

ECOLOGICAL COMPENSATION AREA IN THE ZAGÓRÓW WASHLAND AND ITS ECOTOURISM POTENTIAL

Summary

The Zagórow washland (the Natura 2000 sites, Ostoja Nadwarciańska and the Warta Landscape Park) included in the ecological compensation project, provide an example of ecotourism potential to obtain information on the flora of the region and to conduct nature observations. This area is characterized by varied landscape and considerable floristic diversity. Attractiveness of the area for ecotourism was evaluated using a method proposed by Mahon and Miller based on relevés prepared in the years 2011 - 2012 and landscape records. Results indicate that this area thanks to its predominantly natural landscape resulting from the variety in land relief may be attractive for ecotourism. This is confirmed by the presence of protected species, observations of natural succession in flood meadows, high resistance to recreation land use assessed based on the threshold load index, as well as considerable health-promoting and psychoregulatory value of distinguished communities. Moreover, this object provides an opportunity to investigate the effect of water management on vegetation, and thus to observe succession changes and to control them, which is also an element connected with pure science and education in the promotion of environmental protection and management.

Key words: tourism, ecological compensation, Natura 2000, plant communities

TEREN KOMPENSACJI PRZYRODNICZEJ POLDERU ZAGÓRÓW A JEGO POTENCJAŁ EKOTURYSTYCZNY

Streszczenie

Przykładem możliwości uprawiania ekoturystyki w celach poznawania flory regionu oraz prowadzenia obserwacji ekologicznych jest polder Zagórow (obszar Natura 2000 Ostoja Nadwarciańska oraz Nadwarciański Park Krajobrazowy) objęty projektem kompensacji przyrodniczej. Jest to teren charakteryzujący się zróżnicowanym krajobrazem, a także znaczną różnorodnością florystyczną. Atrakcyjność ekoturystyczną terenu oceniono metodą Mahona i Millera wykorzystując wykonane w latach 2011-2012 zdjęcia fitosocjologiczne i notki krajobrazowe. Wyniki wskazują, że teren ten przez dużą naturalność krajobrazową wynikającą ze zróżnicowania rzeźby terenu może być interesujący do uprawiania ekoturystyki. Potwierdzają to: obecność gatunków chronionych, obserwacje sukcesji naturalnej na obszarach łąk zalewowych, duża odporność na użytkowanie rekreacyjne oceniona wskaźnikiem obciążenia granicznego, znaczne właściwości zdrowotne i psychoregulacyjne wyróżnionych zbiorowisk. Ponadto na przykładzie tego obiektu istnieje możliwość poznania wpływu zarządzania wodą na roślinność, a przez to obserwacji zmian sukcesyjnych i sterowania nimi, co także jest elementem poznawczo-edukacyjnym w zakresie promowania ochrony i kształtowania środowiska.

Słowa kluczowe: turystyka, kompensacja przyrodnicza, Natura 2000, zbiorowiska roślinne

1. Introduction and aim of the study

Ecotourism is an ecologically friendly form of tourism, focused on direct contact of tourists with nature (mainly protected areas), which enables them to gain knowledge, admire and enjoy the natural landscape and the local community. The aim is to broaden knowledge on the traditional lifestyle and regional culture [1, 2]. A new trend in this branch of tourism is connected with promotion of Natura 2000 areas with a simultaneous socio-economic activation of the region, and as such it is found most frequently in areas with the greatest nature and landscape value [3]. A particularly interesting aspect stems from the possibility to observe methods and effects of ecological compensation aiming at restoration of nature value of a given area. In recent years eco-tourism has been developing dynamically in Natura 2000 areas, mainly in river valleys [4, 5]. In recent years the Zagórow washland in the Warta valley has been subjected to compensation tasks, thus the aim of this study is to present landscape value of the study area as an area with an ecotourism development potential.

