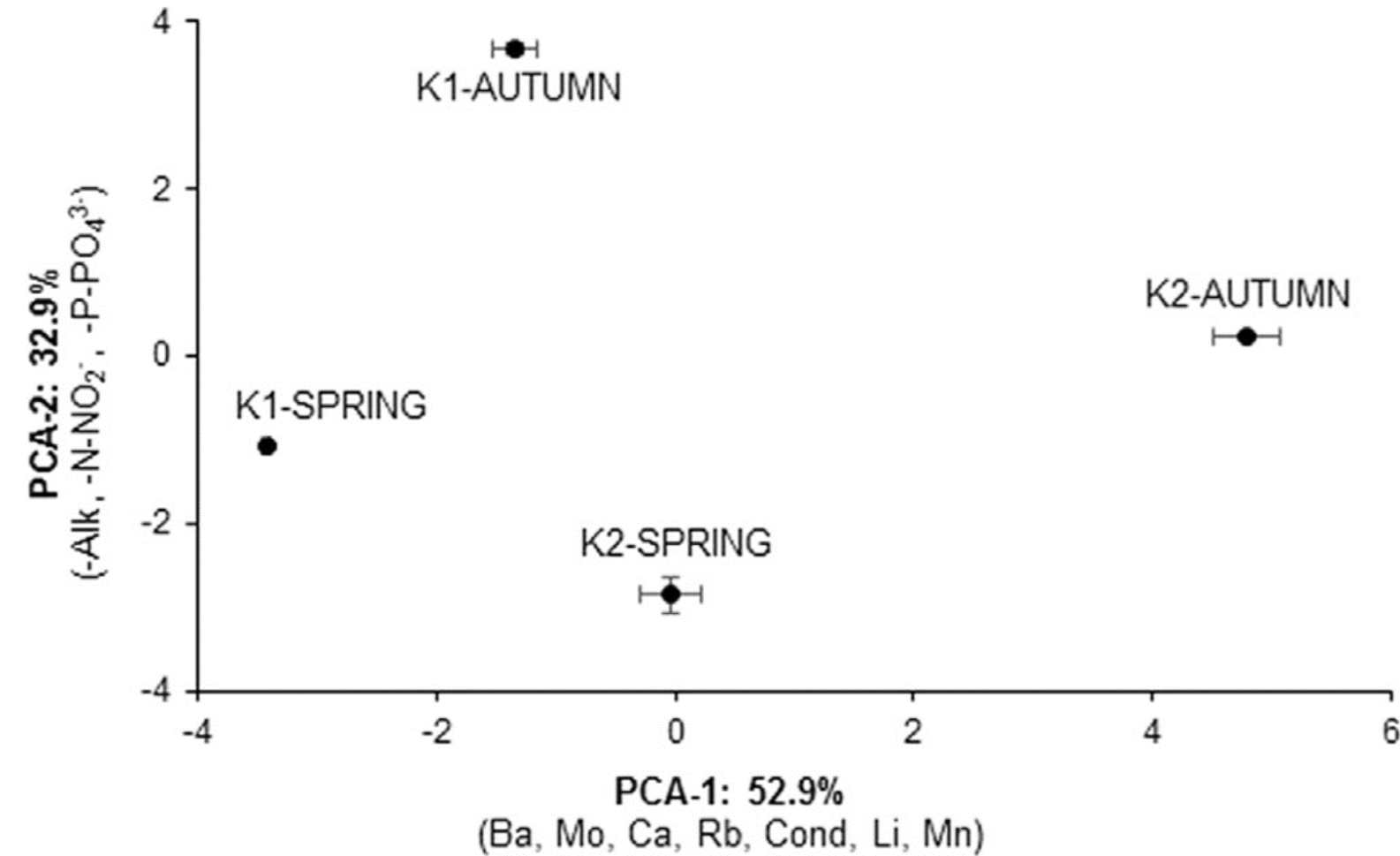


We compared:

- 1) environmental conditions (water physico-chemical parameters, trace- and macro-element concentrations);
- 2) abundance and diversity of periphyton and macroinvertebrate taxa constituting benthos;
- 3) macroinvertebrate benthos-drift relationships between the two sites.



