Effects of lagoon creation and water control changes on birds at a former airfield at Orford Ness, Suffolk, UK: Part 2 - wintering waders

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SUMMARY

A former military airfield at Orford Ness had naturally developed into a coastal grazing marsh, but limited water control caused it to be deeply flooded in winter. With the intention of attracting higher numbers of waders, six large pools were created with low bunds each surrounded by shallower water and linked by new ditches and water control points. A new water pump was installed to enable excess rainwater to be evacuated into the adjacent estuary. The number of wintering waders in the modified areas increased tenfold in mid-winter from pre to post-works, and the waders showed increased use of areas that had become shallowly, rather than deeply, flooded. The rise in wader numbers was not due to within-site movement, as an adjacent, unmodified marsh showed no change in bird numbers. Late summer wader numbers, which may include passage migrants, were 2.5 times higher after the management work.

BACKGROUND

Orford Ness, on the Suffolk coast of the UK (52°05'N, 1°33'E), is a highly designated nature conservation site (Site of Special Scientific Interest, Special Protection Area, Special Areas of Conservation, Ramsar) owned by The National Trust since 1993. Orford Ness is a 16 km long coastal spit and the most significant feature is the rare vegetated shingle habitat (405 ha). There are also UK Priority Habitat areas of coastal marsh (193 ha), saltmarsh (91 ha), saline lagoons (40 ha), mudflats, reedbeds and acid grassland (Warrington *et al.* 2013). One area ('Airfield Marsh') had been encouraged to develop into a coastal marsh, by allowing winter flooding by rainfall through reduced use of an evacuation pump. However, with only the pump to control water depth, much of this marsh was deeply flooded in winter, limiting the attractiveness of the area for waders.

The aim of the work described in this study was to improve the Airfield Marsh habitats for wintering and breeding birds and other wildlife. Wading birds observed at the site from autumn into winter included pied avocet *Recurvirostra avosetta*, common redshank *Tringa totanus*, northern lapwing *Vanellus vanellus*, Eurasian curlew *Numenius arquata*, dunlin *Calidris alpina*, black-tailed godwit *Limosa limosa*, ruff *Philomachus pugnax*, Eurasian oystercatcher *Haematopus ostralegus* and European golden plover *Pluvialis apricaria.* All of these species prefer to feed in shallow water in winter (usually less than 100 mm) and to rest standing in shallow water or on land very slightly raised above, but usually surrounded by, water.

A water level management plan was developed to deliver the desired range of water levels and their control. This plan required the creation of new shallow pools, plus drawdown areas, earth bunds, ditches and sluices, all leading down a very shallow gradient to the evacuation pump. Here we report the effects of this management on the number of wintering waders at the site.

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ACTION

Airfield Marsh consists of an area of 80 ha marsh surrounded by a clay river wall, of which 11 ha is reedbed and 3 ha is dry grassland and tracks on shingle. Thus 66 ha was targeted for coastal marsh habitat improvements.

Wetland habitat management: From October 2011 to February 2012 large-scale earth-moving operations were used to produce six shallow pools (total 6 ha) and two deeper storage lagoons (1.5 ha) in the Airfield Marsh, plus 2.6 km of new ditches. The pools created were between 200 mm and 500 mm deep with gently sloping sides so that shallow water spread for some distance across the marsh. The pools were linked by ditches and the water could be held back by a series of water control sluices set in low step bunds (500 mm high) with an evacuation pump taking water from the lowest point in the system into the estuary (Mason *et al.* 2013, Warrington *et al.* 2014). In the adjacent, but hydrologically separate, Kings Marsh (48 ha) two new saline lagoons were created of 1.5 ha total area which had steeper sides, with water over 500 mm deep and minimal drawdown zones.

Bird monitoring: Surveys of waterbirds present in Airfield and Kings Marshes were undertaken four times every month. Bird counts were carried out for three hours each week, with the site divided into survey zones and the amount of time spent surveying each zone was proportional to its area. In addition the whole of Orford Ness was surveyed each month for the Wetland Bird Survey, which monitors non-breeding waterbirds in the UK (Austin *et al* 2014).