2. Material and methods

The Zagórow washland is situated between Konin and Pызdry, i.e. in the Central Warta Valley. The Warta Landscape Park was established on this area and a special habitat protection area Ostoja Nadwarciańska (PLH300009) was created to protect the river floodplain, exhibiting high biological diversity. The study area covered 1 145 ha. In this fragment of the Warta valley ecological compensation was conducted, which aim was to balance high water stages in the river using a network of culverts and thus practically control natural flooding of the washland, minimizing flood hazard [6, 7]. Analyses were based on the method proposed by Mahon and Miller [8], using relevés prepared in the years 2011-2012 and landscape records. Relevés were prepared according to Braun-Blanquet [9], using a seven-point abundance scale. The analysed area was divided into a network of 100 m × 100 m quadrates, where rows were classified alphabetically from A to J and columns were denoted with numbers. Each quadrate was assessed in terms of the character of vegetation ground cover, presence of protected

species [10], presence of protected natural habitats [11], continuity of the ecosystem, occurrence of monument-sized trees, area synanthropisation index, distance from marshes and wetlands, distance from tourist trails, carrying capacity of ecosystem, therapeutic and psychoregulatory value as well as preferred directions of land use [12].

Synanthropisation index was calculated according to Jackowiak [13]:

$$S = \frac{A_p + A}{C} \times 100\% \quad (1)$$

S – synanthropisation,
 A_p – number of apophytes,
 A – number of antropophytes,
 C – number of all plant species.

In turn, carrying capacity of land was calculated according to Kostrowicki [14]:

$$O = 5 \times \frac{W \times S_g}{N} \quad (2)$$

O – threshold load of ground cover (number of people per 1 ha /week),
 W – mean ground cover sensitivity to mechanical damage,
 S_g – soil cohesion index,
 N – slope index.

Each characteristic was assessed in a five-point scale. As a result identified units were assigned scores for each element and they were investigated in three planes: natural, esthetic and recreation. The study resulted in the preparation of an index map, where each quadrate is assigned landscape value.

Maps were produced using the QuantumGIS 1.9 programme [15].

Statistical calculations were performed using the IBM SPSS Statistics 20 package [16]. Correlations between assessed values were calculated and in order to analyse the direction of the effect of individual factors on the potential to attain complete tourist success in the area a logistics regression was conducted using the reverse stepwise regression method. This method is derived from a model including all variables as explanatory and it eliminates them gradually in order to provide the model of best fit [17].

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3. Results

The study area is mainly washland, thus mowed meadows are found there as predominant, although on the eastern and western side of the polder wetland vegetation and scarce trees were recorded at smaller water bodies (Fig. 1).

Phytocenoses in that area were not abundant in protected species. Based on the analyses of relevés only two protected species were recorded, i.e. yellow everlasting (*Helichrysum arenarium*) and alder buckthorn (*Frangula alnus*). Units C2 and H16 received one point each for the occurrence of a protected species. A markedly greater number of quadrates were found to contain plant communities protected within the Natura 2000 network [11]. Three such communities were recorded, i.e. alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (habitat code 91E0) in quadrates E2 and F2; flooded muddy river banks (habitat code 3270) in quadrates E3, F3 and G3; lowland *Nardus* grassland (habitat code 6230-4) in H14, I15, I16. For the presence of these habitats they were assigned the maximum scores.

Continuity of ecosystems was defined based on historical data (the years 1935, 1940 and 1971 were analysed) in comparison to the current status. Cartographic materials from the first half of the 19th century show an unregulated course of the Warta and numerous ox-bow lakes, while in the 1960's changes were observed in the road system, hydroengineering structures appeared, which resulted on changes in land use in the area. The greatest differences were thus observed at the river channel and in the Czarna Struga stream and as such their scores were the lowest.

