

Chapter 14

Assessment of an Ecological Network at Local Scale in the Context of Landscape Changes: A Case Study from NE Poland

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Abstract The main aim of the study is to assess the functioning of an ecological corridor in the context of landscape changes, especially planned land use at local scale. The analysis was conducted within the Northern Ecological Corridor in Poland, which was first determined at national scale, and then specified at local scale. 29 municipalities in NE Poland were selected for detailed analysis. These municipalities are situated within the Northern Ecological Corridor in Poland, which connects the Knyszyn Forest, through the Biebrza Marshes, with the Pisz Forest. Spatial planning documents developed at local scale were analysed. The research allows the identification of areas where conflicts between land use and landscape connectivity occur. These conflicts are mainly connected with housing development and tourism infrastructure. This study shows that in Poland, where no legal instruments to protect ecological networks exist, the development of ecological corridors at local scale requires not only conducting an analysis of the present land use and landscape permeability, but also a detailed analysis of spatial planning documents. Only a coherent ecological network with a perspective for the future will ensure effective protection of an ecological network and, thus, biodiversity.

Keywords Ecological corridor · Spatial planning · Land use · Landscape fragmentation · Local scale · Conservation

Introduction

In recent years, the concept of an ecological network consisting of core areas, buffer zones and ecological corridors is becoming increasingly popular (Van Der Windt and Swart 2008). On the one hand, this is due to the increase in the

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importance of protecting biodiversity in nature conservation and, on the other hand, the progressive fragmentation of the environment (Hess and Fischer 2001). The theoretical basis of the ecological network concept is provided by the theory of island biogeography and the metapopulation theory (MacArthur and Wilson 1967; Levins 1969; Hanski 1998). These theories emphasize that given populations may function properly if only ecological connectivity between individuals of the population living in adjacent areas is maintained (Jędrzejewski et al. 2009). Therefore, one of the main threats to the conservation of biodiversity is landscape fragmentation (Forman et al. 2003). The effects of fragmentation become visible not only through the population decline of certain species (e.g. Mazerolle 2004), but also by the reduction in genetic variation (e.g. Riley et al. 2006), reduction in dispersal capacity (e.g. Forman and Alexander 1998), and general behavioural changes of individuals (e.g. Mazerolle et al. 2005).

The concept of ecological networks as a tool for biodiversity conservation is closely related to spatial planning (Jongman et al. 2004; Szulczewska 2004; Opdam et al. 2006). On the one hand, this requires developing a coherent ecological network at all scales, from the landscape, through regional, to local ones. On the other hand, effective protection is only possible if there are legal instruments appropriate for it.

Throughout the world, many networks are developed at landscape and regional scales (Bennett 2004; Jongman et al. 2004; Bennett and Mulongoy 2006). In the European Union, the Natura 2000 network is to perform the function of an ecological network. According to the Birds and Habitats Directives in each EU Member State, Special Protection Areas (SPAs) are established for birds and Special Areas of Conservation (SACs) for species other than birds, and for habitats (Council Directive 1992, 2009). Moreover, pursuant to Article 3 and 10 of the Habitats Directive, ecological coherence should be preserved between Natura 2000 sites, which will enable the movement, migration and gene flow of wild species (Council Directive 1992). The Natura 2000 network is implemented in all EU Member States and is part of the national ecological networks. On the EU level, the legislation exists for the protection of ecological networks. Nevertheless, the implementation of this concept in spatial planning is extremely difficult. Most problems occur at the local level, where spatial policy is implemented. On this level, it is necessary to determine the specific boundaries of widely designed ecological corridors and core areas with respect for human needs.

Poland has been an EU member since 2004, and EU regulations which form the basis of the designation of Natura 2000 sites were introduced into Polish law by the Nature Conservation Act of 16 April 2004. Yet to this day there are no clear rules that might regulate the legal protection of ecological corridors in Poland, forming part of a pan-European ecological network. The Nature Conservation Act of 16 April (2004) contains only a definition of an ecological corridor; however, no ways of determining its boundaries, or rules of protection, have been indicated. Thus, the ecological network in Poland is protected only in areas where it overlaps with existing forms of nature conservation, or runs through woodlands, since the Forest Act of 28 September (1991) guarantees the inviolability of forest complexes

(Jędrzejewski 2009). Being a key element of the network, ecological corridors are not provided with effective legal protection and, thus, they are subject to normal planning processes and may undergo fragmentation.

