The effects on birds of land drainage improvements in the North Kent Marshes

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Introduction

The value of wet grazing marsh as a habitat for specialised species of wetland wildlife has been recognised by naturalists for many years. Typically, such areas are under permanent pasture, intersected by a network of drainage channels, and with a high water-table. Frequently the water in the drainage channels is penned to act as 'wet hedges' for the enclosure of stock. Inundation is frequent, particularly in winter, either by floodwater from tidal sources or by the accumulation of drainage water from higher areas. Usually, grazing marshes are used for the summer grazing of cattle or sheep which produces a sward of mixed structure, with tussocks of coarse grasses and closely cropped areas. Such conditions provide a particularly attractive habitat for wintering and breeding wildfowl and waders.

The importance of the North Kent Marshes for birds has been apparent since the mid-1850s. Ornithologically, the complex of mudflats, saltmarsh and grazing marsh can be divided into three discrete areas – the South Thames Marshes between Gravesend and the Isle of Grain, the Medway Estuary, and the Swale with the Isle of Sheppey (Figure 1). The latter two areas, according to the criteria agreed at the Third International Conference on the Conservation of Wetlands held at Cagliari, Italy, in 1980, each qualify as wetlands of international importance for waterfowl (Scott 1980; I.W.R.B. 1981).

The grazing marshes of North Kent were produced by the enclosure of saltings by embankments, a process started in Roman times which has continued, with lapses, until the present day. They consist of undulating wet grassland which lies several feet below the level of normal high tide. They are drained by a system of fleets, between 1 and 30 m in width, which were tidal creeks before enclosure. Tidal sluices allow drainage water to escape to the sea. Many of these fleets are still brackish in nature, making the area both botanically and entomologically unique in Britain.

In recent years, however, many farmers have improved the drainage of their land by the straightening, widening and deepening of the fleets and the installation of field drainage systems. Usually the reason for such work is financial, for drainage improvements permit the con-

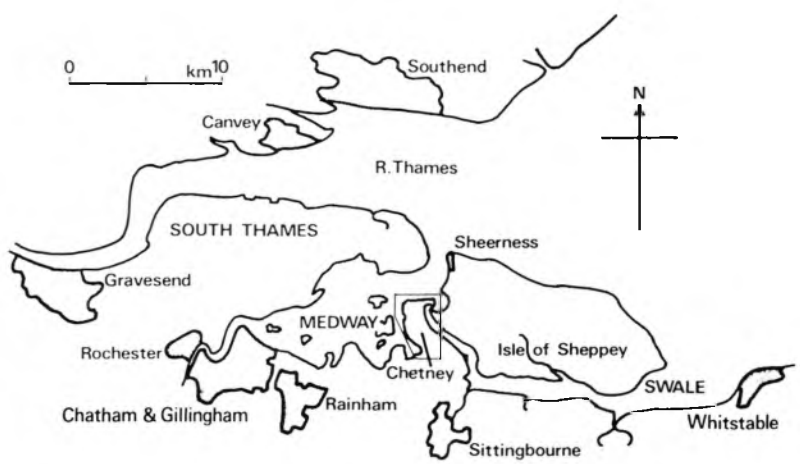

Figure 1. Map showing the location of the North Kent Marshes and its constituent areas.

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version of grazing marsh to more profitable arable, and it is facilitated by generous grants from the Ministry of Agriculture, Fisheries and Food. This process may also be facilitated by arterial drainage improvement works carried out by the Lower Medway Internal Drainage Board or Southern Water Authority.

That the impact of such drainage works can be damaging to the wildlife interest of the area was recognised at least as early as 1909, when Ticehurst blamed a combination of 'artificial drainage' and shooting as the cause of the extinction of the Avocet *Recurvirostra avosetta* from both the North Kent and Romney Marshes.

Land-use changes

Methods

The North Kent Marshes may be defined as the area between Gravesend in the west and Seasalter, Whitstable, in the east below the 12.62 metre (25 foot) contour (Green 1971).

The area of grazing marsh within this region in 1935 was determined by recording on a O.S. 1:50,000 map, the area of permanent pasture and rough land mapped at 1:63,360 scale as part of the First Land Utilisation Survey between 1931 and 1935. These maps are held in the Library of the London School of Economics.

Maps of the Second Land Utilisation Survey, prepared at 1:10,560 scale between 1961 and 1968, and now held at King's College, University of London, were consulted to determine changes in the land-use of the grazing marsh recorded in 1935.

Data for 1979 and 1982 were obtained through aerial photography. Flights were made on 6 March 1979 and 29 March 1982 and oblique photographs, using colour reversal film, were taken from a height of c. 300 metres. The transparencies were then projected and land-use data recorded on O.S. 1:25,000 maps, field by field.

Four land-use types could be distinguished: saltmarsh; urban areas, including residential and industrial areas and mineral workings; arable; and grazing marsh. Grass leys, the area of which was very small, were included in the total for grazing marsh.

The results of the four surveys were standardised by transferring the data from each on to O.S. 1:50,000 outline maps. These were then cut up and the area of each land-use type calculated using a portable area meter.

Results

Between 1935 and 1982 the area of grazing marsh in North Kent decreased from 14,750 ha to 7450 ha – a reduction of 49.5% (Table 1). During this period, however, a small area was converted to grazing marsh, mainly through the reclamation of saltings. The net reduction in grazing marsh, between 1935 and 1982, was 48%. The rate of loss of grazing marsh accelerated dramatically after 1968. Since 1979 this figure has fallen slightly – although even at this reduced rate, all the grazing marsh in North Kent would be lost by 2011.

Table 2 illustrates the nature of the land-use changes in North Kent. Prior to 1968, losses to urban and arable land-uses were relatively small and about equal. After 1968, however, the total losses of grazing marsh accelerated as the conversion of grazing marsh to arable, brought about by land drainage improvement schemes, increased rapidly.

Figure 2 demonstrates that as the area of grazing marsh has diminished, so the resource has fragmented.

Table 1. The reduction in the area of grazing marsh in North Kent, 1935 to 1982 (hectares).