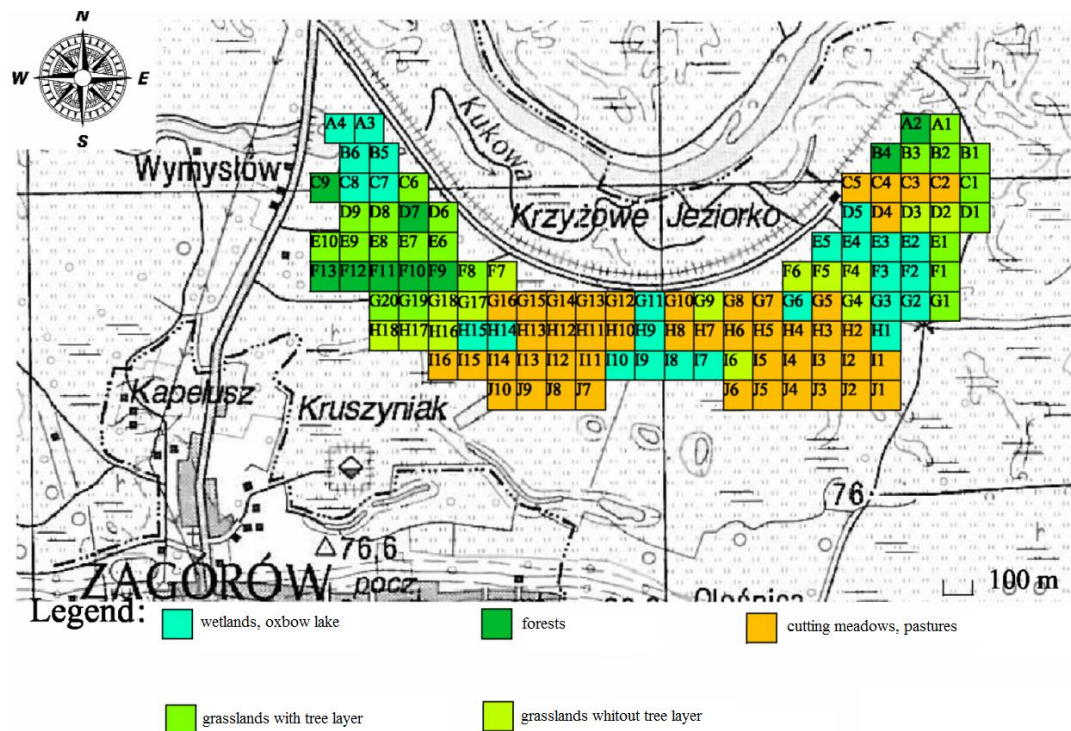


Fig. 1. Charakter of ground cover in the Zagórow washland
 Rys. 1. Charakter pokrycia terenu polderu Zagórow

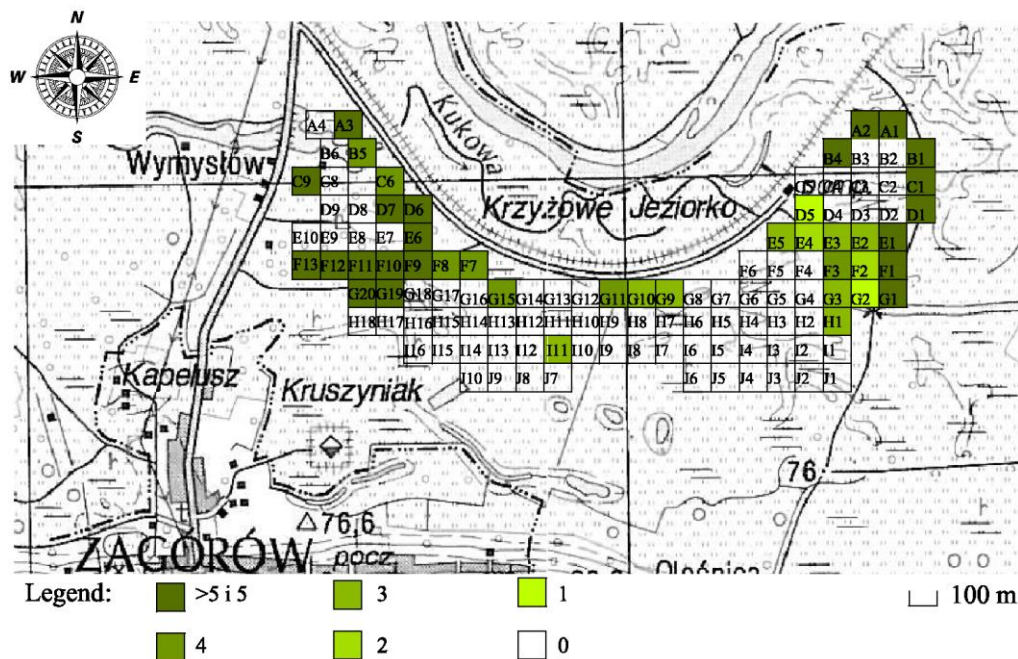
Source: Own work / Źródło: opracowanie własne

