

ECOTONES IN ESTUARY ZONE
OF THE BYSTRZYCA RIVER
CLOSE TO THE ZEMBORZYCKI RESERVOIR
– DELIMITATION, CLASSIFICATION AND VALORIZATION

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Summary. Ecotones are considered as one of the basic components of the spatial structure of the landscape. The Bystrzyca River is one of the major rivers flowing through the Lublin Upland. The aim of this study was to create a delimitation and valorization, such important to the functioning of ecological systems, ecotones in the valley of the Bystrzyca River. The basis of the study was natural valorization of that area, as well as identification and evaluation of ecotones diversity.

The valley of the Bystrzyca River is characterized by rich and densely developed network of ecotones. River valley's landscape consists mainly woodlands and bushes which are overgrown a meadow surrounded by forest. The natural character of land using dominated in the analyzed section of the river valley. The highest nature and landscape aesthetic value had south-eastern and north-western part of the study area. The central part is characterized by low or moderate natural values due to intensive agricultural use of the land. The study area in order to preserve its natural values requires adequate protection.

Key words: ecotones, biodiversity, the Bystrzyca River, nature and landscape units

INTRODUCTION

Defining the landscape, special attention is given to the fact that neighboring ecosystems are closely interrelated and interact with each other. The components of the landscape combines among themselves water cycle, air circulation, various migratory species and the transferring of matter [Czachorowski 2008].

The boundaries between different ecosystems in the landscape are not sharp and plants penetrate neighboring biocenosis. Adjacent to the forest, grassland usually ends with shrubs or bushes which fall gently on the neighboring meadows, forming clumps on it. Such places are called transitional zones – ecotones [Bogatko 2010].

Ecotones are considered as one of the basic components of the spatial structure of the landscape. Civilizational and economic activities of human led to nature defragmentation, and thus reduction of natural patches in the landscape. This, in turn, led to an increase of landscape mosaicism and the number and length of ecotones between different environments [McArthur and Sanderson 1999, Dąbrowska-Prot and Wasilowska 2008].

From an environmental point of view ecotones are important because they affect the landscape and its features. They regulate biodiversity, affect the functioning of the landscape (the exchange of matter, energy, information and species), and also maintain its stability [Dąbrowska-Prot and Wasilowska 2008, Forman and Moore 1992, Kolasa and Zalewski 1995].

Among many types of ecotones, especially water-land ecotones are interesting. They connect or separate the significantly different environments. They make it possible to preserve and maintain biodiversity at all levels. They act as a filter in the ecological flow of energy, matter, and organisms between ecosystems [Kraska *et al.* 1998, Sender and Kułak 2010, Chmielewski 2012].

The Bystrzyca River is one of the major rivers flowing through the Lublin Upland. The aim of this study was to create a delimitation and valorization, such important to the functioning of ecological systems, ecotones in the valley of the Bystrzyca River. The basis of the study was natural valorization of that area, as well as identification and evaluation of ecotones diversity.

STUDY AREA

The entire study area is located within the administrative boundaries of Lublin city, in the estuary of the Bystrzyca River close to the Zemborzycki Reservoir. The study included a stretch of the Bystrzyca River, and estuary stretch of the Nędznica River (Fig. 1).

The Bystrzyca River has its source in Sulejów, at an altitude of 232m above sea level. The sources are the fissure-layered. The Bystrzyca valley is considerably morphometric diversified. Its length – 70.3 km, catchment area – 1315.5 km², the width of the valley – from 300 to 1000 m, the size of the river basin – 228.2 km². The entire study area is located within the Protected Czerniejów Landscape Area [Wilgat 1992].

The study area is located in the direct vicinity of the Dąbrowa Forest. From the west, bordered by fields and buildings of the Zemborzyce Górne district, from the north-east of the Zemborzycki Reservoir, while from the south-east by buildings of the Zemborzyce Bór district (Fig. 1). The study area covered an area of about 70 hectares. Usually they were wetlands, flooded periodically by the river. The dominant form of land cover were wet meadows with numerous shrubs and drainage ditches.

Dry-ground forest and riparian forests are the main plant communities which occur in the Bystrzyca River valley. *Poo-Festucetumrubra* and *Molinio-Arrhenatheretea* mainly developed here. On the dry meadows there are poor pastures dominated by *Deschampsia caespitosa*.