	1935	1968	1979	1982
Grazing marsh	14750	12250	8200	7450
Area converted to grazing marsh	–	200	275	225
Total area of grazing marsh	14750	12450	8475	7675
Net loss of grazing marsh per annum		70	361	267

Note: 725 ha of land in the Sheerness area of the Isle of Sheppey was not surveyed in 1979.

Table 2. Area of land-uses to which grazing marsh was converted, 1968 to 1982. Percentages are given as a proportion of the total area of grazing marsh identified in 1935.

	1968		1979		1982	
	area (ha)	%	area (ha)	%	area (ha)	%
Saltmarsh	125	1	175	1	175	1
Urban	1150	8	1450	10	1925	13
Arable	1225	8	4200	28	5200	35
Total	2500	17	5825	39	7300	49

Note: 725 ha of land in the Sheerness area of the Isle of Sheppey was not surveyed in 1979.

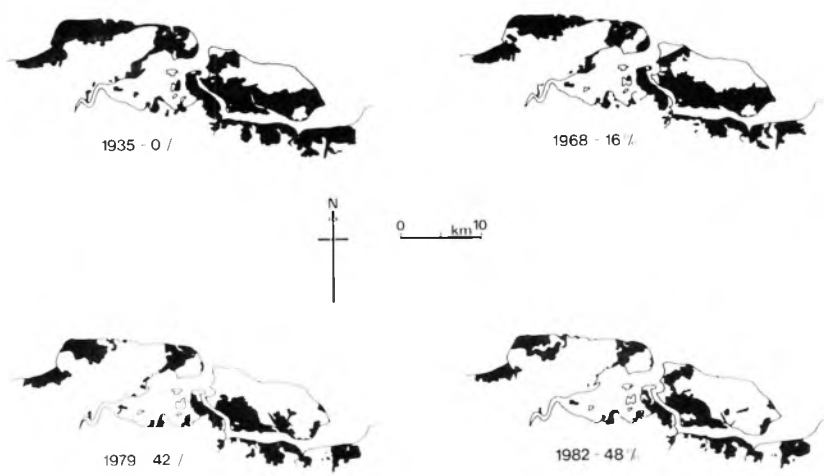

Figure 2. The loss and fragmentation of grazing marsh in North Kent, 1935-1982. Percentages given are for the area of grazing marsh lost since 1935 (base 14,750 ha).

Discussion

The data show conclusively that there have been fundamental changes in the land-use of the North Kent Marshes since 1935. With the marked decrease in the area of grazing marsh and its fragmentation into discontinuous blocks of small area, factors such as those identified by Moore (1962), in relation to Dorset heathland, may come into force: when a habitat is reduced in size, edge effects have an increasingly important bearing on the survival of the wildlife species within. In particular, the isolation of grazing marsh by arable makes it very difficult to retain high water levels in the former. The reduction in an area of a given habitat may also cause it to fall below a minimum critical size if it is to remain viable and meet the needs of its representative wildlife species (Moore & Hooper 1975).

The next two sections of this paper, by relating the direct effects of land drainage improvement works and conversion to arable on bird populations, attempt to assess the significance of some of these changes for bird conservation in the North Kent Marshes, and similar areas of wet grazing marsh.

The ornithological interest of the North Kent Marshes

Historical

Although few comprehensive data on populations have been available until recently, the birds of the North Kent Marshes have been well studied for

many years. The major county avifaunas (Ticehurst 1909; Harrison 1953; Taylor *et al.* 1981) contain many references to the area, and allude to previous authors writing about the marshes. Gillham & Homes (1951) provided an excellent account of the birdlife of the area covered by this paper in the middle of this century.

We have little idea of what birds used the marshes before enclosure and sea-wall construction began, but clearly the community must have been substantially different from that of today, depending as it did on extensive saltmarshes rather than pasture and arable farmland. The effects of drainage are likely to have been progressive. Until 150-200 years ago, the sea-walls were probably far less efficient than today, and breaches may have been fairly commonplace. This in itself may have attracted particular birds. For example, while agreeing with Ticehurst that the extinction of the Avocet from Kent in the early 19th century was due to drainage, Gillham & Homes suggest that their breeding habitat would have been enclosed marsh which had flooded following the sea-wall being breached, and that they may not always have been present.

By the mid-19th century, Denham Jordan ('A Son of the Marshes') was lamenting the enclosure of saltmarsh and drainage, with the consequent decline of wildfowl numbers. Ticehurst records the decline of the Bearded Tit *Panurus biarmicus* in North Kent, from the large numbers which bred even as far upstream as Erith and Woolwich in the late 18th century, to the last few pairs in the mid-19th century, although the residential and industrial development which followed drainage presumably was partly responsible for this. Gillham & Homes drew attention to the continuing efficiency of the drainage system in noting a decrease in numbers of Little Grebes *Tachybaptus ruficollis* in those dykes mechanically dredged following 1945. Taylor *et al.* (1981) attributed decreases in numbers of Coot *Fulica atra* and Lapwing *Vanellus vanellus* on the Marshes to the conversion to arable use.

There is evidence that for several species of breeding wildfowl, there have been marked fluctuations over the years. This is especially true of Shoveler *Anas clypeata*, which responds rapidly to wet conditions on the marshes; for example, in the very wet breeding season of 1975, 20 pairs nested on Chetney Marshes compared with only one in 1973 (Taylor *et al.* 1981). In a study of 121.4 ha of Cooling Marsh, Harrison & Grant (1976) recorded 3 pairs of Shoveler nesting on grazing marsh during the dry spring of 1974. In 1975, after the area had been under-drained and converted to arable, 15 pairs were recorded – as mentioned above, however, this spring was so wet that not only was standing water present on the grazing marsh, but also in the sprouting wheat. Increasingly efficient drainage and improved sea-defence works, however, have meant that high densities of breeding Shoveler are now unlikely to occur away from nature reserves.