One of the main international corridors running through Poland is the corridor in the northern part of the country (the Northern Ecological Corridor) linking Eastern and Western Europe. Owing to it, the continuity of Eastern European natural areas may be extended up to the western borders of Poland, and restoring its permeability will allow gradual recolonization of Western European countries by rare species of animals and plants, among others, the lynx (Jędrzejewski 2009). Therefore, the purpose of this study is to assess the functioning of a selected part of the Northern Ecological Corridor at local scale, in the context of landscape changes, especially planned land use. The specific objectives are as follows: (1) to present the planned land use within the corridor based on planning documents, (2) to identify the problem areas resulting from changes in land use within the corridor, and (3) to evaluate the implementation of ecological corridor conservation in the planning documents. This research work was conducted as a part of the project by the World Wide Fund for Nature (WWF) Poland.¹

Study Area

29 municipalities in North-Eastern Poland were selected for a detailed analysis. The municipalities are located within two voivodeships, i.e. the Podlaskie voivodeship (24 municipalities) and the Warmińsko-Mazurskie voivodeship (5 municipalities). The course of the Northern Ecological Corridor, specified at local scale in the section connecting the Biebrza Marshes, the Knyszyn Forest, and the Pisz Forest, is located within the limits of these municipalities. This section is located within the limits of an international ecological corridor connecting Eastern and Western Europe (Jędrzejewski et al. 2005). It is a lowland area with a young glacial relief, varied by numerous glacial lakes and river valleys. The area is covered by extensive complexes of coniferous forests (mainly pine and spruce). Along the river valleys, there are large areas of wetlands and peatlands which, together with forests, constitute natural habitats and migration corridors of many species of mammals [including the elk (*Alces alces*), red deer (*Cervus elaphus*), European

¹ The project as a part of the “Active protection of the lowland populations of the lynx in Poland” project, implemented by the WWF Poland Foundation, co-financed by the European Union from the European Regional Development Fund, under the Operational Programme Infrastructure and Environment (OPIE) 05.01.00-00-341/10) and the National Fund for Environmental Protection and Water Management. Upon detailing the course of the ecological corridor, fieldwork was conducted. Also there were meetings with stakeholders in the region (including representatives of municipality authorities, forest district authorities, road administration). The final outcome of the project is the creation of a comprehensive programme to protect the Northern Ecological Corridor in Poland.

