Wallasea Island

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Abstract

The RSPB's Wallasea Island Wild Coast Project in Essex has created a 740-ha coastal wetland on former arable land, comprising intertidal habitat, saline lagoons, islands and coastal grassland. The project has aimed to both provide valuable wetland habitat for birds and other wildlife and act as an example of large-scale adaptation to coastal change caused by climate-

change-driven rises in sea level. The reserve's creation has involved a range of innovative techniques and approaches, including raising land levels prior to the introduction of tidal flooding using material excavated during construction of Crossrail's Elizabeth Line beneath London. In the seven years since the start of wetland creation, numbers of wintering waders and wildfowl have steadily grown and, in the past three years, have reached peak counts of over 30,000 birds.

Introduction

Wallasea Island, Essex, is one of a group of islands in the River Crouch and River Roach Estuaries. The reserve is about 740 ha, covering approximately three-quarters of the island, and comprises a mixture of wetland habitats: about 265 ha of intertidal habitat, 173 ha of saline waterbodies and 119 ha of wet grassland. It also contains approximately 9 km of sea wall and large expanses of rough grassland.

In this paper, we describe the creation by the RSPB of the nature reserve on Wallasea Island, the main aims of which have been to provide a large-scale example of adaptation to coastal change due to sea-level rise, and to mitigate for current and future losses of habitat within the Rivers Crouch and Roach. The wetland has been created on former arable land and was the UK's largest-ever coastal wetland creation project.

75. An aerial view of most of Wallasea Island, Essex, looking west, July 2019.

Since the reserve is on an island, there is no significant inflow of fresh water onto the reserve and the area also has low rainfall. This lack of fresh water has been a major factor in the design and management of the reserve's habitats. Lack of fresh water in summer is an issue at many other wetlands in southern England, not just island reserves such as Wallasea Island, and this is expected to be exacerbated by climate change and increased demand for water from growing human populations. Wallasea Island therefore offers a good test case for how diverse coastal wetland areas that lack significant availability of fresh water can be created and managed.

History

About 800 years ago, what is now Wallasea Island comprised four islands. Over time, additional land was reclaimed from the sea, with embankments

created; eventually, the four islands became one single island – Wallasea Island. This area was used for livestock and arable farming. A hundred years ago, there were several farmsteads across the island, a school and several ferry connections crossing the Rivers Crouch and Roach.

In 1952, about two-thirds of the island was bought by Wallasea Farms and converted to one large, arable farm. However, the farmland was flooded by sea water during a storm in 1953 and, following this, ditches were cut, which ran north–south at intervals of 250–300 m and drained the large fields. The ditch water flowed into the borrow dykes and out through sluices into the adjacent tidal rivers at low tide. The land remained in intensive arable farming until the start of this century.

76. The different areas of Wallasea Island RSPB, looking east across the reserve, August 2019.

Meanwhile, between 1998 and 2002, the RSPB undertook a project to identify

potential sites for re-creation of intertidal habitat around the coast of mainland Britain. This project, known as ‘Seas of Change’, identified Wallasea Island as a potentially suitable site – but questions were asked whether it was too large a task given current knowledge and abilities.

In 2006, Defra created a 155-ha area of intertidal habitat on Wallasea Island through managed realignment along its northern edge, an area known as Allfleets Marsh. The managed realignment involved breaching the existing sea wall to allow tidal flooding to its landward side and was accompanied by the construction of a new sea wall further inland. This area of managed realignment followed a case brought against the British Government by the RSPB at the European Court, and was to provide retrospective compensatory habitat for intertidal habitat lost to development at Lappel Bank, Kent, and Fagbury Flats, Suffolk, during the 1980s and early 1990s. Allfleets Marsh remains under Defra ownership.

77. Construction of Jubilee Marsh, Wallasea Island, April 2015. This photo was taken prior to the introduction of tidal flooding. The pale

brown areas are material excavated from beneath London and transported to Wallasea Island by ship. The outlines of future saline lagoons and tidal creeks can be seen.

In 2006, following discussions with Wallasea Farms, the RSPB agreed an option to buy 668 ha of their farmland and surrounding saltmarsh. A key issue with any work undertaken was the predicted impact on the adjoining Crouch and Roach Estuaries' tidal prism – the difference in volume of water in the estuary between high and low tide. Because Wallasea Island is so large and low-lying, any breach of its sea wall – interntional or otherwise – would result in an extremely large increase in the estuary's tidal prism, estimated to be 11 million cubic metres on a mean spring tide. Modelling predicted that if this breach occurred along the island's southern sea wall, the extra flow of water would deepen the channel in this part of the estuary, put additional pressure on remaining areas of sea walls and possibly cause other, unpredicted change. The modelling showed that to avoid adverse impacts on the rest of the estuary, any increase in the tidal prism needed to be 2.2 million cubic metres or less on a mean spring tide.

The first option investigated was the installation of large tide-gates to control the flow of water onto and off the island on each tide, thus reducing the increase in tidal prism to within an acceptable level. This technique is known as regulated tidal exchange (RTE). Although technically feasible, it would have been extremely costly, requiring expensive upgrading of the island's sea walls to keep pace with rising sea levels.

The second option was to raise land levels prior to introducing tidal flooding,

to reduce the volume of water flowing into and out of the managed realignment area on each tide. This is where a partnership with Crossrail was born. Crossrail, as part of the development of the Elizabeth Line, was planning the excavation of 42 km of twin-bore railway tunnels deep below London – and they needed somewhere to dispose of the material.

The material from Crossrail was used for two purposes: firstly, to construct a new sea wall to the landward side of the managed realignment (subsequently named Jubilee Marsh) and, secondly, to raise the height of the land prior to the introduction of tidal flooding to reduce the increase in tidal prism. Some 3.2 million cubic metres of material from beneath London was deposited on Jubilee Marsh, together with an additional 1 million cubic metres of material from the excavation of additional creeks and lagoons on the reserve further to the west, in an area now known as Marsh Flats and Acresfleet Lagoons.

An advantage of using this material was that the elevation of different areas of Jubilee Marsh, and thereby the habitats that subsequently developed, could be designed largely as the RSPB wanted, albeit within wider hydrodynamic constraints. A problem for mudflat-feeding waders at some other managed realignment sites is that the sites accrete sediment rapidly, especially when connected to sediment-rich estuaries, and quickly turn to saltmarsh (e.g. Mazik *et al.* 2010). Managed realignments often have just one fairly narrow opening to the sea through their former sea wall. This can mean they have limited throughflow of water and are sheltered from strong tidal and wave action by the remaining length of sea wall., both of which tend to increase the rate the seidment accumulates. We therefore designed Jubilee Marsh such that water flows along channels between three breaches, helping to maintain areas of open mudflats.