The presence of old monument-sized trees, having a positive effect on landscape structure, is important from the point of view of both nature and esthetic value. In the analysed area clusters of monument-sized trees were found mainly in the vicinity of roads and watercourses (Fig. 2). The greatest scores were assigned to the quadrates where the total number of trees was at least five, while the number of granted points decreased with a reduction in the number of trees.

Synanthropisation indexes were calculated for individual plant communities (Table 1). The degree of synanthropisation for all analysed plant communities was on average approx. 80%. The highest synanthropisation index was assigned to plant communities with *Agrostis capillaris* and *Holcus lanatus*, for which they received one point each at the evaluation. In turn, the lowest synanthropisation index

was recorded for rush and floodplain communities. However, evaluation was conducted on quadrates and not individual plant communities. Points for each compartment were calculated based on the dominant plant communities and generally individual quadrates received one or two points, as observed synanthropisation was always min. 70%.

The methodological criteria were applied in the evaluation of the distance from wetlands and marshes, which firstly are natural buffer zones and secondly are esthetically important in view of their visual attractiveness. Quality evaluation of this criterion assumes a score from 3 to 5. In the case of the analysed study area only land covered with marshes and ox-bow lakes received points, i.e. the western and central part of the polder as well as the area along the Czarna Struga stream.



Source: Own work / Źródło: opracowanie własne

Fig. 2. Presence of monument-sized trees in the study area
Rys. 2. Obecność okazałych drzew na badanym terenie

Table 1. Plant communities and the degree of their synanthropisation
Tab. 1. Zbiorowiska roślinne a stopień ich synantropizacji

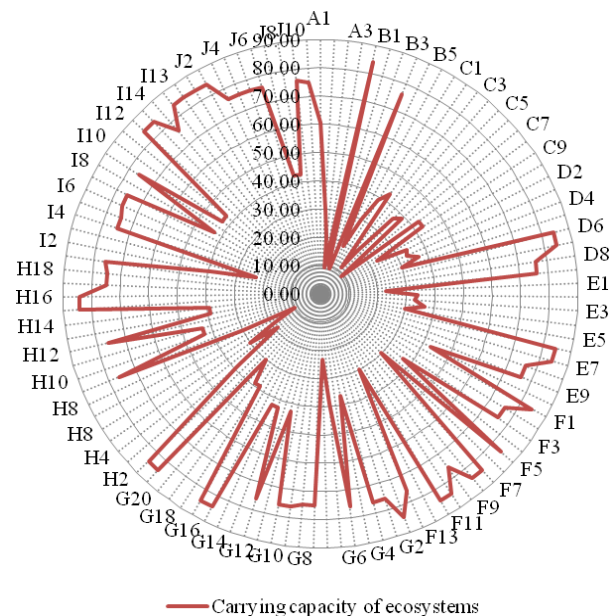
Phytosociological unit	Index of synanthropisation [%]	Number of point
Community with <i>Agrostis capillaris</i>	96,0	1
Community with <i>Holcus lanatus</i>	94,1	1
Community with <i>Festuca rubra</i>	83,9	1
Community with <i>Nardus stricta</i>	84,8	1
Community <i>Deschampsia caespitosa</i>	86,5	1
<i>Ranunculo-Alopecuretum geniculati</i>	81,5	1
Community with <i>Bidens tripartita</i>	81,3	1
<i>Caricetum acutiformis</i>	75,8	2
<i>Glycerietum fluitantis</i>	76,6	2
<i>Sparaginetum erecti</i>	76,6	2
Community with <i>Alnus glutinosa</i>	76,6	2
<i>Caricetum gracilis</i>	77,4	2
Community <i>Agrostis stolonifera-Potentilla anserina</i>	76,5	2
Community with <i>Potentilla anserina</i>	76,5	2
<i>Acoretum calami</i>	80,0	2
<i>Salicetum albo-fragilis</i>	80,0	2
<i>Rorippo-Agrostietum</i>	72,4	2
<i>Glycerietum maximae</i>	72,0	2
<i>Phalaridetum arundinaceae</i>	72,0	2
<i>Alopecuretum pratensis</i>	70,0	2

