Biological Conservation 214 (2017) 223–232

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Substantial decline of Northern European peatland bird populations: Consequences of drainage

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ARTICLE INFO

Keywords:
Boreal peatlands
Bird biodiversity
Habitat loss
Ditching
Protected areas

ABSTRACT

Northern European peatlands are important habitats for biological conservation because they support rich biodiversity and unique species compositions. However, historical management of peatland habitats has had negative consequences for biodiversity and their degradation remains a major conservation concern. Despite increasing awareness of the conservation value of peatlands, the statuses and ecological requirements of peatland species have remained largely understudied. Here, we first analysed temporal trends of Northern European peatland birds to document the status of their populations using bird data from five different countries. Second, we used Finnish monitoring data to assess habitat preferences of peatland bird species, hence helping to target conservation to the most relevant habitat types. There was a general decline of 40% in Northern European peatland bird population sizes in 1981–2014 (speed of decline 1.5%/year) largely driven by Finland, where populations declined almost 50% (2.0% annual decline). In Sweden and Norway, peatland bird populations declined by 20% during 1997–2014 (1.0% annual decline). In contrast, southern populations in Estonia and Latvia, where the majority of open peatlands are protected, showed a 40% increase during 1981–2014 (1.0% annual increase). The most important habitat characteristics preferred by common peatland species in Finland were openness and low tree height, while wetness proved to be an important feature for waders. Drainage of peatlands had clear negative effects on the densities of many species, with the only exception of rustic bunting, which specializes on edge habitats. Our findings call for more effective conservation actions in Northern European peatland habitats, especially in Finland where peatland drainage represents a major threat to biodiversity.

1. Introduction

Peatlands are wet habitat types characterized by peat accumulation and are typically dominated by *Sphagnum* moss vegetation in high latitudes (Pakarinen 1995; Parish et al. 2008). Globally, about 4.0 million km^2 of the world's land area is covered by peatlands. The vast majority are northern peatlands (~90%), although there are also 368,500 km^2 of tropical peatlands and 45,000 km^2 of southern peatlands (Patagonia) (Yu et al. 2010). Among all northern peatlands the majority occurs in Russia, Canada, the US, and Fennoscandia (Gorham 1991). In the European Union, almost one third of the peatland cover is located in Finland, which is considered to be the country with the highest proportion of peatlands worldwide (see Supplementary Table S1).

Many specialized species inhabit peatlands, making them critical habitats for biodiversity conservation (Pearce-Higgins and Grant 2006). Not least are they key habitat for many bird species, several of which are included in the Annex I of the European Commission Birds Directive (Littlewood et al. 2010; European Commission 2015). The high value of the peatland breeding bird assemblages at the European level has

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http://dx.doi.org/10.1016/j.biocon.2017.08.025
Received 21 March 2017; Received in revised form 28 July 2017; Accepted 14 August 2017
Available online 29 August 2017
0006-3207/