The excavated material was placed at varying heights to allow the full range of intertidal habitats to develop, from mudflats at lower levels, through lower, middle and upper saltmarsh, and up to a transition grassland zone, which may be inundated on storm surges and briefly on the highest spring tides. The design of the site has taken into account expected rises in sea levels in the future, creating shallow slopes – with an incline of 1:15 leading away from the new sea wall – that rise to 1 m above the current Highest Astronomical Tide (the highest tide level that could occur in the absence of strong winds and low air pressure). This should allow the full range of intertidal habitats to 'migrate' up the slope as sea levels continue to rise. Transitions from upper saltmarsh to non-tidal grassland are rare along most of the UK's coastline, having often been truncated by the presence of sea walls.

We also used the material to create lagoons with islands in the upper tidal range for nesting and roosting birds. The levels of the lagoons were set so that they are topped up with sea water on high spring tides in early spring but the islands within them remain free from tidal flooding during the breeding season. Safe nesting and roosting sites for birds are in short supply along much of the UK's coastline.

Construction of Jubilee Marsh was completed in 2015 and the existing sea walls were breached to allow tidal flooding of the area in July that year. To complement the intertidal habitat, we also created an area of RTE known as Pool Marsh, a saline lagoon called Grass Farm Lagoon, a salt pan and an area of grazing marsh called Marsh Flats. The first was finished in 2015 while the last three were completed in 2016 and are fed water from a sluice that opens into Allfleets Marsh and the River Crouch. In the past, this sluice was used to drain the island for the arable crops but the flow has now been reversed.

Once this work had been finished, two-thirds of the former arable land had been converted to intertidal habitat, RTE, saline lagoons and grazing marsh.

In the original design, it was envisaged that Jubilee Marsh would be the first of three areas of managed realignment on the island created by raising land levels prior to introducing tidal flooding. However, no additional sources of material have so far become available for land raising. Therefore, in the meantime, we have converted the remaining arable to three large shallow saline lagoons (the Beagle Lagoons) and an area of saline-water-fed marsh (Lytag Marsh), while retaining an area of freshwater marsh to the east. These were completed in 2018 and are fed through a sluice that was also once used to drain the farmland.

As of 2022, the reserve has about 173 ha of saline waterbodies (saline lagoons and RTE), which we believe to be the largest complex of shallow saline waterbodies in northwest Europe.

Management

and development of the habitats

Intertidal habitat

Jubilee Marsh is left largely unmanaged. Its mudflats have been quickly colonised by invertebrates, with the most abundant species (in terms of weight per unit area) being Laver Spire Shells *Peringia ulvae*, the bivalve *Abra*

tenuis and the ragworm *Hediste diversicolor*. All of these are important prey for wading birds.

The areas of Jubilee Marsh that are of suitable elevation for the development of lower-level saltmarsh have been quickly colonised by plants, mainly Purple Glasswort *Salicornia ramosissima* and Annual Sea-blite *Suaeda maritima*. Meanwhile, areas above the current highest tides have rapidly developed into grassland, often dominated by large swathes of Narrow-leaved Bird's-foot-trefoil *Lotus tenuis,* an uncommon plant nationally (plate 78). However, areas of suitable elevation for the development of middle and upper saltmarsh have, so far, developed only sparse vegetation. As expected, these areas are yet to accrete much sediment and therefore still comprise mostly clay, excavated from beneath London. This lack of accretion, together with the drying out of the clay between tides during long periods of dry weather, is probably the main reason why they have been slow to vegetate. While this is not expected to be a problem in the longer-term, since sediment should accrete in these areas as sea levels continue to rise, it is probably at least in part the reason for the current lack of breeding Common Redshanks *Tringa totanus* on the developing saltmarsh, with the vegetation in these areas of middle marsh still being too sparse for them to nest in.

78. The view across part of Jubilee Marsh, Wallasea Island, showing a high-level lagoon and its islands with, in the foreground, transitional grassland containing a fringe of abundant Narrow-leaved Bird's-foot-trefoil *Lotus tenuis,* June 2022.

One island has been planted with scrub to hopefully provide nesting habitat for Eurasian Spoonbills *Platalea leucorodia*. This is in the far southeast corner of Jubilee Marsh, furthest away from footpaths and the main land area on the reserve, and so hopefully less accessible to Red Foxes *Vulpes vulpes* and European Badgers *Meles meles*. Given the lack of fresh water on the island and the hard clay substrate, scrub is taking its time to establish but a few plants are now nearly 2 m high. In addition, two areas of shingle and cockleshells have been deposited in Jubilee Marsh, with the aim of providing nesting habitat for Oystercatchers *Haematopus ostralegus*, Ringed Plovers *Charadrius hiaticula* and, potentially, Little Terns *Sternula albifrons.*

Saline lagoons and the regulated tidal exchange area

The saline lagoons are managed to maintain their salinity within an appropriate range for invertebrates and fish, to provide suitable water depths for birds and to manipulate vegetation. This is all achieved by controlling the flow of water into and out of each lagoon. High water levels in winter are used to kill or help break down vegetation on islands to provide open nesting habitat for Avocets *Recurvirostra avosetta* and terns, with any remaining

vegetation removed manually, while drying out and reflooding are also used to make seed available for wildfowl. Maintaining suitable salinities is crucial, since lagoon invertebrates and fish can only tolerate particular ranges and sudden, large changes in salinity can kill them. Key prey for most waders (and some wildfowl) in the saline lagoons are benthic invertebrates (i.e. those in and on the surface of the mud), of which chironomid (non-biting midge) larvae are thought to be particularly important. Small fish, such as Three-spined Sticklebacks *Gasterosteus aculeatus* and Common Gobies *Pomatoschistus microps*, and large shrimps, such as Common Ditch Shrimps *Palaemon varians* and Brown Shrimps *Crangon crangon*, provide prey for Eurasian Spoonbills (Kemper 1995; Triplet *et al*. 2008), egrets, Greenshanks *T. nebularia* and Spotted Redshanks *T. erythropus*.