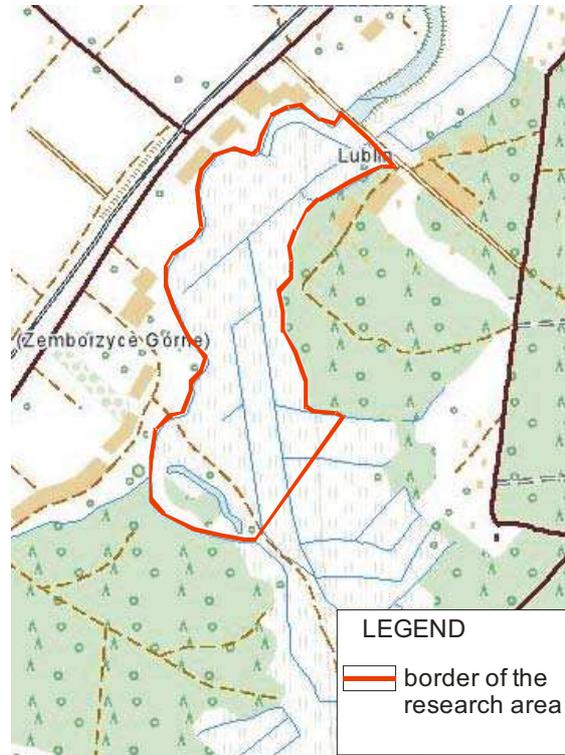


Fig. 1. The study area (based on 1:10.000 topographic map)

The studied area is exposed to strong anthropogenic influence due to the close proximity of the Zemborzycki Reservoir, which in the summer season is frequently visited by many tourists [Sroczyński 2006]. The Bystrzyca River is supplied by waste water from households that adversely affect, the quality of water. Partly the analyzed area is used for intensive agricultural activities, such as mowing meadows. There are numerous illegal garbage dumps in nearby of the Dąbrowa Forest.

METHODS

The study was conducted mainly with using methods of the natural landscape unites. Delimitation and the occurrence range of the transition zones were made, based on field investigation and topographic map in scale 1:10000. Valorisation of particular ecotones was based on: a photographic and cartographic documentation, floristic inventory and morphometric measurements (length, width, shape, size), the number of plant communities, the presence of rare species, as well as the origin of zones (natural, semi-natural, anthropogenic) and the type of units.

Table 1. Point indexation of natural and landscape units

Points feature	3	2	1
Ecotones number	5	4	3 and below
Diversity of vegetation	7	6	4 and below
Species diversity and aesthetic value	high	average	poor

The study also included the characteristics of natural-landscape units in each the surface, the number of interior, the average size and shape of the interior, the density of ecotones and their diversity were analyzed. Natural and landscape valorization based on the point evaluation of units (Tab. 1).

RESULTS AND DISCUSSION

The valley of the Bystrzyca River is valuable area from natural and landscape point of view. It is characterized by a great diversity of ecological structures. Among five natural and landscape units distinguished on investigated area, the unit number 1 covered the most surface and is characterized by the highest diversity of the analyzed features (Fig. 2). The density of ecotone in this unit was 123 m ha^{-1} with five types of ecotones.

The smallest area occupied unit number 5, – only 3.13 ha. It contained only one nature and landscape interior with an area of 1.09 ha and varied shape. The density of ecotones was 300 m ha^{-1} with four types of ecotones (Tab. 2).

Table 2. Characteristics of nature and landscape units

Number of nature and landscape unit	Surface, ha	Number of interior	Surface of interior, ha	Average surface of interior in unit	Shape of interior	Density of ecotones, $\text{m}\cdot\text{ha}^{-1}$	Diversity of ecotone types
1.	28.73	1.	4.3	2.74	labyrinthine	123	2
		2.	4.55		elongate		
		3.	1.69		rectangular		
		4.	1.54		rectangular		
		5.	1.23		rectangular		
		6.	2.39		rectangular		
		7.	3.5		labyrinthine		
2.	11.72	8.	2.18	3.89	rectangular	108	2
		9.	5.6		labyrinthine		
3.	14.69	10.	6.14	3.57	elongate	104	2
		11.	1.15		rectangular		
		12.	3.43		labyrinthine		
4.	14.23	13.	4.28	5.88	labyrinthine	80	2
		14.	7.49		labyrinthine		
5.	3.13	15.	1.09	1.09	labyrinthine	300	2

