Responses of autumn-staging ducks and Coot *Fulica atra* to the Skjern River Valley wetland restoration project

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Abstract

Following 35 years of drainage and intensive arable tillage, the lower Skjern River in west Jutland, Denmark was re-engineered to a meandering riverbed and natural flooding regime to restore sediment and nutrient retention and reduce sedimentation and eutrophication of Ringkøbing Fjord at its efflux. The creation of 22 km^2 of lakes, shallow wetlands and seasonally flooded grassland has attracted large numbers of autumn-staging waterbirds, including peaks of 8,800–19,700 individuals and more than three-quarters of a million bird-days *per annum* spent there by nine common freshwater duck species during 2002–2016. Over this period, annual numbers of bird-days have declined by 45–68% amongst Mallard *Anas platyrhynchos*, Eurasian Wigeon *Mareca penelope*, Northern Pintail *A. acuta* and Eurasian Coot *Fulica atra*, fluctuated without trend for Eurasian Teal *A. crecca* (hereafter Teal) and Gadwall *M. strepera* and increased by 99–557% amongst Northern Shoveler *Spatula clypeata*, Common Pochard *Aythya ferina* (hereafter Pochard), Tufted Duck *A. fuligula* and Common Goldeneye *Bucephala clangula* (hereafter Goldeneye). Despite these changes in species composition, there have been no overall declines in total bird-use of the site during 2002–2016. Regression models showed a positive relationship between annual numbers of bird-days for Teal and the mean autumn water depth (likely a response to the extent of shallow flooded grassland created by high water levels), as did those for the diving ducks (Pochard, Tufted Duck and Goldeneye), which benefited from the extent and depth of floodwaters. We lament the lack of environmental monitoring post-restoration on the lower Skjern River, which would have provided better information on how changes in food supply, abundance and accessibility affected the annual numbers of autumn-staging waterbirds at the site. Nevertheless, the site, which was formerly devoid of any waterbirds, has immediately become, and remained, one of Denmark's five most important freshwater wetlands for autumn-staging waterbirds with minimal management intervention, confirming the considerable potential for such restoration schemes.

Key words: management, trends, water level, waterbirds, wetland mitigation.

Wetland drainage in the Western Palearctic has been a major cause of habitat loss to migratory waterbirds in the 20th century, although the rate of loss was reduced in the second half of the century by supra-national legislation, such as the Ramsar Convention on Wetlands of International Importance and the Birds and Habitats Directives in the European Union (*e.g.* Jones & Hughes 1993). Periodic seasonal flooding of low-lying land traditionally provided migratory waterbirds with ephemeral but often highly productive feeding resources outside of the breeding season, yet such areas were also readily dewatered by embankment and pump-drainage schemes in the valleys and river basins. One such scheme involved the Skjern River, the longest river in Denmark, which is the catchment for some 2,500 km^2 of agricultural land on sandy free-draining soils and discharges into the shallow estuarine lagoon of Ringkøbing Fjord on the west coast of Jutland (Fig. 1a). During the 1950s, it was an important autumn staging area for waterbirds on the west coast of Denmark (Ferdinand 1971). However, the lower reaches of the Skjern River were canalised and deepened in the 1960s and *c.* 40 km^2 of inundated wet grassland, permanent marsh and shallow lakes were converted to arable land, mainly for wheat and barley, maintained by pump drainage into the canal to maintain low water tables throughout the valley (Pedersen *et al.* 2007). Despite the initial agricultural return on investment, the drainage scheme had many unforeseen adverse consequences for the economic viability of the project and upon the local environment. Oxidation of organic matter and drying of the soil horizons caused substrate shrinkage, which increased the costs of pump drainage required to maintain arable agriculture. Canalisation of the river effectively removed the sediment and nutrient (especially nitrogen) retention characteristics of the former wetlands, causing major sedimentation and eutrophication problems at its discharge into Ringkøbing Fjord. This in turn affected economic activity in the area (especially fishing, tourism and amenity interests) as well as causing major biodiversity loss within internationally protected areas in the fjord (*e.g.* changes in waterbird numbers described by Meltofte & Clausen 2011). Canalisation of the river virtually eliminated one of the last native populations of Atlantic Salmon *Salmo salar* in Denmark, with major financial consequences for the local community (Nielsen & Schierup 2007).

In 1987, the Danish Parliament therefore committed the government to restoring the lower stretches of the Skjern River to its former state, a commitment finally endorsed by the "Act on Skjern River Nature Project" (Act No. 493 of 1 July 1998). Engineering and reconstruction works commenced during 1999–2001 to restore the Skjern River to its former meandering course and to permit periodic flooding in sections of the floodplain. The primary motivation was to restore the nutrient retention capacity of the system that was causing such problems for human and biological communities downstream in Ringkøbing Fjord (Petersen *et al.* 2008). In this sense, the project was very much a process-orientated restoration programme (*sensu* Cairns & Hackman 1996), where the objective is to attain some kind of