79. Periodic lowering of water levels in some of the saline lagoons on Wallasea Island is used to provide suitable conditions for the growth of annual plants such as Purple Glasswort *Salicornia ramosissima*, Annual Sea-blite *Suaeda maritima* and Spear-leaved

Orache *Atriplex prostrata*, August 2020. Raising water levels in autumn suspends the seeds of these plants and makes them available to feeding wildfowl.

At Wallasea Island, the aim has been to maintain the salinity of the lagoons and RTE area between 15 and 45 parts per thousand (ppt). Sea water is about 35 ppt. It has been important to monitor salinities as well as water levels, while a programme of monitoring invertebrates and fish has been valuable in informing management.

The three shallow Beagle Lagoons have been designed so that each can be periodically dried out and reflooded on rotation. This cycle aims to maintain a continuity of early successional habitat at the site, while also providing abundant seed for wintering wildfowl. Lowering water levels during late spring and summer exposes moist mud on which annual plants germinate and grow, by far the most abundant of which in the lagoons at Wallasea Island is Purple Glasswort (plate 79). Raising water levels in autumn suspends the seeds produced by these annuals, making them available to wildfowl such as Eurasian Teals *Anas crecca*. Water levels are initially raised by adding sea water from the River Roach, and the lagoons then closed off to allow them to retain winter rainfall. This rainfall reduces the salinity of the water over winter, making it slightly easier to prevent the lagoons from becoming hypersaline during the following breeding season.

The benthic fauna of the saline lagoons at Wallasea Island is dominated by chironomid larvae, Lagoon Cockles *Cerastoderma glaucum* and the spire snail *Ecrobia ventrosa*. The most abundant prey in the saline lagoons for

Eurasian Spoonbills and other fish- and shrimp-eating birds are Common Ditch Shrimps. Of the benthic invertebrates, chironomid larvae recolonise the lagoons most rapidly following drying out and reflooding. Nevertheless, lagoons that have been reflooded in autumn still contain little in the way of benthic invertebrate prey for birds the following spring but support a far higher biomass by the second spring after reflooding. For example, three lagoons reflooded in September/October of year one had a mean ash-free dry weight of chironomid larvae of just 0.3 g per square metre in the first March and May following flooding. Two of these lagoons then remained flooded and supported a mean ash-free dry weight of chironomid larvae of 2.9 g per square metre in the second March following flooding. Common Ditch Shrimps also occur at fairly low densities during the first spring following autumn reflooding. However, these breed prolifically in the lagoons and attain high densities by late summer, with good numbers then remaining through the following winter and spring. The same three lagoons as detailed above, reflooded in September/October, had a mean density of 12 Common Ditch Shrimps per square metre in May of the following spring, and 62 per square metre in the two lagoons in March the year after.

Prior to the introduction of tidal flooding, Pool Marsh had accumulated rainwater and the salinity gradient that developed once it was opened to tidal flooding was presumably responsible for it attracting large numbers of Three-spined Sticklebacks from the adjoining estuary to breed. We have subsequently tried to create a similar salinity gradient by closing the RTE off from the sea in winter so that it accumulates rainwater and then opening the sluices in late February/early March so that fresher water trickles out on ebbing tides. Densities of sticklebacks have, though, subsequently remained low in the RTE area, but it instead now supports high densities of shrimps,

particularly Common Ditch Shrimps. It also supports two species of shrimps not found so far in the saline lagoons: the Brown Shrimp, which migrates into the RTE area from the adjoining estuary, and low densities of the Chameleon Shrimp *Praunus flexuosus* (fig. 1a).

The benthic fauna of the RTE area was initially dominated, in terms of biomass, by chironomid larvae and Lagoon Cockles but has subsequently developed a more diverse fauna (fig. 1b). This comprises taxa found in the saline lagoons (chironomid larvae, *Ecrobia ventrosa* and Lagoon Cockles), together with those found in nearby fully intertidal areas (ragworms, Laver Spire Shells and the bivalve *Abra tenuis*). While the total biomass densities of benthic invertebrates in the RTE has been increasing, this has been accompanied by a decline in relative abundance of chironomid larvae.

