The effects of road crossings on stream macroinvertebrate diversity

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Hit the road and the road hits back

Urbanization and associated road sprawl are together responsible for continued habitat degradation globally, which is accompanied by a decline in biodiversity. Although roads can promote diversified societal and economic benefits and they are widespread, we lack knowledge of the exact impacts of roads on freshwater biodiversity. Macroinvertebrates (e.g. insects, molluscs and crustaceans) are sensitive to human-induced habitat modifications, thus they are the most widely used organisms in freshwater biomonitoring. Roads and associated culverts and bridges may change habitat quality, and consequently, impact local biodiversity. Without understanding the complex mechanisms shaping biological diversity patterns under road-related human disturbances, we cannot effectively manage biodiversity in urbanized landscapes.

Objectives & questions

Objecitve

We examined the effects of road crossings on the diversity of stream macroinvertebrates.
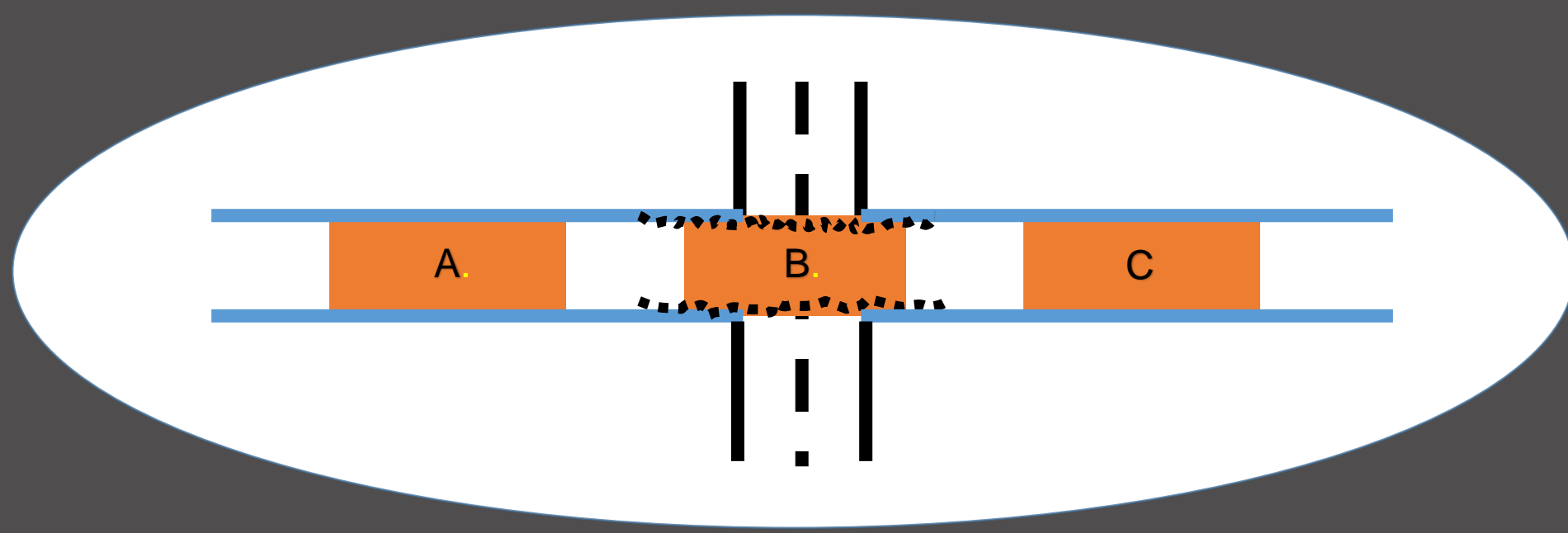
The present research focuses on the following questions:

- Whether the abiotic habitat at road crossings is different from the unaltered upstream and downstream sections?
- Whether the road crossings decrease the diversity of native macroinvertebrates?
- Whether the road crossings attract more alien taxa than the unaltered stream sections?
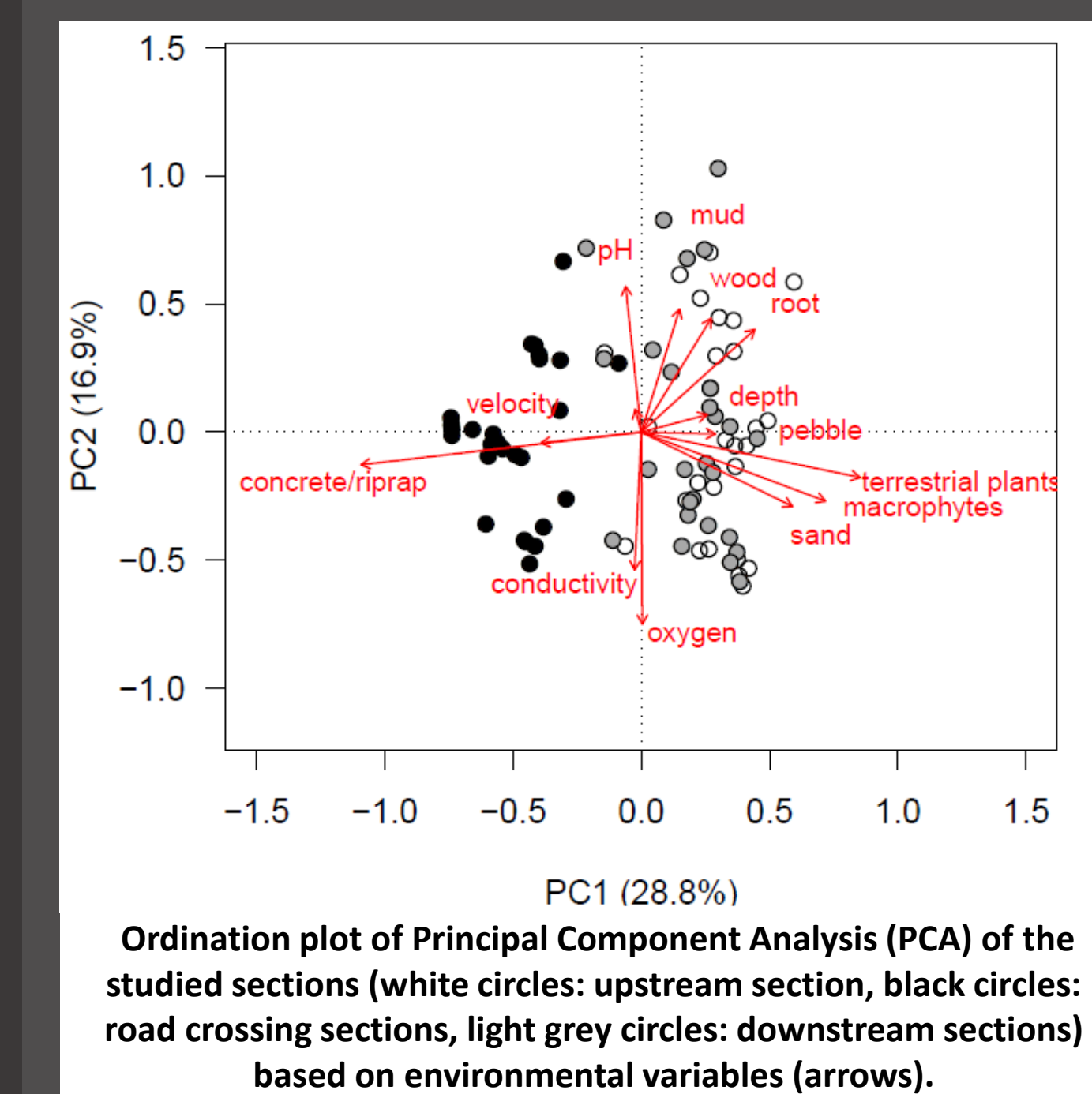- Whether the road crossings alter the community composition of macroinvertebrates?