1) environmental conditions (water physico-chemical parameters, trace- and macro-element concentrations);



Despite higher values of all measured physico-chemical parameters, and most trace- and macro-element concentrations at the urban-influenced site (K2), the concentrations of contamination indicators (i.e., COD, nutrients, metals) at both sites were generally low.

?! high contaminant retention potential of the underlying tufa and/or macrophyte substrates ?!

- seasonally - higher values of most parameters in spring

- both sites (K1 and K2) can be classified as waters of very good and good quality, as they fit within the respective range of national limit values (pH 7.0 – 9.0; COD ≤ 4mg O₂ L⁻¹; N-NO₃⁻ ≤ 0.7 mg N L⁻¹; P-PO₄³⁻ ≤ 0.03 mg P L⁻¹) set by the Croatian Directive on water quality status (GRC, 2013).

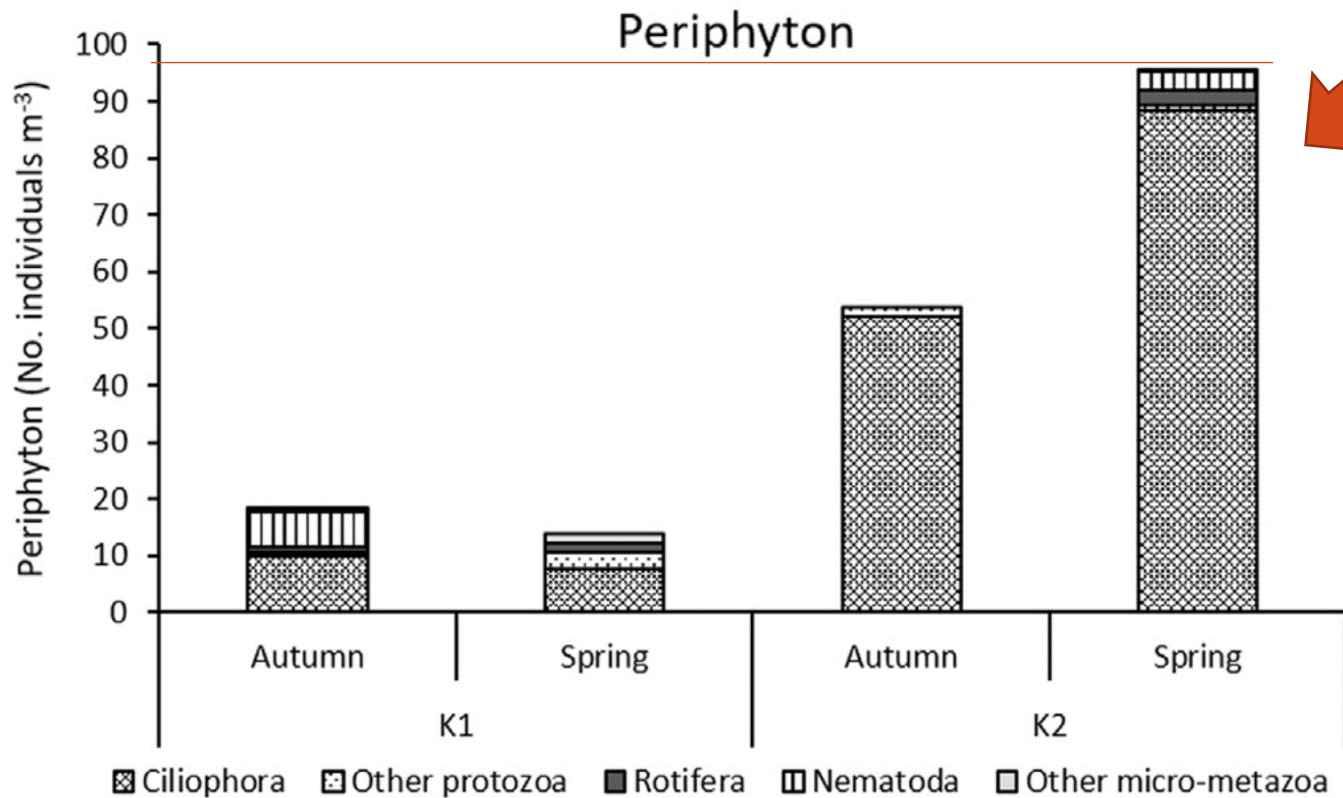


2) abundance and diversity of periphyton and macroinvertebrate taxa constituting benthos

Between-site differences in water quality further affected the spatial variation of macrozoobenthos, drift, and periphytic microfauna.