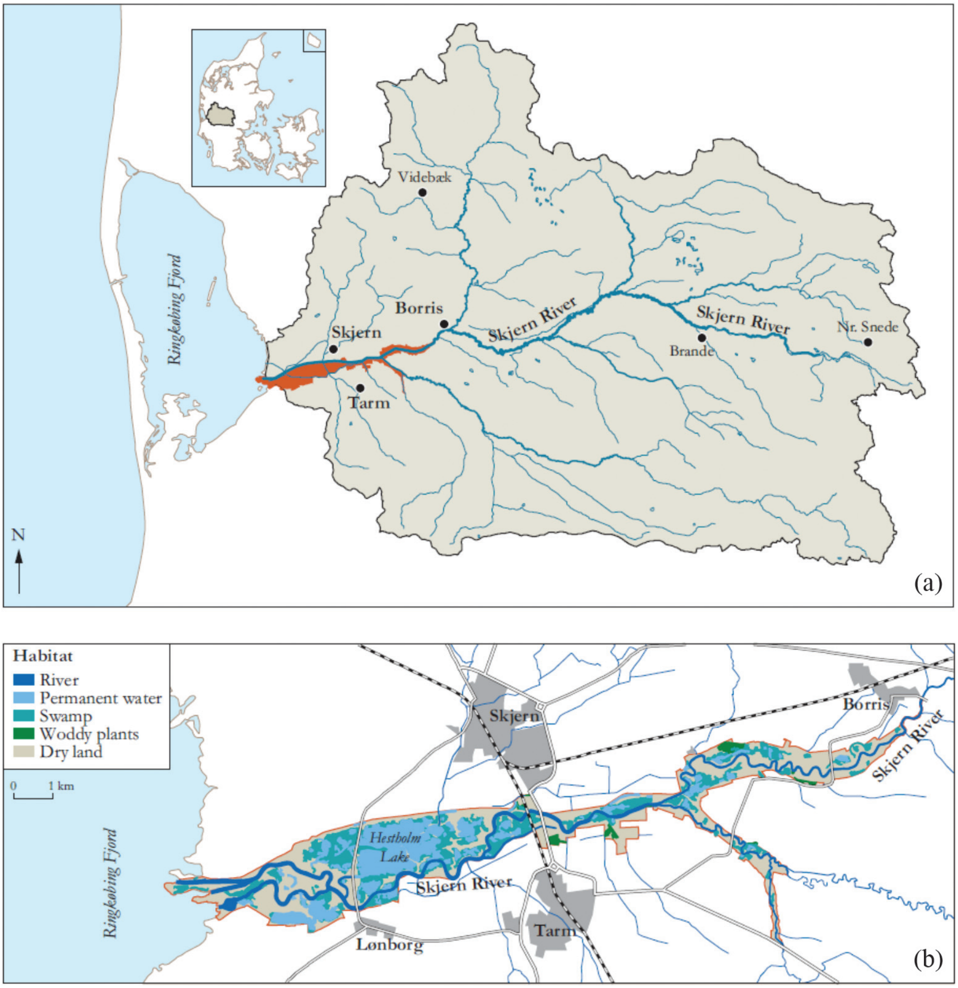

Figure 1. Maps of the study area showing: (a) the catchment area of Skjern River and the restoration project area (in orange) with its location within Denmark (inset), and (b) the main habitats and also the location of Hestholm Lake within the project area following restoration during 1999–2001.

"structural return to a pre-disturbance state" (Cairns 1991), rather than attain a specific goal (*e.g.* reduction of nitrogen input by a given percentage). Other, longer-term objectives established under the Act were to promote the fishery in Ringkøbing Fjord, including enhancement of the last self-sustaining population of Atlantic Salmon in the Skjern River (Nielsen *et al.* 2001) and increase recreational and tourist activities in the project area, including hunting over the wetlands (Pedersen *et al.* 2007). Of major significance for the analyses presented here was the final aim, namely to restore an internationally important wetland and associated habitats for breeding and staging birds, which had been drained and degraded in the 1960s (see Rambusch 1900; Tåning 1933–1936; Ferdinand 1971).

In an earlier analysis (Bregnballe *et al.* 2014a), we assessed the benefits of the programme of restoring the wetlands of the Skjern River Valley (SRV) to breeding birds. In the present paper, we complement and update earlier evaluations of the responses of common staging waterbirds that use the area in autumn *en route* to ultimate winter quarters (Bregnballe *et al.* 2009a, 2014b). Except for some night-time foraging by dabbling ducks, autumn-staging waterbirds were completely absent in the valley during the intervening period of dewatering and arable agriculture in the 1960s–1990s, so we were interested in assessing the use of the wetlands by waterbirds post-restoration and to see how these may have changed over time. We focus entirely on duck species and Eurasian Coot *Fulica atra* (hereafter Coot), which frequent freshwater habitats, using regular counts to assess the annual fluctuations in autumn-staging waterbirds at the site since restoration to assess changes in abundance. In doing so, we made the assumption that, because birds are passing through on their way to ultimate wintering areas, turnover ensures that the numbers of birds using autumn staging sites relate mainly to the available feeding resource, levels of disturbance or other features of the general attractiveness of the area (*e.g.* Madsen 1998). We consider that this is a reasonable assumption for most species, because the Skjern River discharges into Ringkøbing Fjord, which itself is a very important EU Special Protection Area and Ramsar Site, designated for its outstanding importance for staging migratory waterbirds (Meltofte & Clausen 2011, 2016; Meltofte *et al.* 2016). Hence, there are already waterbirds aggregated in the immediate vicinity of the lower Skjern River and these birds are likely to find and exploit the habitats now available in the river delta. For this reason, we consider that changes in the overall flyway populations of the waterbirds studied and the attractiveness of other sites contribute little to year-to-year variation in numbers counted in the SRV.