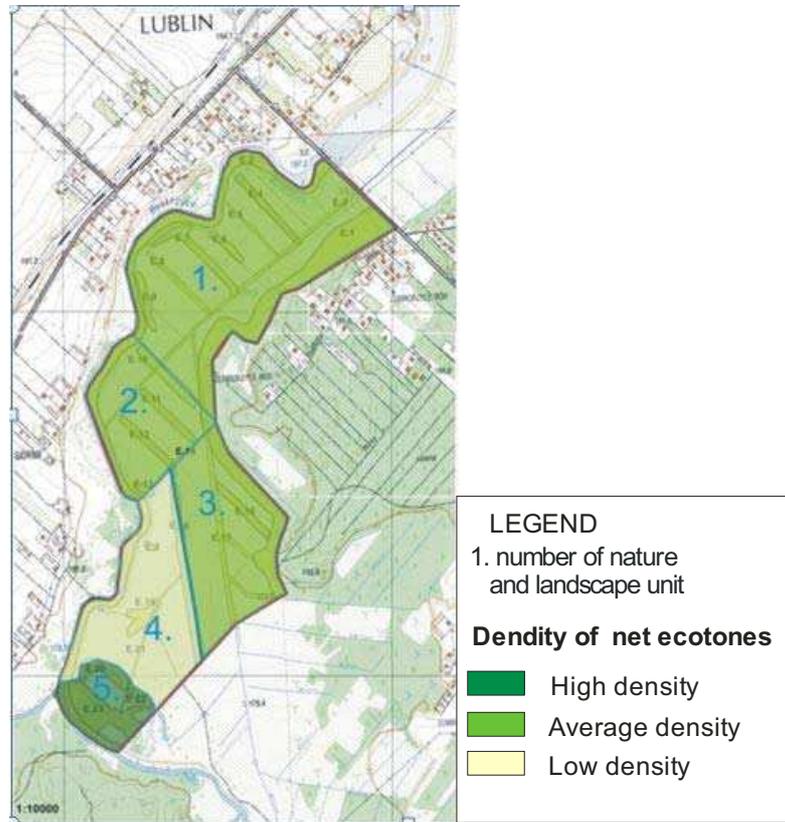


Fig. 2. Nature and landscape units and the density of ecotones in the valley of the Bystrzyca River

Table 3. Points valorisation of natural and landscape units

Number of unit	Diversity of ecotone types (points)	Diversity of vegetation types (points)	Diversity of ecotones in part. units (points)	Aesthetic values of the unit (points)	Score (points)
1.	3	3	3	2	11
2.	2	2	2	2	8
3.	1	1	1	1	4
4.	2	3	2	2	9
5.	1	3	3	3	10

The highest natural and landscape values had two units, extremely situated in the investigated area, no. 1 and no. 5 (Fig. 3). In the unit 1 a large variety of different types ecotones, a large variety of plant communities and high species diversity within the ecotones occurred (Tab. 3). Nature and landscape unit no. 5 was characterized by small differences in types of ecotones, while had high aesthetic value and floristic diversity (Tab. 3). The lowest landscape and environment values had unit no. 3. Intensive use of land by agriculture was the main reason of low valuation.