Data on all bird species present were collected, with ongoing monitoring starting in April 2010. A large dataset has been generated by the bird surveys, so here we illustrate the impact of the work by presenting the average numbers of wintering waders across the four surveys carried out in February 2011 (mid-winter before site works) and February 2013 (one year after the works were completed), plus the post-breeding and passage migration period of August 2011 (pre-works) and August 2013 (post-works). These data allow a

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'before and after intervention' comparison of bird numbers across the site and within each section of the Marshes. In addition, any change in the occupation by birds of different parts of the marshes was investigated by use of Jacobs Preference Index, which assesses whether there are more or fewer birds than expected in each zone, taking account of their different areas (Jacobs 1974). Jacobs index ranges from -1 (complete avoidance) to +1 (exclusive use), with 0 indicating use exactly in proportion to the area.

CONSEQUENCES

Changes to the habitat: The creation of pools and their shallow muddy margins, plus the installation of the water level control infrastructure, slightly reduced the winter flooded area of the 66 ha Airfield Marsh from 26 ha in February 2011 to 22 ha in February 2013. This was in line with the aims of the management plan, as the post-works flooded areas were designed to be shallower, with the pools surrounded by wide margins of very shallow water, exposed mud and short vegetation.

Impact on wintering waders: Total wader numbers increased significantly, by over tenfold, on Airfield Marsh from an average of 27 (S.D. = 4) per survey in February 2011 (pre-works) to 300 (S.D. = 28) in February 2013 ($t = 11.20$, d.f. = 3, $p < 0.01$). There was no change in wader numbers on the adjacent Kings Marsh between these two time periods (February 2011 average = 23 (S.D. = 5), February 2013 average = 19 (S.D. = 4), $t = 2.20$, d.f. = 3, $p > 0.05$). Thus the increase in winter wader numbers on Airfield Marsh was not due to movement of birds from Kings Marsh, but instead to additional birds using the site.

There was a significant shift in the numbers of waders between zones of Airfield Marsh and Kings Marsh from February 2011 (pre-works) to February 2013 (post-works) (χ^2 contingency test = 412, d.f. = 6, $p < 0.001$) (Table 1). A much higher number and proportion of waders used the east and west areas of Airfield Marsh after the works compared to before. However, bird numbers were almost unchanged in all other zones and thus the preference index for these areas declined (Table 1, Figure 1).

Impact on late summer waders: In August there was a 2.5 times increase in numbers of waders post-works on both Airfield Marsh and Kings Marsh, from an average of 54 to 133 birds ($t = 3.20$, d.f. = 3, $p < 0.05$, Table 2). There was no clear shift in numbers before and after the management works in the different zones of these marshes ($\chi^2 = 12$, d.f. = 6, $p > 0.05$) (Table 2), with the preference for each zone remaining similar (Figure 1).

Table 1. Average numbers of waders in each zone in February 2011 (pre-works) to February 2013 (post-works) and the area of each zone areas .

Zone	Area (ha)	February 2011	February 2013
Airfield Marsh reedbed	12 (9%)	1	0
Airfield Marsh west	34 (27%)	1	110
Airfield Marsh centre	14 (11%)	20	19
Airfield Marsh east	20 (16%)	5	171
Kings Marsh lagoons	10 (8%)	12	7
Kings Marsh south	18 (14%)	1	2
Kings Marsh north	20 (16%)	10	10

Table 2. Average numbers of waders in each zone in August 2011 (pre-works) and August 2013 (post-works).

Zone	August 2011	August 2013
Airfield Marsh Reedbed	1	0
Airfield Marsh west	30	73
Airfield Marsh centre	4	15
Airfield Marsh east	2	2
Kings Marsh Lagoons	12	29
Kings Marsh south	3	10
Kings Marsh north	2	4

DISCUSSION

The creation of new water bodies and improvements in water controls carried out on the marshes at Orford Ness was primarily aimed at improving the site for breeding waders (Warrington *et al.* 2014), but it clearly also delivered a marked increase in the number of waders using the site in mid-winter, and a smaller increase in the late summer period. The increases in wader numbers evident soon after the intervention was completed is encouraging, although it is not possible to attribute this increase to specific aspects of the habitat creation or ongoing habitat management, as the bird response could be due to any or all of the actions. However, Airfield Marsh west and east clearly increased in attractiveness for the waders. This is probably because, post-works, these two zones both provided shallow flooded marshes and long margins of water/mud/grass due to the creation of the bunded pools. Prior to the intervention, the west zone closer to the evacuation pump flooded more deeply whilst the slightly elevated east zone remained as grassland with wet ditches, and only the central zone provided the waders' preferred habitat.

