



# The role of churches in maintaining bird diversity: A case study from southern Poland

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## ABSTRACT

With the human population increasing there have been losses in biodiversity. A common feature of mankind is religious beliefs with various associated positive and negative consequences for biodiversity. Religion also has associated religious sites, many of which have a long history. The role of churches in benefitting biodiversity has not received attention. To examine the impact of churches we measured the taxonomic, phylogenetic and functional diversity of birds around Christian churches and compared this with matched farmsteads. We surveyed 101 churches and equal number of farmsteads in villages of southern Poland. We measured structural and compositional characteristics (e.g. number of trees, shrubs, number of buildings and height) at both churches and farmsteads. General additive models, ordination and rarefactions methods were used in data analysis. Species richness, abundance and phylogenetic diversity were each higher at churches than at farmsteads. The species composition differed between building types but functional diversity was similar at both types of buildings. Bird species richness and abundance were correlated with the church's age. Previous studies showed village farmsteads supported high species diversity, thus our current findings that churches are richer show they may increase bird diversity in studied villages. We suggest that the green surroundings and tall towers create strong environmental gradient that enhances species richness, functional and phylogenetic diversity. There are over ten thousand churches in Poland, and similar places of worship are present in many religions, thus this habitat may be important for sustaining local taxonomic, functional and phylogenetic biodiversity in different global areas.

## 1. Introduction

Current human activity leads to habitat loss, land degradation, pollution, urban sprawl and the spread of invasive species, which collectively heavily impact biodiversity (McKee et al., 2003; Cardinale et al., 2012; Miraldo et al., 2016; Waters et al., 2016). Some species can adapt to these highly modified environments living alongside humans, while other species are unable to adopt to use such artificial landscapes (Erwin, 2008; Parhar and Mooers, 2011; Miraldo et al., 2016). With perishing species the unique biotic features and links with other species are lost (Barnosky et al., 2011). Thus, the biodiversity loss may diminish functional and phylogenetic diversity (Barnosky et al., 2011; Pimm et al., 2014; Pan et al., 2016).

The scientific community has sought to identify processes lying behind the worldwide decline of biotic diversity and means to stop them (Sutherland et al., 2009; Pimm et al., 2014). However, much less attention has been paid to the understanding of the opposite

phenomenon: human alterations to ecosystems that prove to have benefits for biodiversity. Some man-made landscape transformations have offered alternative new habitats for several species with local high species diversity and functional complexity (Lenda et al., 2012; Moroń et al., 2014; MacLagan et al., 2018). As a consequence in highly modified regions a substantial proportion of biodiversity may be associated with these modern landscapes (Martínez-Abraín and Jiménez, 2016). Conservation and management may need to be adjusted to these specific conditions.

Traditional cultural landscapes of Europe have centuries-long evolution as tightly coupled social-ecological systems (Plieninger and Bieling, 2012; Fischer et al., 2012). In such landscapes the ecosystem services are co-produced by environmental friendly (often traditional) agricultural and forestry practices and rich natural capital. This results in ecosystems and landscapes with outstanding biodiversity, commonly referred as high nature value landscapes (Hartel et al., 2013, 2014). For instance, traditional villages were identified as hot-spots of bird

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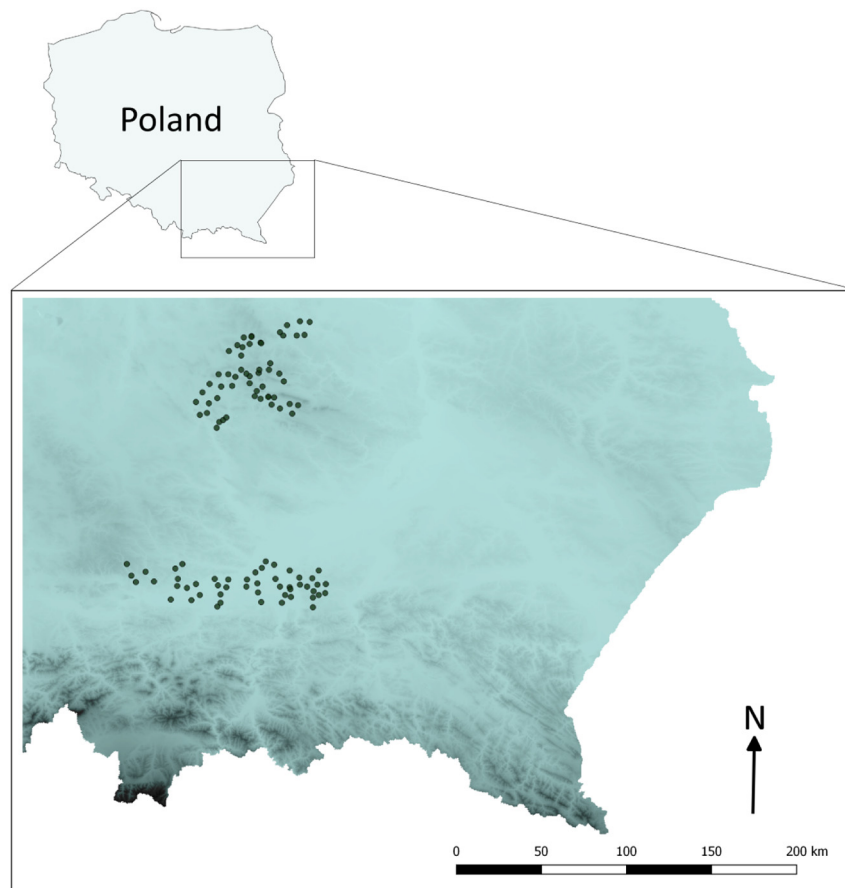