Source: Own work / Źródło: opracowanie własne

Currently transportation routes in the Zagórów polder are located on the flood embankment and along farmland plots as access roads. Buffer for a positive score in a recreation land assumes their location within a distance of max. 30.84 m from the observation point, thus the roads and units mentioned above received the maximum score.

Threshold load of phytocenoses in the study area ranged from almost 10 people/ha/week to 84.25 people/ha/week. On average it was ~56 people/ha/week. The differences resulted most frequently from plant resistance to treading. The greater mean sensitivity of ground cover in a given phytocenosis to mechanical damage, the greater threshold load of ground cover. The greatest loads were recorded for quadrates with the plant community of *Deschampsia caespitosa*, while it was lowest for *Rorippo-Agrostietum*. Based on the calculated values the quadrates (Fig. 3) assigned a respective number of points in the recreation plane. None of the quadrates received the score of 5 points, but for most of them their carrying capacity fluctuated around 56 - 84 people/ha/week, which classified them to a score of 3 points. Below the value of 28 people units gave one point to the overall valuation score.

Therapeutic and psychoregulatory properties of plant communities influenced the scores in the recreation plane. Plant communities generate a bioclimate characteristic of the area in which they grow. According to Krzymowska-Kostrowicka [18] meadows and pastures, typical of the analysed area, provide practically unlimited insulation potential, undisturbed air flow, variable moisture content depending on the season of the year and produce relatively high amounts of oxygen. Seasonally high concentrations of phyto-aerosols and aeroplankton are appear, depending on the species composition. Spring and summer in that area are particularly dangerous for people suffering from allergies. Plant communities of the alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* exhibit similar bioclimatic properties as meadows.