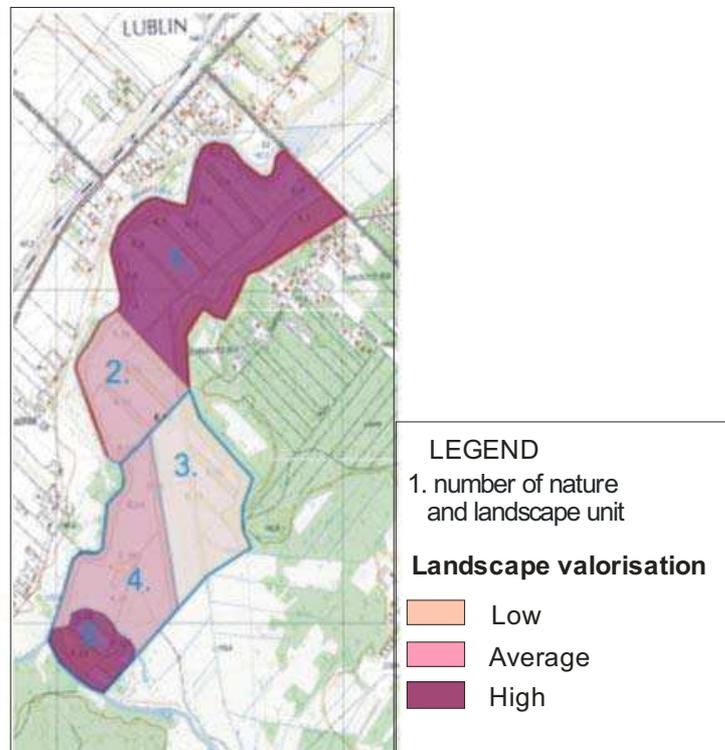


Fig. 3. The evaluation of natural and landscape units

In the investigated area there were 23 ecotone zones. Two of the most characteristic were located at the edge of the forest (E1) and along the river (E2). The other areas covered the edges of ditches, oxbow lakes in the western part of the area and the larger grouping of high vegetation (Fig. 4).

Among the distinguished ecotone zones, the largest surface occupied ecotone no. 1 – 6.89 ha. It was a smooth transition between forest and meadow with a length of 1570 m and an average width of 40 m. The area most of distinguished ecotone zones ranged from 0.06 ha to 1.72 ha. Dominated ecotones with an elongated shape (Tab. 4).

Ecotones with natural and anthropogenic origin occupied a similar surface. The significant was also the participation of semi-natural origin ecotones – 6 (Tab. 5). Ecotone zones in terms of sharing the types of ecosystems was few varied. Transitional zone between the meadows and aquatic ecosystems (drainage ditch) was dominated one.

In the valley of the Bystrzyca River there was a large variety of plant communities (Fig. 5). Aquatic vegetation was located in the natural meanders and on the shores where the flow of water was slow down. There were: *Lemna minor* (L.), *Sagittaria sagittifolia* (L.), *Polygomum amphibium* ((L.) Gray.), *Hydrocharis morsus-ranae* (L.).

Table 4. Type of ecotone occurring in valley of the Bystrzyca River

Ecotone number	Length, km	Min. width, km	Shape	Surface, ha
1.	1.57	0.04	elongate	6.89
2.	2.68	0.03	elongate	4.89
3.	1.05	0.009	elongate	1.05
4.	0.28	0.012	elongate	0.6
5.	0.23	0.01	elongate	0.18
6.	0.13	0.02	elongate	0.28
7.	0.29	0.023	elongate	0.8
8.	0.27	0.014	elongate	0.36
9.	0.18	0.028	elongate	0.44
10.	0.25	0.014	elongate	0.73
11.	0.22	0.015	elongate	1.48
12.	0.25	0.012	elongate	0.36
13.	0.07	0.024	oval	0.13
14.	0.18	0.008	elongate	0.06
15.	0.04	0.016	oval	0.06
16.	0.56	0.013	elongate	1.06
17.	1.06	0.008	elongate	1.48
18.	0.23	0.02	elongate	0.49
19.	0.14	0.04	irregular	0.51
20.	0.18	0.032	oval	0.74
21.	0.42	0.007	elongate	1.19
22.	0.09	0.029	oval	0.26
23.	0.24	0.09	irregular	1.72

Table 5. Characteristics of ecotone zones based on the origin

Number of ecotone zones	Natural	Type of cover	Semi-natural	Type of cover	Anthropogenic	Type of cover
1.	+	bushes				
2.	+	rushes				
3.					+	ditch
4.					+	ditch
5.			+	bushes		
6.			+	bushes		
7.			+	bushes		
8.					+	ditch
9.	+	bushes				
10.			+	bushes		
11.			+	bushes		
12.					+	ditch
13.	+	bushes				
14.					+	ditch
15.	+	bushes				

16					+	ditch
17					+	ditch
18			+	bushes, ditch		
19	+	bushes				
20	+	rushes				
21					+	ditch
22	+	rushes				
23	+	bushes				