Pochard *Aythya ferina* increased to reach a peak during the 1960s, but has probably declined since (Taylor 1981), with a shift away from areas converted to arable at that time. Garganey *Anas querquedula* has decreased from 13-18 pairs in the early 1960s to 9 pairs in 1975 and only 1 or 2 since 1980; while this may be partly associated with climatic change, habitat changes also may be implicated.

There has been, then, a continual change in the bird communities of the North Kent Marshes for several centuries. Only recently has the rate of change been such that concern has been aroused, and attempts made to quantify the effects of specific changes. The significance of the area in a national and international context is still, however, considerable.

Current interest

The general structure of the breeding and wintering bird communities is broadly similar throughout the area, although there are minor variations dependent on, for example, the presence of more common reed *Phragmites australis* in the dykes in the west of the area than in the east, or the occasional presence of scrub. The final part of this paper describes the bird community of one typical area – Chetney Marshes – in detail and provides comparative data for other parts of the marshes.

The importance of North Kent for

passage and wintering wildfowl and waders is fairly well documented (Ticehurst 1909; Gillham & Homes 1951; Harrison 1953; Williams 1979; Taylor *et al.* 1981). Table 3 gives average peak numbers for 1975-80 for the South Thames Marshes, Medway and Swale areas of the North Kent Marshes, taken from the relevant Kent Bird Reports.

Data on the populations of breeding birds on the whole of the North Kent Marshes are not available for most species. Using the results of localised surveys, however, including those summarised in Scott (1978), Williams (1979) and Taylor *et al.* (1981) and the results of the 1982 B.T.O./R.S.P.B. 'Breeding Waders of Wet Meadows' survey, estimates of the overall breeding populations for selected species for which the area is of national importance (i.e. it supports 1% or more of the population in Britain) are given in Table 4.

In addition, the presence of over 1,000 pairs of Lapwing, one or more pairs of Garganey and Pintail *Anas acuta* in most years, and between 5 and 25 pairs of Bearded Tit is of interest. Other scarce species which have bred, or probably have done so, during the past 20 years include Wigeon *Anas penelope*, Black-tailed Godwit *Limosa limosa*, Little Tern *Sterna albifrons*, Short-eared Owl *Asio flammeus* and Cetti's *Cettia cetti* and Savi's Warblers *Locustella luscinioides*.

These important breeding, wintering and passage bird populations are reliant

Table 4. Estimated total breeding populations of selected species for which the North Kent Marshes are of national importance, 1975-80. The estimates of national populations used are from Sharrock (1976), which are based on data for the years 1968-72.

Heron	180-200 pairs
Shelduck	200-250 pairs
Shoveler	70-90 pairs
Pochard	30-50 pairs
Redshank	750-950 pairs
Yellow Wagtail	1600-2000 pairs

Table 3. Average peak numbers 1975-80 of selected wintering wildfowl and waders on the Thames, Medway and Swale areas of the North Kent Marshes, reaching national (*) or international (**) levels of importance. The qualifying levels for these classifications – 1% of British population and 1% of northwest or west European population respectively – are taken from Salmon (1982). Note that no criterion is available for Ruff. Although present in large numbers, no meaningful estimate can be given for Lapwing.

	Thames	Medway	Swale
White-fronted Goose	692*	53	985*
Dark-bellied Brent Goose	217	760*	953*
Shelduck	1015*	2905**	1653**
Wigeon	1939	5899**	6690**
Gadwall	38	12	46
Teal	910	3921**	2612**
Mallard	1516	1478	1843
Pintail	135	619*	116
Shoveler	296*	255*	317*
Pochard	360	122	217
Oystercatcher	203	813	3007*
Ringed Plover (passage)	643*	500*	249
(winter)	269*	313*	110
Golden Plover	2155	328	1962
Grey Plover	791*	843**	1084**
Knot	1388	425	4416**
Dunlin	17330*	13399*	11117*
Ruff	60	5	93
Black-tailed Godwit	21	401**	496**
Bar-tailed Godwit	59	128	734*
Curlew	1318*	1020*	1935*
Spotted Redshank	44	132*	63*
Redshank	1251*	2228**	1964*
Greenshank	38	81*	69*
Turnstone	143	185	371*

on a range of habitats – mudflats, saltmarsh, pasture, open water and aquatic vegetation are all of value in supporting an abundant, diverse avifauna. Many birds utilise different habitats at different times of day or through the year. Redshank, for example, which use the grazing marsh for nesting may move their young to inter-tidal areas to feed. An important feature of the ornithological interest of the North Kent Marshes as a whole, therefore, is its dependence on the juxtaposition of, and complex ecological relationships between, these habitats.

The impact of land drainage on the birds of Chetney Marshes

The site

Chetney Marshes is a peninsula of about 520 ha, which separates the western part of the Swale from the Medway Estuary, located about 5 km due north of Sittingbourne, Kent (Figure 1).

Reclamation of the area started in Roman times, but the final embankment of the peninsula was not completed until the mid-19th century (Harrison 1970). Until 1972, none of the area was arable, being grazed mainly by sheep. After this date, however, a substantial area of the peninsula was progressively under-drained and converted to arable (Figure 3). The agricultural management of the remaining areas of grazing marsh also changed as cattle replaced the sheep.

Ornithologically, the area has received more attention than most parts of the North Kent Marshes. A breeding wildfowl census was carried out between 1961 and 1964 (Hudson 1967). A survey of all breeding species was carried out in 1968 and 1969, approximately half of the peninsula being covered in each year (Harrison 1970). The survey was repeated for selected species in 1970, 1971 and 1972 (Harrison *et al.* 1972). The area was also regularly visited by casual ornithologists, providing many data, of a less systematic nature.

Because of the changes in land-use and the availability of past ornithological records, Chetney Marshes provides an ideal area in which to assess the impact of land drainage improvements on bird populations. This section of the paper records the results of surveys of breeding and wintering birds in 1978-79 (Williams 1979) and repeated for breeding birds for selected areas of the peninsula in 1982 (Henderson 1982), for this purpose.