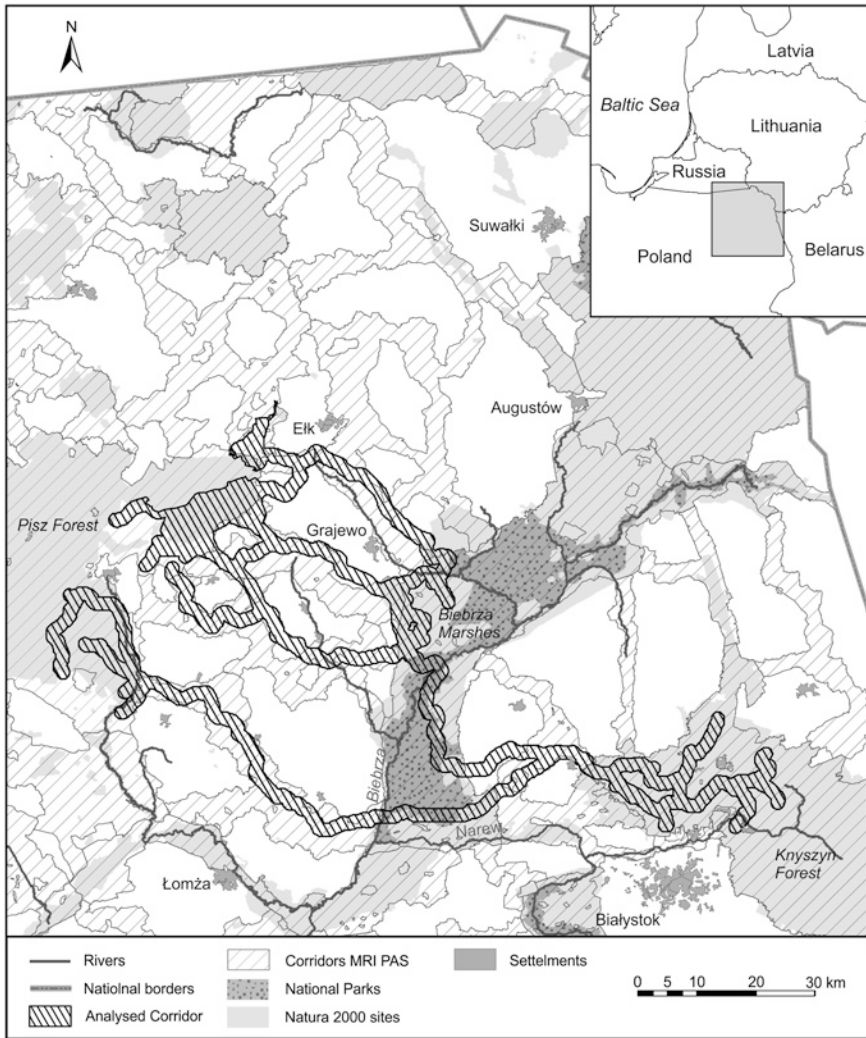


Fig. 14.1 The location of the research area

bison (*Bison bonasus*), grey wolf (*Canis lupus*) and lynx (*Lynx lynx*), and birds (including the Eurasian crane (*Grus grus*), heron (*Ardeidae*) and white stork (*Ciconia ciconia*)). In the majority of these territories, protected areas such as the Biebrza National Park and the Natura 2000 sites have been established. They represent one of the key connections to maintain wolf populations and restore the populations of the lynx in the area of Northern Poland (Jakimiuk and Górny 2012). Areas between forestlands and river valleys are used mostly for agricultural purposes; there are several medium-sized cities, and dispersed settlements constitute the majority of human settlements (Fig. 14.1).

Materials and Methods

Planning documents drawn on the local (municipal) level, i.e. studies of conditions and directions of spatial development (SCDSD) and local spatial development plans (LSDP), were used to conduct an analysis of the planned spatial development within the ecological corridor. The study of conditions and directions of spatial development establishes the spatial policy at the local level by determining principles, objectives and directions of spatial development. Studies of directions are implemented by LSDP, which usually cover just a section of the municipality. The local plan establishes the land use (zoning) and determines the ways of development and locating buildings in a given area. This plan constitutes an act of local law and is the basis for issuing administrative decisions. In this paper, we analysed these documents for 29 selected municipalities, in terms of planned development within the analysed ecological corridor. We also examined whether the texts contained provisions for the protection of ecological corridors, and if their course was marked on the study maps.

All of the analysed municipalities have SCDSD. In 22 municipalities, the SCDSD has been adopted, amended or updated in the last 7 years, i.e. since the recent law on spatial planning in Poland has been in force.² There are only 37 LSDP in force within the boundaries of the ecological corridor (Table 14.1). In other areas (not included in the LSDP) buildings can be located without major restrictions, with the consent of the local authorities.

An analysis of the documents allowed us to determine the possibility of maintaining the permeability of ecological corridors that have been designated at the national level, and then specified at the local level, under the WWF Poland Foundation project. This project uses the ecological network developed at the national level by the Mammal Research Institute of the Polish Academy of Sciences in Białowieża (MRI PAS). The network was created in 2005, commissioned by the Ministry of the Environment in collaboration with the Association for Nature ‘Wolf’ and the PAS Museum and Institute of Zoology (Jędrzejewski et al. 2005). Existing forms of nature protection, including Natura 2000 sites, were adopted as core areas. The results of studies of indicator species (mostly the wolf, partly the lynx, elk and deer) were used, and an earlier concept of corridors, ECONET-POLAND, was taken into account (Liro et al. 1995). It is the most comprehensive and recent network of ecological corridors in Poland, which has been verified and updated since 2005. The MRI PAS network was developed at the national level, and thus its implementation in lower levels of planning requires specifying boundaries. Therefore, the course of the Northern Ecological Corridor was specified, under the project, using the least cost path method (Lewandowski 2014).

