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Biological and hydromorphological integrity of the small urban stream

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Abstract

Biological and hydromorphological integrity of five reaches of the small urban stream were assessed. Because macroinvertebrate communities respond to both organic pollution and habitat change, impacts of both measures can be hardly separated. In our study on the urbanized small stream, an impact of organic pollution was excluded as all five sampling sites were assessed as moderately polluted. On the other hand differences in morphological degradation of banks and channel of selected sites enabled us to relate hydromorphological stress and biotic metrics and taxa. Physical habitat quality was assessed using River habitat survey (RHS) methodology. A downstream–upstream gradient of physical habitat degradation was observed and related to the macroinvertebrate community characteristics. Similarity analyses and biotic metrics were calculated and correlated with results of the RHS analyses. Composition of the macroinvertebrate assemblages did not follow the longitudinal pattern of habitat modification observed by the RHS analysis. However, some metrics corresponded well. Percentage of detritivores, percentage of *Caenis luctuosa*, number of individuals, percentage of EPT individuals were best predictors of changes in the physical habitat quality. However, the metric percentage of EPT individuals was negatively correlated to the habitat degradation, what is in contradiction with results from studies of other authors.

Keywords: Urban stream; Macroinvertebrates; Habitat modification; Ecological quality; RHS

1. Introduction

Macroinvertebrate communities are widely used to assess the biological integrity of running waters (Beisel et al., 2000). They respond to both organic pollution and habitat change (Buffagni et al., 2000; Beavan et al., 2001; Lorenz et al., 2004). In urban streams macroinvertebrates are often exposed to combination of both factors. Channelisation is the most common habitat change in urban areas. Ecological consequences of channelisation are that habitat diversity and niche potential are reduced and the quality and function of the species are changed (Brookes and Gregory, 1998). The number of taxa appears to be higher in a heterogeneous environment, where habitats are more varied and a higher number of taxa can potentially find ecological niches (Beisel et al., 2000). Urbanized lotic systems are often classified as having poor or very poor biotic integrity as in a homogeneous environment there is usually a particular type of microhabitat that can shelter a large number of individuals of a specific set of species. Aggregation of very adapted species is therefore favoured in a very homogeneous environment (Davis et al., 2003; Beisel et al., 2000). In organically polluted rivers Beavan et al. (2001) found biotic scores and beta diversity analysis to indicate that less modified sites supported a slightly higher quality invertebrate fauna than physically modified sites. Altered fluvial processes as a result of urbanization and their influence upon channel geomorphology may be a more fundamental determinant in the functioning of urban stream ecosystems than factors related to toxicity or organic loading. Urban rivers are straightened and banks reinforced in an attempt to channel high flows out of the area quickly and safely. The altered features of an urbanized stream system may impact the

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bottom fauna directly through specific habitat changes or indirectly through the temporal reduction in the quantity of available food (Pedersen and Perkins, 1986). Urbanized streams though, seem to be preferred by less specialized feeders due to inconsistency of food sources (as decaying leaves) that are rapidly transported downstream (Pedersen and Perkins, 1986).

In the presented study both the hydromorphological and the biological integrity of the selected stream reaches of the Glinščica stream were assessed. In order to determine how changes in hydromorphological integrity of the stream affect the biological one the correlations were calculated between stream hydromorphological characteristics and the biotic metrics based on benthic macroinvertebrate fauna. Glinščica stream has been chosen for a case study system, which exhibits modifications of the hydromorphological characteristics as well as changes in riparian and channel vegetation, which progress downstream in a relatively short distance from a pristine to a heavily modified channel.

2. Description of the study site

The Glinščica stream, a tributary of the Ljubljanica River, lies on the western outskirts of Ljubljana in the centre of Slovenia (Fig. 1).

Elevations of the stream range from 500 m above mean sea level at the source to 289 m at the mouth. The relief of the Glinščica watershed is heterogeneous with steep headwater areas in the north and plains in the south. By extending the paved impermeable urban areas on the plain parts of the watershed, the hydrology of the entire watershed has changed dramatically in the last 20 years. Prior to intensive urbanization, these plain areas did not contribute in the formation of peaks of runoff hydrographs. The increase in impervious surfaces (extension of building, traffic surfaces) brought about the augmentation of the runoff coefficient. Furthermore, the drainage system caused a further decrease in the concentration time of rainfall runoff. Urban areas present 38% of the entire Glinščica watershed, i.e. 6.6 km^2. The approximate value for the average runoff coefficient, computed from the average annual rainfall (1376 mm) and average annual discharge in the Glinščica stream (0.383 m^3/s), is 0.58 (Rusjan et al., 2003). Besides changes in the watershed and hydrology there are also changes in the stream hydromorphology. Modifications include stream habitat characteristics as well as changes in riparian vegetation and progress downstream. In the lower stretch the stream has concrete channel and banks and flows through urban area (Tables 1 and 2).

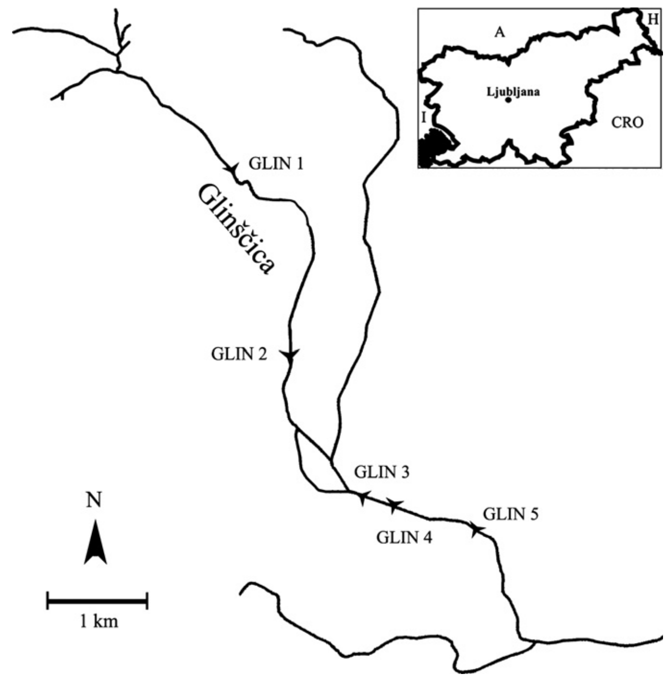

Fig. 1. Sketch of the study area with location of sampling sites on the Glinščica stream.

3. Materials and methods

Five sampling sites of different habitat quality (Table 1) were chosen for biological and hydromorphological analyses (Fig. 1). Each sampling site was selected as a representative of the certain state of the habitat degradation. Site GLIN 1, the uppermost, was located in the nearly pristine reach, whereas the other four in reaches affected by the anthropogenic land-use disturbances, which progress

Table 1
Location and description of sampling sites of the Glinščica stream

Site code	Location	Distance to source (km)	Elevation (m)	Stream order	Bank/channel modifications	Riparian vegetation
GLIN 1	Podutik	2.3	310	2	None	Dense riparian vegetation (trees and shrub)
GLIN 2	Koseze bridge	4.6	302	2	Straightened channel	Sporadic trees and shrub
GLIN 3	Brdnikova street	6.0	300	3	Straightened channel, bank reinforcement with stones	Grass
GLIN 4	PST bridge	6.2	299	3	First half trapezoidal reinforced banks, the other half trapezoidal concrete channel	Grass
GLIN 5	Biotechnical faculty	7.1	298	3	Trapezoidal concrete channel	Grass