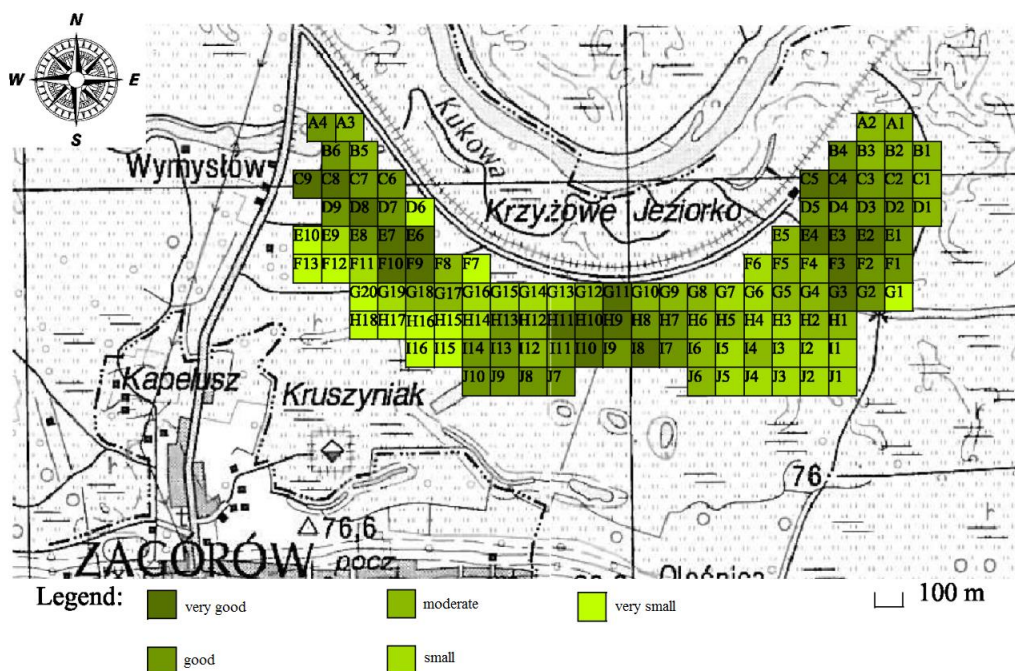


Source: Own work / Źródło: opracowanie własne

Fig. 3. Admissible carrying capacity for each valuation unit
Rys. 3. Dopuszczalne obciążenie graniczne przedstawione dla każdego pola waloryzacji

Points were given to these areas (Fig. 4), which have the highest number of plant species positively influencing human health (both therapeutic psychoregulatory effects), as well as areas with a positive influence on mental health (varied landscape, forming a harmonious whole).

Preferred directions of use for plant communities are also evaluated in terms of their potential use for recreation. Analysed areas are characterized by very low and low development potential for recreation, due to a lack of adequate tourist facilities. The lack of proper infrastructure practically prevents development of this area in the field of recreation.



Source: Own work / Źródło: opracowanie własne

Fig. 4. Therapeutic and psychoregulatory properties of plant communities in each quadrate
Rys. 4. Właściwości lecznicze i psychoregulacyjnych zbiorowisk w obrębie każdego kwadratu

Only the areas located along transportation routes received higher scores. A negative effect on leisure and recreation is also observed for the building of the intermediate pumping station of very low esthetic value. However, Watercourses and water bodies in the vicinity of this hydroengineering structure improve the overall image of this area.

Summing up, the study area may be considered in terms of three planes, i.e. nature, recreation and esthetic value. The units with the highest ecological values were found in quadrates F3 and G3. The F3 unit contained the plant community *Salicetum albo-fragilis*, while in G3 it was *Agrostis stolonifera-Potentilla anserina*. High scores resulted mainly from the location of these areas in the vicinity of the river and a small in-filled water body, as well as the presence of priority habitats from the list in the Ordinance of the Ministry of the Environment [11].

Similarly as in the previous category a high effect on the total score was observed for surface waters, thus the quadrates, which received values comparable to the maximum were E2, E3, E4, F2, F3 and G3 located near the Czarna Struga stream and A4, B5, B6, H9 and I10, situated in the areas having unlimited access to surface waters. Exceptions in this respect were only found for the units in the vicinity of the intermediate pumping station, which despite the vicinity of the stream received fewer points, because the pumping station building reduces visual value of this area.

