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SESSION 06

MAINTAINING AND ENHANCING EUROPEAN BIODIVERSITY

Ecological status of a mountain river based on pre- and post-flood data

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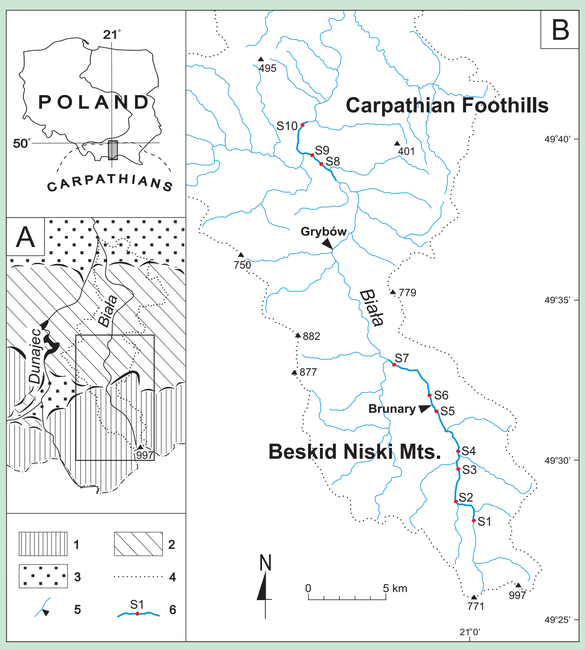
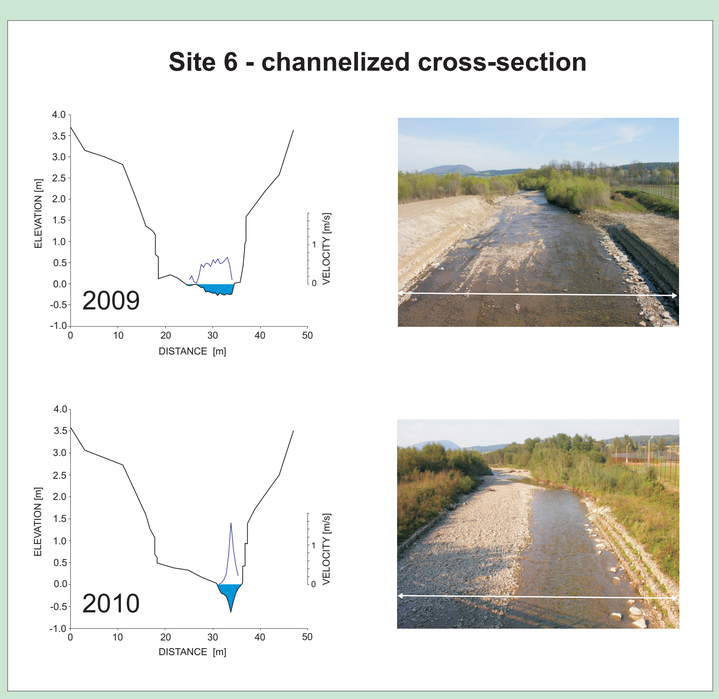


1 (A) Location of the Biała River in relation to physiogeographic regions of southern Poland. (B) Drainage network of the upper and middle parts of the Biała catchment and detailed setting of the studied sites: (1) mountains of intermediate and low height; (2) foothills; (3) intramontane and submontane depressions; (4) boundary of the Biała catchment; (5) flow-gauging stations; (6) study sites and river reaches proposed for erodible river corridor



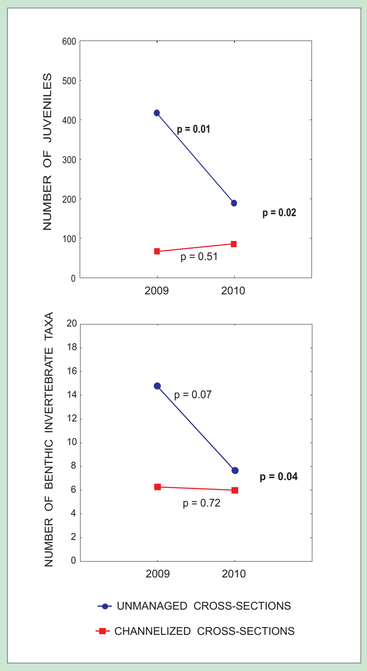
2 Example of the morphology of channelized cross-sections of the Biała River before (2009) and after (2010) the major flood of June 2010

The Biała is a 102 km long gravel-bed river flowing north across the Outer Western Carpathians. In 2009 and 2010, repeated **assessments of the physical habitat conditions and fish and benthic invertebrate communities** were performed in 10 sites of the Biała River situated in two investigated reaches **proposed for erodible river corridor** (1).