Methods

Winter bird census

A full count of the peninsula was carried out once per fortnight by two to three observers between the last week of November 1978 and the last week of April 1979. All birds seen were counted and their distribution recorded according to habitat. Birds in flight were only included if they were clearly associated with the habitat over which they were flying (e.g. Short-eared Owl quartering the grazing marsh). Each census took between three and four hours and started three hours before high tide. An additional one to three visits per week were made by G.M.W. to provide supplementary information, and to assess the pattern of bird usage at different stages of tide. At the end of the census, the number of bird days for each species, by habitat, was calculated.

Breeding bird census

The 1979 survey was carried out by G.M.W. using largely the well established methods utilised by the British Trust for Ornithology for their Common Bird Census (International Bird Census Committee 1969). Moorhen *Gallinula chloropus*, Coot, Oystercatcher *Haematopus ostralegus* and Ringed Plover *Charadrius hiaticula*, however, were recorded by nest only – although the latter two species' nests were located in all areas where territorial behaviour was noted. The census area of 530.9 ha was covered five times in 31 separate visits carried out between 0900-1300 hours B.S.T. 420.5 ha of the area covered was grazing marsh and 100.4 ha arable land (including arable sea-wall). Registrations were plotted onto 1:10,000 or 1:10,560 scale maps and the results analysed using 1:2500 scale maps. The weather was poorer than in 1982 – high winds in particular hindered the census.

The 1982 Breeding Bird Census was

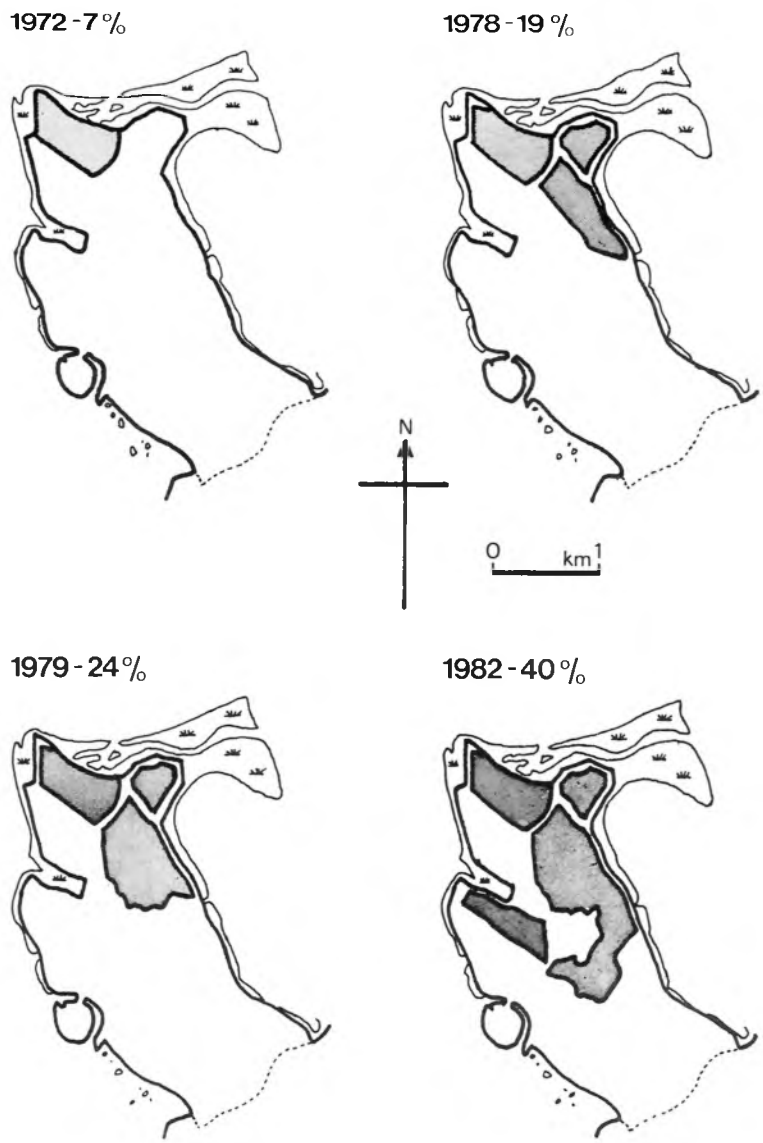

Figure 3. The loss of grazing marsh on the Chetney Peninsula. Percentages given are for the area converted to arable (base 520 ha).

carried out by A.H. using the Common Bird Census methodology throughout. Six visits were made, between 22 April and 19 June, and the presence and activity of each bird seen or heard was recorded on 1:5500 scale maps. Most (79%) of the census work was carried out before 1000 hours B.S.T. Generally, weather conditions were good. The results were analysed using the standard B.T.O. rules to give the number and location of territories for each species. The area surveyed totalled 155.5 ha of which 95.0 ha was cattle-grazed pasture, with its integral dykes and fleets. 60.5 ha was arable (winter-sown wheat and barley), again with watercourses. This included 6 ha of ungrazed grassland – mainly sea-wall – and dykes on the perimeter of the arable land ('arable sea-wall').

Differing observer techniques and

survey times, and less favourable weather conditions in 1979 may have introduced anomalies between the two surveys. An additional source of variation was eliminated, however, by ensuring that the data for 1979 and 1982 were analysed by the same person.

It is not clear how Harrison carried out his 1968-1969 survey; the work involved up to six people walking over each field in line abreast, and recording birds as for a C.B.C., but whether multiple visits were made is uncertain. Only limited use of these data has been made, therefore, in this study.

The area covered by each survey is shown in Figure 4.

Results

Winter bird census

The total bird days and density usage by the main groups of bird species present, for grazing marsh and arable land, are given in Table 5.

Of 74 species on the peninsula, 24 were unique to the grazing marsh and only one to the arable land. An average of 1849 birds of all species was observed during each census, 1404 on the grazing marsh and 445 on the arable land: an average density of 3.34 birds/ha on grazing marsh and 4.44 bird/ha on arable.

