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The recovery of the Barn Owl *Tyto alba* in Friesland, northern Netherlands: population growth in relation to landscape features

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By 1979, the Barn Owl *Tyto alba* had almost disappeared from the province of Friesland, northern Netherlands. With the placement of nest boxes and by specific forms of landscape restoration, the minimum breeding population of 8 pairs increased to 573 pairs in 2007. In this paper I compare the increase of the breeding Barn Owls across the three landscape types in Friesland, based on soil type sand, peat and clay. Each of these three soil types was divided into 15 categories of openness: open (1–5), partly-open (6–10) and closed landscapes with many trees and bushes (11–15). Each year, a large group of volunteers ensured that all nest boxes (up to 1470 in 2007) were inspected. The increase first became apparent in the sandy soil region with the breeding density exceeding the 1 pair/100 km² threshold in 1982. This threshold was crossed on peat soils in 1985 and on clay soils in 1990. During the population increase, increasing numbers of nest boxes were made available so that nest sites were never in short supply. The population increase on all soil types stabilized as of 2000. In the peak vole year of 2004 the population density was 25.5 pair/100 km² on sand, 20.1 pair/100 km² on peat, and 10.9 pair/100 km² on clay. To our surprise during the population increase Barn Owls did not show clear preferences for a particular degree of landscape openness on any soil type. To explain the highest densities of pairs that eventually established on sandy soils, the habitat type that is least open, I suggest that food conditions are more constant in the most heterogeneous landscape (sandy soils) which leads to the highest reproductive success. Only in good vole years did reproduction in the clay and peat areas exceed that of sandy soils.

Key words: Barn Owl, *Tyto alba*, conservation, soil types, nest boxes, reproduction, density, population growth, landscape condition

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INTRODUCTION

In The Netherlands up until the 1950s, approximately 1800 pairs of Barn Owls *Tyto alba* bred in low vole years and up to 3500 pairs in peak vole years (Honer 1963). However after the severe winter of 1963 only about 100 pairs remained (de Jong 1995). Six contributing factors to this decline have been suggested (van der Hut *et al.* 1992, de Bruijn 1994).

- (1) Loss of nest sites resulting from the renovation and associated reduction of access into buildings.
- (2) Intensification of agricultural land-use, causing reduction of suitable hunting habitat.
- (3) Harsh winters with prolonged periods of deep snow cover.
- (4) Disappearance of granaries, resulting in the loss of prey-rich hunting habitat.
- (5) Use of chemical biocides.
- (6) Increase in traffic mortality, especially in winter.