² The former Spatial Development Act of 7 July (1994) ceased to apply when a new law on spatial planning and development was adopted on March 27, 2003.

Table 14.1 A list of municipalities in the section connecting the Pisz Forest, through the Biebrza Marshes, with the Knyszyn Forest, together with information on planning documents

No.	Name of municipality	Number of LSDPs within the corridor	Year of adoption of the study/ change to the study	Protection of corridors in the SCSDS	
				Map	Text
1	Biała Piska	3	2011	No	No
2	Czarna Białostocka	3	2006	No	No
3	Dobrzyniewo Duże	0	2005	No	No
4	Ełk (city—municipality)	2	2013	No	No
5	Ełk	8	2013	Local corridors	Protection
6	Goniądz	1	2011	No	No
7	Grabowo	0	2012	Local corridors	Protection
8	Grajewo	3	2012	No	No
9	Janów	0	1999	No	No
10	Jedwabne	0	2012	No	Protection
11	Knyszyn	0	2000	Local corridors	Protection
12	Kolno	5	2012	Local corridors	Protection
13	Krypno	0	2000	No	No
14	Mońki	1	2012	No	No
15	Piątnica	0	2012	Local corridors	Protection
16	Pisz	4	2010	No	No
17	Prostki	1	2012	Local corridors	Protection
18	Radziłów	1	2013	MRI PAS corridors	Protection
19	Rajgród	0	2009	No	No
20	Sokółka	0	2011	Local corridors	Protection
21	Stawiski	0	2012	Local corridors	Protection
22	Supraśl	1	2011	No	No
23	Szczuczyn	1	2012	Local corridors	Protection
24	Trzcianne	1	2000	No	No
25	Turośl	0	2002	No	No
26	Tykocin	0	2000	No	No
27	Wasilków	1	2010	No	Protection
28	Wąsosz	0	2012	No	Protection
29	Wizna	1	2010	Local corridors	Protection

Source own study

Results

Based on the analysis of planning documents, it can be stated that most of the areas within the boundaries of the ecological corridor will be used in the same manner as before, in the next few years (Fig. 14.2). The greatest threat resulting from the planned spatial development is a large increase in investment areas intended for housing and holiday buildings planned in the studies of many municipalities. Three problem areas can be distinguished where, if the spatial development policy of a municipality is implemented, the permeability of the corridor will be seriously undermined:

1. North-east of the Pisz Forest (the Elk municipality)—almost the entire area of the ecological corridor is planned for development; the corridor runs at a close distance to the city, whose nearby location makes it an attractive area for single and multi-family housing, and holiday and recreation buildings; a large part of the area has already been invested in;
2. West of the Biebrza Marshes—a threat to the functioning of the corridor is the residential, as well as production and service development planned around some villages, especially in the Grajewo municipality, the implementation of which will lead to dispersed development;

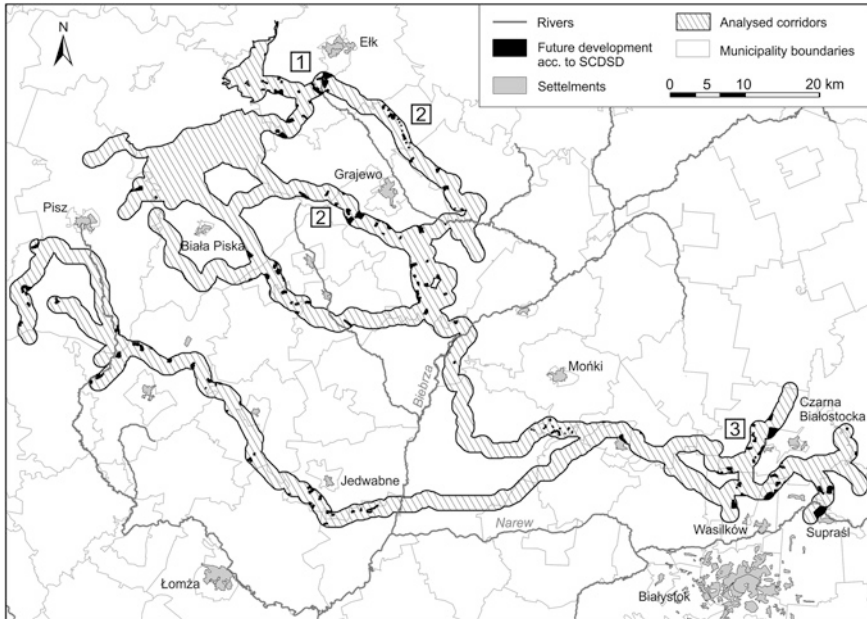


Fig. 14.2 Changes in land use and development within the ecological corridor analysed, according to the study of conditions and directions of spatial development of municipalities