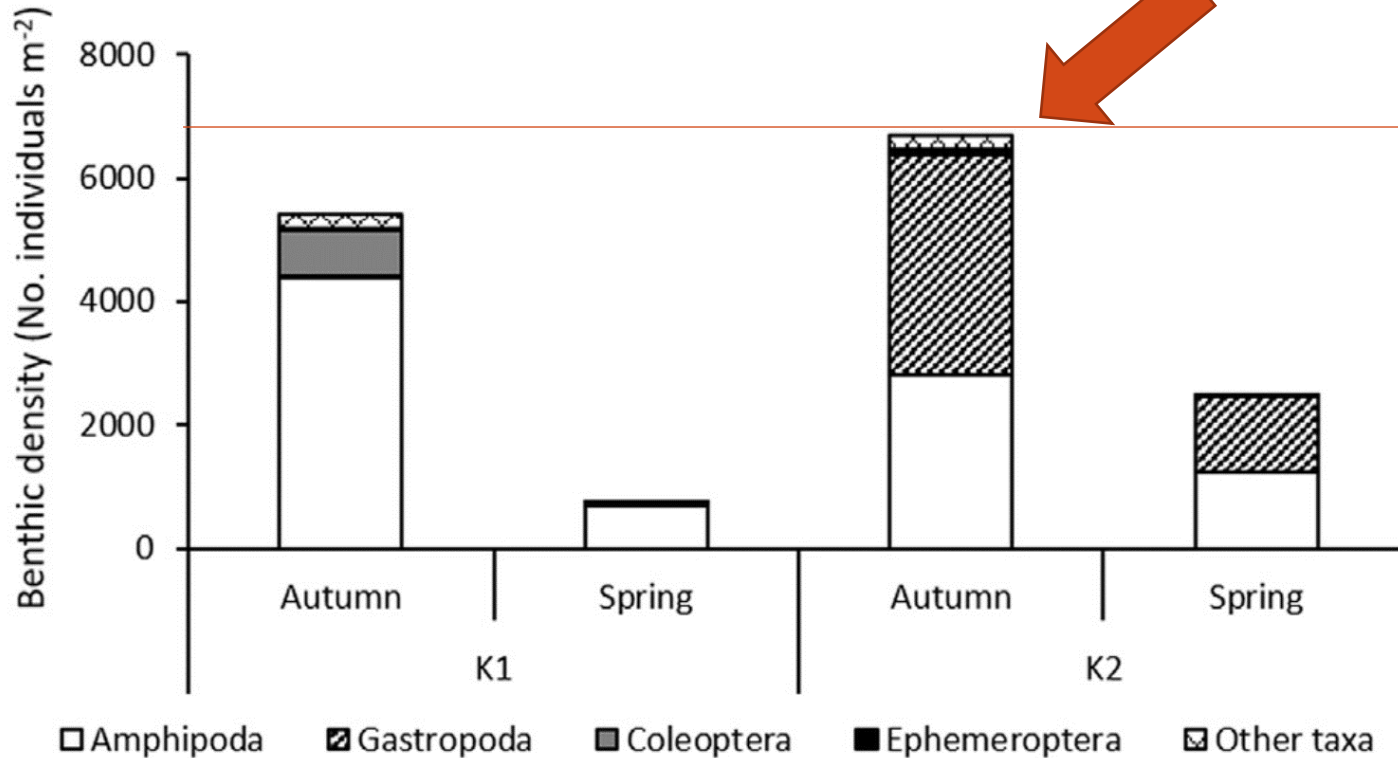
C



- higher COD and orthophosphate concentration, and macrophyte presence at site K2 likely enhanced algal and microbial community growth...

...which then supported significantly higher densities and diversity of periphytic microfauna dominated by eurivalent (i.e., contamination-tolerant) bacteriovorous and algivorous ciliate taxa (e.g., *Tetrahymena pyriformis*, *Trithigmostoma cucullulus*, *Trochilia minuta*)



A**Benthos**