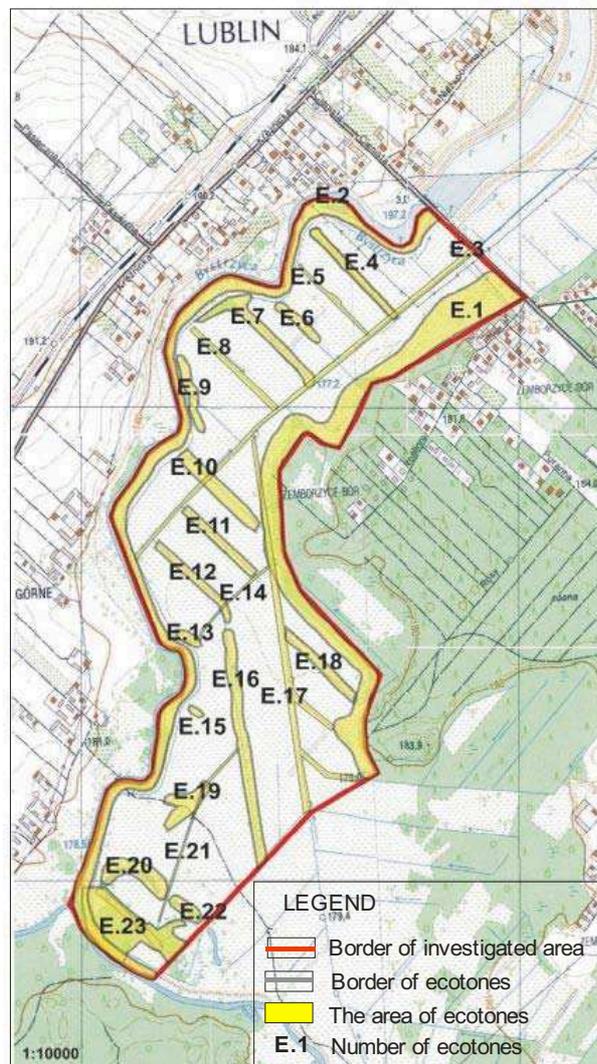


Fig. 4. Network of ecotone zones in the valley of the Bystrzyca River

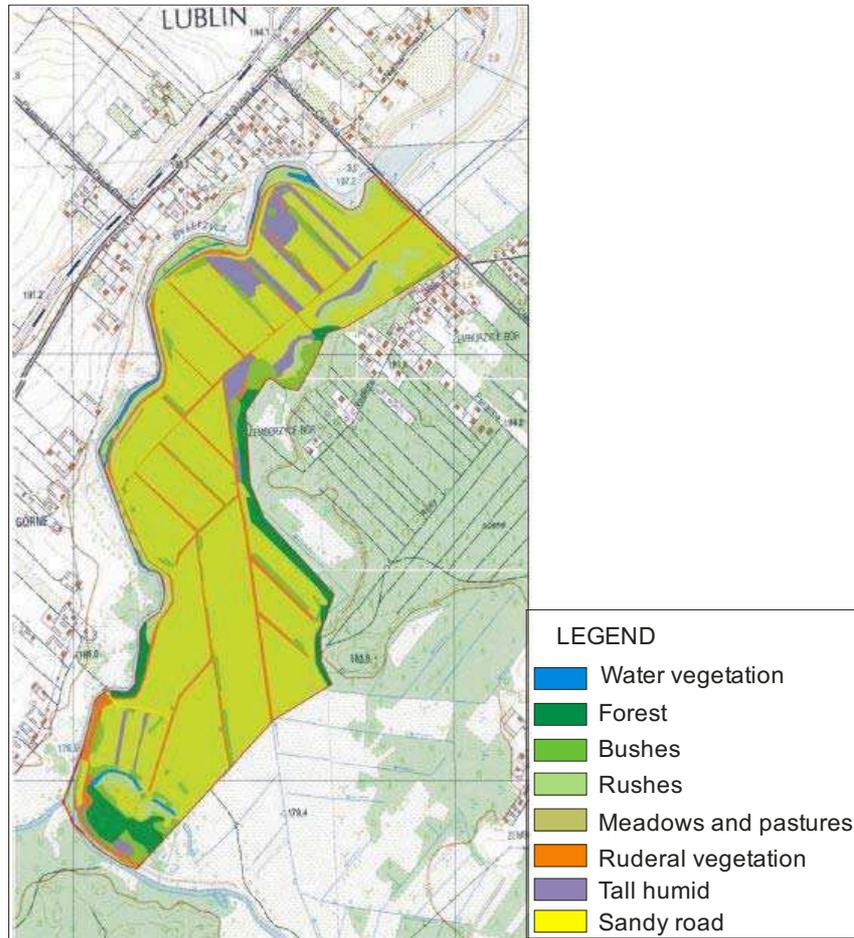


Fig. 5. Plant communities in the investigated area

Rushes occurred also abundantly both in the shore zone of the river and in the Dąbrowa Forest. Rushes represented: *Typha latifolia* (L.), *Phragmites australis* ((Cav.) Trin. Ex Stued), *Acorus calamus* (L.), *Iris pseudoacorus* (L.), *Glyceria aquatic* ((L.) Wahlenb.).