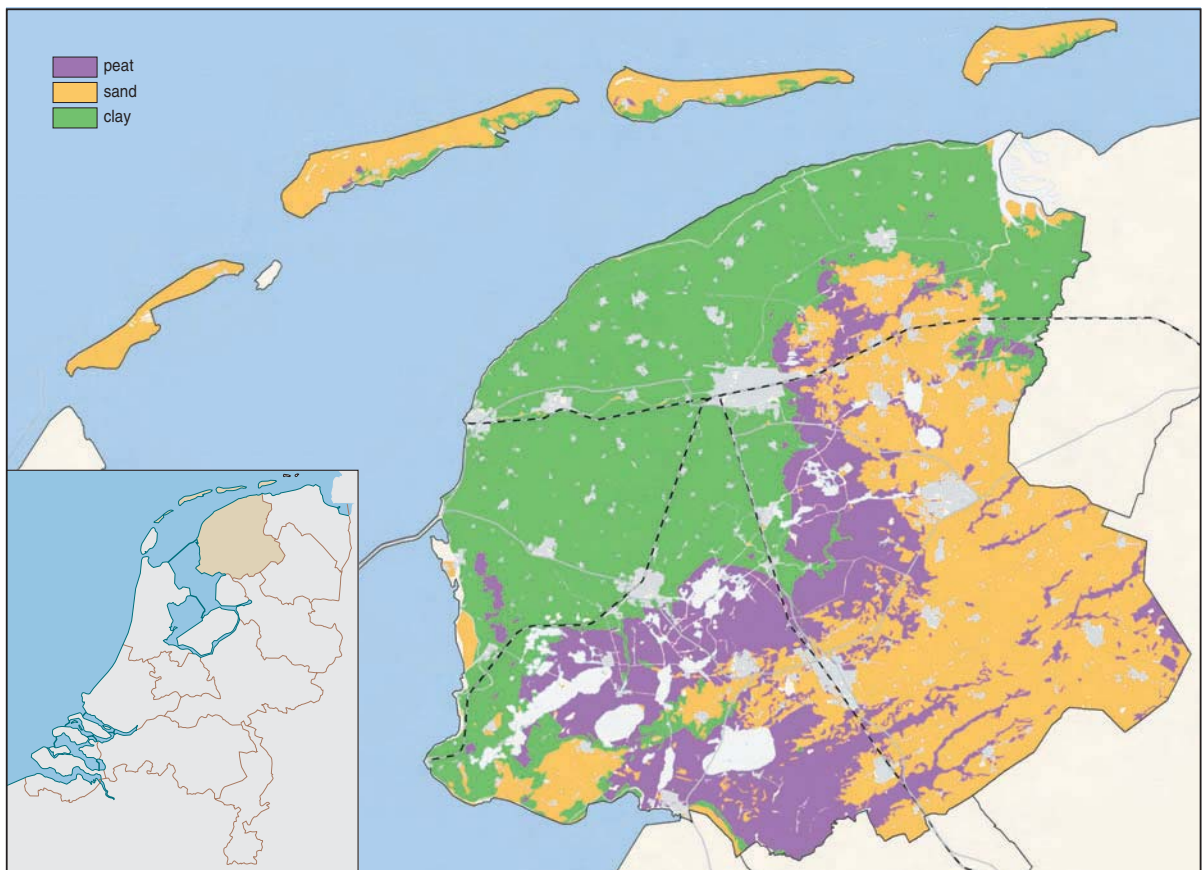


Figure 1. The three soil types (sand, peat and clay) in the province of Friesland, The Netherlands.

Both the decline in Barn Owls, and the cause of their decline, were considered similar in various west-European countries (Bunn *et al.* 1982, de Jong 1983, 1995, Shawyer 1987, Illner 1988, Voous 1988, Taylor 1994, Tucker 1994, Mebs & Scherzinger 2000). More recently, these negative developments are also occurring in east-European countries (Tucker 1994).

During the late 1980s, the population of the Barn Owl exhibited an explosive population growth. The loss of nesting sites was counteracted by providing nest boxes on a massive scale. This action involved 800 volunteers in The Netherlands (80 volunteers in Friesland), who also had an important educational outreach role to farmers. The food supply improved as road verges were managed less intensively, causing vole populations to increase (de Bruijn 1994, de Jong 1995). Prey numbers were further improved as a result of greater emphasis on the conservation, creation and management of natural elements in the agricultural landscape (Ziesemer 1980, Shawyer 1987, de Bruijn 1994, Taylor 1994, de Jong, 1998, Mebs & Scherzinger

2000). Many of the harmful pesticides were banned in the early 1980s (van der Hut *et al.* 1992). Together, these factors have facilitated the recovery of the Barn Owl in the Netherlands.

The foraging habitat of the Barn Owl is a wide range of rather open, mosaic vegetation types such as grassland, landscapes with scattered trees, cultivations, mostly near human settlements (Schönfeld *et al.* 1977, Bunn 1982, Brandt 1992, van der Hut *et al.* 1992, Epple 1993, de Bruijn 1994, Taylor 1994, de Jong 1995, Marti 1997, Baudvin 2001). Whereas nowadays the Barn Owl is distributed all over Friesland and habitat preference is not clear from its distribution, the preferred habitat can be derived from the expansion pattern. In an expanding population, the habitats that are occupied first are expected to be the highest quality and most preferred (O'Connor 1985, 1986, Newton 1998). Regional differences in habitat preference may require a fine-tuning of conservation measures to remove regional limitations to further population growth.