Restoration schemes are subject to processes of community succession; in particular, after years of intensive fertiliser application, soil nutrient accumulation potentially encourages growth of biomass and species, which may provide a food source for ducks and Coot during the initial restoration phase, which has a diminished effect over time, especially as the fertiliser is leached out of the system (Jansson *et al.* 1994; Zedler 2000). Open, shallow water interfaces with gently shelving terrestrial habitats will become colonised by dense growth of dominant plants, however, with species such as Soft Rush *Juncus effusus*, Common Reed *Phragmites australis* beds, Reed Canary Grass *Phalaris arundinacea*, Tufted Hair-grass *Deschampsia cespitosa* and willow *Salix* sp. scrub. Such succession gradually denies dabbling ducks of their favoured foraging habitats (Weller 1994) and potentially reduces reproductive success (*e.g.* Thompson *et al.* 2012). Here, we therefore used counts made at the site to estimate the numbers of bird-days spent by each species on the site, as an index of species' use of the

SRV, to test two hypotheses relating to long-term changes in annual total numbers of bird-days. Firstly, we predicted that, because of vegetation succession processes, numbers of dabbling ducks that forage in shallow productive habitats might be greater in the initial stages following restoration than after a few years of establishment, and therefore show declines over time. Secondly, we would expect the numbers of diving ducks to increase with water area and water depth, which varies annually according to degree of flooding. One of the objectives of elevating the water levels included the restoration of Hestholm Lake and other waterbodies, resulting in greater water depths over greater areas which would provide enhanced foraging opportunities for Common Pochard *Aythya ferina* (hereafter Pochard), Tufted Duck *A. fuligula* and Common Goldeneye *Bucephala clangula* (hereafter Goldeneye). Such areas provide consistent deep water feeding resources unavailable to dabbling ducks, which themselves benefit more from the greater ephemeral extent of shallow water flooding over wetlands and grasslands. Unfortunately, we lack data on the annual extent of open water and therefore use water depth in the valley as a proxy, predicting that these species will show a positive response to increased water levels.

Methods

Study area

The Skjern River drains 2,500 km^2 of lowland agricultural land in Jutland, discharging into Ringkøbing Fjord (see Fig. 1a). The lower 22 km^2 of the 40 km^2 of land claimed for agriculture in the 1960s were restored between 1999 and 2002 to shallow lakes, wetlands and wet grassland and 19 km of the river was re-engineered to its original meandering course (Pedersen *et al.* 2007). The restoration project was successful in providing large inter-connected shallow lakes and grazed meadows, especially in the western part of the restoration area. The main management activity in the restored area has been cattle grazing, which has occurred across most of the valley since 2004 (*e.g.* 800 cattle grazed across 12 km^2 of the site in 2005). In some areas, the grazing has been supplemented by mechanical mowing and removal of the vegetation. Despite these management interventions, between 2000 and 2003 invasion of *J. effusus* increased from 2% to 26%, *P. arundinacea* from 9% to 20% and *D. cespitosa* from 1% to 5% cover (Larsen *et al.* 2005), while local development of willow carr has continued, probably to the general detriment of ducks and their potential foraging areas. No hunting was permitted over Hestholm Lake or in the wet meadows to the west, implemented under the management plan drafted for the area (see Fig. 1b for lake location). Furthermore, all other types of human activity were also forbidden on the lake and most pedestrians visiting meadows to the west were confined to the public paths in order to greatly reduce recreational disturbance to waterbirds (Bregnballe *et al.* 2009b). The eastern part of the restoration area experienced limited use by duck and Coot in autumn because of restricted areas of open and shallow water there and because of higher levels of anthropogenic disturbance in the vicinity of potentially attractive areas (Bregnballe *et al.* 2009a, 2014b).

Each year, water levels increase in autumn, creating a range of semi-permanently flooded areas that are extremely attractive to autumn-staging waterbirds, including Hestholm Lake, the largest permanent body of water with a mean depth of 60 cm (see Pedersen *et al.* 2007 and Bregnballe *et al.* 2009a for details).

Data collection

Waterbirds were monitored within the restoration area (Fig. 1b) between August and November in 2002–2016. These counts, which were usually made from around 09:00 h to 17:00 h, were conducted by the same two professional ornithologists who together successively covered the entire area. The two observers counted total numbers of all species seen from 30 fixed elevated observations points, for example from the top of dikes and observation towers, which oversee the key sections of the site used by waterbirds. Inevitably, such fixed-point counts cannot account for differential effects of detectability, because waterbirds can conceal themselves in emergent vegetation to an extent dependent on species and conditions at the time of the count. However, we consider this factor contributes little to explaining the variance in the data presented here. For the purposes of this analysis we only consider the abundant duck species: Mallard *Anas platyrhynchos*, Eurasian Wigeon *Mareca penelope* (hereafter Wigeon), Northern Pintail *A. acuta* (hereafter Pintail), Eurasian Teal *A. crecca* (hereafter Teal), Gadwall *M. strepera*, Northern Shoveler *Spatula clypeata* (hereafter Shoveler), Pochard, Tufted Duck and Goldeneye, and also Coot. Complete counts of the site were repeated 1–4 times each month (7–11 counts per season) by the same two ornithologists (employed full time to conduct the waterbird counts) during 2002–2011. Leica 32 × 77 and 20–60 × 77 spotting telescopes and 10 × 42 binoculars were used to count the eastern and western sections of the restoration area simultaneously, to minimise double-counting resulting from within-site movements by the birds. During 2012–2016, complete counts were conducted 1–2 times per autumn (during August–November), by the same two observers as in the earlier years. The results from these counts were supplemented by a monthly complete count conducted during August–November by one or both of the two experienced professional observers together with the local Skjern River counting group of volunteer ornithologists.