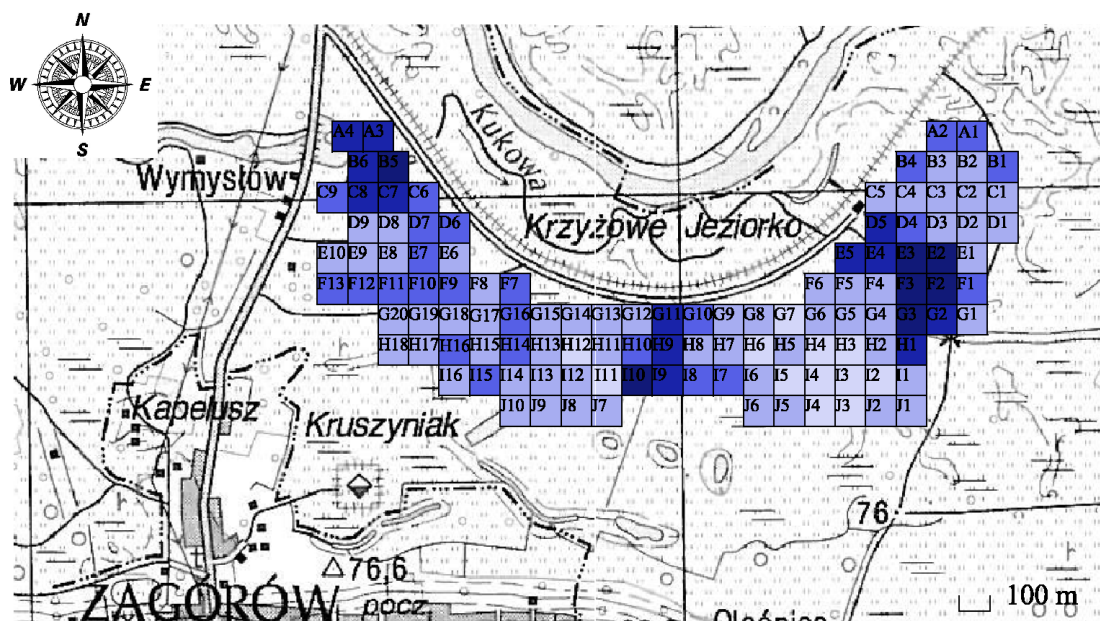
A relatively high total number of points for recreation was caused by the transportation route in the vicinity as well as high psychoregulatory properties resulting from the presence of watercourses and medicinal plants. All the units along the road and the embankment belong to class 2 of the scale, while the others to class 3. No areas were classified as having the lowest value.

In order to prepare an index map for all the values the nature, recreation and esthetic planes, were overlaid (Fig. 5). All the analysed elements had an identical effect on the identification of the most attractive objects in land-

scape. The units with the highest value in each investigated aspect included quadrates B5, E2, E3, F2, F3, G3 and I10. The highest total score was awarded to unit F3 (59). Such good results of these units were caused by their location within wetlands, near rivers, ox-bow lakes, while an additional element, which determined the highest value was connected with the presence of habitats of high nature value and the occurrence of old, monument-sized trees. A considerable effect on the score was also found for therapeutic and psychoregulatory properties of plant communities and the preferred directions of use of plant communities resulting from their esthetic value. In these categories the above mentioned units received maximum scores. The lowest scores were given to units G7, H3, H4, H6, H12, I2, I3, I4, I5, I11, J3 and J4. Such a result was a consequence of their considerable distance from surface waters, a lack of trees and anthropogenic transformation of natural ecosystems.

4. Discussion

The analysed area may be classified to natural landscapes undergoing renaturalisation. It generally showed high diversity and it was characterised by harmony of individual elements [19]. As a result of conducted analyses it was stated that the investigated area is characterised by limited transformation of landscape structure. The most attractive areas are those located within the Czarna Struga stream, flowing into the Warta and the part of the polder on the side of Zagórow. Advantages of the analysed area include continuity of vegetation ground cover over most of the area. The most typical types of agricultural activity over the years have not changed considerably, since they have been determined by abiotic factors (climate, water conditions, geology). Additionally, visual attractiveness results from the unique character distinguishing landscape of this region from those in areas, providing it with exceptional character thanks to ecological compensation works conducted for many years now.



Legend:

Received points: ≥ 61 60-51 50-41 40-31 30-21 ≤ 20

Source: Own work / Źródło: opracowanie własne

Fig. 5. The index map of nature, recreation and esthetic value of the Zagórow polder

Rys. 5. Mapa wynikowa walorów przyrodniczych, rekreacyjnych i estetycznych polderu Zagórow

The most attractive areas from the point of view of nature, esthetic as well as recreation value are invariably those connected with the presence of natural water bodies, which is also connected with diverse land relief, determined by the modeling activity of flowing waters. Forested areas are also valuable [20]. Less attractive both visually and esthetically areas in the agricultural landscape are connected with crop monocultures, simplifying the ecological and spatial structure due to the excessively intensive land use.

The optimal solution, both in terms of landscape esthetics and for agriculture, would be to preserve the diverse landscape structure in the mosaic and contrasting form [19]. Such a system may be obtained by the variation in the agricultural landscape thanks to the application of various barriers and corridors in the form of ecological margins, i.e. belt tree plantings, boundary strips or small water bodies [21].