The same was true of usage. Of a total

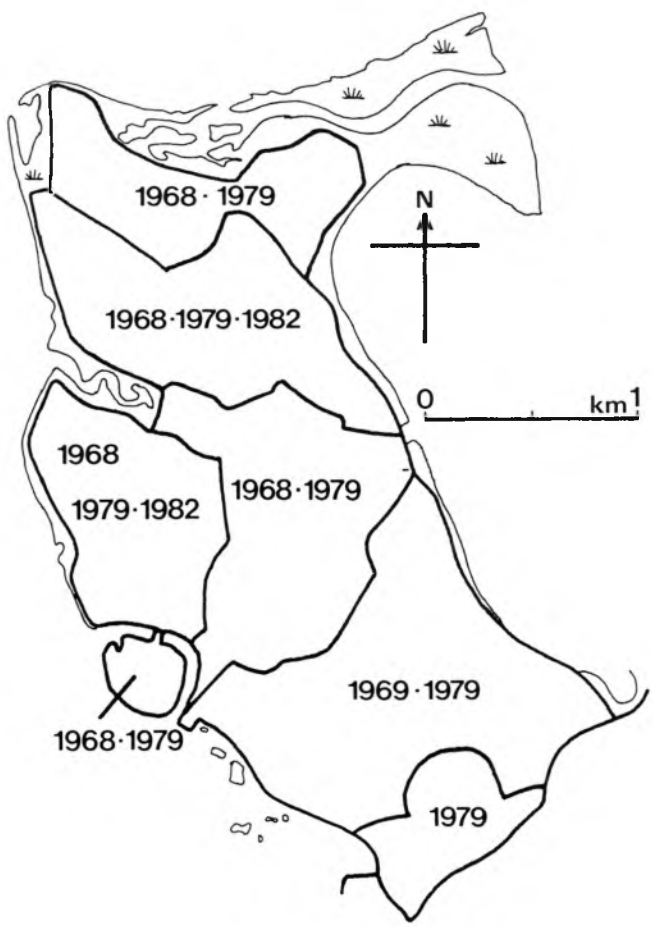

Figure 4. Breeding bird census coverage of Chetney, 1968-9, 1979 and 1982.

of 302,971.5 bird days recorded within the sea-wall, 75% were from on the grazing marsh and 25% on arable. The density of usage, however, was 542 bird days/ha for grazing marsh and 747 bird days/ha on arable.

Table 5 also illustrates a considerable variation in the usage of the two habitats by the different groups of bird species. The density of usage by wildfowl was broadly similar, whilst those for passerines and waders were markedly higher for the arable area.

In general, wildfowl (and particularly Wigeon, Teal *Anas crecca* and Dark-bellied Brent Goose *Branta b. bernicla)* were observed feeding on the grazing marsh. In contrast, those on the arable land were usually noted resting by a large pool of floodwater on a field at the northwestern end of the peninsula. Floodwater was also regularly used by waders as a high-tide roost. The only other major high-tide roost within the sea-wall was at the Teal Hole – an area of bare mud by a brackish pool within the grazing marsh of the centre-west of Chetney. Of the waders, only Lapwing were observed feeding regularly within the sea-wall.

The density of passerines was higher on the arable land because large flocks were attracted to feed on the seed heads of sea-beet *Beta maritima* located on the 'arable sea-wall'. In the grazing marsh area, animals had generally grazed the sea-beet, so preventing it from going to seed. Although the density of raptors and owls was similar for both habitats, their usage differed. In the arable area they were usually to be seen flying over the 'arable sea-wall' area or dykes, presumably hunting for the passerines and small mammals concentrated there. Only infrequently were they recorded over cultivated land. In contrast, no such 'concentration' effect was noted over the grazing marsh.

In the arable area, many of the dykes had not recovered after being enlarged during land drainage improvement works, and thus cover was lacking. In more mature dykes, open water was generally absent, due to the dense growth of vegetation. The low densities of Moorhen and Coot present in the arable areas was probably a reflection of these factors.

Breeding bird census

Table 6 sets out, as density per 100 ha, the numbers of territories of each species recorded in 1982, with comparative data for 1979 (based on the re-analysis of 1979 census results for the area covered in 1982 only), and 1968-1969 (based on figures for the whole of the Chetney peninsula). For 1982, the densities for the various land-use categories are shown separately. In addition, Table 7 provides, as density per km of dyke, the number of 'dyke' breeding species recorded in the 1979 (for which figures for the whole peninsula are used) and 1982 surveys.

Skylark *Alauda arvensis* was found to be, by far, the most numerous breeding species on Chetney. Eight other species – Yellow Wagtail *Motacilla flava,* Redshank *Tringa totanus,* Meadow Pipit *Anthus pratensis,* Mallard *Anas platyrhynchos,* Lapwing, Moorhen, Coot and Shelduck *Tadorna tadorna* – occurred

Table 5. Density of usage by main groups of species of grazing marsh and arable land, November 1978-April 1979. The total number of species recorded in each group is given in brackets.

	Grazing marsh (420.46 ha)		Arable land (100.35 ha)		Total bird days
	Bird days	Days/ha	Bird days	Days/ha	
Little Grebe	68.0 (1)	0.2	–	–	68.0
Grey Heron	959.0 (1)	2.3	188.5 (1)	0.2	1147.5
Wildfowl (14)	52906.5 (14)	125.8	11425.5 (10)	113.8	64332.0
Raptors & Owls (5)	713.5 (5)	1.7	180.5 (4)	1.8	894.0
Grey Partridge	858.5 (1)	2.0	–	–	858.5
Moorhen & Coot	6423.0 (2)	15.3	91.0 (2)	0.9	6514.0
Waders (13)	71238.0 (13)	169.4	36044.5 (9)	359.2	107282.5
Gulls & Terns (6)	3969.5 (5)	9.4	327.5 (5)	3.3	4297.0
Pigeons & Doves (3)	2119.5 (3)	5.0	293.0 (1)	2.9	2412.5
Passerines (28)	88726.5 (28)	211.0	26439.0 (18)	263.4	115165.5
Total (74)	22798.2 (73)	542.2	74989.5 (50)	747.2	302971.5

Table 6. Nesting densities (territories per 100 ha) of each species for combined Chetney Marshes census plots in 1982 and in 1979, and for whole peninsula in 1968/69. Only those species recorded in 1982 are listed.