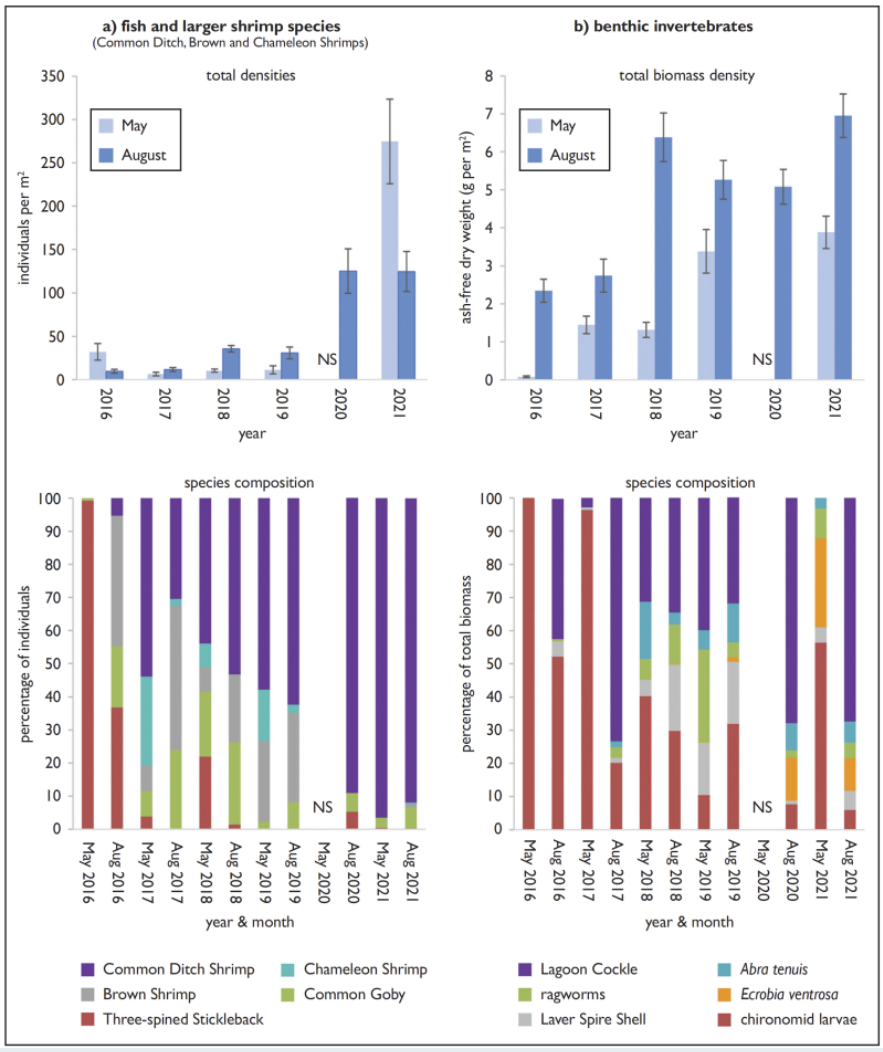


Fig. 1. Changes in abundance of benthic invertebrates, fish and larger shrimp species in the area of regulated tidal exchange at Pool Marsh. The area was first flooded with saline water in winter 2015/16. For densities, bars show means ± one standard error. Benthic invertebrates were recorded in mud samples 6.2 cm diameter by 5 cm deep, and fish and shrimps using a 41-cm diameter Robertson dustbin sampler (Ausden 1996). Thirty samples were taken on each occasion. Note that no sampling was carried out in May 2020

due to Covid-19 restrictions. Virtually all Common Ditch Shrimps *Palaemon varians* recorded in August are very small immatures.

A predator-exclusion fence (plate 80) has been installed in a specially constructed ditch that surrounds the 120-ha area containing Grass Farm Lagoon, the Salt Pan and Marsh Flats, with the aim of protecting nesting birds from predation by Foxes and Badgers. Foxes are also controlled on the reserve in areas outside of this fence.

80. A section of 'in-ditch' predator-exclusion fence designed to protect nesting waders, terns and gulls from predation by Red Foxes *Vulpes vulpes* and Badgers *Meles meles*, Wallasea Island, November 2018. The fence works because Foxes and Badgers are unable to jump or climb over even a low fence from a 'swimming position'. During its first seven years of operation, there has been only one

known instance of a Fox getting inside the fence, when the surface of the saline ditch briefly froze following heavy snowfall. Black-headed Gulls *Chroicocephalus ridibundus* and Avocets *Recurvirostra avosetta* have become so accustomed to the lack of Foxes and Badgers within the fenced area that they nest around the edges of the lagoon, as well as on islands. Similar designs of in-ditch fences have since been installed on other RSPB reserves.

Grazing marsh

Marsh Flats and Tillets Marsh (plate 81) are managed in a similar way to other coastal grazing marshes, with the aim of benefiting breeding waders and other wildlife, albeit without the ability to add fresh water. Cattle are brought onto the grazing marsh by a local grazier each April, with the animals remaining until November. The intention is to provide a suitable sward for grazing geese and Eurasian Wigeons *Mareca penelope* in winter and for breeding Northern Lapwings *Vanellus vanellus* and Common Redshanks in spring, while minimising the risk of nests being trampled.

81. Tillets Marsh, Wallasea Island, March 2020. The view across the eastern part of the grazing marsh when high winter rainfall caused extensive flooding. With no input of fresh water other than rainfall, the extent of this surface flooding can vary greatly between years.

Part of Marsh Flats is fed with saline water via the Salt Pan and so can be kept wetter by management of sluices. The western half, however, relies on rainfall to fill the scrapes and foot drains (shallow ditches). This means that water levels vary each year, both in how high they reach at the end of winter and in how long this surface water remains through spring and summer.

Rough grassland

Unlike Marsh Flats, Lytag and Tillets Marshes were not seeded with a grass mix and were left for their vegetation to develop through natural regeneration.

Lytag and a large area of Tillets Marsh and some other areas of the reserve are managed to provide rough grassland, mixed with areas of shorter grass, bare ground and ruderal vegetation. This is primarily to provide habitat for Corn Buntings *Emberiza calandra* and to support high densities of Short-tailed Field Voles *Microtus agrestis*, which are important prey for raptors including Hen Harriers *Circus cyaneus*, Barn Owls *Tyto alba,* Short-eared Owls *Asio flammeus* and Common Kestrels *Falco tinnunculus*. The highest densities of breeding Yellow Wagtails *Motacilla flava* on Wallasea Island have occurred where grassland has been patchily flooded with saline water leaving a mixture of tussocks and open ground (plates 82 & 83).

82 & 83. Lytag Marsh, Wallasea Island, August 2019. These areas of tall grassland interspersed with open areas, which were created by patchy flooding with saline water, supported high densities of breeding Yellow Wagtails *Motacilla flava*, with 18 territories

present on the 52 ha of Lytag Marsh in 2019. Yellow Wagtails nest in dense vegetation but use nearby open areas to access their nests and for feeding. Those breeding on Wallasea Island probably feed mainly on adult non-biting midges that emerge from the saline waterbodies.

An area of grassland to which reptiles have been translocated is managed by annually mowing one-third of it in a series of wavy lines in early autumn. This is done to increase the heterogeneity of the sward for reptiles, and may also increase the accessibility of Short-tailed Field Voles to hunting raptors (e.g. Schlaich *et al*. 2015). Mowing is carried out in warm conditions, so that the reptiles are active and have a chance to move away, and with the flail set about 10 cm above the ground to further minimise the risk to them.

Sea walls

The aim of sea-wall management is to maintain a flower-rich sward to benefit invertebrates. A proportion of them are cut each year using a ‘cut and collect’ attachment on the mower, which allows for the removal of the mown material. Maintaining and increasing the cover of good nectar sources, such as Red Clover *Trifolium pratense,* along the sea walls should benefit a range of insects, including the rare Shrill Carder Bee *Bombus sylvarum* and the Brown-banded Carder Bee *B. humilis,* both of which are present on site

Birds

Wintering and passage waterbirds

Use of Jubilee Marsh by most wildfowl species remains fairly constant throughout the tidal cycle, but its use by most wader species is far higher within the three hours or so around high tide, especially on the rising tide (fig. 2). This is presumably due to the lack of higher-elevation mudflat elsewhere on the adjoining estuary for waders to feed on during the higher states of the tide, and of undisturbed areas for them to roost elsewhere on the estuary at high tide. Higher areas of intertidal habitat are probably under-represented on many estuaries, lost in the past through land reclamation, while undisturbed roost sites are often in short supply due to recreational disturbance from humans.