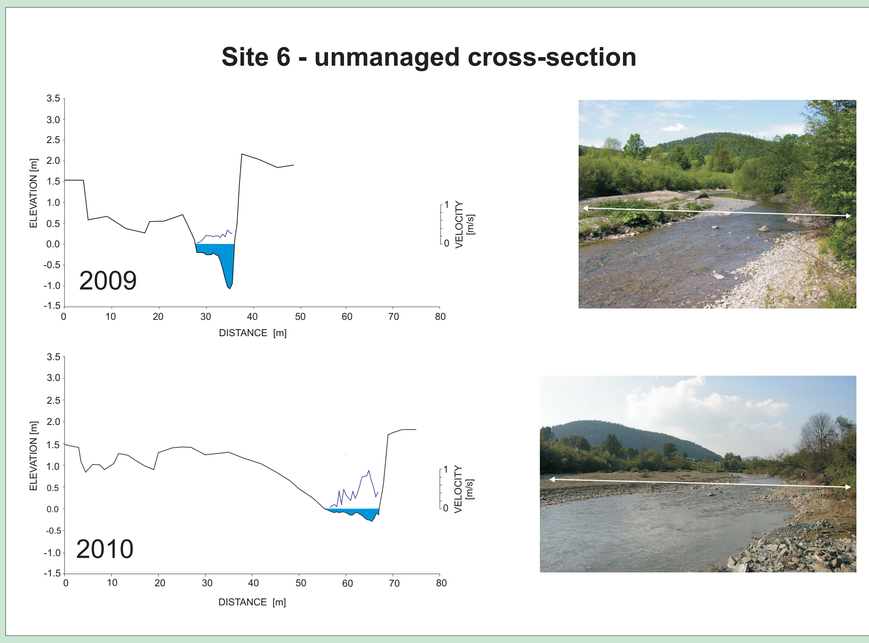
Each site consisted of **a pair of unmanaged and channelized cross-sections** located between significant tributaries which thus represented similar hydrological and water quality conditions (1). Between the two assessment surveys, an extreme flood event with a recurrence interval of at least tens of years occurred, significantly changing both habitat characteristics and river biocenoses. During baseflow conditions in July and August 2009 and 2010, we surveyed elevation profiles and measured: active channel and low-flow channel widths at the cross-sections, water depth, near-bed and depth-averaged flow velocity and mean grain size of surface bed material at equal intervals across the low-flow channel (2, 4). **Means and coefficients of variation of the measured physical habitat parameters were calculated for each cross section.**

Species composition and abundance of fish communities in the investigated cross-sections were determined by electrofishings conducted in the early September 2009 and 2010. All captured individuals were identified and assigned to one of two age categories: juveniles (YOY) or subadult and adult fishes.

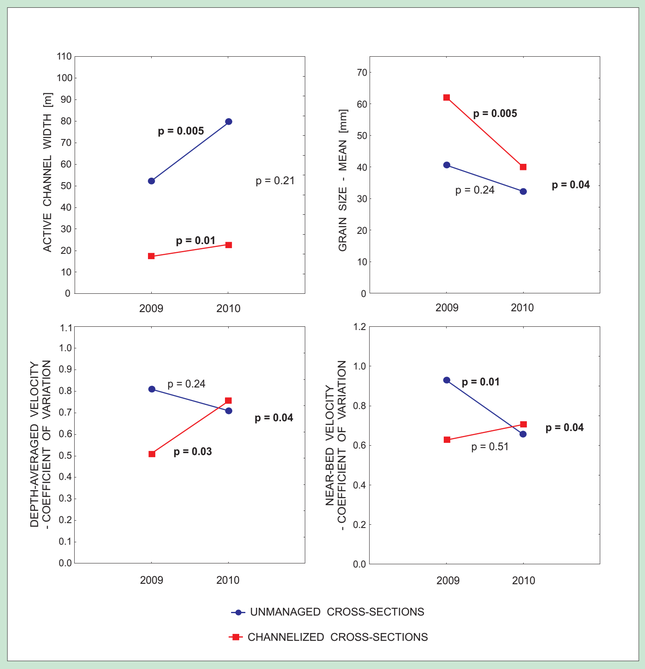
Benthic macroinvertebrate surveys were made in July 2009 and June 2010 and taxonomic richness of invertebrate assemblages was determined for each survey. Changes in both biotic and physical habitat characteristic of



3 Changes in the number of fish juveniles and benthic invertebrate taxa in the unmanaged and channelized cross-sections of the Biała River related to the occurrence of the major flood of June 2010, their statistical significance shown by a Wilcoxon test, and the statistical significance of changes along temporal and channel management-related gradients shown by two-way analysis of variance



4 Example of the morphology of unmanaged cross-sections of the Biała River before (2009) and after (2010) the major flood of June 2010



5 Changes in active channel width, mean grain size of surface bed material, and the coefficients of variation of depth-averaged and near-bed velocity in the unmanaged and channelized cross-sections of the Biała River related to the occurrence of the major flood of June 2010, their statistical significance shown by a Wilcoxon test, and the statistical significance of changes along temporal and channel management-related gradients shown by two-way analysis of variance

RESULTS

1. In unmanaged cross-sections, active channel width increased after the major flood, whereas the degree of cross-sectional variation of flow velocity decreased. In channelized cross-sections, the increase in active channel width and the cross-sectional variation of flow velocity was accompanied by a decrease in mean grain-size of bed material.