Species	1968/9 total	1979 total	1982 total	1982 pasture	1982 arable
Little Grebe	1	–	3	3	2
Mute Swan	2	–	1	2	–
Greylag Goose	–	–	1	2	–
Canada Goose	–	–	1	1	–
Shelduck	7	10	8	9	5
Wigeon	–	–	1	1	–
Mallard	18	19	21	22	20
Pintail	–	–	1	1	–
Tufted Duck	1	1	1	1	–
Kestrel	–	–	1	–	2
Grey Partridge	4	1	1	2	–
Moorhen	12	8	12	16	7
Coot	6	15	12	16	7
Oystercatcher	2	1	2	2	2
Ringed Plover	2	3	4	4	3
Lapwing	21	17	14	23	–
Snipe	–	–	1	1	–
Redshank	15	14	24	27	18
Stock Dove	1	–	1	1	2
Skylark	164	125	143	159	119
Swallow	–	–	1	–	2
Meadow Pipit	22	6	23	28	13
Yellow Wagtail	19	15	28	17	45
Blackbird	1	–	1	1	–
Reed Warbler	4	–	3	4	2
Crow	1	–	1	2	–
Starling	2	–	1	1	–
House Sparrow	2	1	3	5	–
Linnet	–	–	2	1	3
Reed Bunting	1	–	3	1	5
Corn Bunting	1	1	5	1	12
Area covered (ha)	476	155.5	155.5	95.0	60.5

Table 7. Nesting densities of 'dyke' breeding species 1979 and 1982.

	1979				1982			
	Grazing marsh (34.33 km)		Arable (4.64 km)		Grazing marsh (8 km)		Arable (6 km)	
	Territories	Terr/km	Territories	Terr/km	Territories	Terr/km	Territories	Terr/km
Little Grebe	4	0.12	0	–	3	0.38	1	0.17
Mute Swan	0	–	0	–	2	0.25	0	–
Greylag Goose	0	–	0	–	2	0.25	0	–
Canada Goose	0	–	0	–	1	0.13	0	–
Wigeon	0	–	0	–	1	0.13	0	–
Mallard	78	2.27	2	2.32	21	2.63	12	2.00
Pintail	0	–	0	–	1	0.13	0	–
Garganey	1	0.03	0	–	0	–	0	–
Pochard	3	0.09	0	–	0	–	0	–
Tufted Duck	1	0.03	0	–	1	0.13	0	–
Moorhen	33	0.96	1	0.22	15	1.88	4	0.67
Coot	60	1.75	0	–	15	1.88	4	0.67
Reed Warbler	14	0.41	0	–	4	0.50	1	0.17
Reed Bunting	1	0.03	1	0.22	1	0.13	3	0.50

at a density of 10 territories per 100 ha, or higher, in one or more of the censuses. These species, and most of those present at lower densities, fall into two broad categories – those preferring open pasture and those of the dykes and fleets. One further group – dependent on the limited amount of scrub available, and the built environment – was also identified.

Several species not recorded in the limited survey of 1982 (and thus not included in Table 6) were recorded in 1968, 1969 or 1979; these are Shoveler, Garganey, Gadwall *Anas strepera,* Pochard and Little Tern.

Assessment of the effect of underdrainage and conversion to arable was attempted by a comparison of the densities of birds breeding on adjacent and otherwise apparently similar blocks of grazing marsh and arable land.

Of the species present at low densities (that is, fewer than 5 territories per 100 ha), only 4 were more frequent on arable land. All of these – Kestrel *Falco tinnunculus,* Stock Dove *Columba oenas,* Swallow *Hirundo rusticola* and Linnet *Carduelis cannatina* – are atypical of marshland, dependent on alien or artificial nest sites. Four of the low density species which were less frequent on arable (Blackbird *Turdus merula,* Carrion Crow *Corvus corona,* Starling *Sturnus vulgaris* and House Sparrow *Passer domesticus)* are similarly atypical. For a fifth – Reed Warbler – the distribution was coincidental, depending on the location of stands of common reed. The remainder of those species which were less frequent on, or absent from, arable land are those typical of wetland or open pasture habitats, and include three species which are locally or nationally scarce – Wigeon, Pintail and Snipe *Gallinago gallinago.*

Of the more numerous species (with densities of more than 5 territories per 100 ha), the complete absence of Lapwing from the arable was most notable. To an extent this might be expected in view of this species' preference for spring-sown over winter-sown cereals (Murfitt & Weaver 1982) – and all cereals on Chetney were winter-sown. This finding, however, was surprising in view of the presence of several areas of more or less bare ground on which the crop had failed. Of the other species present at lower densities on the arable, the difference was greatest in Redshank, Skylark and Meadow Pipit.

Corn Bunting *Miliaria calandra* was more frequent on arable areas than on pasture, presumably responding to the growth of rank grassland on the periphery of the arable land.

For Yellow Wagtail, the results for the 1982 census differed from those of 1979, when higher densities were recorded on pasture. It is apparent from these and other surveys (e.g. Round 1978, Henderson 1982, Clack & Cadbury 1982) that the species often utilises both habitats – feeding on pasture and nesting among or beside crops – and that the apparent result of any one census will depend on the layout of the area surveyed. This predilection for the conjunction of arable land and pasture was noted, also, by Gillham & Homes (1951).

Those species using watercourses (Table 7) showed a greater correlation with the length of dyke or fleet available – the lower density on arable was thus closely related to the loss of some dykes through infilling and the realignment and regrading of others.

Data from the 1979 survey, however, suggested that vegetational changes may also be important. During the improvement of the land drainage system, all dykes are dredged deeply and the banks graded, thus removing nearly all vegetation. Consequently, very few birds nest on the dykes after conversion. Due to the lack of grazing and trampling dense stands of sea club-rush *Scirpus maritimus* developed within three years. If the improvement scheme results in a marked drop in water levels (as occurred in the areas drained in 1979, but not in 1982), sea club-rush may colonise the whole dyke. By relating the results for 1979 and 1982, it is clear that wildfowl and species such as Coot, Moorhen and Little Grebe prefer dykes with a mixture of open water and dense stands of vegetation. Only Reed Bunting *Emberiza schoeniclus* showed a preference for the totally vegetated dykes which typified the arable land.