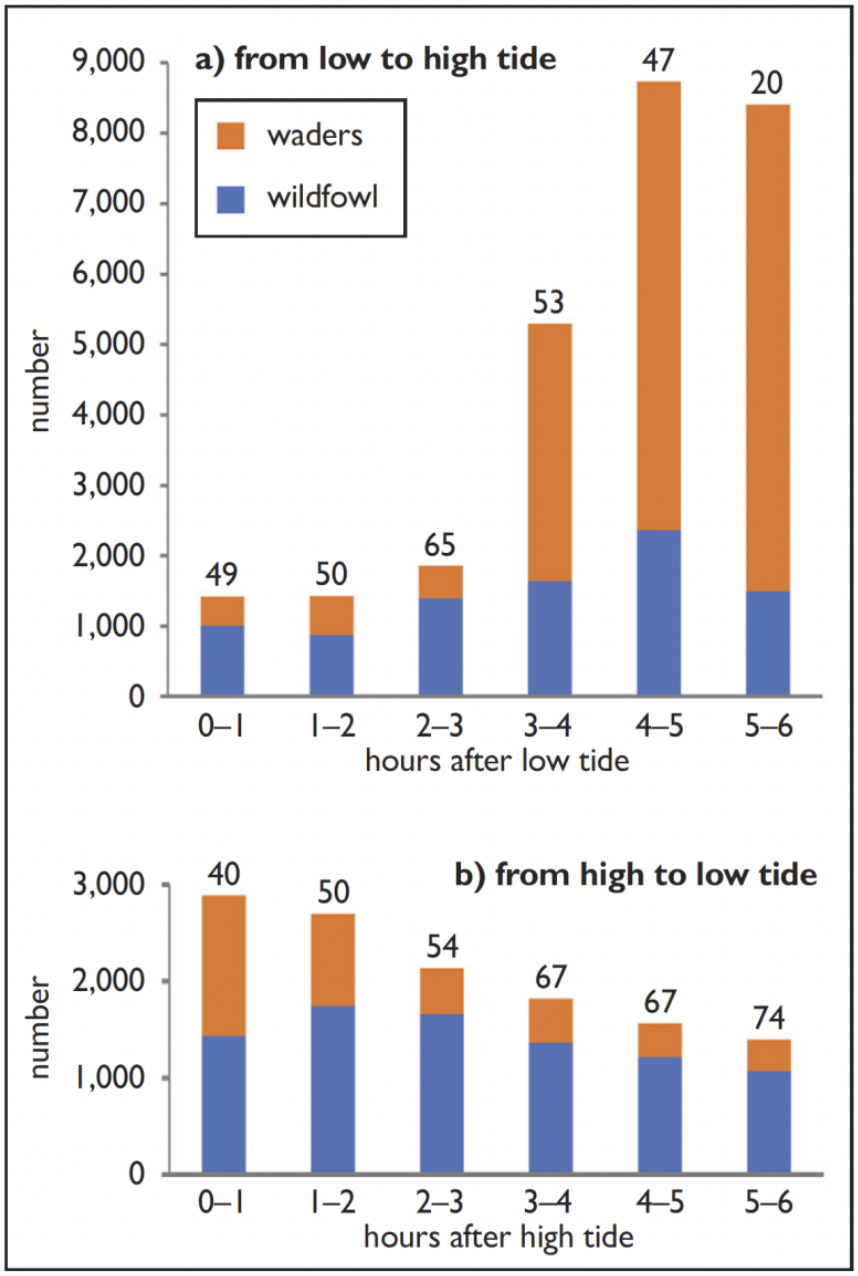


Fig. 2. Changes in use of Jubilee Marsh by all wildfowl and waders between low and high tide and vice versa. Figures are the means of three counts of each made between 11th January and 6th February 2018, and of three counts of each made between 5th January and 11th February 2022. The figures above each bar show the percentage of waders that

were feeding on Jubilee when first observed.

During the winters of 2019/20 and 2021/22, the c. 150 ha of mudflat and c. 173 ha of saline waterbodies at Wallasea Island supported, respectively, an average of 60% and 46% of the wildfowl and waders counted at high tide on the whole Crouch and lower Roach Estuaries, which contain an estimated 498 ha of mudflat (fig. 3). Four species already occur in internationally important numbers at Wallasea Island – Grey Plover *Pluvialis squatarola*, Red Knot *Calidris canutus*, Bar-tailed Godwit *Limosa lapponica* and Shoveler *Spatula clypeata* – while a further seven species are present in nationally important numbers.

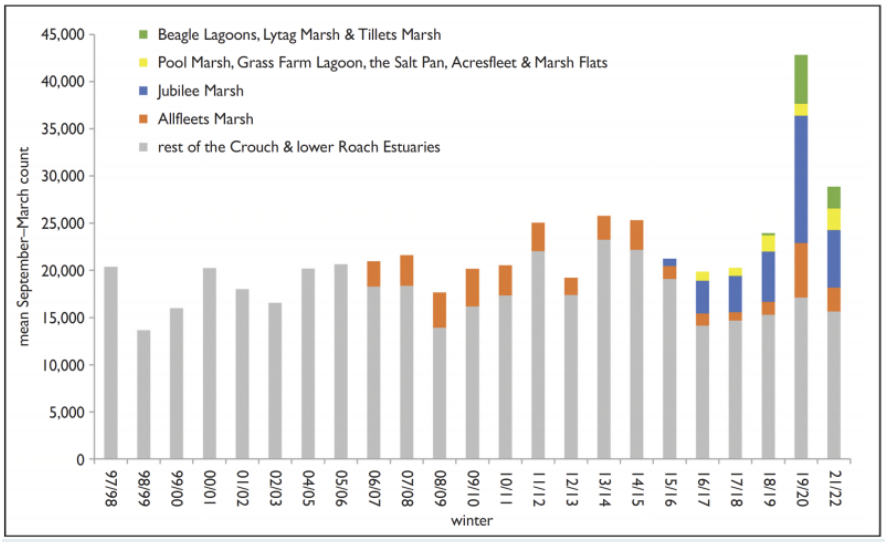


Fig. 3. Total numbers of wintering waterbirds (not including gulls) on different areas of Wallasea Island RSPB reserve compared with on the rest of the Crouch and lower Roach Estuaries. Data are from monthly Wetland Bird Survey (WeBS) high-tide counts with

