

Supplementary material

Thomas Bregnballe, Ole Amstrup, Thomas E. Holm, Preben Clausen & Anthony D. Fox: Skjern River Valley, Northern Europe's most expensive wetland restoration project: benefits to breeding waterbirds. — *Ornis Fennica* 91: 231–243.

Supporting Information Appendix S1.

Breeding waterbird survey techniques

Breeding pairs of all birds were monitored in three years prior to the restoration of the lower section of the SRV and in five of the first 11 post restoration years (2006 counts are tabulated, but not included in the analyses because they did not cover all waterbird species). In all years except 2006, counts were conducted of all waterbird species, i.e. grebes, cormorant, herons, swans, geese, ducks, coots, waders, terns and gulls. Positions of birds were sequentially mapped to establish the distribution and abundance of breeding pairs throughout each season, but throughout we take presence of birds in suitable habitat as evidence of breeding. Pre-restoration counts were conducted in 1980–1987, 1994 and 2000 all by the same two observers following established protocols (Kjeldsen 2008). Not all species were counted in each of the years 1980–1987, complete surveys comprising seven counts were only conducted in 1987. The 1994 survey included six counts conducted throughout the breeding season from late April until early July. The 2000 survey comprised a survey on foot of the entire area during 2–7 May, repeated during 16–20 June. Surveys mapped (a) positions of all breeding waders, grebes and dabbling ducks using telescopes and binoculars from selected points on roads, dikes and other elevated locations throughout the entire area 2–4 times between late April and early June, (b) breeding waders by walking slowly over the dry and wet terrain (early morning surveys in the beginning of June), (c) Great Bittern *Botaurus stellaris*, Water Rail *Rallus aquaticus*, Spotted Crake *Porzana porzana* and Common Moorhen *Gallinula chloropus* by 1–3 night surveys by bicycle and car with regular stops, and (d) parents attending chicks, especially for grebes, Greylag Goose *Anser anser*, Common Shelduck *Tadorna tadorna* and diving duck species (several surveys in May–June).

Reference

Kjeldsen, J.P. 2008: Ynglefugle i Vejlerne efter inddæmningen, med særlig vægt på feltstationsårene 1978–2003. — *Dansk Ornitologisk Forenings Tidsskrift* 102: 1–240. (In Danish with English summary)

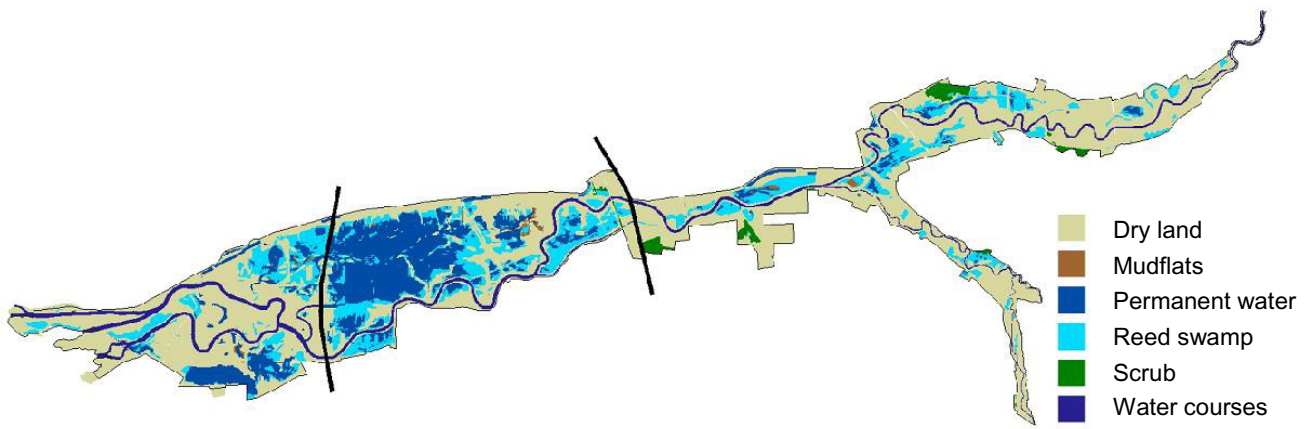


Fig. S1. Map showing the current (2012) extent of habitats within the Skjern River Valley, West Jutland, Denmark following restoration. The solid black lines are major roads traversing the restoration area.

Supporting Information Table S1. List of avian species which form the basis of the justification for designation of Ringkøbing Fjord and Skjern Å restoration area as European Union Birds Directive Special Protection Area No. 43. Species are defined according to whether they are listed on Annex I of the Birds Directive or whether they occur at levels of abundance within the SPA that constitute national or international importance. Breeding birds shaded grey indicate those species which the restoration programme reinstated or substantially supplemented as breeding birds within SPA Area No.43.