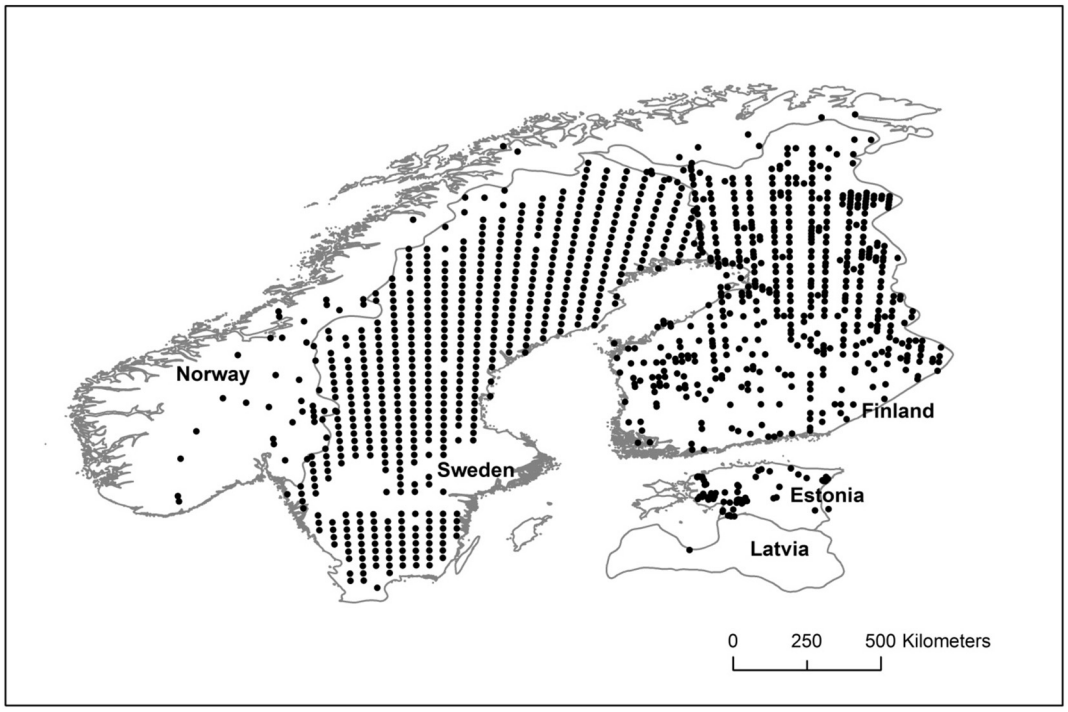

Fig. 1. Map of the study area comprising Finland, two Scandinavian countries (Sweden and Norway), and two Baltic countries (Estonia and Latvia). Country borders have been slightly smoothed for visualisation. Black dots show all census sites including peatland habitats.

contributed to turning some peatland areas into Special Protection Areas (SPAs) (Rieley and Lubinaite 2014). Despite their importance as biodiversity reservoirs, peatlands are typically under-represented in protected area networks, both nationally and internationally (Parish et al. 2008; Čivić and Jones-Walters 2010). Yet, peatlands have been listed as some of the most threatened habitat types within the European Union (Janssen et al. 2016).

Natural peatlands have been globally drained for different purposes, including agriculture (responsible for 50% of peatland loss), forestry (30%) and peat extraction (10%) for energy production and/or gardening (Vasander et al. 2003). Although some authors have suggested that peatlands could be drained sustainably (e.g. Uda et al. 2017), research evidence shows that most of these studies have largely neglected the issue of peatland subsidence in the long-term (Evers et al. 2017, Wetlands International and Tropenbos International 2016). Indeed, a plethora of scientific papers in the last decade have documented the pervasive effects of peatland drainage on biodiversity (Carrol et al. 2011). In contrast to wetland drainage, draining peatlands irrevocably involves removing most water from the extraction area (Holden et al. 2004). This causes extensive peatland degradation, resulting in a complete loss of peatland ecosystem functions (Parish et al. 2008). Finally, peatland removal encompasses a release of vast quantities of carbon into the atmosphere, modifying the biogeochemical processes of their soils and decreasing their biological productivity (Limpens et al. 2008). These long-term irreversible impacts reduce biodiversity and accelerate climate change (Carrol et al. 2011). While several different peatland types have been identified (Čivić and Jones-Walters 2010), the term *peatland* in the present study includes various habitats of fens, bogs and mires (see Supplementary Table S1).

Climate is a major determinant of peatland function and species composition (Dieleman et al. 2015). Evidence of climate change driven range shifts has mounted for many species, regions and habitats (e.g. Chen et al. 2011), but little is known about range shifts in peatland species. Given the predicted increases in temperatures and changes in rainfall patterns, and the resulting precipitation-evaporation dynamics, climate change poses a threat to the longevity of peatland ecosystems and therefore to birds and other species dependent on them (Holden et al. 2007). With cool, wet northern peatlands becoming warmer many species are expected to lose suitable climatic conditions, therefore having implications for their population performance in the long-term (Carrol et al. 2015).

Peatland bird diversity and abundance are known to increase along a northern gradient in Europe (Järvinen and Sammalisto 1976). However, the ecological requirements of peatland birds remain poorly investigated, except for a few well understood species in the UK uplands (Douglas et al. 2014; Newey et al. 2016). To our knowledge, only a few studies have examined habitat preferences of peatland birds and/or quantified the effects of drainage on bird populations (e.g. Poulin et al. 2006; Hancock et al. 2009), most likely because they are often scarce and thus difficult to study without additional effort. Attempts to increase the information on the importance of peatlands contribution to regional diversity are essential for peatland protection (Calmé et al., 2002). In this context, identifying species' habitat preferences helps prioritizing in conservation and restoration (Noss et al. 2009; Fraixedas et al. 2015).

Here, it is our aim to increase the ecological knowledge about peatland birds by providing information on: a) the joint bird population trends from five Northern European countries, therefore producing the first pan-European peatland bird status indicator (see Gregory et al. 2005); b) the regional trends of Finnish, Scandinavian and Baltic peatland bird populations; and c) the species-specific habitat preferences and spatio-temporal trends of six common peatland birds and seven less common peatland wader species, based specifically on Finnish peatland bird counts.

In general, we hypothesize that peatland bird populations will show stronger declines in areas where peatlands have been drained and a smaller proportion of the habitat is protected (in this case Finland, where only 14% of the current peatlands are protected; Alanen and Aapala 2015) compared to areas with a high level of protection (e.g. Estonia, where 75% of the open mires are currently protected; Supplementary Table S1). Furthermore, if climate change acts as a driver of peatland bird populations, we expect poleward shifts in species distributions (Chen et al. 2011) and more pronounced declines in the southern part of the study area, i.e. Baltic countries compared to