Figure 2. Six examples of open to closed landscapes (i.e. small-scale landscape categories 1, 4, 6, 8, 11 and 14) in Friesland, The Netherlands.

Territories with a greater variation in landscape elements support a greater diversity of prey species (de Jong 1983, 1995, de Bruijn 1994). Barn Owls benefit from this diversity, as it enables them to switch from one prey type to another at times when particular food types are scarce. In this way, the owls that inhabit a diverse habitat may have higher reproductive and survival rates. Here I examine the road to recovery and stable population sizes of Barn Owls in Friesland from 1979 to 2007. I pay particular attention to the role of habitat, as indicated by soil type and landscape

openness, and examine whether the population increase (nest box occupancy) relates to these landscape features.

STUDY AREA AND METHODS

This study was carried out in the province of Friesland (3261 km²) in northern Netherlands (Fig. 1) between 1976 and 2007. Using a network of keen observers, and connected by the larger public through regular

appearances in the provincial media, I was able to follow the breeding population developments in great detail and with high accuracy. The study area was divided into three soil types that also differ in other landscape elements.

- (1) Sand soil region – 1018 km², mainly the eastern half of Friesland. In the southern part of this area there are remnants of stream-valleys and in the south-eastern part there is woodland. Many wooded banks, canals, and other small-scale landscape elements are characteristic of the sand soil landscape.
- (2) Peat soil region – 721 km², central Friesland. As a result of peat extraction during the 18th and 19th centuries, the creation of lakes and subsequent land reclamation, the landscape has become lower (> 1 m or below sea-level). The area is open with few stands of trees; there are many lakes and ponds.
- (3) Clay soil region – 1364 km², mainly in northern and western Friesland. In the north part of this region, arable agriculture is predominant and in the western parts dairy farming is most common. The clay-landscape consists of extensive open areas with few landscape elements. Trees and bushes are only found around farm houses.

Table 1. Percentage coverage of small-scale landscape elements by categories distinguished. Small-scale landscape elements are: low herbaceous and grassy vegetation, road sites, slopes of dykes and banks, wooded banks, wooded canals, hedgerows and wood edges, other overgrown grassy areas, non-grazed edges of meadows.

Category	Coverage of small landscape elements (%)
1	0–5
2	6–10
3	11–15
4	16–20
5	21–25
6	26–30
7	31–35
8	36–40
9	41–45
10	46–50
11	51–55
12	56–60
13	61–65
14	66–70
15	>70

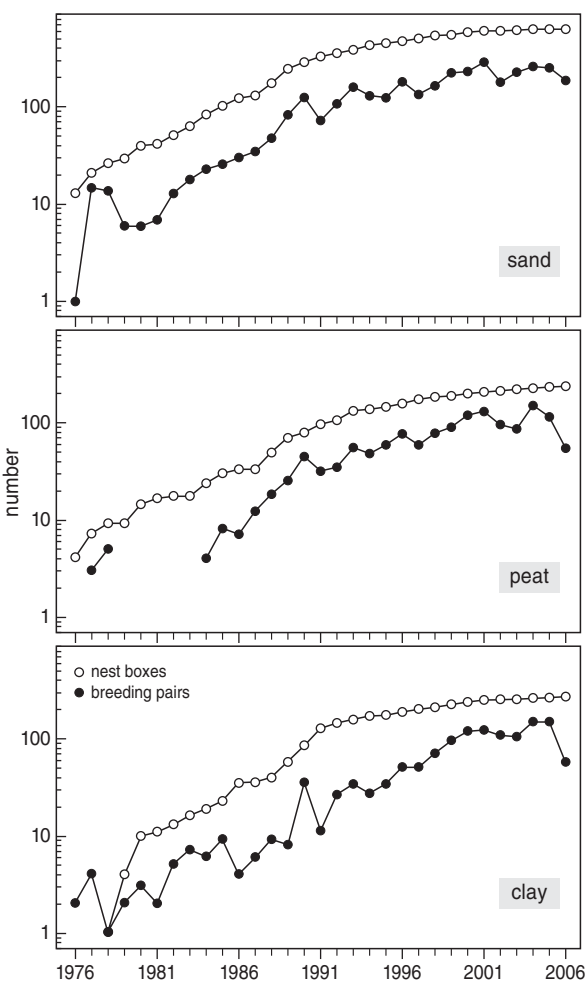


Figure 3. Nest availability and breeding pairs on sand, peat and clay. The number of nest boxes always exceeded the number of breeding pairs in all three soil types.