2. Prior to the flood, unmanaged cross-sections hosted three times more benthic invertebrate taxa than the channelized ones, whereas after the flood, the number of taxa was reduced to such a low level that both types of cross-sections became similar in terms of the taxonomic richness of benthic invertebrate communities.

3. In comparison to pre-flood conditions, the abundance of fish juveniles in unmanaged cross-sections was reduced nearly by half; before the flood the cross-sections hosted 5 times more juvenile individuals than channelized cross-sections and only twice as many after the flood.

CONCLUSIONS

The differences between the outcomes from both surveys indicate that assessment carried out prior or after a large flood event may yield significantly different results for the quality of abiotic and biotic elements of the ecological status of a river. This can seriously affect the appraisal of measures aimed at improving river health or the success of particular restoration projects. Therefore, it seems vital that the final assessment be based on repeated surveys of abiotic and biotic elements of the river ecological status to balance the effect of single, extreme hydrological events.

Physical habitat parameter	Cross-section type	Year 2009	Year 2010	p-value of Wilcoxon test	p-value of Two-Way Anova
Number of fish species	Unmanaged	**4.7**	4.0	p = 0.07	p = 0.64
	Channelized	4.2	3.8	p = 0.20	
Number of subadult and adult fish individuals	Unmanaged	22.7	14.2	p = 0.11	p = 0.38
	Channelized	12.2	8.8	p = 0.33	
Number of juveniles	Unmanaged	416	188	**p = 0.01**	**p = 0.02**
	Channelized	68	87	p = 0.51	
Number of benthic invertebrate taxa (summer)	Unmanaged	14.7	7.6	p = 0.07	**p = 0.04**
	Channelized	6.3	6.0	p = 0.72	
Number of benthic invertebrate taxa (winter)	Unmanaged	13.2	12.0	p = 0.08	p = 0.28
	Channelized	5.6	7.1	p = 0.06	

6 Results of a Wilcoxon test for the significance of difference between biotic characteristics of a given type of the studied cross-sections of the Biała River before (2009) and after (2010) the major flood of June 2010, and the significance of changes along temporal and channel management-related gradients shown by two-way analysis of variance

Physical habitat parameter	Cross-section type	Year 2009	Year 2010	p-value of Wilcoxon test	p-value of Two-Way Anova
Number of low-flow channels	Unmanaged	2.0	1.6	p = 0.14	p = 0.27
	Channelized	1.2	1.2	p = 1.00	
Active channel width (m)	Unmanaged	52.4	79.3	**p = 0.005**	p = 0.21
	Channelized	17.4	23.0	**p = 0.01**	
Low-flow channel width (m)	Unmanaged	14.3	14.6	p = 0.96	p = 0.93
	Channelized	10.3	10.9	p = 0.72	
Flow depth: mean (m)	Unmanaged	0.33	0.20	p = 0.24	p = 0.22
	Channelized	0.24	0.22	p = 0.58	
Flow depth: coefficient of variation	Unmanaged	0.563	0.465	p = 0.11	p = 0.08
	Channelized	0.437	0.504	p = 0.28	
Depth-averaged velocity: mean ($m\ s^{-1}$)	Unmanaged	0.28	0.29	p = 0.80	p = 0.59
	Channelized	0.33	0.30	p = 0.80	
Depth-averaged velocity: coefficient of variation	Unmanaged	0.811	0.711	p = 0.24	**p = 0.04**
	Channelized	0.509	0.757	**p = 0.03**	
Near-bed velocity: mean ($m\ s^{-1}$)	Unmanaged	0.17	0.21	p = 0.17	p = 0.56
	Channelized	0.20	0.21	p = 0.88	
Near-bed velocity: coefficient of variation	Unmanaged	0.950	0.677	**p = 0.01**	**p = 0.04**
	Channelized	0.629	0.707	p = 0.51	
Grain size: mean (mm)	Unmanaged	41.3	33.0	p = 0.24	**p = 0.04**
	Channelized	60.5	38.4	**p = 0.005**	
Grain size: coefficient of variation	Unmanaged	0.525	0.475	p = 0.77	p = 0.38
	Channelized	0.187	0.256	p = 0.28	

7 Results of a Wilcoxon test for the significance of difference between physical habitat parameters recorded in a given type of the studied cross-section of the Biała River before (2009) and after (2010) the major flood of June 2010, and the significance of changes along temporal and channel management-related gradients shown by two-way analysis of variance