Data analysis

Bird-use of the area was expressed as the number of bird-days. Because counts were at regular intervals each autumn, bird-days were calculated as the average number of birds for each count multiplied by the number of days in the month, summing the monthly number of bird-days for August to November. Although all waterbirds present (except gulls: Laridae) were counted, we restrict the analysis here to dabbling and diving duck species and Coot. Unfortunately, Coot count data were incomplete in 2013 and 2016 so this species had to be excluded from the analyses in these years. The mean measured water flow in the river was highly correlated with the mean water levels recorded (September–November) in the largest of the lakes (Bregnballe *et al.* 2005).

Due to temporary failure in measuring water levels in the lake, here we use the mean daily water flow from September to November as an index to describe the general water level in each autumn. Data on daily water flow (m^{-3} sec) was obtained from a recording station at Gjaldbæk Bridge (within the study area) cumulated for each 24 h period. We subjected the natural logarithmically transformed number of bird-days to simple regression models to test for significant changes in number over the years for which we have counts and against a water level index. The proportions of birds foraging were recorded simultaneously in most years, as reported in Bregnballe *et al.* (2009a, 2014b). The phenology of occurrence for dabbling ducks is described in Bregnballe *et al.* (2009a) and for all waterbird species in Bregnballe *et al.* (2014b).

Results

Numbers of common freshwater ducks and Coot following restoration

After 35 years of arable field management, the restoration of the lower Skjern River floodplain to lakes and flooded wetland with extensive cattle grazing attracted large numbers of autumn-staging waterbirds. For the years 2002–2016, subject to detailed analysis given here, summing the peak numbers recorded for the nine common freshwater duck species considered gave annual values ranging from 6,059 (2016) to 19,705 individuals (2012), with a mean (± s.d.) peak count of 12,089 ± 3,643 birds/year over the study period. Maximum annual numbers of Coot counted varied between 668 (2012) and 4,309 (2003), with a mean of 2,028 ± 1,254, excluding 2013 and 2016 when data were incomplete. Summing the peak annual counts from each of the nine duck species showed that between at very least 8,798 (2015) and 19,705 (2012) individuals of these species used the site before accounting for any turnover. There was no significant change in this measure during 2002–2016 (mean ± s.d. = 12,089 ± 3,643; $F_{1,14} = 0.91$, $r^2 = 0.07$, $P = 0.36$, n.s.), nor did the annual total number of bird-days for the nine common duck species change over the same period (mean = 779,409 ± 139,103; $F_{1,14} = 2.30$, $r^2 = 0.15$, $P = 0.15$, n.s.). Clausen *et al.* (2019) gives a comprehensive review of waterbird numbers from 2004 to 2017 in all Danish Special Protection Areas (SPAs) designated under the EU Birds Directive for migratory birds, as well as new SPAs potentially qualifying for such designations in a forthcoming revision. For these years, the most numerous species in the SRV were Teal (peaking at 13,865 in 2012) and Wigeon (peaking at 6,282 in 2006, but note that 11,293 was recorded in 2003), but the site attracted internationally or nationally important numbers of seven duck species and Coot (Table 1), and obviously added value as an important staging area for waterbirds, with far higher numbers of Gadwall, Pochard and comparable numbers of Teal, Mallard, Shoveler and Coot to those found in the adjacent Ringkøbing Fjord (Table 1).

Trends in autumn-staging numbers of dabbling duck bird-days following restoration

Mallard, Pintail and Wigeon responded promptly to the restoration project, but the

Table 1. Summary of averages, maximum and minimum annual peak counts of common freshwater ducks and Coot recorded in the lower Skjern River Valley wetland restoration area during 2004–2017, and the number of years (of 14 possible) where peak counts have been above international and national 1% criteria for the species (Clausen *et al.* 2019). * indicates that the species is included as qualifying species in the designation of Ringkøbing Fjord Special Protection Area (SPA) No. 43. The entire Skjern River restoration area was designated as SPA No. 118 in autumn 2018 (Ministerial Order from the Ministry of Environment and Food of Denmark No. 1595 of 06/12/2018), but the qualifying species have not yet been adopted by authorities.

	Counts			Importance	
Species	**Average**	**Minimum**	**Maximum**	**International**	**National**
		SPA No. 43 Ringkøbing Fjord			
Wigeon*	13,173	4,803	31,457	5	14
Gadwall	18	3	37	0	5
Teal*	5,965	2,557	9,940	8	14
Mallard	1,794	1,201	2,808	0	12
Pintail*	2,299	680	6,989	14	14
Shoveler*	344	49	1,233	4	12
Pochard	6	1	19	0	0
Tufted Duck	74	3	282	0	0
Goldeneye*	1,288	340	4,444	0	11
Coot*	1,430	308	4,340	0	6
		SPA No. 118 Skjern Å			
Wigeon	3,861	1,926	6,282	0	14
Gadwall	125	57	246	0	14
Teal	4,553	1,272	13,865	3	14
Mallard	1,212	587	2,133	0	5
Pintail	199	29	400	0	9
Shoveler	417	141	736	6	14
Pochard	83	10	209	0	3
Tufted Duck	511	260	966	0	0
Goldeneye	54	4	112	0	0
Coot	1,626	208	5,958	0	5

Table 2. Summary of annual changes in autumn (August–November) staging numbers of bird-days of all duck species and Coot species during 2002–2016 in the lower Skjern River Valley wetland restoration area. Statistical significance of the change was based on simple regression models for natural logarithm transformed total autumn number of staging bird-days for each species. The estimated percentage declines were based on the difference in back-transformed number of bird-days estimated by each model for the start (2002) and end (2012) of the time series and expressed as a percentage of the 2002 estimate in each case. n.s. = not significant.