Methods

We collected stream macroinvertebrates at 9 study sites from road crossings **(B)** (bridges and culverts) and compared their diversity with upstream **(A)** and downstream **(C)** sections.
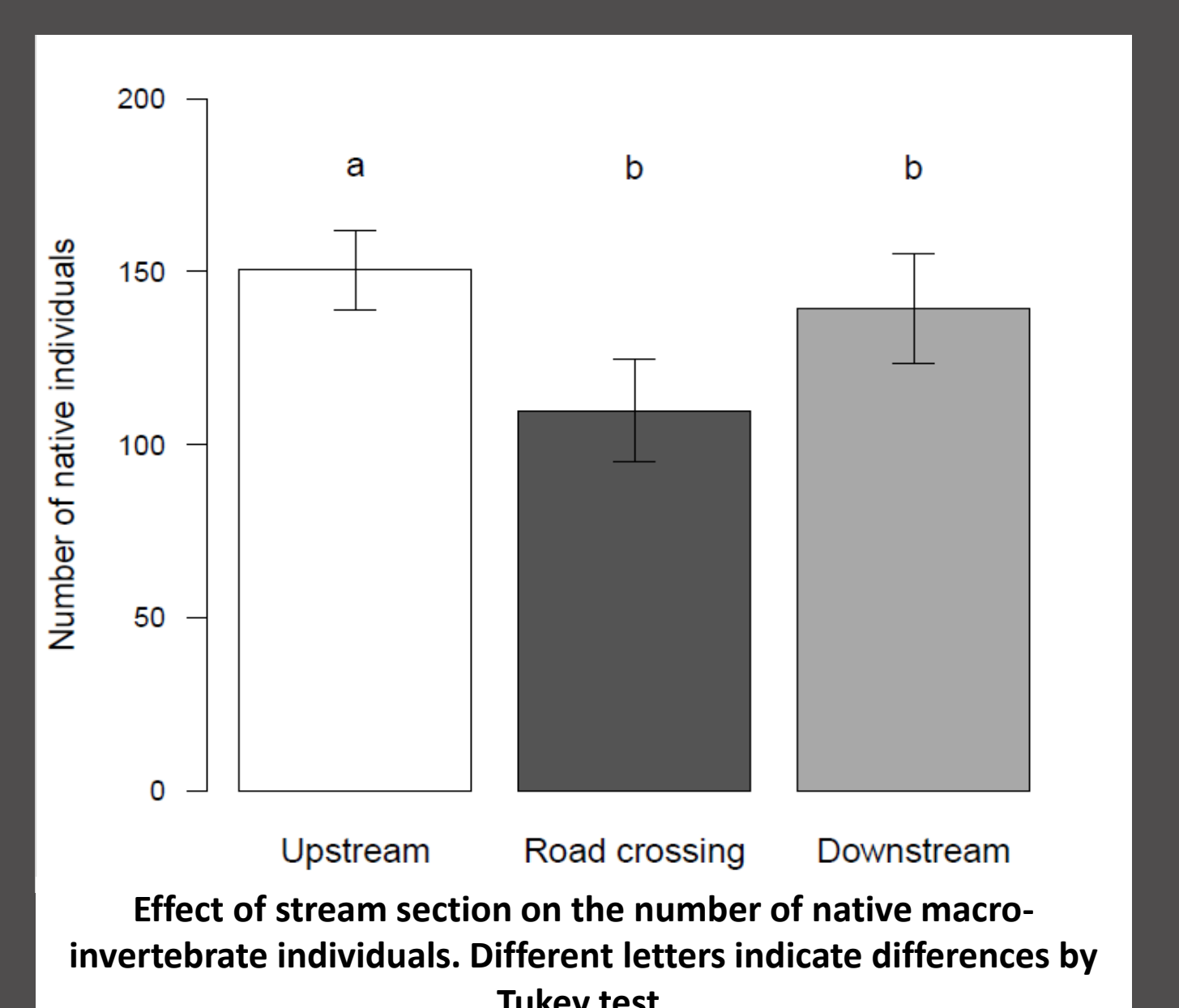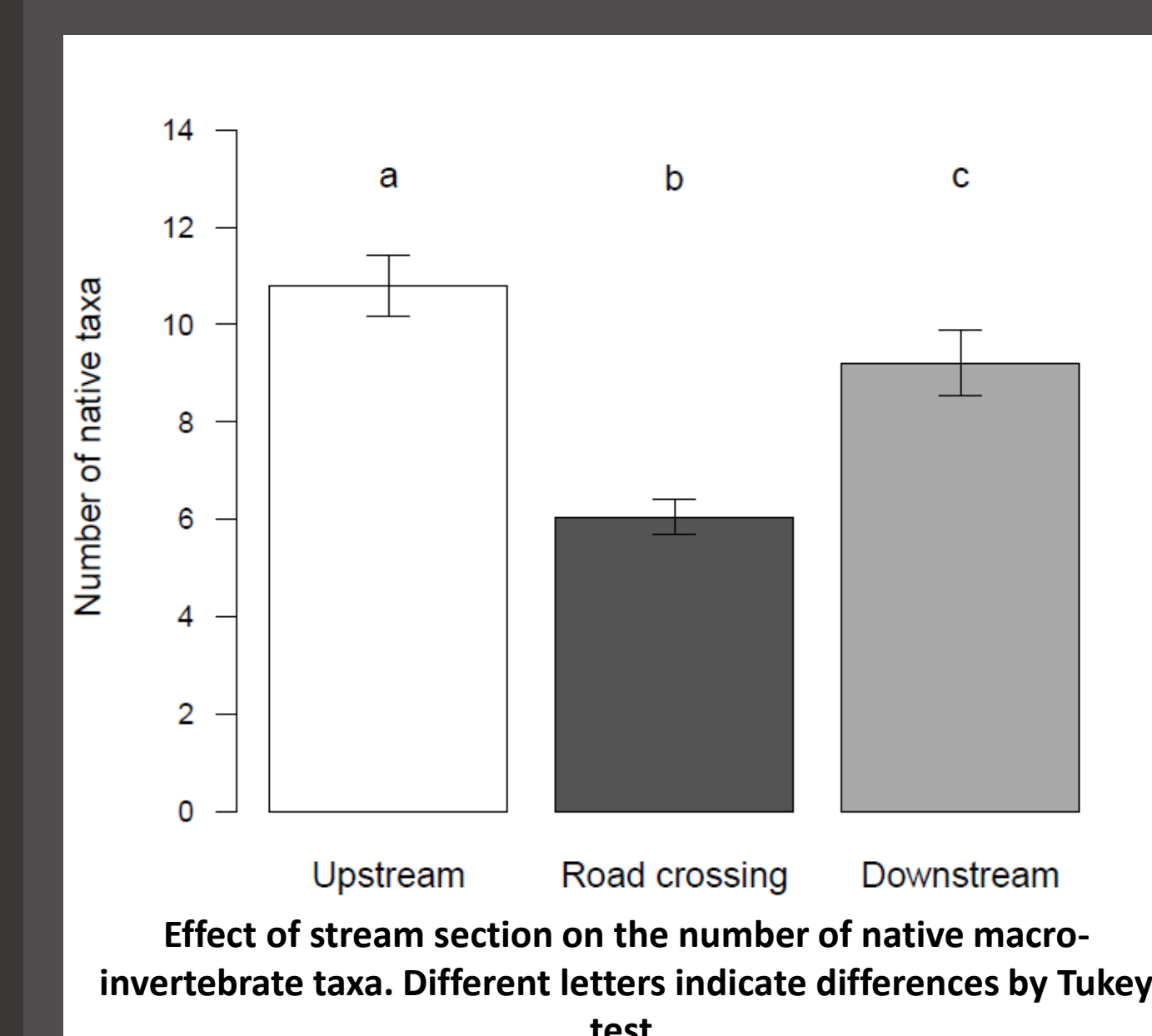
- Sampling method: kick and sweep sampling technique (hand net 500 µm), 3 replicate three-minute samples covering most microhabitats present in the section
- Sections were characterized by visually estimated environmental variables (eg. water depth, current velocity and substrate composition)
- Water chemistry parameters e.g. temperature, pH, conductivity and salinity were also measured