Synanthropisation of vegetation in this area has been connected with human activity. Despite that fact, the relatively high resistance of plant communities to recreation use of this area was interdependent with the high synanthropisation index, since replacement of spontaneophytes by anthropophytes and apophytes caused increased resistance of this area to treading. In the analysed area we may indicate many locations with good health-promoting properties and psychoregulatory plant communities, which is connected with adequate humidity, atmospheric oxygen content, air flow and clean air free from dust and gases.

In the case of the analysed area the most attractive units in terms of landscape structure were those located at the Czarna Struga stream and in the vicinity of water bodies (small water bodies, ox-bow lakes). Their nature value was significantly correlated with their esthetic value (tab. 2). The natural character of the evaluated section of the Warta valley confirmed the dependence of significance of biocentric elements in landscape on visual values.

Table 2. Correlations between evaluated planes
Tab. 2. Korelacje między ocenianymi płaszczyznami

		Nature	Esthetic	Recreation
Nature	Pearson's correlation	1	0.849**	0.102
	Significance (bilateral)		0.0001	0.277
	N	115	115	115
Esthetic	Pearson's correlation	0.849**	1	0.072
	Significance (bilateral)	0.0001		0.444
	N	115	115	115
Recreation	Pearson's correlation	0.102	0.072	1
	Significance (bilateral)	0.277	0.444	
	N	115	115	115

** Correlation is significant at 0.01 (bilaterally)

Source: Own work / Źródło: opracowanie własne

The recreation value, as it is stressed by Krzymowska-Kostrowicka [18], constitutes the sum of nature value in combination with the development potential of an area. If the assumed objective is to have an area suitable for ecotourism, we need to follow the principles of sustainable development [22]. In the Zagórów polder there are transportation routes operating, but for its full development potential its economic infrastructure needs to be expanded. Changes in this direction ensure comprehensive presentation of nature and esthetic value. Based on the reverse stepwise regression model (tab. 3) highly significant effects were obtained on the nature ($P < 0.0001$), recreation ($P < 0.0001$) and esthetic planes ($P < 0,005$), which confirms that each of

them is of importance in landscape valuation in terms of tourism [23, 24].

Table 3. Effects of reverse stepwise regression model
Tab. 3. Efekty modelu regresji krokowej wstecznej

Source	Sum of squares	df	Mean square	F	Significance
Adjusted model	11210.036	18	622.780	130.664	0.0001
Nature value	1037.808	11	94.346	19.794	0.0001
Recreation value	151.257	1	151.257	31.735	0.0001
Esthetic value	94.262	6	15.710	3.296	0.0005

Source: Own work / Źródło: opracowanie własne

Ecotourism promotes nature conservation and improves local economy and as such it is included in the trend towards sustainable development. Many studies [25, 26, 27] stress a positive role of ecotourism activity on biodiversity of plant communities. On the other hand, active forms of ecosystem observation expose the natural environment to accidental or intentional introduction of alien species or destruction of valuable phytocenoses. Nevertheless, proper ecological education results in well-educated communities and then the risk of nature losses decreases drastically [28, 29, 30].

5. Conclusions

- The ecotourism potential of the Zagórów washland ecological compensation area is indicated by:
 - considerable heterogeneity of washland areas connected with the presence of marshes and oxbow lakes as well as clusters of old monumental trees, providing a positive esthetic effect in the landscape,
 - plant communities protected within the framework of the Natura 2000 network, i.e. alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (habitat code 91E0), flooded muddy river banks (habitat code 3270) and lowland *Nardus* grassland (habitat code 6230-4), providing it with nature value,
 - considerable resistance of phytocenoses to treading,
 - health-promoting and psychoregulatory properties of plant communities resulting in a unique bioclimate.
- The recreation potential of the ecological compensation areas is currently limited by a lack of an appropriate tourist infrastructure and by the pumping station facilities, markedly reducing its esthetic value.

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