- higher mean macrozoobenthos densities at site K2 → **dense submerged aquatic vegetation stands** (“shelter areas” for many macroinvertebrate taxa)

The most numerous macroinvertebrate taxa in benthos were...

amphipods*Gammarus balcanicus**Echinogammarus acarinatus*

eurivalent, tolerate a wide range of environmental conditions, prefer moss- and macrophyte-rich aquatic habitats, much **detritus** (**shredders**)

gastropods*Emmericia patula**Radomaniola curta germari*

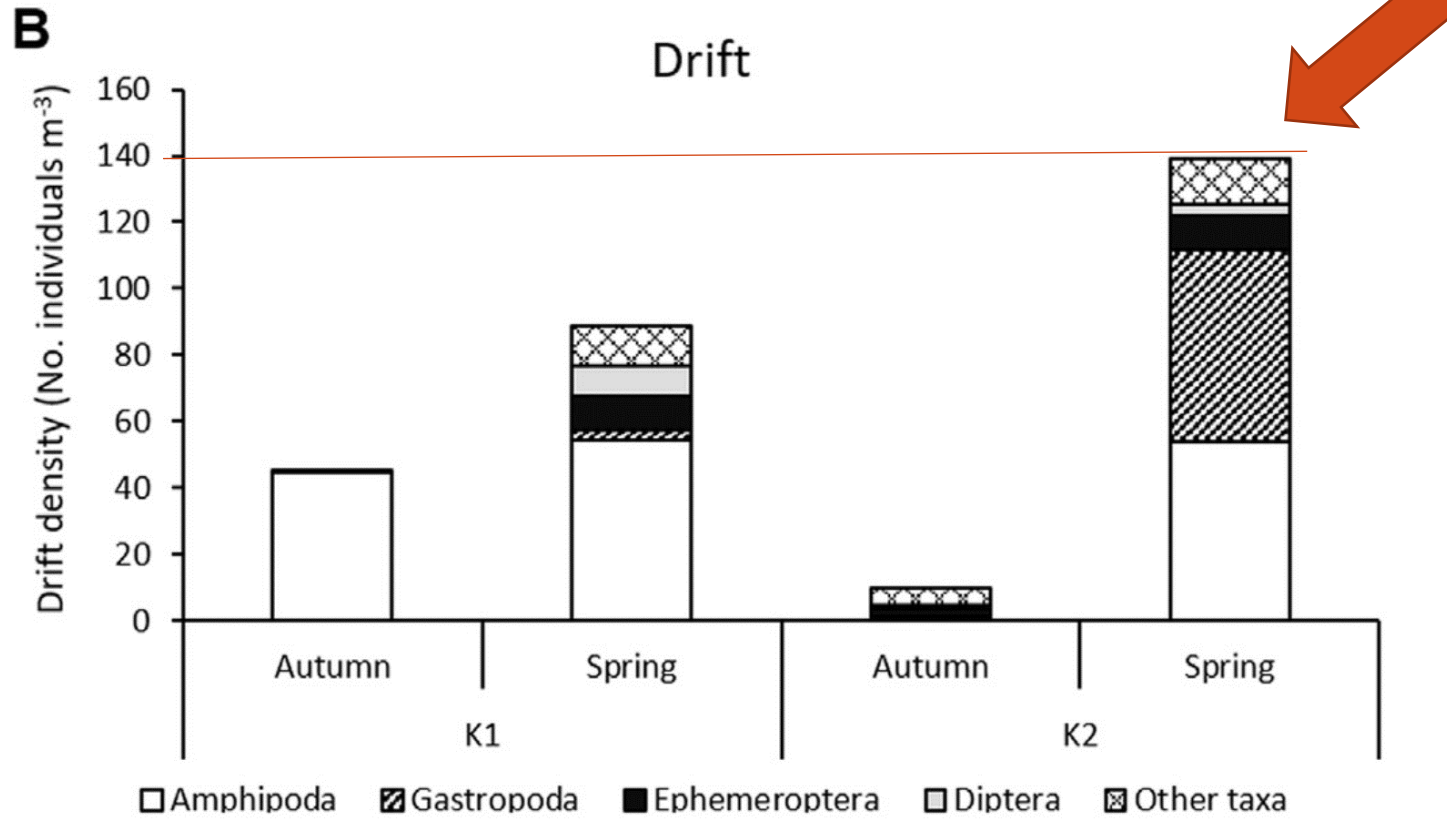
moderately sensitive to contamination, feeding mostly on algae and detritus by **grazing**

