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## Dealing with Floods within Constraints

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# Impact of land use changes on breeding birds in floodplains along the rivers Rhine and Meuse in the Netherlands

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## Introduction

Over the last decades the habitat availability and quality for breeding bird species in floodplains along the rivers Rhine and Meuse significantly changed as a result of physical reconstruction measures and land use changes aiming at flood defence and ecological rehabilitation (e.g. excavation of floodplains, removal of levees, digging of side channels and transition of agricultural land in nature). This paper presents spatial patterns and trends in breeding bird diversity on various levels of scale, i.e. river branches, floodplain areas and riverine ecotopes. In addition, breeding bird composition of rehabilitated floodplains is analysed. The relations between species richness and several landscape ecological characteristics (e.g. surface area of various riverine ecotopes) are described.

## Material and methods

Data on presence and abundance of breeding birds in floodplains were obtained from bird watch organisations, floodplain managers and (scientific) literature (Erhart & Bekhuis, 1996; Faunawerkgroep Gelderse Poort, 2002 & SOVON Vogelonderzoek Nederland, 2003). Relations between cumulative species richness and surface area of several riverine

ecotopes were analysed using Biodiversity Professional Beta 1 (McAleece, 1997). The surface area of ecotopes per grid or floodplain was calculated with Arcview 3.2, using the river ecotope map of Rijkswaterstaat (1997). Canonical Correspondence Analysis (CCA) was performed with Canoco for windows (Jongman, 1995).

## Results

Over the period 1973-2000 more than 70 percent of the grids surveyed along the rivers Meuse and Rhine in the Netherlands showed a decrease in the number of red-listed breeding bird species (Fig. 1). This particularly holds for bird species that are characteristic of reed marshes and wet grasslands. However, the diversity of characteristic species of riverine ecotopes such as lakes, side channels, pioneer vegetation and softwood forest tended to increase. Similar trends were observed at the regional scale. For instance, in the international wetland "Gelderse Poort" a decrease was observed in distribution of 21 out of 35 red-listed breeding bird species over the period 1975-2000 (Erhart & Bekhuis, 1996 & Faunawerkgroep Gelderse Poort, 2002). Rehabilitated floodplains showed a strong increase of breeding bird diversity.

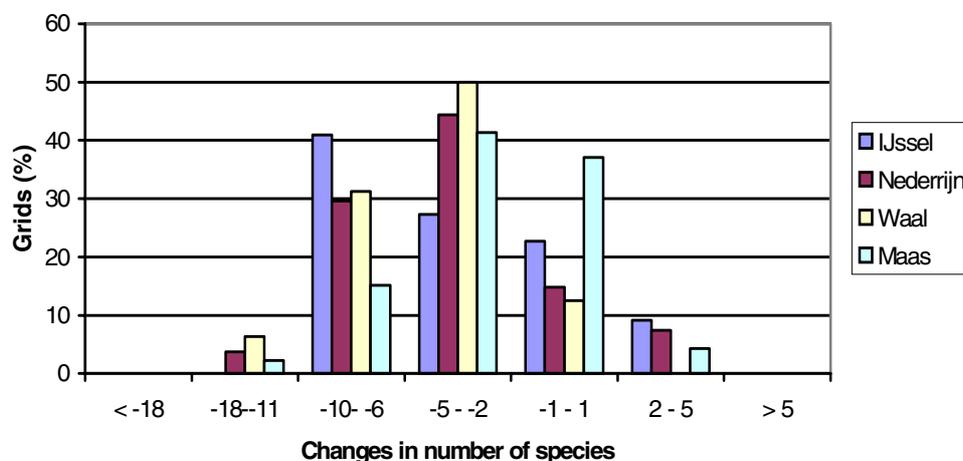


Figure 1. Changes in number of red-listed breeding bird species between 1973-1977 and 1998-2000 atlas surveys of 5 x 5 km grids in Dutch river district, only probable and confirmed breeding records included (Data: SOVON Vogelonderzoek Nederland, 2002).

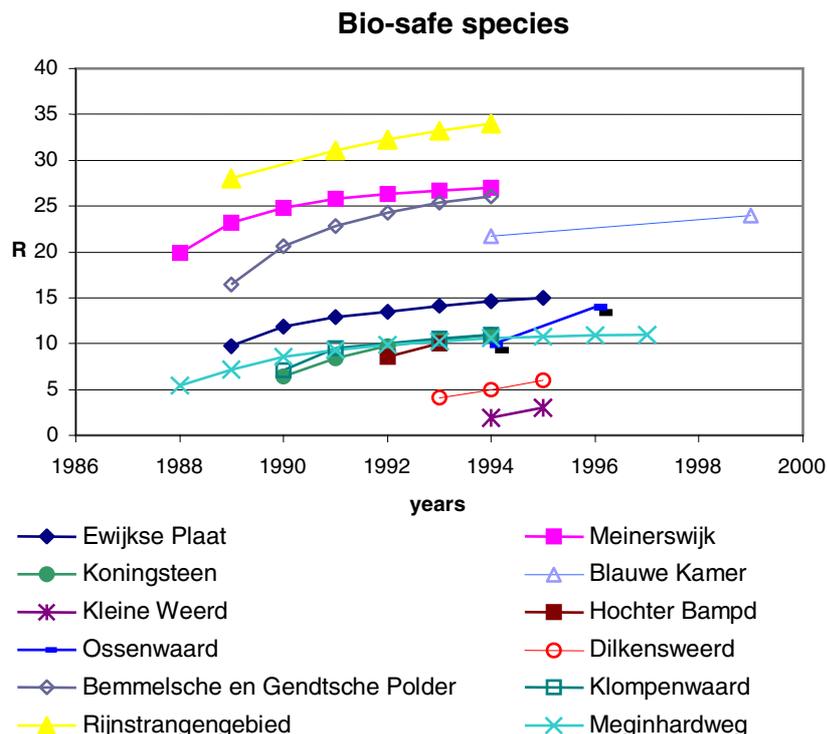


Figure 2. Cumulative species richness (R) of protected and endangered bird species in ecological rehabilitated floodplains along the rivers Meuse and Rhine.