Species	Regression model formula	r^2	P	Difference in bird-days between 2002 and 2016	Percentage change
Mallard	ln[N] = –0.0455 × year−34.9	0.35	0.02	–77,371	–47.1
Pintail	ln[N] = –0.0821 × year+174.5	0.35	0.02	–10,455	–68.3
Wigeon	ln[N] = –0.0432 × year+99.3	0.42	0.01	–184,156	–45.4
Teal	ln[N] = 0.0013 × year+9.8	0.0002	0.96	+23	n.s.
Gadwall	ln[N] = 0.0434 × year−78.2	0.18	0.11	+5,016	n.s.
Shoveler	ln[N] = –0.049 × year−88.2	0.28	0.04	+19,607	+98.6
Pochard	ln[N] = 0.0427 × year−77.2	0.10	0.24	+3,244	n.s.
Tufted Duck	ln[N] = 0.1345 × year−260.2	0.47	0.01	+48,386	+557.3
Goldeneye	ln[N] = 0.0953 × year−183.6	0.31	0.03	+3,711	+279.7
Coot	ln[N] = –0.0808 × year+174.0	0.43	0.01	–139,922	–67.7

number of bird-days spent by these three species subsequently declined significantly by almost 50% or more during 2002–2016, while those of Teal and Gadwall showed no trend and Shoveler numbers increased significantly (doubling during the study; see Table 2, Fig. 2).

Trends in autumn-staging numbers of diving duck and Coot bird-days following restoration

Coot were likewise rapidly attracted to the restored wetland, but there were significant declines (by approximately two-thirds) in their numbers during 2002–2016. In contrast, there was no significant trend for Pochard, while the trend for Tufted Duck increased over 6-fold and for Goldeneye almost 4-fold over the study period (Table 2, Fig. 3).

Relationship between autumn-staging numbers of bird-days and water level index

Among the dabbling duck species, only Teal showed a significant relationship between natural log transformed numbers of bird-days during 2002–2016 and the water level index (Table 2, Fig. 4). For the same period, Pochard, Tufted Duck and Goldeneye natural log transformed numbers of bird-days increased with increasing water depth, while Coot numbers significantly declined (Table 2, Fig. 4).

Discussion

The results of the post-restoration waterbird monitoring presented here show that the 22 km^2 of lakes, shallow wetlands and seasonally flooded grassland in the lower SRV have attracted large, and for some species even internationally important numbers of autumn-staging waterbirds. These include peaks of 8,800–19,700 individuals and an annual average number of > 779,000 bird-days spent at the site by nine common freshwater duck species during 2002–2016. This represents an improvement over the almost total lack of waterbirds present in autumn in the stubble fields of the former arable agricultural land (as witnessed elsewhere when restoring agricultural claimed land back to lakes and wetlands; Hagy *et al.* 2017). This is especially the case because, although a secondary objective for the restoration programme had been to restore staging bird habitat, no specific management interventions had been designed with the particular aim of fulfilling this objective, nor were any specific attainable targets established for this.

Summing the annual maximum numbers and generating numbers of bird-days spent by nine common duck species is a relative crude method of assessing true bird-use of a site. However, based on these metrics, the lower Skjern River wetlands have become a major autumn staging area for ducks and Coot. Despite reductions in Mallard, Wigeon, Pintail and Coot numbers since restoration, the overall numbers of autumn-staging birds have been maintained because of increasing numbers of diving ducks at the site. The extensive use of the wetland by dabbling ducks is probably partly explained by its proximity to other extensively used large wetlands located on the autumn migration route of dabbling ducks along the west coast of Jutland (*e.g.* Ringkøbing Fjord including the Tipperne Peninsula, and the