Each of these three landscapes was subdivided into 15 categories of openness: open landscape (classified from 1–5), half-open landscape (classified from 6–10), closed landscape (classified from 11–15) (Table 1, Fig. 2). Breeding events were classified into the landscape openness categories on the basis of nest location (soil type region) and degree of openness within an area of 1 km radius around the nest. Additional nest boxes were installed yearly (Fig. 3) during the entire period of population growth, so that nest sites were not a limiting factor. Nest box numbers varied from 1 in 1976 to 1470 in 2007. Nest boxes were put up throughout the province, covering all soil regions and categories of openness. However, the installation of nest boxes was not random and breeding sites judged to be more suitable for the owls were favoured.

Nest occupancy was determined during visits to nest boxes from April to December. For the purposes of this study, nest success was defined as the number of fledged young; in turn, 'fledged young' reflected the number of young present at the ringing date minus any remains of (dead) chicks in the nest box.

Differences in Barn Owl reproduction and the degree of landscape openness at breeding sites were tested using pair-wise comparisons, with soil type as the explanatory variable.

RESULTS

In the province of Friesland only 8 breeding pairs were recorded in 1979. After 1989, the population increased rapidly and the number of breeding pairs in 2007 was 573 (and an additional 162 second broods were raised by these pairs) (Fig. 4B). Annual fluctuations in the number of pairs matched the cyclic pattern of Field Voles *Microtus arvalis*. The increase of the Barn Owl population in Friesland coincided with the increase in Barn Owls observed throughout the Netherlands (Fig. 4A).

Clear differences in population development were found between the three soil-type regions (Fig. 5). From 1979 the recovery of the population started in the sand region. In 1982, Barn Owl density in this soil type was over 1 pair/100 km². On peat, this density was reached in 1985 and on clay in 1990. In 2004 the population density in the sand region was 25.2 pair/100 km², 10.9 pair/100 km² on clay, and 20.1 pair/100 km² on peat.

On the scale of Friesland, the pattern of increase of the Barn Owl population from 1979 was not centred on the last remaining pairs; new breeding pairs were found throughout Friesland (but dependent on soil-type region) (Fig. 6). This meant that the locality of new breeding events could be considered independent from locations of already settled owls. Nest box occupancy differed in the degree of openness between soil types (Fig. 7). However, the choice of habitat openness by Barn Owls was random considering the distribution of available nest boxes per soil type. Also, no preference of landscape openness was found during the population increase, i.e. there were no trends in the interaction between year, soil type and degree of habitat openness.

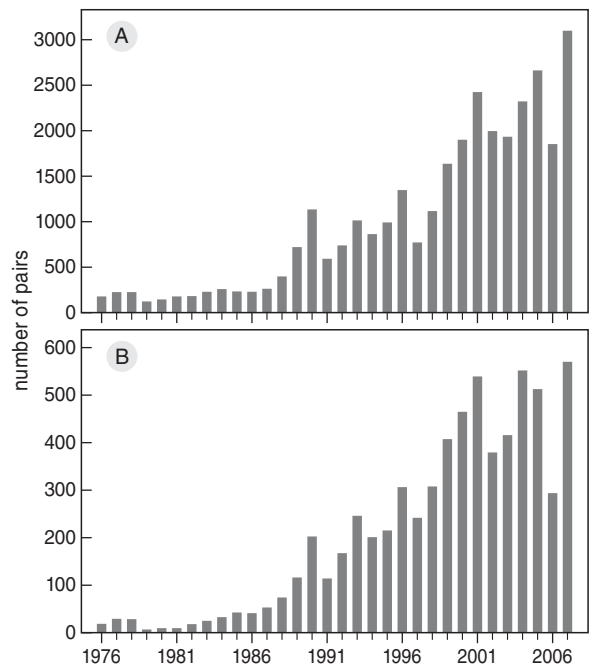


Figure 4. A. Number of breeding Barn Owl pairs in The Netherlands (1976–2007). B. Number of breeding Barn Owl pairs in the province of Friesland (1976–2007).