Fig. 1. Map of the study area. Dots indicate studied objects (pairs of church and farmstead).

diversity in agricultural systems in Central Europe (Rosin et al., 2016; Šálek et al., 2018). Thus, long-term survival of different species together with their functional and phylogenetic diversity is now strictly associated with human culture and infrastructure development (Rosin et al., 2016; Šálek et al., 2018).

Religious beliefs are a universal feature of human culture across the globe (Botero et al., 2014). The relation between faith, religious groups and wildlife has become a growing research topic with the prospect of enhancing future nature conservation (Palmer and Finlay, 2003; Wild and McLeod, 2008; Frascaroli, 2013; Sheppard-Walwyn and Bhagwat, 2018). Religion may contribute to nature conservation in two major ways: indirectly by influencing attitude of people towards nature or directly by enforcing protection of areas that are devoted to the spiritual cult (Dudley et al., 2009; Frascaroli, 2013). The latter can be important as the conservation benefits of sacred sites have been documented in several religions (Dudley et al., 2009). For example, sacred natural sites in Ethiopia (Reynolds et al., 2017), Italy (Frascaroli, 2013), Greece (Avtzis et al., 2018) have been identified as important for the conservation of animal and plant species. Plant species richness was higher at Tibetan sacred sites than at randomly chosen sites in mountains of Northwest Yunnan (Anderson et al., 2005), while supplemental feeding used as religious practice in such sites increased reproductive performance of the endangered and endemic buff-throated partridge *Tetraophasis szechenyii* (Yang et al., 2016). Unlike in Asia and Africa, in Europe the link between religion and nature has been remaining underexplored, perhaps because some view Christianity as anti-naturalistic (Frascaroli, 2013).

In the European tradition, Christian churches are often cultural as well as religious centres, especially in rural areas, and for that reason are surrounded by special care, worship and regularly persist for centuries, often through political conflicts and wars (Frascaroli, 2013;

Klima, 2011). Many churches are historic buildings that are closely related to the cultural heritage of the village and surrounding locations (Bartnik, 1987). Churches are usually located centrally in a location, differ from other buildings as churches are usually the largest and tallest man-made structures in a village. Therefore, churches are sites with strong environmental gradient consisting of tall “rocks” and a green surrounding with several vegetation layers. Such strong gradient of conditions may increase available niches and boost species diversity (Amarasekare, 2003; Nord and Forslund, 2015). Moreover, due to consistent management, the structural complexity at churches is long-persisting thus may serve as suitable persistent environments for many taxa. The structure of the church buildings (high towers, holes) and churchyards (numerous trees and shrubs) can be refugia for different taxa. Although in landscapes of Europe churches are a distinctive and common landscape feature, there is no work showing their natural role for bird communities. They are, therefore, a good subject to study the relationship between religious-cultural heritage and natural values.

The aim of this study is to understand the associations between sacral buildings – Christian churches with their surrounding - and taxonomic, phylogenetic and functional diversity of bird communities in Poland. Birds are group well known in term of biology, phylogeny and functional traits and are good indicators of environmental health (Gregory et al., 2005; Skórka et al., 2013). The relatively high species richness of Polish rural landscape, resulting from extensive agriculture and land-use heterogeneity (Tryjanowski et al., 2011) provide the opportunity to track the responses of a wide diversity of bird species. First, we correlated taxonomic, phylogenetic and functional diversity of bird communities at churches and churchyards with characteristics of these objects, to identify main drivers of multilevel bird diversity in sacred buildings. Next, we related bird communities found at churches to those occurring at agricultural farmsteads (village buildings and their yards)

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