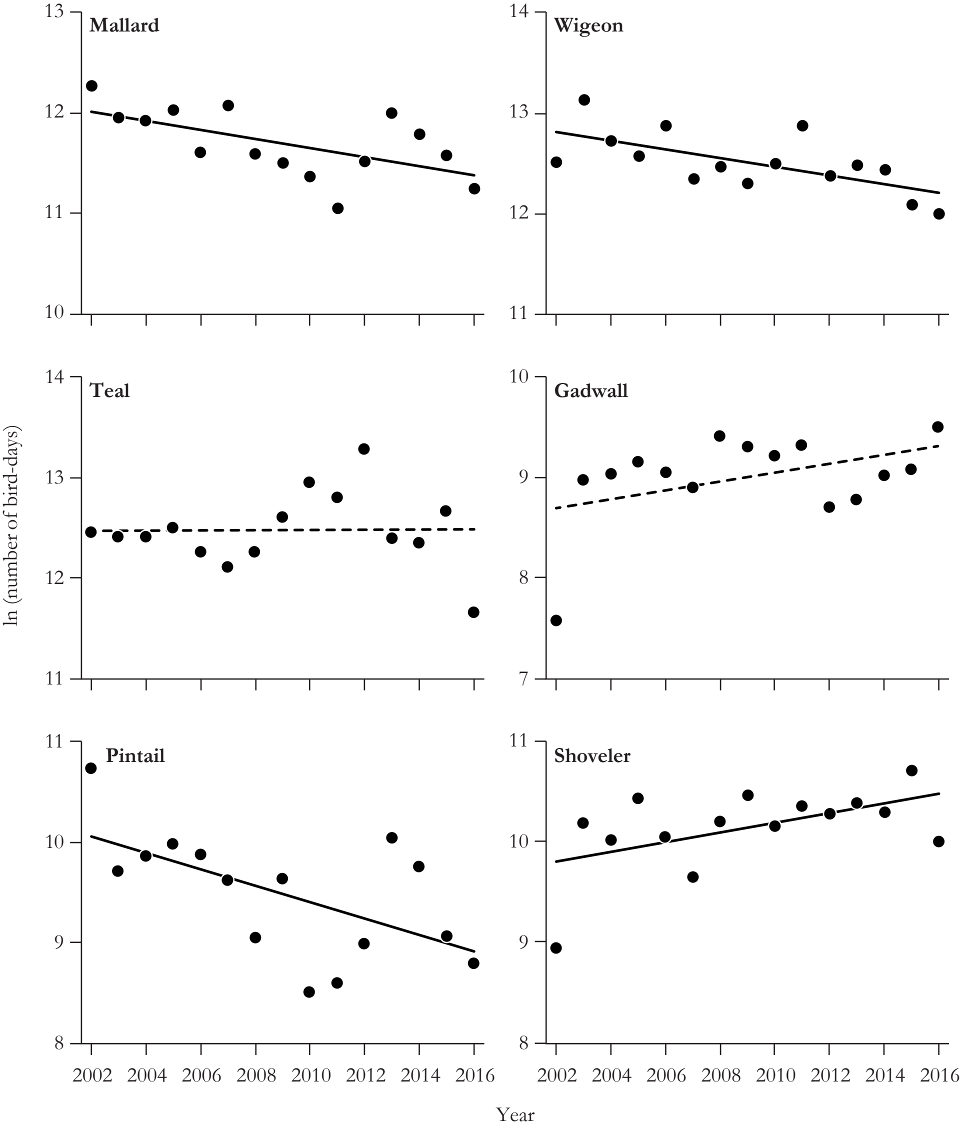

Figure 2. Natural log transformed numbers of bird-days (ln[N]) in the Skjern River restoration area during the autumns of 2002–2016 for six species of dabbling ducks: Mallard, Teal, Pintail, Wigeon, Gadwall and Shoveler. Significant trends in numbers over the years are indicated by solid regression lines whereas pecked lines denote non-significant linear trends. Fitted regression models were as follows: Mallard $F_{1,14} = 7.11$, $r^2 = 0.35$, $P = 0.02$; Teal $F_{1,14} < 0.01$, $r^2 < 0.01$, $P = 0.96$, n.s.; Pintail $F_{1,14} = 6.90$, $r^2 = 0.35$, $P = 0.02$; Wigeon $F_{1,14} = 9.48$, $r^2 = 0.42$, $P = 0.01$; Gadwall $F_{1,14} = 2.94$, $r^2 = 0.18$, $P = 0.11$, n.s.; and Shoveler $F_{1,14} = 5.15$, $r^2 = 0.28$, $P = 0.04$.