→ restricted to Southern Europe/Mediterranean Zone

→ endemic species inhabiting Dinaric karst



3) macroinvertebrate benthos-drift relationships between the two sites



Although we expected to observe **significantly increased drift** at the urban-influenced site (K2) due to the degraded environmental conditions, it was **not observed**.

drift was low at both sites – in comparison to autumn and spring drift records within another Croatian karst hydrosystem (National Park Plitvice Lakes)

amphipods

Gammarus balcanicus
Echinogammarus acarinatus
 (exuviae)

gastropods

Emmericia patula
Radomaniola curta germari

The most numerous macroinvertebrate taxa in drift were...

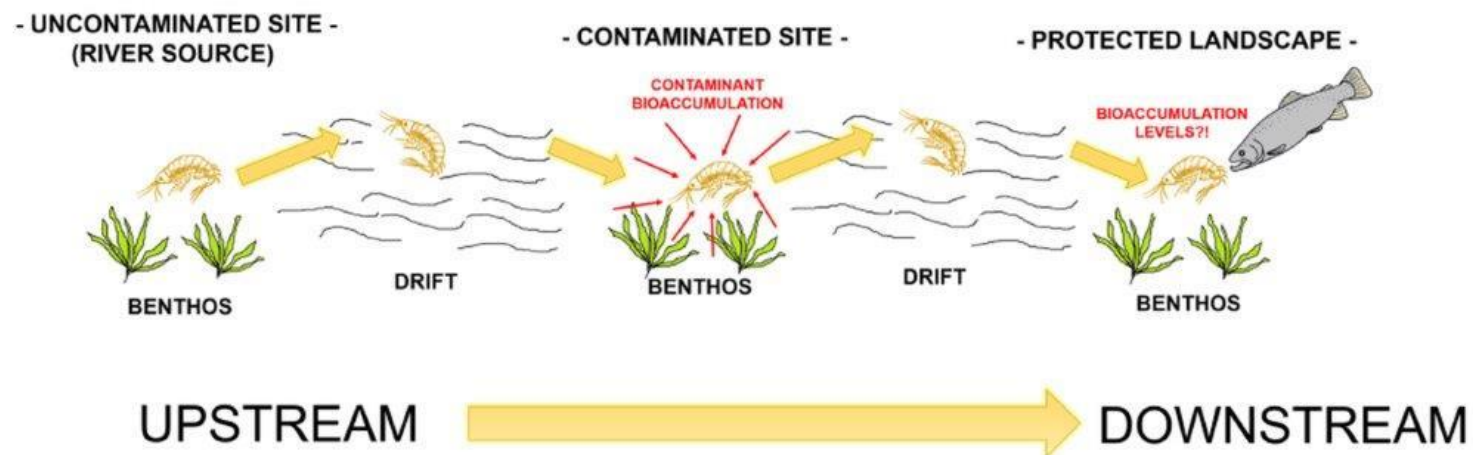


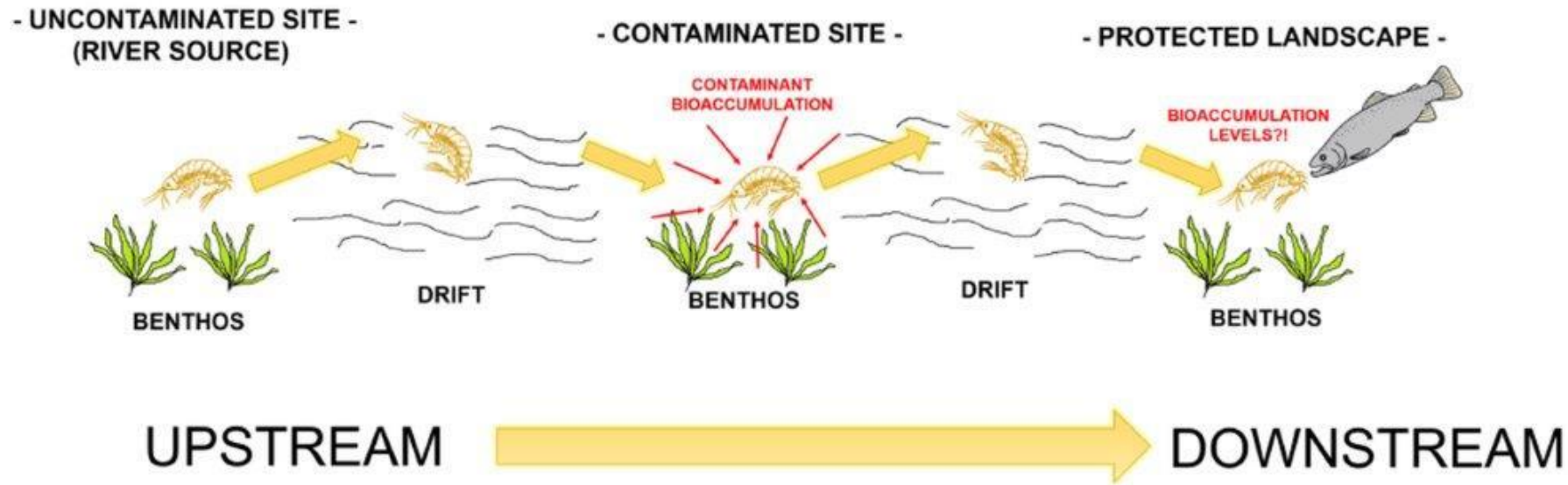
The observed benthos-drift patterns suggest....

...freshwater amphipods (i.e., **gammarids**), which were found most numerous in drift, could be considered as the **most suitable bioindicators of a contaminant** (i.e., metal) **accumulation and (re)mobilization** within karst aquifers comparable to Krka River

...especially because...

- ...they serve as an important food source for drift-feeding fish
- ...important link in food webs and nutrient cycling
- ...sensitive to contamination (accumulating metals in their tissues)





→ include the investigation of the benthos-drift patterns as **a pilot-method** for **initial detection of the potential bioindicator taxa** for dispersion of bioaccumulated freshwater contamination