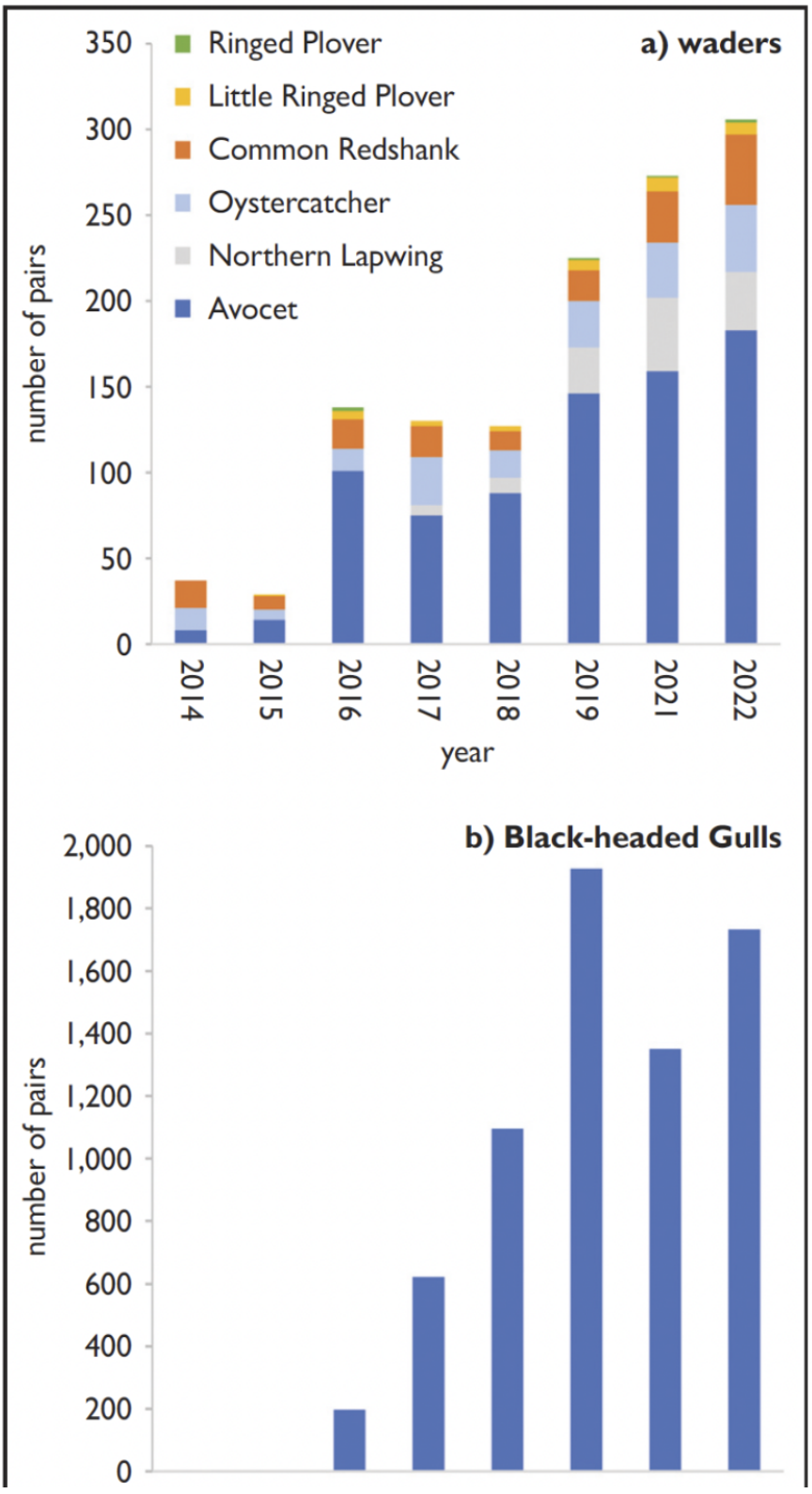
occasional missing counts for the rest of the estuary interpolated or estimated. WeBS counts for the rest of the Crouch and lower Roach Estuaries were too incomplete during winters 2003/04 and 2020/21 to enable comparison for these periods.

As shown in fig. 3, the creation of wetland habitats at Wallasea Island has increased the total number of waterbirds using the whole Crouch and lower Roach estuarine complex. In the case of Common Shelducks *Tadorna tadorna*, Shovelers, Teals, Avocets, Bar-tailed Godwits, Knots and Dunlins *Calidris alpina*, numbers on the Crouch and lower Roach complex have increased by an amount similar to that at Wallasea Island since the start of habitat creation. In the case of Wigeons and Lapwings, although numbers have increased considerably on the reserve, total numbers on the entire estuary complex have remained more or less stable. Nevertheless, by providing additional habitat that is favoured by these species, the newly created habitat is hopefully increasing the fitness of individuals and thereby benefiting their population.

Breeding waterbirds, gulls and terns

The number of breeding waterbirds has, in general, continued to increase at Wallasea Island (fig. 4). A disappointment, though, has been the lack of breeding Ringed Plovers on the reserve and, although occasional pairs have been present, there has still not been any successful breeding. However, areas of open ground at Wallasea Island do usually support breeding Little

Ringed Plovers *C. dubius*, with a peak so far of eight breeding pairs in one season. Little Terns have not yet shown any interest in the site, and their population remains low elsewhere in Essex. It is hoped that decoys at Wallasea Island will attract them to breed in suitable areas of shingle.