Look at some data

Ordination plot of Principal Component Analysis (PCA) of the studied sections (white circles: upstream section, black circles: road crossing sections, light grey circles: downstream sections) based on environmental variables (arrows).

Altogether 157 taxa were found among the 32,507 identified individuals. We identified 7 protected and 4 non-native taxa. Six protected species were present exclusively in upstream and downstream sections while a single protected species was present only at one road crossing section. Our results suggest that road crossings cause changes in stream channel geomorphology, reduce habitat heterogeneity and present conditions that are notably different from the natural stream ecosystems.

Effect of stream section on the number of native macro-invertebrate taxa. Different letters indicate differences by Tukey test.

Effect of stream section on the number of native macro-invertebrate individuals. Different letters indicate differences by Tukey test.

Effect of stream section on the number of alien macro-invertebrate individuals. Different letters indicate differences by Tukey test.

Ordination plot of Constrained Analysis of Principal Coordinates (CAP) of the studied section based on macro-invertebrate communities (white circles: upstream section, black circles: road crossing sections, light grey circles: downstream sections).

Conclusion & what's next?

We found that road crossings had negative effects on the richness and abundance of native macro-invertebrates, as well as on the number of protected taxa. Our results showed also that alien individuals were more abundant at road crossings. These findings support the assumption that road crossings contribute to the spread of alien species. The assessment of environmental variables indicated that road crossings caused habitat modifications, and based on these it can be assumed that habitat modifications and associated phenomena (e.g. pollutants ¡and storm events) were the major drivers of the observed patterns in biodiversity. In the future we intend to examine multiple aspects of the biodiversity considering the functional trait-based and phylogenetic facets were still infrequently studied in comparison to the traditional taxonomic-based approaches.