European Union Special Protection Area No. 43 Ringkøbing Fjord and Skjern Å restoration area is designated for the following avian species			
Species	Breeding and/or Resident	Staging and/or Wintering	Designation year
<i>Botaurus stellaris</i>	Annex I		2005
<i>Platalea leucorodia</i>	Annex I	Annex I, National ¹	2005
<i>Cygnus olor</i>		International	1983
<i>Cygnus columbianus bewickii</i>		International	1983
<i>Cygnus cygnus</i>		International	1983
<i>Anser brachyrhynchus</i>		International	1983
<i>Anser anser</i>		International	2005
<i>Branta leucopsis</i>		International	2005
<i>Branta bernicla bernicla</i>		International	1983
<i>Tadorna tadorna</i>		International	1983
<i>Anas penelope</i>		International	1983
<i>Anas crecca</i>		International	1983
<i>Anas acuta</i>		International	1983
<i>Anas clypeata</i>		International	1983
<i>Bucephala clangula</i>		International	1983
<i>Mergus merganser</i>		International	1983
<i>Haliaeetus albicilla</i>		Annex I, National	2006 ²
<i>Circus aeruginosus</i>	Annex I		1983
<i>Circus cyaneus</i>		Annex I, National	2006 ²
<i>Pandion haliaetus</i>		Annex I, National	2012 ³
<i>Falco peregrinus</i>		Annex I, National	2005
<i>Porzana porzana</i>	Annex I		2006 ²
<i>Fulica atra</i>		International	1983
<i>Recurvirostra avosetta</i>	Annex I	International	1983
<i>Pluvialis apricaria</i>		International	2012 ³
<i>Calidris alpina</i>	Annex I	International	2005
<i>Philomachus pugnax</i>	Annex I		2005
<i>Limosa lapponica</i>		International	2005
<i>Sterna sandvicensis</i>	Annex I		1983
<i>Sterna hirundo</i>	Annex I		2005
<i>Sterna paradisaea</i>	Annex I		2005
<i>Asio flammeus</i>	Annex I		1983

Notes:

“Annex 1” indicates that the site was designated because this species occurs on the site and is listed in Annex I of the Birds Directive

“International” indicates that the site was designated because this species regularly occurs on the site in internationally important numbers

“Annex 1, National” indicates that the site was designated because this species is listed in Annex 1 and regularly occurs on the site in nationally important numbers

¹mentioned as designated in Natura 2000 database, but not actually named on the Forest and Nature Agency website

Designation years as

follows:

1983 original first designation;

2005 included during the first major revision process for all SPA designations

²2006 included in SPA No. 43 designations when the SPA was enlarged to include parts of the nature restoration area

³2012 included during the second major revision process for all SPA designations

Supporting Information Table S2. Annual estimated numbers of breeding waterbird pairs within the Skjern River restoration area, 1980-2011. Species shaded in dark grey are those listed on ¹Annex 1 of the European Birds Directive, or ²are Danish Red List breeding bird species or ³which have bred in the restoration area in nationally important numbers. Counts in italicised bold typeface are estimates or (in the case of commoner species present but not counted) interpolation between years or best assessments. Species considered to be open water species are shown by*, the remainder are classified as meadow or marsh species for the purposes of this analysis. Note that only species on Annex 1 of the Birds Directive were monitored in 2006. Also indicated are the presence (+) of those species breeding annually or thought to be regular breeders during the 1870s to late 1890s, according to Rambusch (1900), including those now extinct or almost extinct in Denmark as breeding species (†).