The higher numbers recorded in late summer (August) was also encouraging, as at this time of the year many birds are on passage migration and the marshes at Orford Ness may now provide more suitable habitat for feeding, resting and roosting.

The intervention work was typical of that undertaken on many wetland sites to improve their habitat condition for waders. However, the Orford Ness site provided a number of significant challenges. The historical environment of Orford Ness is of international significance, thus all historic tracks, structures and buildings were identified and retained. The habitat and water management manipulations had to be designed specifically for the Orford Ness marshes, so the estimated project costs were high, and due to the uniqueness of the site, the outcomes were not predictable. The site was a very challenging one for engineering operations, being almost an island, and the transport costs alone to bring the heavy earth-moving equipment onto and off the site were over £80,000, and the engineering works totalled over £300,000 (Mason *et al.* 2013).

Also, the marshes at Orford Ness are below mean high water, and are protected from flooding by old, clay walls and thus there is a high risk of coastal flooding. Indeed the Kings

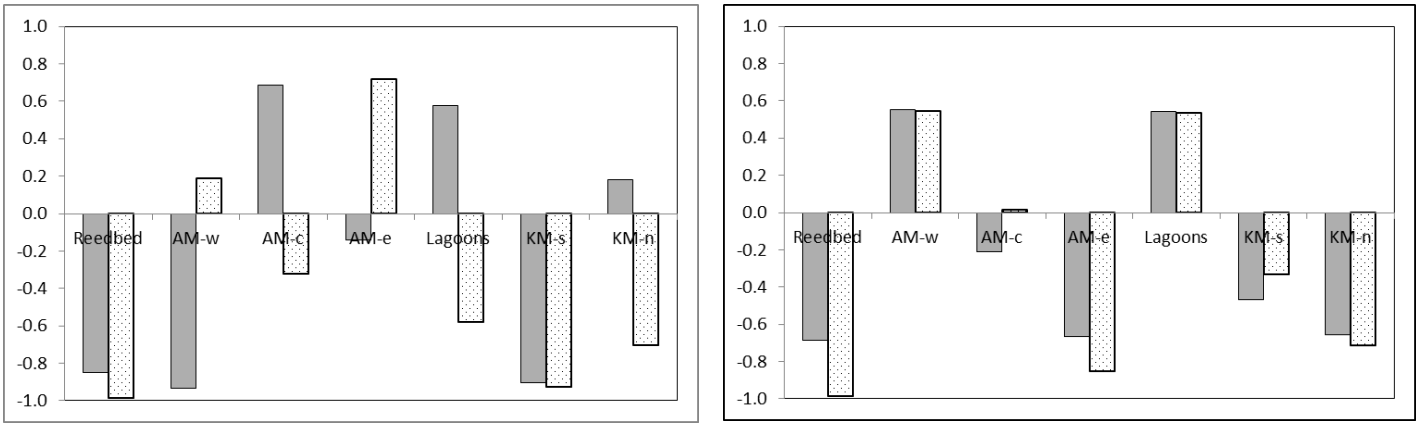

Figure 1. Preferences of waders for the zones of Airfield Marsh and Kings Marsh, Orford Ness, expressed by Jacobs Index, for February (left) and August (right) before (2011, grey bars) and after (2013, dotted bars) management work was undertaken. (Reedbed = Airfield Marsh Reedbed; AM-w = Airfield Marsh west; AM-c Airfield Marsh centre; AM-e Airfield Marsh east; Lagoons = Kings Marsh lagoons; KM-s = Kings Marsh south; KM-n = Kings Marsh north).

Marsh area did flood to about 2 m depth due to the exceptional tidal surge on 5 December 2013, and the water took more than four weeks to be evacuated through tidal sluices. The Airfield Marsh walls were over-topped in places leading to extensive surface flooding. Thus, because of the high likelihood of a coastal flood, the habitats and the site infrastructure have to be resilient to, and able to recover from, such an event.

The long-term value of these habitats for birds and other wildlife on this will be monitored closely over the next few years, to better understand if these interventions continue to produce increased bird numbers and how best to manipulate water levels using the new site infrastructure.

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