Of the remaining species, Shelduck occurred at slightly higher densities on the grazing marsh – although because it generally nested down rabbit holes or amongst ruined buildings, it depended

little on either habitat for nest cover. Oyster-catcher and Ringed Plover occurred at similar densities in both habitats, but their preference was for areas of bare, disturbed grounds, such as around cattle drinking areas along dykes and in areas of sea-wall reconstruction.

The influence of grassland management

Harrison (1970) compared heavily and lightly grazed areas on Chetney. He concluded that there was little difference in the nesting densities of Skylark, Meadow Pipit and Lapwing, but that Yellow Wagtail and Redshank nested more densely on the lightly grazed areas.

Boston and Parkin (undated) showed that on the Swale National Nature Reserve, Isle of Sheppey, a smaller number both of species and of total number of breeding birds utilised ungrazed areas of grassland relative to winter-grazed grassland.

The grazing intensity on Chetney, however, has fallen since 1968 (from a maximum of 2.32 livestock units per ha in 1968, to a maximum of only 1.10 livestock units per ha in 1979), and over most of the grazing marsh, cattle have replaced sheep. There is little evidence, however, that the changes in grazing stock and diversity had any effect on the bird community. The changes in individual species densities over this period can be explained in terms either of national population trends (Fuller, pers. com.) or the conversion of part of the area to arable use.

Comparison also was made, using data from the 1979 survey, between sheep and cattle grazed areas and cattle only grazed areas. On the sheep and cattle grazed grassland, Skylark, Meadow Pipit, Yellow Wagtail, Lapwing, Redshank and Grey Partridge *Perdix perdix* nested at a total density of 11 pairs/100 ha. The density on the cattle grazed area, 15 pairs/100 ha, was higher. This finding should be regarded with caution, however, since neither area could be described as heavily grazed and other factors may account for the difference.

Of greater significance to bird populations may be the application of sewage slurry to selected areas of grazing marsh on Chetney. During the winter survey, it was apparent that Dark-bellied Brent Goose, White-fronted Goose *Anser albifrons* and, to a lesser extent, Wigeon were feeding on these treated areas in preference to the remainder of the grazing marsh. At that time, the slurry-treated areas were greener and more lush, and presumably the wildfowl were feeding there because of the greater palatability and nutritive content of the grass (Williams & Forbes 1980). In addition, sward length was more even and less tussocky.

The effects on the breeding bird community were unclear, but such developments need to be viewed with caution. Many species, for example, prefer to nest in tussocky growths (Thomas 1980). Applications of fertiliser, by encouraging lush, uniform growth, are likely to be detrimental to the interests of the key wetland breeding bird species on Chetney. This view is supported by Murfitt and Weaver (1982) who noted that, in Norfolk, grassland improved by the application of fertilisers, or re-seeding with grass leys, appeared to be unsuitable for Lapwing.

Comparisons with breeding bird surveys of other marshland areas

Table 8 compares the results for selected species from the three breeding bird censuses on Chetney with those of other surveys in Kent and elsewhere. From Round (1978) and Clack & Cadbury (1982) are taken the results of surveys in the Somerset Levels and the Nene Washes, respectively, in which drained and undrained areas are compared. The table also shows the area of land covered by each survey, and the proportion under arable use.

The table shows that marked differences do exist for some species between Chetney and other parts of North Kent. Most notably, the dyke species are present at higher densities on the Swale National Nature Reserve and especially Cliffe Marshes; this reflects the greater lengths of dykes in these two areas, which, on Cliffe Marshes, tend to be dominated by taller plants (especially common reed) than on Chetney.

The North Kent Marshes also support higher densities of the commoner breed-

Table 8. Nesting densities (territories per 100 ha) of selected species on Chetney Marshes in 1968/9, 1979 and 1982 compared with those on other marshland areas. Species not present are indicated by '0'; species not recorded are indicated by '–'. Data are from: 1. Harrison (1970); 2. Williams (1979); 3, 6, 7. Henderson (1982); 4. Scott (1978); 5. Boston & Parkin (undated); 8, 9. Round (1978); 10, 11. Clack & Cadbury (1982).

	1 Chetney 1968/9	2 Chetney 1979	3 Chetney 1982	4 Cliffe Marshes 1976	5 Swale NNR 1975-8	6 Sholden E Kent undrained 1982
Little Grebe	1.0	0.8	2.6	15.6	8.4	0
Shelduck	6.5	6.9	7.7	–	9.8	0
Mallard	17.2	15.4	21.2	30.5	32.8	9.3
Pochard	1.4	0.6	0	9.1	3.5	0
Partridge	4.3	1.4	1.3	–	6.2	0
Moorhen	11.8	6.5	12.2	29.6	25.1	9.3
Coot	15.5	11.5	12.2	18.9	35.9	0
Lapwing	20.6	9.8	14.1	28.8	18.4	4.7
Redshank	15.5	10.2	23.8	32.1	28.8	0
Skylark	160.0	101.4	143.4	167.1	63.7	97.7
Meadow Pipit	21.3	9.6	22.5	61.7	45.9	51.2
Yellow Wagtail	18.2	8.3	27.7	22.2	12.9	37.2
Reed Warbler	3.7	2.7	3.2	56.0	12.2	0
Reed Bunting	1.0	0.4	2.6	26.3	23.7	37.2
Corn Bunting	0.2	1.4	5.1	–	5.1	0
Area (ha)	489.5	520.8	155.5	121.5	112.7	21.5
of which, Arable (ha)	–	100.4	60.5	–	–	21.5