	Historical data			Breeding survey year									Means		Overall
	1870s-1890s	1930-1932	1962-1967	1980-87	1994	2000	2001	2002	2003	2004	2006	2011	Pre-restoration	Post-restoration	
Little Grebe <i>Tachybaptus ruficollis</i> *				1	0	0	2	4	7	1	-	0	0	3	2
Great Crested Grebe <i>Podiceps cristata</i> *			2	5	1	0	30	37	26	25	34	23	2	28	18
Red-necked Grebe <i>Podiceps grisegena</i> *				0	0	0	3	5	9	7	2	0	0	5	3
² Eared Grebe <i>Podiceps nigricollis</i> *				0	0	0	10	34	54	37	40	7	0	28	18
Great Cormorant <i>Phalacrocorax carbo</i> *				0	0	0	0	8	3	18	34	0	0	6	4
^{1,2} White Stork <i>Ciconia ciconia</i> †				0	0	0	0	0	0	0	-	0	0	0	0
^{1,2,3} Eurasian Spoonbill <i>Platalea leucorodia</i> *				0	0	0	0	5	4	6	14	0	0	3	2
^{1,2} Great Bittern <i>Botaurus stellaris</i> *		++	1	0	0	0	2	4	4	4	-	2	0	3	2
Mute Swan <i>Cygnus olor</i> *			1	1	0	1	5	15	19	18	23	66	1	25	16
Greylag Goose <i>Anser anser</i> *				0	0	0	1	0	2	3	-	5	0	2	1
Egyptian Goose <i>Alopochen aegyptiacus</i> *				0	0	0	1	1	2	0	-	0	0	1	1
Common Shelduck <i>Tadorna tadorna</i> *				6	0	0	1	2	8	9	-	24	2	9	6
Gadwall <i>Anas strepera</i> *				0	0	3	6	9	18	10	-	17	1	12	8
Teal <i>Anas crecca</i> *		+	++	0	0	0	1	0	0	0	-	0	0	0	0
Mallard <i>Anas platyrhynchos</i> *	++	++	++	3	22	41	107	174	240	174	-	180	22	175	118
² Northern Pintail <i>Anas acuta</i> *		+		0	0	0	0	4	5	0	-	0	0	2	1
^{2,3} Garganey <i>Anas quequedula</i> *	++	++	++	0	0	0	0	10	27	10	-	15	0	12	8
Northern Shoveler <i>Anas clypeata</i> *	++	+		0	0	0	0	18	37	17	-	20	0	18	12
Common Pochard <i>Aythya ferina</i> *				0	0	0	2	2	6	6	-	8	0	5	3
Tufted Duck <i>Aythya fuligula</i> *				0	0	0	0	1	3	10	-	17	0	6	4
Red-breasted Merganser <i>Mergus serrator</i> *				1	1	0	0	0	0	0	-	0	1	0	0
Water Rail <i>Rallus aquaticus</i>		+		1	0	0	3	5	14	18	-	19	0	12	8
^{1,2,3} Spotted Crake <i>Porzana porzana</i>	++		+	0	0	0	2	12	9	1	4	4	0	6	4

	Historical data			Breeding survey year									Means		Overall
	1870s-1890s	1930-1932	1962-1967	1980-87	1994	2000	2001	2002	2003	2004	2006	2011	Pre-restoration	Post-restoration	
¹ Corncrake <i>Crex crex</i> †	++	+		0	0	0	0	0	0	0	-	0	0	0	0
Common Moorhen <i>Gallinula chloropus</i>		+		1	4	0	3	2	23	4	-	7	2	8	6
Eurasian Coot <i>Fulica atra</i>	++	+		0	6	5	200	200	200	200	-	100	4	180	114
Eurasian Oystercatcher <i>Haematopus ostralegus</i>			+	1	1	1	3	3	5	4	-	1	1	3	2
¹ Pied Avocet <i>Recurvirostra avosetta</i>	(+)	+		0	0	0	15	72	85	77	19	28	0	55	35
^{2,3} Little Ringed Plover <i>Charadrius dubius</i>				0	0	3	5	3	8	4	-	0	1	4	3
Ringed Plover <i>Charadrius hiaticula</i>			+	1	0	0	2	1	0	0	-	0	0	1	1
Northern Lapwing <i>Vanellus vanellus</i>		++	++	72	140	74	91	109	127	109	-	106	95	108	104
¹ Great Snipe <i>Gallinago media</i> †				0	0	0	0	0	0	0	-	0	0	0	0
Common Snipe <i>Gallinago gallinago</i>				0	0	1	9	10	14	11	-	13	0	11	7
^{1,2} Ruff <i>Philomachus pugnax</i>				0	0	0	0	0	0	0	-	0-3	0	1	0
Common Redshank <i>Tringa totanus</i>				3	0	2	1	1	3	1	-	14	2	4	3
^{1,2} Wood Sandpiper <i>Tringa glareola</i>				0	0	0	0	0	0	0	-	0	0	0	0
^{1,2} Dunlin <i>Calidris alpina schinzii</i>	++	+	+	0	0	0	0	0	0	0	-	0	0	0	0
² Black-tailed Godwit <i>Limosa limosa</i>				0	0	0	0	0	0	0	-	0	0	0	0
Black-headed Gull <i>Chroicocephalus ridibundus</i> *				0	0	0	800	1155	735	800	1460	1532	0	1004	628
Common Gull <i>Larus canus</i> *				0	0	0	0	0	1	0	-	2	0	1	0
^{1,2} Black Tern <i>Chlidonias niger</i> *				0	0	0	0	2	0	0	-	0	0	0	0
Common Tern <i>Sterna hirundo</i> *				0	0	0	0	1	1	5	4	8	0	3	2
TOTALS				96	175	131	1305	1909	1699	1509	-	2218	134	1744	1141

Supporting Information Table S3. “Expert” estimations (provided by three of the authors) of the potential numbers of breeding pairs of waterbirds within the Skjern River restoration area post re-meandering that could be present given appropriate management. The species list follows the order in Table 1 in the body text, and the actual breeding numbers are shown in 2011 for comparison.