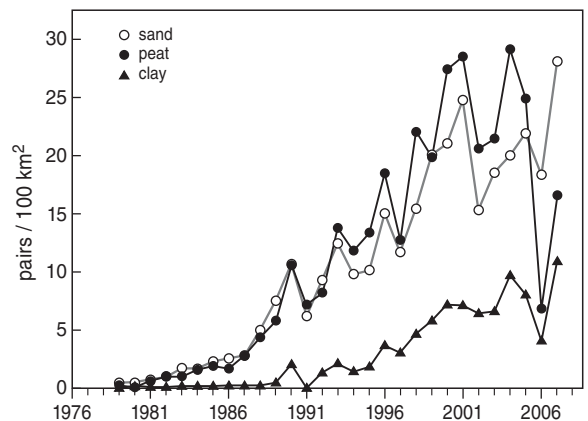


Figure 5. Increase in population density of breeding pairs in the three soil-type regions sand, peat, and clay (see Fig. 1) from 1979 to 2006, Friesland, The Netherlands.

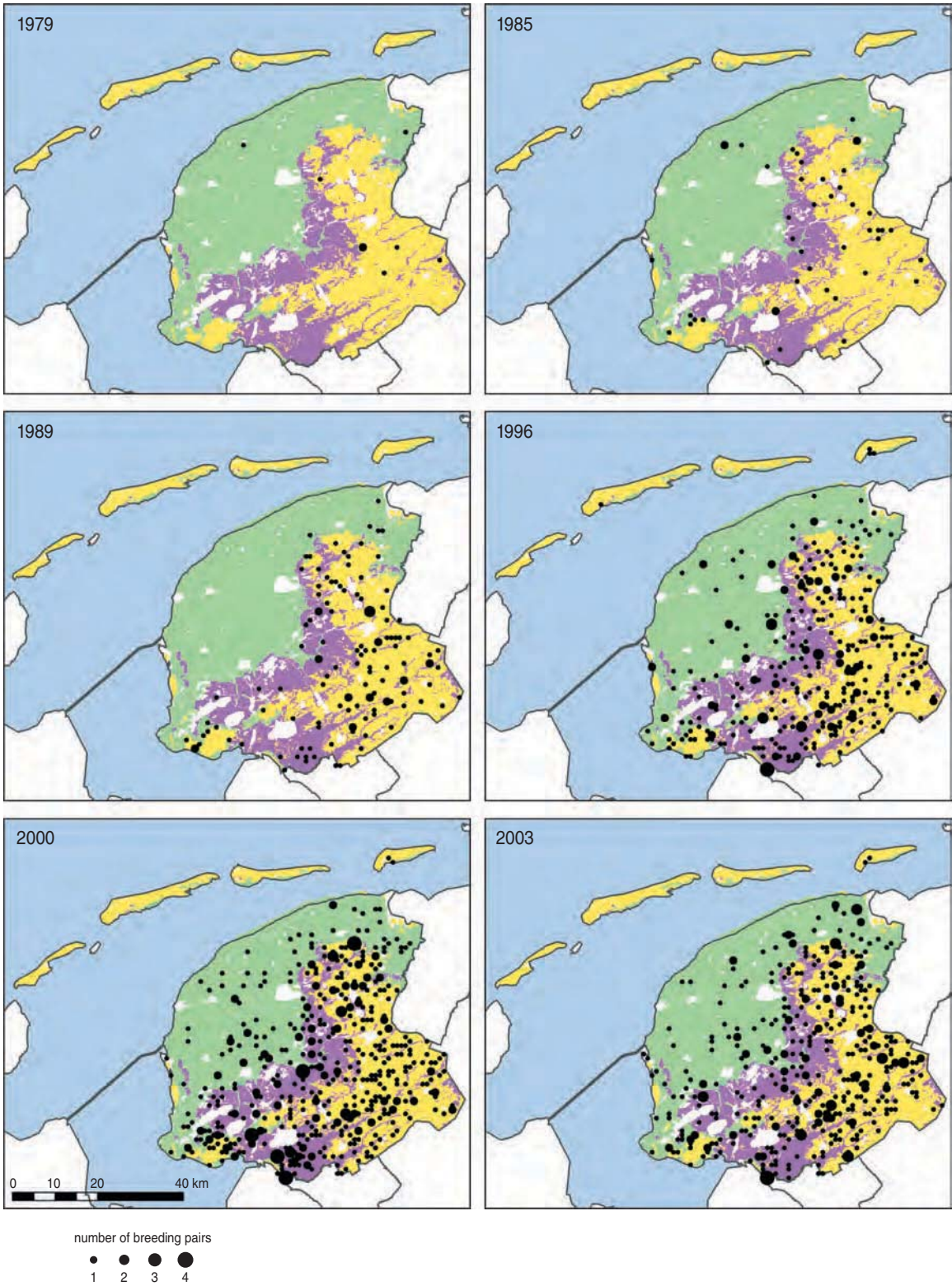


Figure 6. Spatial representation of the Barn Owl population increase in Friesland, Netherlands. On the scale of Friesland, the breeding range did not expand from the last remaining pairs; new breeding events were independent of localities of previous breeding pairs.

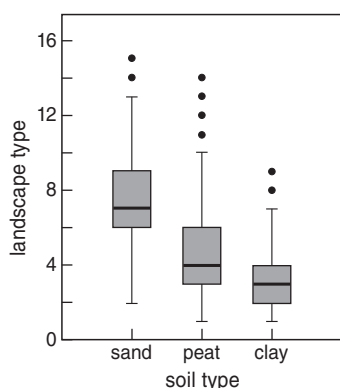


Figure 7. Degree of openness of the area surrounding nest sites for different soil type regions in Friesland, Netherlands. Although the differences between soil types are statistically significant (for all pair-wise combinations $P < 0.005$), these matched the differences in nest box availability. This analysis does not support, therefore, a preference for habitat openness in Barn Owl.

DISCUSSION

The increase of Barn Owls in Friesland became apparent first in the sandy soil region of the province. In this area, the openness of the landscape is less than in the peat and clay regions. However, during the increase of the population, there was no tendency of Barn Owls to occupy increasingly open habitats, which was expected if preferred (half-open) habitats were occupied before the less suitable more open habitats. Although nest box occupation was higher in more closed habitats in the sandy soil region compared to the peat and clay regions, this was merely a reflection of nest box availability. I found no evidence that habitat openness itself was explanatory for the initial preference of Barn Owls for the sand region compared to the peat and clay regions.

So far, little distinction has been made in the level of landscape openness in describing the optimal habitat for Barn Owls (de Bruijn 1994, Taylor 1994, de Jong 1995, Mebs & Scherzinger 2000). My data suggest that Barn Owls do not strongly select for habitats with a particular degree of openness, but rather, that the species shows considerable plasticity in this regards. Also, breeding success was not higher in the sand region compared to the peat and clay regions. In contrast, the number of fledged chicks per successful brood was lower on sand than either peat or clay. There was no relationship between landscape openness and breeding success, corroborating the above finding that habitat openness was not a key factor in the Frisian Barn Owl population. To my knowledge, there have

been no studies in the Netherlands describing a relationship between the level of landscape openness and reproduction, although the importance of half-open landscapes is often put forward (de Bruijn 1994, de Jong 1995). However, Taylor (1994, 2002) showed a positive relationship between the density of woodland edge foraging habitat and the number of young fledged in a population in Scotland.