3. The western part of the Knyszyn Forest:

- (a) the Czarna Białostocka municipality: in this section, the corridor extends partially within the town limits of Czarna Białostocka, where extensive development has been planned, which, together with existing and planned development in nearby towns, can cause significant fragmentation of the ecological corridor;
- (b) the Wasilków municipality: the main threat to this section is the planned development of single and multi-family housing; a large part of the corridor is located within the town boundaries and, thus, areas attractive for investors and inhabitants;
- (c) the Supraśl municipality: the areas intended for development, designated in the study in the north-western part of Supraśl, fragment the corridor to a considerable extent.

It is worth noting that in the planning documents of several municipalities in the area of the designated corridor, also positive steps, such as afforestation, have been planned. These include the municipalities of Jedwabne, Wizna, Biała Piska and Elk. Such actions can improve the functioning of the ecological network.

The majority of municipalities do not have LSDP within the boundaries of the analysed section of the Northern Ecological Corridor (Table 14.1; Fig. 14.3). One problem area, where the implementation of LSDP can significantly affect the

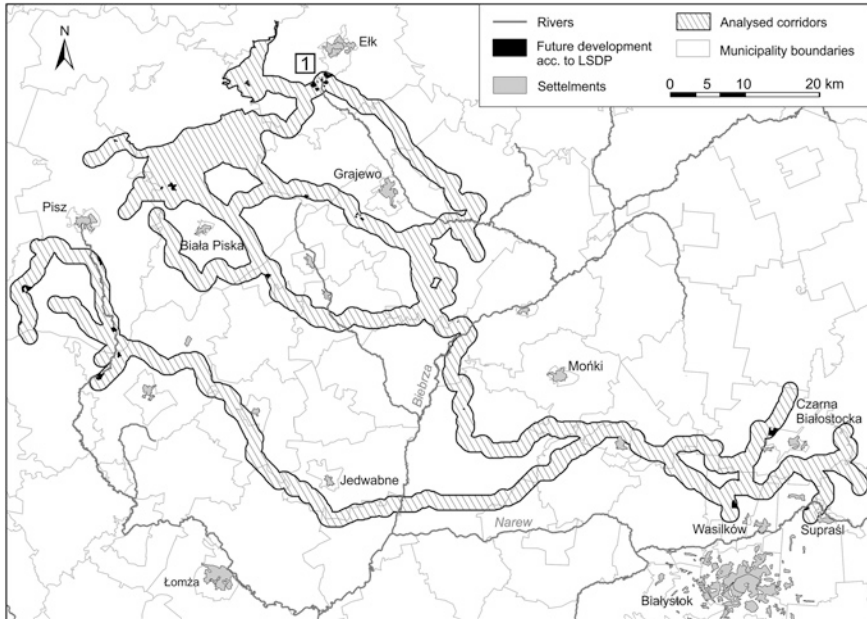


Fig. 14.3 The areas covered by the range of local spatial development plans within the ecological corridor analysed

functioning of the corridor, has been distinguished. It is the municipality of Ełk, where the ecological corridor runs within the city limits, and in the vicinity of it. This area is intended for development. Currently, 10 LSDPs in the Ełk municipality are being implemented, in which only a small portion of land has been allocated for green areas. Therefore, in the next several years, the permeability of the corridor in this section may be lost.