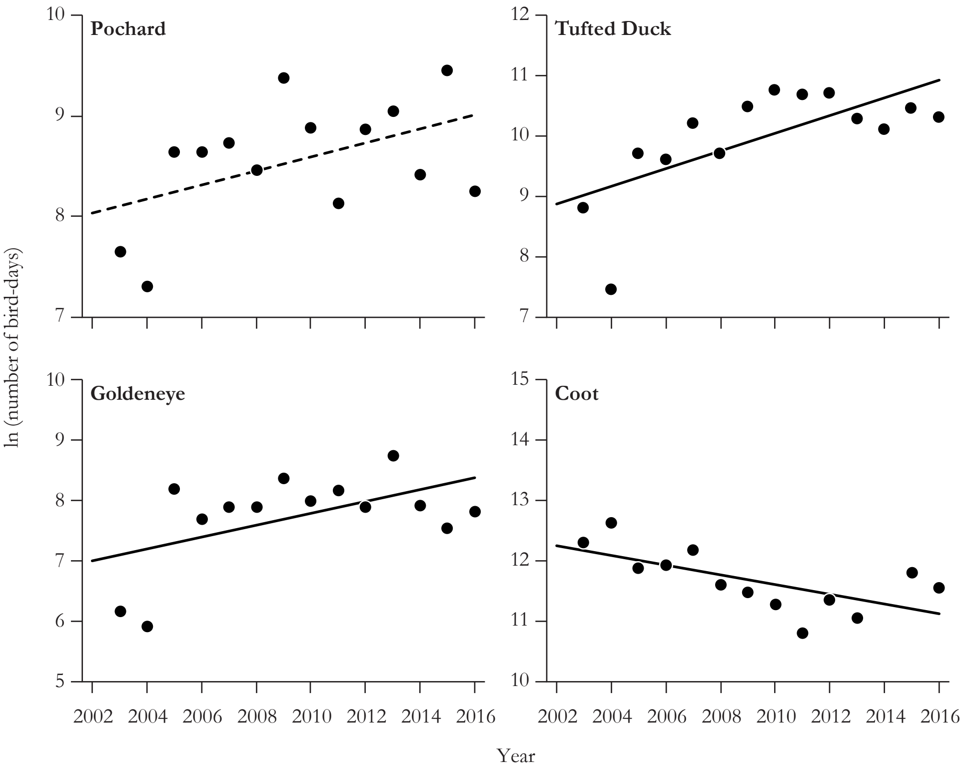

Figure 3. Natural log transformed numbers of bird-days (ln[N]) in the Skjern River restoration area during the autumns of 2002–2016 for three species of freshwater diving ducks (Pochard, Goldeneye and Tufted Duck) and Coot. Significant trends in numbers over the years are indicated by solid regression lines whereas the pecked line denotes a non-significant linear trend. Fitted regression models were as follows: Pochard $F_{1,14} = 1.50$, $r^2 = 0.10$, $P = 0.24$, n.s.; Goldeneye $F_{1,14} = 5.83$, $r^2 = 0.31$, $P = 0.03$; Tufted Duck $F_{1,14} = 11.45$, $r^2 = 0.47$, $P < 0.01$; and Coot $F_{1,14} = 8.32$, $r^2 = 0.43$, $P = 0.02$.

lagoons at Harboøre and Agger Tange; Meltofte & Clausen 2011; Holm & Clausen 2006). That the presence of neighbouring wetlands was of some importance is supported by regular observations by the counters of dabbling ducks commuting between the restoration area and the shallow lagoon of Ringkøbing Fjord (O. Amstrup, pers.comm.). Part of the attractiveness of the area to dabbling ducks and Coot can probably be explained by the large Hestholm Lake being completely closed to human activity and humans only rarely being visible anywhere at all inside the extensive meadows to the west of Hestholm Lake. A large proportion of most of the duck species as well as Coots were recorded foraging throughout daylight hours (Bregnballe *et al.* 2009a, 2014b), which suggests that the restoration area is of value