Along the river in the hills and throughout drainage ditches ruderal and segetal communities were observed. They were represented by: *Urtica urens* (L.), *Carduus acanthoides* (L.), *Tanacetum vulgare* (L.), *Arctium tomentosum* (Mill.), *Daucus carota* (L.). The whole study area was occupied by meadow vegetation, represented by numerous sedge communities. Frequently in the study area were woodlots and bushes growing on drainage ditches and scattered throughout the area. Among them there were: *Malus sylvestris* (L.) Mill., *Salix alba* (L.), *Cornus sanguinea* (L.), *Prunus avium* (L.), *Viburnum opulus* (L.), *Syringa vulgaris* (L.), *Alnus glutinosa* ((L.) Gaertn.).

In the south-eastern part of the area and in the west at the mouth of the Krężniczanka river mixed forest occurred, created by pine, spruce, willow species, gray alder and silver birch. In areas of grassland, where agricultural technology was not undergoing occurred tall humid.

The investigated area was characterized by a rich nature values. Due to its location and the landform it can be used as an ecological corridor. It will be possible by preserving the current status and a series of actions. First of all, should be introduced completely ban for non-building in the area. Traffic of vehicles and agricultural practices should be limited to a minimum. In addition, removal of scrubs and riparian woodlots from the coastal zone of the rivers should be prohibited. In the study area shaping of the biological cover of the river should be implemented. Absolutely discharge untreated sewage into rivers should be prohibited, as well as mineral extraction from the river bed.

CONCLUSIONS

The valley of the Bystrzyca River is characterized by rich and densely developed network of ecotones.

River valley's landscape consists mainly woodlands and bushes which are overgrown a meadow surrounded by forest.

The natural character of land using dominated in the analyzed section of the river valley.

The highest nature and landscape aesthetic value had south-eastern and north-western part of the study area. The central part is characterized by low or moderate natural values due to intensive agricultural use of the land.

The study area in order to preserve its natural values requires adequate protection.

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EKOTONY STREFY UJŚCIA RZEKI BYSTRZYCY DO ZALEWU ZEMBORZYCKIEGO – DELIMITACJA, KLASYFIKACJA, WALORYZACJA

Streszczenie. Ekotony są uważane za jeden z podstawowych elementów struktury przestrzennej krajobrazu. Rzeką Bystrzyca jest jedną z głównych rzek płynących przez Wyżynę Lubelską. Celem pracy była delimitacja oraz waloryzacja tak istotnych w funkcjonowaniu układów ekologicznych stref ekotonowych w dolinie rzeki Bystrzycy oraz określenie walorów przyrodniczych tego terenu. Badania oparto na identyfikacji stref ekotonowych i ocenie różnorodności typów ekotonów. Dolina rzeki Bystrzycy charakteryzuje się bogatą i gęsto rozbudowaną siecią stref ekotonowych. Krajobraz dolinny rzeki tworzony jest głównie przez liczne zadrzewienia, zakrzewienia porastające obszar łąkowy otoczone przez kompleksy leśne.

W dolinie rzeki Bystrzycy jednakowy udział miały strefy naturalne, półnaturalne i antropogeniczne. Największe walory estetyczne przyrodnicze i krajobrazowe cechowały południowo-wschodnią i północno-zachodnią część obszaru badań. Centralna część charakteryzowała się niskimi lub umiarkowanymi walorami przyrodniczymi ze względu na intensywne użytkowanie rolnicze tego terenu. Jest to obszar cenny przyrodniczo, który wymaga odpowiedniej ochrony w celu zachowania jego dotychczasowych walorów przyrodniczych.

Słowa kluczowe: ekotony, różnorodność biologiczna, rzeka Bystrzyca, jednostki przyrodniczo-krajobrazowe