Under the law currently in force, municipalities must include in each SCSDS provisions for the protection of ecological continuity. However, in most of the documents, the provisions are insufficient (15 out of 29 municipalities); so, there is no real protection of corridors at the local level (Table 14.1). The exact course of corridors is not determined, nor are there any specific provisions (bans, orders) how to protect them. The need to protect corridors was included in the documents of the remaining municipalities (14), mostly by protecting river valleys (treated a priori as corridors), and maintaining the current land use within the corridor. In most of these cases (11 municipalities), corridors are marked out on maps, but their course is usually confined to river valleys, and mostly does not refer to the networks designated at the regional and national levels.

Discussion and Conclusions

Anthropogenic land use in Europe has a long history. Therefore, the impact of land use changes on the composition, structure and function of landscapes, and thus species, habitats and the ecosystem is obvious (Edman et al. 2011). Some authors (e.g. Angelstam et al. 1997) state that biodiversity, connected to the naturalness of forest, decreases from the eastern to the western part of Europe, which is a result of different history. Nowadays, the possibilities of recolonization of Western European countries by rare species of animals and plants are being considered. As mentioned, the continuity of Eastern European natural areas may be extended up to the West if the permeability of the ecological network is maintained (Jędrzejewski 2009).

However, our study shows that the permeability of the key part of the Northern Ecological Corridor in Poland is, at local scale, in some places endangered. Although most of the area covered by the ecological network is to remain in its current use, several areas that are subject to strong pressure from urbanization have been identified. This applies especially to the western part of the Knyszyn Forest, and the areas between the Biebrza Marshes and the Pisz Forest where, alongside a planned increase in housing areas, holiday buildings have been developing intensively. The development of urban areas in these regions will affect the functionality of the entire ecological corridor, and therefore, the possibility of connecting Eastern European natural areas with Western Europe. It should be emphasized that ecological corridors fulfil their function only when they are permeable over their entire length. The development of building areas, and accompanying infrastructure, in the areas of corridors causes disruption or interruption to their

continuity (Jędrzejewski 2009). The threat is not only this interruption of continuity, but also dispersed development. All these actions lead to the fragmentation of the environment (Keys and McConnell 2005), which has three major components: loss of the original habitat, reduction in habitat patch size and increasing isolation of habitat patches (Andrén 1994).

Maintaining ecological connectivity is increasingly seen as one of the key tasks facing contemporary nature conservation. Owing to tools such as GIS, it has become possible to model them, and techniques such as least cost (Adriaensen et al. 2003), and friction analysis (e.g. Joly et al. 2003; Nikolakaki 2004) are most frequently used. Models developed using these techniques are based on the analysis of landscape structure, vegetation type, elevation, slope and other landscape features. All these elements are assigned weights or resistance values, which correspond to the conditions of migration of individual species (Epps et al. 2007). These methods were also used during the development of the ecological network of Poland, both at the national level, and during specification at the local level. However, despite the fact that there is a hierarchical system of spatial planning in Poland, which enables the implementation of an ecological network from the national level, through the regional, to the local (municipality-based) one, it is not effective. There are no sufficient legal instruments that would provide the protection of ecological corridors (Bernatek 2013). The municipality authorities have no real legal obligation to protect ecological corridors, so they do not pay much attention to it. The areas of ecological corridors are subject to pressure from urbanization and, hence, fragmentation of the environment. In the current legal situation in Poland, it can only be encouraged that action be taken to maintain the functionality of the ecological network.

As we can see, the increasing urbanization requires a new approach to landscape planning, including the creation of an ecological network. There is a need to integrate interactions between ecosystems and human activities. The landscape has to be understood not only from an ecological point of view but also from the view of human activities. Our study shows that creating an ecological network without human needs is ineffective. It can be seen that the ecological network developed only on the basis of environmental factors (without taking into account the planned spatial development and future investment) will not be effectively protected. Many authors emphasize that only close cooperation between scientists and authorities can provide effective protection of ecological continuity and, further on, biodiversity (Hanski 2002; Nassauer and Opdam 2008; Van Der Windt and Swart 2008; Deodatus et al. 2013). Deodatus et al. (2013) presented the model for ecological corridor creation based on the study conducted in the Ukrainian Carpathians. It was proved that the creation of ecological corridors should be based not only on ecology and landscape, but also on the administrative process. The engagement of all stakeholders is a key to the successful inclusion of corridors to the land management system. Recently, De Montis (2014) confirmed that land management is believed to be an appropriate instrument for implementing landscape policy.

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