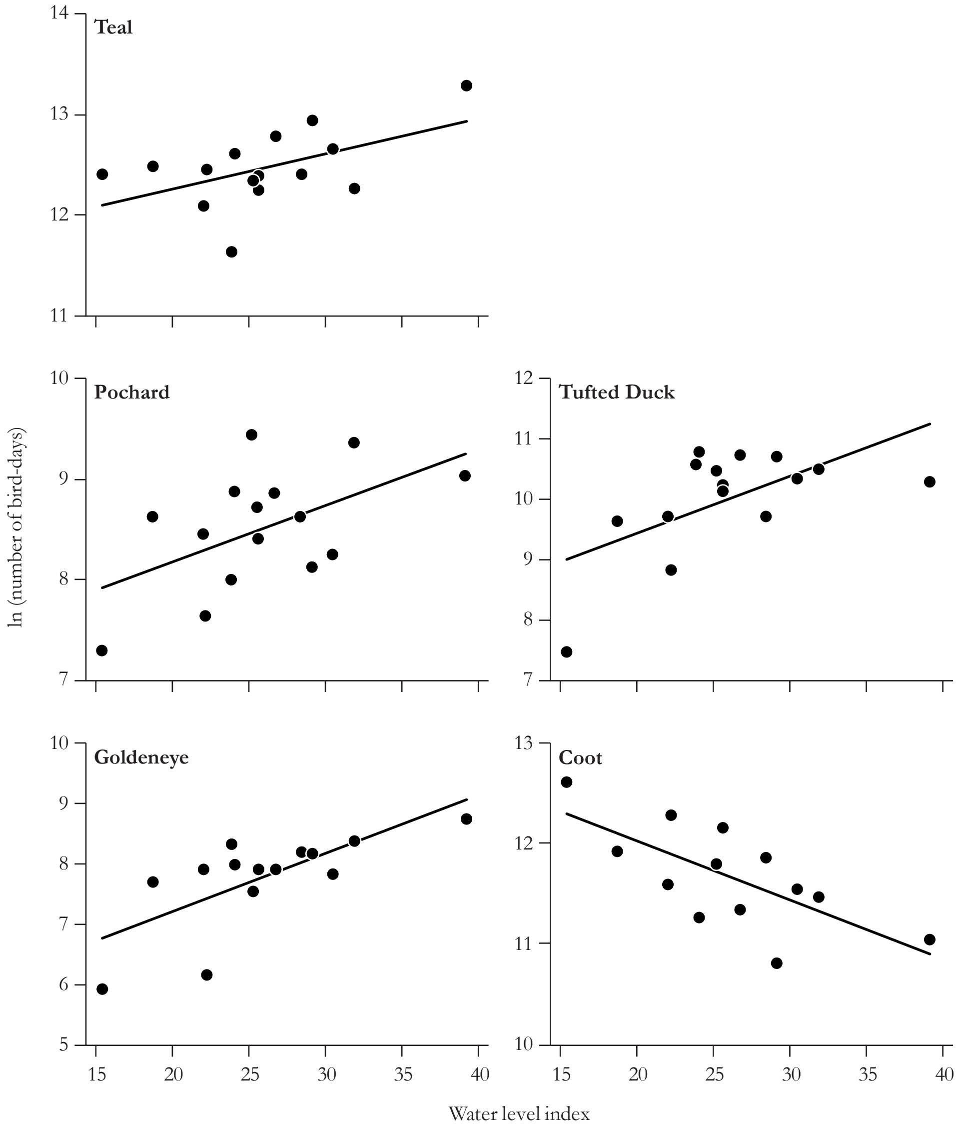

Figure 4. Natural log transformed numbers of bird-days (ln[N]) in the Skjern River restoration area in relation to the water level index for the Skjern River valley during the autumns (September–November) of 2002–2016 for the five species (Teal, Pochard, Goldeneye, Tufted Duck and Coot) where these relationships were significant. Fitted regression models were as follows: Teal $F_{1,14} = 4.98$, $r^2 = 0.28$, $P = 0.04$; Pochard $F_{1,14} = 5.22$, $r^2 = 0.29$, $P = 0.04$; Goldeneye $F_{1,14} = 13.54$, $r^2 = 0.51$, $P < 0.01$; Tufted Duck $F_{1,14} = 7.61$, $r^2 = 0.37$, $P = 0.02$; and Coot $F_{1,14} = 10.44$, $r^2 = 0.49$, $P < 0.01$.

not only as a suitable disturbance-free day-time roost for these species but also as a feeding site.

We predicted that the combined effects of leaching of accumulated agricultural fertiliser nutrient in the soil and normal wetland vegetation succession would have an adverse effect on dabbling duck species and this was supported by the bird-day data for Mallard, Wigeon and Pintail, which declined by 45–68% during the years 2002–2016. Unfortunately, we lack data on nutrient levels, accurate mapping of the vegetation and of the food resources to provide better support for this interpretation. The decline in the numbers of these ducks may also represent the gradual improvement of water quality and re-establishment of submergent vegetation in the adjacent Ringkøbing Fjord (Clausen *et al.* 2017), where dabbling duck numbers have been increasing recently (Meltofte *et al.* 2016; Nielsen *et al.* 2019) potentially drawing Skjern River birds elsewhere to feed. Coot bird-days also significantly declined by 68% through the study period. The decline in Coot numbers over the study period may be related not only to changes in the abundance and access of submersed vegetation but also to an increasing use of the area by White-tailed Eagles *Haliaeetus albicilla*, especially after 2006. White-tailed Eagles were specifically observed targeting and attacking Coots over other species. Another contributing factor could be the rather marked decline in the breeding as well as wintering Coot population in Denmark in recent years (Moshøj *et al.* 2019; Nielsen *et al.* 2019), many of which also winter in Denmark (Bønløkke *et al.* 2006). Yet despite this decline, the SRV still attracts greater numbers of Coot than the nearby Ringkøbing Fjord (Table 1). Teal and Gadwall showed fluctuating numbers with no long-term significant change in abundance, while numbers of annual Shoveler bird-days increased significantly.

Numbers of Pochard, Tufted Duck and Goldeneye bird-days all significantly increased during the period, but regression models showed strong relationships between annual numbers of bird-days and the annual mean water level index. These species particularly benefit from high water levels that create the greatest depths and extent of shallow water at the site. The three species of freshwater diving ducks may also have benefitted from gradual post-restoration changes in the communities of invertebrates, such as snails and bivalves. Regrettably, in the absence of broader monitoring of biodiversity at the site post-restoration, we lack data to support such an assertion. Regression models also showed a positive relationship between Teal bird-days and annual water level index, probably because higher water levels also create extensive areas of shallow flooded grassland that are known to be attractive to this species (*e.g.* Thomas 1982; Williams *et al.* 1983; Boertmann & Riget 2006). Annual numbers of Coot bird-days were inversely related to annual water level index and, although this seems counter-intuitive, this is because Coot in the lower Skjern River tend to feed in peripheral areas and less by diving in deeper water from which the freshwater diving ducks benefit in years of highest water levels. However, our ability to interpret the patterns in the annual fluctuations in the abundance of the commoner freshwater duck species and Coot at the site is greatly hampered by the lack of post-restoration environmental monitoring on the lower Skjern River. This is highly lamentable, because not only was this one of the European Union's most expensive wetland restoration projects (costing *c.* 38 million Euros) but restoring staging waterbirds was a declared objective for the project (albeit without any pre-set targets for achievement). Given the lack of knowledge about wetland function following such major restoration of arable agricultural land, and the potential for even greater improvement at the site as a result of positive management interventions (*e.g.* McClain *et al.* 2019), it is a pity that monitoring (at least beyond the first 2–3 post-restoration years) of the flora and fauna of the system was not a major element of the restoration programme. Such monitoring would have provided vital information on how changes in food supply, abundance and accessibility had affected the annual numbers of autumn-staging waterbirds at the site and enabled the accumulation of knowledge to better inform such projects in the future.

Nevertheless, there remains no doubt that the site, which was formerly devoid of waterbirds, has immediately become, and remained, one of Denmark's top five most important freshwater wetlands for autumn-staging waterbirds, as evidenced from summed annual peak counts of waterbirds in all Danish SPAs (Clausen *et al.* 2019). Moreover, minimal management intervention is required, confirming the considerable potential for many more such restoration schemes to make major contributions to local, national and regional biodiversity targets.

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Photograph: Following restoration, the lower Skjern River became one of Denmark's five most important freshwater wetlands for staging waterbirds, by Kim Aain/NaturalEyes.