In most study sites the number of bird species quickly reached a meta-stable equilibrium. Graphs of cumulative species richness indicate relatively high species turnover rates (Fig. 2). Fig. 3 shows the relation between cumulative species richness of breeding birds and surface area of reed marshes in floodplains of the Gelderse Poort. The species pool of reed marshes saturated at about 35 ha. Table 1 summarises data on minimum surface areas required for saturation of species pools of various riverine ecotopes.

Ecotope type	Total surface area available (ha)	Surface area required for species saturation (ha)
Open water	1613	680
Grassland	409	83
Forest	288	200
Reed marsh	96	34

Table 1. Surface area of various riverine ecotopes in floodplains of the Gelderse Poort required for saturation of the species pool.

### Discussion

The number of endangered and protected breeding bird species in the Dutch river district strongly decreased over the period 1973-2000, due to deterioration and fragmentation of their

habitats (e.g. as a result of land use changes and physical reconstruction of floodplains). Ecological rehabilitation of floodplains had positive effects on species diversity of breeding birds. However, species turnover rates in rehabilitated sites were high owing to vegetation succession. Some protected and endangered species were also negatively affected by floodplain rehabilitation (e.g. species associated with wet grasslands such as Black-tailed Godwit, Common Redshank). Decrease of these species was caused by succession of wet grasslands into herbaceous vegetation, shrubs and soft wood forest. Preliminary results of multivariate analyses revealed that bird diversity was strongly correlated with habitat availability (surface area) and landscape heterogeneity (Houlliere, 2003). Other studies also showed that distribution of species associated with reed-dominated marshes (e.g. Great Bittern and Great Reed Warbler) was strongly limited by habitat availability and fragmentation (Foppen, 2001). Habitat quality (e.g. sediment and soil contamination) limits the distribution of birds of prey, such as Little Owl and Kestrel (Kooistra et al., 2001). Abundance of herbivorous waterfowl was significantly correlated with nutrient contents in river water, flooding regime and winter temperature (Schaap, 2003).

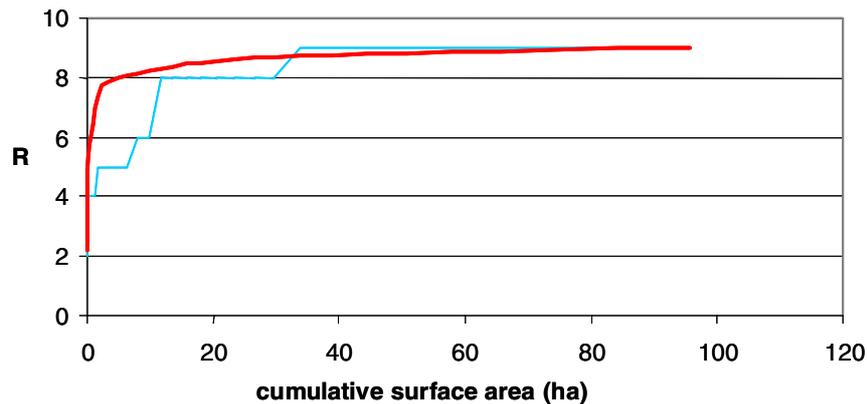


Figure 3. Breeding bird diversity – surface area relations for reed marshes in river floodplains of the Gelderse Poort (Blue line: arranged from small to large ecotope patches; Red line: average of 50 random samplings).

In spite of numerous ornithological surveys in the Dutch river district, it appeared to be very difficult to construct a consistent database on long-term landscape dynamics in relation to the distribution of breeding birds. Cumulative species richness – habitat surface area graphs are very useful for guidelines for floodplain reconstruction. Future research will focus on development and validation of GIS-based models for the evaluation of effects of riverine landscape dynamics on presence, abundance and population viability of (breeding) birds. These models must be suitable for integration in decision support systems for river management and will particularly be used for the evaluation of strategies for cyclic floodplain rejuvenation and multiple spatial planning. Remote sensing techniques and additional field surveys will have to be performed to acquire consistent data on spatial patterns and trends of (breeding) birds in relation to landscape ecological factors (e.g. availability, quality and configuration of habitat, land use and flooding regime).

## Conclusions

Recently, a strong decline in the number of red listed breeding birds has been observed in the Dutch river district due to habitat deterioration and fragmentation. Ecological rehabilitation yields positive effects on bird diversity in river floodplains. However, breeding bird communities still show high species turn over rate, due to vegetation succession. Negative effects of rehabilitation measures have been observed for species associated with wet grasslands. GIS-based models for ecological impact assessment of multiple spatial planning and cyclic floodplain rejuvenation strategies require validation of species-habitat-ecotope algorithms.

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