	2011	TB	Expert opinions	
			PC	ADF
Little Grebe <i>Tachybaptus ruficollis</i>	0	8	10	8
Great Crested Grebe <i>Podiceps cristata</i>	23	5	15	20
Red-necked Grebe <i>Podiceps grisegena</i>	0	2	10	10
Eared Grebe <i>Podiceps nigricollis</i>	7	8	10	30
Great Cormorant <i>Phalacrocorax carbo</i>	0	40	0	20
Eurasian Spoonbill <i>Platalea leucorodia</i>	0	10	0	10
Great Bittern <i>Botaurus stellaris</i>	2	6	50	10
Mute Swan <i>Cygnus olor</i>	66	5	10	30
Greylag Goose <i>Anser anser</i>	5	25	50	20
Egyptian Goose <i>Alopochen aegyptiacus</i>	0	3	0	3
Common Shelduck <i>Tadorna tadorna</i>	24	2	15	15
Gadwall <i>Anas strepera</i>	17	3	30	20
Eurasian Teal <i>Anas crecca</i>	0	4	5	5
Mallard <i>Anas platyrhynchos</i>	180	25	100	200
Eurasian Pintail <i>Anas acuta</i>	0	3	5	5
Garganey <i>Anas quequedula</i>	15	7	25	10
Eurasian Shoveler <i>Anas clypeata</i>	20	4	25	25
Common Pochard <i>Aythya ferina</i>	8	3	30	10
Tufted Duck <i>Aythya fuligula</i>	17	2	30	20
Red-breasted Merganser <i>Mergus serrator</i>	0	0	0	0
Water Rail <i>Rallus aquaticus</i>	19	25	100	30
Spotted Crake <i>Porzana porzana</i>	4	4	20	10
Common Moorhen <i>Gallinula chloropus</i>	7	20	50	25
Eurasian Coot <i>Fulica atra</i>	100	30	200	200
Eurasian Oystercatcher <i>Haematopus ostralegus</i>	1	5	20	20
Pied Avocet <i>Recurvirostra avosetta</i>	28	40	100	80
Little Ringed Plover <i>Charadrius dubius</i>	0	0	0	5
Ringed Plover <i>Charadrius hiaticula</i>	0	0	3	1
Northern Lapwing <i>Vanellus vanellus</i>	106	300	150	200
Common Snipe <i>Gallinago gallinago</i>	13	12	75	50
Ruff <i>Philomachus pugnax</i>	3	10	5	10
Common Redshank <i>Tringa totanus</i>	14	80	100	70
Black-headed Gull <i>Chroicocephalus ridibundus</i>	1532	400	100	900
Common Gull <i>Larus canus</i>	2	2	10	5
Black Tern <i>Chlidonias niger</i>	0	5	10	2
Common Tern <i>Sterna hirundo</i>	8	0	0	0

Supporting Information Table S4. Mean annual estimated numbers of breeding pairs of selected waterbirds (Annex 1 EU Birds Directive or Danish Red List breeding species) within the Skjern River restoration area, 2001–2011, in relation to national population size. Danish populations were derived from DOF (2014) or Nyegaard et al. (2014)*. Final column expresses the mean Skjern River estimates as a percentage of the national totals, with maxima for the period 2001–2011 in brackets. These figures are given only as a guide to relative abundance, since several of the species occur in low and fluctuating numbers at the Skjern River and throughout Denmark. Note that for the Ruff the mean is generated on the basis of 3 pairs present in a single year, but confirms the importance of the mere presence of the species now in a national context.

	Average number of breeding pairs 2001–2011	Most recent Danish population estimate	Percentage of national breeding population
Eared Grebe <i>Podiceps nigricollis</i>	28.4	250	11.4 (21.6)
Eurasian Spoonbill <i>Platalea leucorodia</i>	3.0	100*	3.0 (6.0)
Great Bittern <i>Botaurus stellaris</i>	3.2	250	1.3 (1.6)
Northern Pintail <i>Anas acuta</i>	1.8	75	2.4 (6.7)
Garganey <i>Anas quequedula</i>	12.4	400	3.1 (6.8)
Spotted Crake <i>Porzana porzana</i>	5.6	46*	12.2 (26.1)
Pied Avocet <i>Recurvirostra avosetta</i>	55.4	4000	1.4 (2.1)
Little Ringed Plover <i>Charadrius dubius</i>	4.0	425	0.9 (1.9)
Ruff <i>Philomachus pugnax</i>	0.6	65*	0.9 (4.6)
Black Tern <i>Chlidonias niger</i>	0.4	65*	0.6 (3.1)