At a national level, the increase in the Netherlands' Barn Owl population was clearly centred on remaining relict populations (unpubl. data). At the smaller, provincial scale of Friesland, such a pattern could not be detected, given the distances between old and new breeding sites. The dominant effect of soil type did not limit dispersal distances, as adults and young dispersal distances greatly exceeded distances between soil type regions.

As the results from this study do not show why the expansion of the Barn Owl population was at first especially in the sand region of Friesland, I hypothesise that its causes are most likely related to food availability. The density of prey items is not necessarily higher in the sand region, but probably more diverse, providing a more stable and predictable food supply. The habitat of the sand region is more heterogeneous with more edge habitats capable of supporting small mammals and this may have been the cause for the initial preference for this region. If one prey species is scarce in a given year or season, its effect on the owls may be mitigated by higher numbers of other prey species. Although breeding success on sand was lower compared to peat and clay, lifetime reproduction may be higher on sand, if more favourable food conditions in both summer and winter result in higher survival rates of breeding adults.

There are few predators in Friesland that affect the distribution or reproductive success of Barn Owls. A few Barn Owls are taken by Northern Goshawks *Accipiter gentilis* each year. The Stone Marten *Martes foina* has arrived from eastern Europe and is now common in Friesland. The marten sometimes disturbs nesting owls or kills young owls in the nest boxes. While there are about five breeding pairs of Eagle Owls *Bubo bubo* in The Netherlands, none are in Friesland.

Although the degree of openness did not explain differences in the rate of population increase in the Frisian soil type regions, partly-open landscapes are essential to the stability of Barn Owl populations. No Barn Owls inhabited completely-closed or completely-open landscape types, and therefore, the protection and further creation of partly-open agricultural landscapes is crucial to maintain Barn Owl populations. Increasing the availability of places to breed in such habitats by

putting up nest boxes triggered the increase of the Dutch Barn Owl population and has been shown to be a very effective conservation measure, given the setting of the early 1980s in which lack of nest sites was the final bottleneck that needed to be addressed.

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SAMENVATTING

Rond 1979 was de Kerkuil *Tyto alba* nagenoeg verdwenen in de provincie Friesland. Door het aanbrengen van nestkasten en gericht landschapsherstel is de populatie gestegen van een dieptepunt van acht paren naar 573 broedparen in 2007. In dit artikel wordt de populatie-toename van de Kerkuil vergeleken voor de zand-, veen- en kleigronden in de provincie. De landschappen in deze drie gebieden werden geclassificeerd als open (1–5), halfopen (6–10) en gesloten landschappen (met talrijke bomen en struiken). Elk jaar werden alle nestkasten (tot 1470 in 2007) geïnspecteerd door talrijke vrijwilligers. Daarbij werd het grootste deel van de nestjongen geringd. De populatie-toename was het eerst duidelijk op de zandgronden. Daar werd al in 1982 een dichtheid van één broedpaar per 100 km² bereikt. Deze drempel werd op de veengronden pas overschreden in 1985 en op de kleigronden eerst in 1990. Tijdens de periode van populatie-toename werden alsmaar meer nestkasten ter beschikking gesteld, zodat er steeds een overmaat aan broedgelegenheid aanwezig was. Vanaf 2000 stabiliseerde de populatie zich in alle drie gebieden. Tijdens het uitzonderlijke veldmuizenjaar van 2004 bedroeg de dichtheid op de zandgronden 25,5 broedparen per 100 km², op de veengronden 20,1 broedparen per 100 km² en op de kleigronden 10,9 broedparen per 100 km². Tijdens de populatie-toename vertoonde de Kerkuil binnen geen van de drie gebieden een voorkeur voor een bepaalde openheid van het landschap. De hoge dichtheden op de zandgronden worden wellicht veroorzaakt door een constanter voedselaanbod in de kleinschaliger landschappen op deze gronden, met een hoger broedsucces tot gevolg. Alleen in jaren met veel veldmuizen oversteeg de reproductie op de klei- en veengronden die van de zandgronden.

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