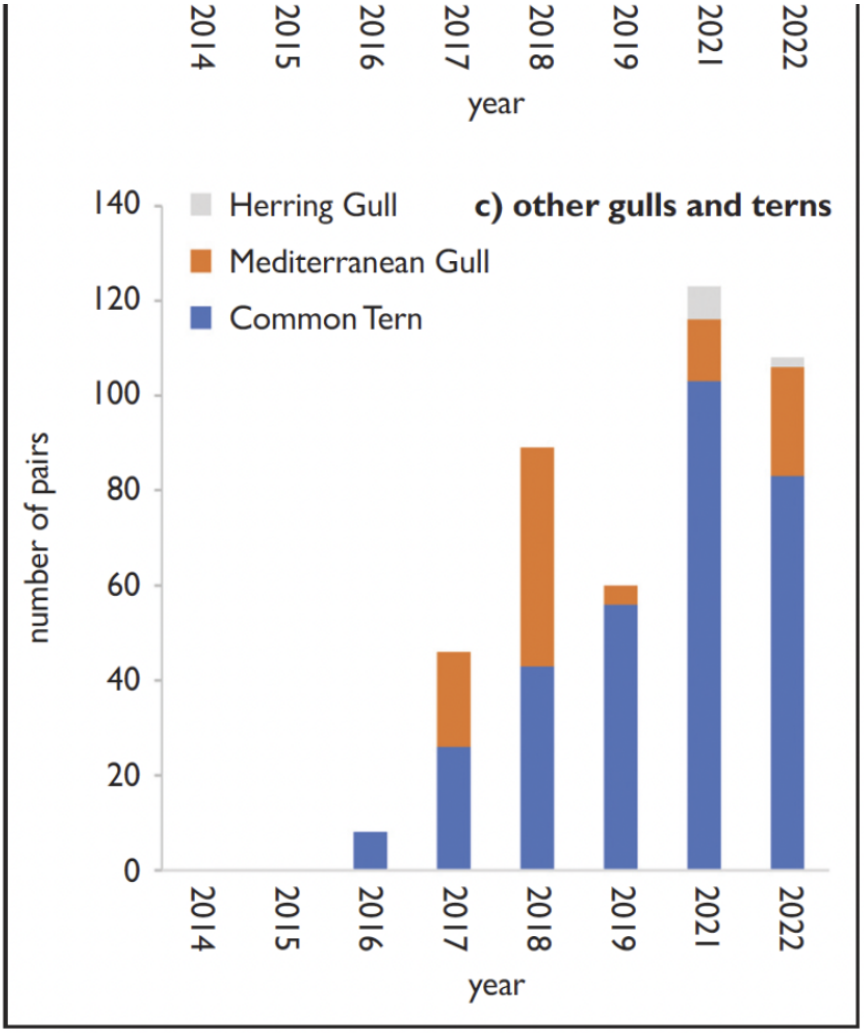


Fig. 4. Numbers of pairs of breeding waders, gulls and terns at Wallasea Island RSPB reserve. Jubilee Marsh and Grass Farm Lagoon, which support the majority of these species, were completed, respectively, prior to the 2016 and 2017 breeding seasons. Breeding birds were not fully monitored in 2020 due to Covid-19 restrictions.

Although Spoonbills have yet to breed on the reserve, the numbers present and the length of time they remain on the site have both increased. Three

birds wintered for the first time in 2021/22, following a large increase in densities of Common Ditch Shrimps, a key prey item for them, in the Beagle Lagoons and Pool Marsh.

Wintering raptors

A special feature of Wallasea Island is its wintering raptors, with its large expanses of rough grassland being a good place to see Short-eared Owls and Hen Harriers. Peregrine Falcons *Falco peregrinus* and Merlins *Falco columbarius* are also regular in winter, and two Rough-legged Buzzards *Buteo lagopus* were present during the 2014/15 winter and one in October/November 2018. These, together with the almost constant presence of commoner raptor species across the open landscape, make Wallasea Island one of the best places in Essex to seebirds of prey in winter.

Breeding songbirds

While Wallasea Island supports only a limited range of breeding songbirds, it makes up for this in the large numbers and high densities of some species, including species that are scarce or declining elsewhere. In spring and early summer, its wide, open skies are full of the song of Skylarks *Alauda arvensis*, virtually every bush and patch of Black Mustard *Brassica nigra* has a Corn Bunting singing from it, and there is an almost constant background sound of Yellow Wagtail songs and calls. Numbers of breeding songbirds, apart from Yellow Wagtails (which may be declining slightly), are still similar on the 260 ha of grassland to what they were across the entire 600 ha of arable land; Corn Buntings were probably declining on the arable land until it was converted to wetland and grassland, at which point the population stabilised. Consequently, the density of breeding pairs is now higher per area of ‘dry

habitat' than when the land was arable (table 1).

Table 1. Numbers and densities of the most abundant breeding songbirds on the area of land that is now Wallasea Island RSPB reserve. Songbirds were not surveyed in 2020 due to Covid-19 restrictions.

species	prior to habitat creation – 600 ha of arable in 2008		following conversion to 260 ha of grassland & 340 ha of intertidal & saline lagoons (mean of figures for 2018, 2019, 2021 & 2022)	
	total number of territories	territories per km² of arable	total number of territories	territories per km² of grassland
Skylark *Alauda arvensis*	182	30	206	79
Yellow Wagtail *Motacilla flava*	73	12	51	20
Corn Bunting *Emberiza calandra*	94	16	96	37
Reed Bunting *Emberiza schoeniclus*	78	13	71	27

84. Corn Bunting *Emberiza calandra*, Yorkshire, May 2020. Wallasea Island supports large numbers of breeding Corn Buntings, with 70 territories present in 2022.

Tim Melling

Other species

Shore Lark *Eremophila alpestris* and Twite *Linaria flavirostris,* which are both rare in Essex, have been seen on the site during winter. Twites feed on the abundant seed of glassworts and Annual Sea-blite, which are found both on the developing saltmarsh and around many of the edges of the lagoons and creeks.

Rarer geese that have been seen on the reserve in the last few years include 'Black Brant' *Branta bernicla nigricans,* Red-breasted Goose *B. ruficollis* and Lesser White-fronted Goose *Anser erythropus,* while White-fronted Geese *A. albifrons* are becoming increasingly regular.

Given the location of the site close to the east coast, and its attractiveness to Yellow Wagtails, it is unsurprising that 'Blue-headed Wagtails' *Motacilla flava flava* and 'Channel Wagtails' *M. flava flavissimma x flava* occur on passage most springs. A male Blue-headed Wagtail was present in summer 2019 and was seen carrying food.

The current lack of large areas of good-quality habitat for passage waders means that the site has yet to deliver many rare and scarce waders, and this may continue to be the case given the lack of fresh and low-salinity pools on which a large proportion of rarer waders in Britain occur. The rarest wader recorded so far is a Broad-billed Sandpiper *Calidris falcinellus* on Allfleets Marsh in October 2008.

Other wildlife

Wallasea Island is home to a number of scarce and uncommon invertebrate species, one of the most visible of which is the Black Oil Beetle *Meloe proscarabaeus*. The adults can be seen in March and April, particularly along

the edges of the footpaths where short and longer grass meet. Scarce Hymenoptera found on the sea walls include the aforementioned Shrill Carder and Brown-banded Carder Bees, together with the Black-headed Mason Wasp *Odynerus melanocephalus*.