	7 Sholden E Kent drained 1982	8 Somerset Levels undrained 1977	9 Somerset Levels drained 1977	10 Nene Washes undrained 1982	11 Nene Washes drained 1982
Little Grebe	0	–	–	0	0
Shelduck	0	–	–	1.7	0
Mallard	7.3	0	1.8	3.5	3.9
Pochard	0	–	–	0	0
Partridge	0	–	–	0	0
Moorhen	18.2	–	–	5.2	0
Coot	0	–	–	3.5	0
Lapwing	0	24.5	8.8	11.0	4.7
Redshank	0	7.5	0	11.0	0
Skylark	47.2	52.8	26.3	39.3	50.4
Meadow Pipit	3.6	30.1	0	34.7	0
Yellow Wagtail	10.9	1.9	7.0	3.5	3.9
Reed Warbler	105.4	–	–	9.8	4.6
Reed Bunting	65.1	28.3	1.8	20.2	4.7
Corn Bunting	25.5	–	–	0	0
Area (ha)	27.5	53.0	57.0	173.0	129.0
of which, Arable (ha)	23.1	3.6	33.0	–	129.0

ing wildfowl and waders than many other areas of Britain with the exception of snipe, which requires a soft – usually peat – substrate.

Comparison with other surveys, which have censused the breeding bird communities of drained and undrained land elsewhere in Britain, shows that the overall results of improved drainage works are similar to those on Chetney, with marked declines occurring in Lapwing, Redshank and Meadow Pipit.

Naturally, the circumstances of individual sites does produce anomalies. At Sholden in east Kent, for example, breeding densities of Moorhen, Reed Warbler and Reed Bunting were higher on the drained areas because of the vigorous growth of common reed which, in pasture, was checked by grazing cattle, and also the utilisation by Reed Warbler *Acrocephalus scirpaceus* of oil seed rape. On the Somerset Levels and Nene Washes, these species were at lower densities in the drained areas, which more resembles the situation on Chetney.

Conclusions

There have been great changes in the character of the North Kent Marshes, particularly since 1968, as land drainage improvement schemes have permitted the conversion of many hectares of grazing marsh to arable.

The breeding bird surveys of the Chetney peninsula illustrate clearly that this process is having a detrimental impact on breeding wetland birds – especially wildfowl, Redshank and Lapwing – because the area is being rendered unsuitable for nesting.

The available breeding bird population estimates for the North Kent Marshes, as a whole, suggest that there have been significant declines in the breeding populations of Pochard, Shoveler and Garganey. The Chetney data would suggest that habitat changes as a result of field drainage improvement works are largely responsible, although in the case of Garganey, climatic factors may also be involved. Improvements to the arterial drainage system have also had a detrimental impact on 'dyke' nesting species – but there is an indication that if water levels are kept as high as possible, and a mixture of open water and aquatic vegetation is retained, this impact may be reduced.

Wintering bird populations do not appear to have been affected by habitat changes to the same degree, but this must be due in part to the 'buffering' effect of having, readily available, other habitats within the North Kent Marshes complex (particularly mudflats and saltmarsh) which can meet their requirements. Furthermore, wintering wildfowl and waders appeared to be less dependent on a particular habitat than on the presence of floodwater, particularly for loafing and roosting during high-tide.

The Swale and the Medway Estuaries are each recognised as being of international ornithological importance; the South Thames Marshes are at least of national ornithological importance. The grazing marshes are one of the key components of a range of habitats which support the area's breeding, passage and wintering bird populations. If the outstanding ornithological interest of the North Kent Marshes is to be maintained, it is essential that this loss be stemmed.

With one important exception (the western end of Cliffe Marshes), the Government's statutory adviser on nature conservation, the Nature Conservancy Council, has notified most of the remaining areas of grazing marsh as Sites of Special Scientific Interest. It now falls to the N.C.C. to make full use of their statutory powers, particularly under the Wildlife and Countryside Act 1981, to secure the conservation of this vital resource and its wildlife.

Acknowledgements

We would like to thank Mr. T. Ledger, Messrs. W. and H. Mouland and Bowater United Kingdom Paper Co. Ltd., for allowing access to their land during this study. Mr. A. Clack of Southend Flying Club piloted the aircraft used in the 1979 and 1982 land-use surveys. We are also most grateful to all those members of the Kent Ornithological Society who helped with the 1979 winter bird census of Chetney. Tony Prater very kindly carried out the analysis of the 1979 and 1982 breeding bird census data for Chetney, and R. J. Fuller commented on breeding bird population trends on Chetney relative to the national situation. Hatfield Polytechnic made available their portable area meter. Dr. James Cadbury, Dr. Ken Smith and John Andrews of R.S.P.B., and Dr. Rick Keymer of N.C.C. made helpful comments on an earlier draft of this paper. Finally, we would like to thank Gillian Rounding for typing the manuscript.

The study was carried out with substantial financial support from the R.S.P.B. G.M.W. was also funded under Nature Conservancy Council contract no. EZ/36/01.

Summary

Between 1935 and 1982, there was a net re-

duction of 48 per cent in the area of grazing marsh in North Kent. By far the greatest loss of this habitat was due to land drainage works, which permitted the conversion of grazing marsh to arable. This process has accelerated since 1968, and has caused considerable disquiet amongst conservationists, because of the potential detrimental impact of these changes on the internationally important bird populations of the area.

The impact of land drainage improvement schemes and the conversion of grazing marsh to arable on the birds of the North Kent Marshes are examined, by looking at both the bird populations of the area as a whole, and of an individual site – Chetney Marshes. At Chetney, the impact on wintering bird populations of these land-use changes appeared to be relatively small. However, breeding birds – particularly wildfowl and Lapwing and Redshank were affected detrimentally, with a lower density of territories being recorded on arable areas.

Evidence for the whole of the North Kent Marshes, suggests a severe decline in the numbers of breeding Shoveler *Anas clypeata*, Pochard *Aythya ferina* and Garganey *Anas querquedula*. The loss or fragmentation of grazing marsh is probably the primary cause – although in the case of Garganey, climatic factors may also be involved.

It is clear that if the considerable ornithological interest of the North Kent Marshes is to be maintained, then urgent steps must be taken, primarily by the Nature Conservancy Council, to conserve the grazing marshes which remain.

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