The sea walls abound with commoner butterfly species in summer, including large numbers of Marbled Whites *Melanargia galathea,* small numbers of Brown Arguses *Aricia agestis* and, in some years, good numbers of Clouded Yellows *Colias croceus.*

Meanwhile, the saline waterbodies have quickly developed a characteristic saline-lagoon fauna and support, amongst other species, the rare Lagoon Sand Shrimp *Gammarus insensibilis,* discovered in Grass Farm Lagoon in 2020. The bare and sparsely vegetated margins of the saline lagoons and RTE area and their associated plant detritus already support a wide range of Nationally Scarce invertebrates, such as the shore bugs *Halosalda lateralis* and *Saldula pilosella* and the ground beetles *Tachys scutellaris* and *Pogonus littoralis*. Extensive stands of Sea Aster *Tripolium pannonicum* in some areas of the lagoons support large numbers of Sea Aster Mining Bees *Colletes halophilus*, which excavate their nest burrows in the transition zone from saltmarsh to grassland.

The reserve holds good populations of several annual plant species characteristic of bare and disturbed saline ground, including the Nationally Scarce Stiff Saltmarsh-grass *Puccinellia rupestris*, Borrer's Saltmarsh-grass *P. fasciculata*, Sea Barley *Hordeum marinum* and Annual Beard-grass *Polypogon monspeliensis*. Prior to the wetland creation, these were largely confined to trackways and other disturbed areas on the island but have all since colonised the newly created wetland habitat. Other Nationally

Scarce plant species found at the reserve include the annuals Sea Clover *Trifolium squamosum*, which is found mainly on the new sea walls, and Bithynian Vetch *Vicia bithynica*.

A notable feature of Wallasea Island is its large population of Brown Hares *Lepus europaeus*. Night-time surveys across the reserve in April 2017 and 2021 estimated a population of about 80 individuals. Hares probably benefit from the absence of Foxes within the predator-exclusion fence, and the control of Foxes outside it. There is also a breeding colony of 20–30 Common Seals *Phoca vitulina* on the adjacent River Roach, which sometimes enter Jubilee Marsh to feed. The seals are often stained orange from the iron-oxide-rich mud. Eurasian Otters *Lutra lutra* were seen on the reserve for the first time during winter 2021/22.

Visitors

Unusually for the southeast of England, visitors to Wallasea Island can find themselves in the middle of a large, wild, coastal landscape. There are 15 km of trails to explore, some along the grassy sea walls and some through the centre of the reserve, with views across the lagoons and grasslands.

Caroline's Hide is located about 1.5 km from the car park with plenty of benches on the way. A viewing mound lies to the south of Grass Farm Lagoon, providing views across the water and to the south over the rough grassland, where raptors are often found in winter. At the far northeast and southeast corners of the reserve, there are two wind-shelters.

The reserve is open and flat, so one of the main considerations is to welcome visitors whilst also preventing disturbance to the birds and other visitors

watching them. This has involved creating earth bunds to screen visitors in sensitive areas. The number of visitors visiting the reserve each year has increased over the past decade and now stands at over 30,000 visits per year.

85. Bar-tailed Godwit *Limosa lapponica*, Norfolk, December 2011. Bar-tailed Godwit is one of the wader species for which numbers have increased markedly in the whole Crouch and lower Roach estuarine complex following creation of intertidal habitat on Wallasea Island.

The future

The Wallasea Island project has provided a large-scale example of adaptation to coastal change caused by climate-change-driven sea-level rise, while also increasing the numbers of waterbirds using the Crouch and Roach estuarine

complex in winter, something it should continue to do as sea levels rise further. The reserve also now supports good numbers of breeding waterbirds as well as retaining significant breeding populations of farmland birds. The project has also demonstrated the benefits that can be delivered through thinking big and developing partnerships with organisations such as Crossrail.

Despite these successes, challenges remain. The first is that, while the Beagle Lagoons work well in terms of providing seed for wintering wildfowl and supporting high densities of shrimps for birds such as Eurasian Spoonbills, it has so far proved difficult to provide good conditions for breeding and passage waders in these and the other lagoons. Even though we have taken climate change projections into account in the design of the lagoons, recent springs have been incredibly dry, making it difficult to prevent the large, shallow Beagle Lagoons from drying out too much through evaporation and/or becoming hypersaline. In fact, in the four springs since the Beagle Lagoons were first flooded in winter 2018/19, total rainfall in April and May in East Anglia has been, respectively, just 52%, 30%, 86% and 47% of its long-term (1985–2022) average (www.metoffice.gov.uk/research/climate/maps-and-data/uk-and-regional-series). These prolonged periods of dry weather have been caused by persistent periods of high pressure. More frequent and persistent weather patterns such as these are possibly also linked to climate change (Francis & Vavrus 2015).

We have, until now, not been able to maintain the Beagle Lagoons at their intended maximum winter water levels as their banks had not fully vegetated and stabilised. Meanwhile, the difficulty of adding sea water to reduce salinity in spring and early summer has been exacerbated by Avocets often nesting

on low-lying islands close to the water line. This has meant that adding sea water to top up water levels risks flooding their nests. To try to overcome this problem, we raised existing islands in 2022 in addition to creating new ones, so we can maintain higher water levels in the future without covering islands, thereby reducing the risk of salinities rising too rapidly. The new islands will also provide better viewing opportunities for visitors.

Another issue affecting the suitability of all the lagoons for waders is that, due to them being constructed on ex-arable clay soil, much of their substrate is solid and seemingly rather inert. Fine organic matter is accumulating in the lagoons, but this tends to settle in the deeper areas, leaving their shallow margins rather hard and less suitable for benthic invertebrates and thereby feeding waders. In 2022, we have trialled rotovating some of these shallower areas while the lagoons were dried out, to help break up the substrate and incorporate organic matter from vegetation that has grown on it.

A further challenge involves maintaining suitable conditions for breeding farmland birds in the longer-term, by preventing all of the rough grassland from becoming dominated by tall, perennial grasses. The aim is to retain a mixture of tall and short grasses, including a high proportion of annual plants that provide abundant seed, and bare ground, through patchy flooding, occasional cultivation, and patchy cattle grazing.

Finally, as at virtually all sites in Britain with suitable habitat for ground-nesting birds, predation by generalist predators remains an ongoing issue. While the predator-exclusion fence has worked well, waders such as Avocets are faced with an unenviable dilemma: nest outside the fenced area and be vulnerable to predation by Badgers and Foxes, or nest within the fenced area and be vulnerable to predation from the large numbers of gulls that also

breed on the lagoons. The underlying issues to be resolved are the reasons for the high densities of generalist predators now present in Britain (e.g. Roos *et al*. 2018), and the lack of alternative nesting areas that have both suitable habitat and are safe from disturbance by people and dogs.

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Wallasea Island
Malcolm Ausden, Rachel Fancy and Chris Tyas
2023 Vol.116: Pages 77–91

< Previous article

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