

Bitterns: booming, or boom and bust?

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Abstract Action taken since the mid 1990s to prevent the extinction and then bring about the recovery of the UK Eurasian Bittern *Botaurus stellaris* population might reasonably be regarded as a huge success: there were some 236 booming males in 2023, the highest number ever recorded. But Bitterns are closely associated with reedbeds, a habitat prone to rapid succession to habitats unsuitable for Bitterns, at least in the current British landscape. In this paper we assess what action might be required to ensure that we retain the UK Bittern population and promote further increase. We first update information on the extent of recovery and identify the key factors which have driven it. We provide a summary of the current state of the reedbed resource, based on a recent audit of 29 key sites, and identify actions which might be applied both at these sites and across those within the historical UK range of the species.

Introduction

The Eurasian Bittern *Botaurus stellaris* was once widespread across lowland areas of the UK but had become extinct by the late 1880s (Brown *et al.* 2012). The species returned as a breeding bird in the early twentieth century, with numbers increasing to a peak of 79–82 booming males in 1954, before decreasing once again to just 11 booming males in 1997. These remaining birds were located mainly in Suffolk and Norfolk, with a small, outlying population at Leighton Moss, Lancashire & North Merseyside.

The alarming decline from 79–82 males to just 11 in less than five decades prompted detailed research into clarifying the basic habitat needs of breeding Bitterns in the UK in order to identify the causes of the decline and a means of halting – and hopefully reversing – it (Gilbert *et al.* 2005a,b, 2007). At its simplest, the key factor driving the decline from at least the 1970s

onwards was natural succession within the reedbeds. As reedbeds dried out and habitat diversity declined, female Bitterns needed to move further – and so spent more time away from the nest – to find adequate food for their chicks. Additionally, drying up of reedbeds allowed predators easier access to nests.

It was therefore theorised that by reversing natural succession – and the drying up – of reedbeds, fish populations might increase and access by predators might decline, promoting a corresponding



David Tipling

291. Eurasian Bittern *Botaurus stellaris*, Holme, Norfolk, February 2014.

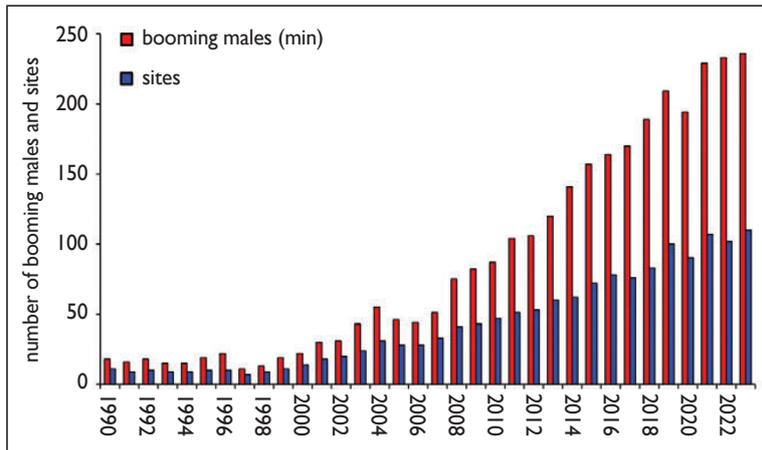


Fig. 1. The number of booming Eurasian Bitterns *Botaurus stellaris* and occupied sites 1990–2023.

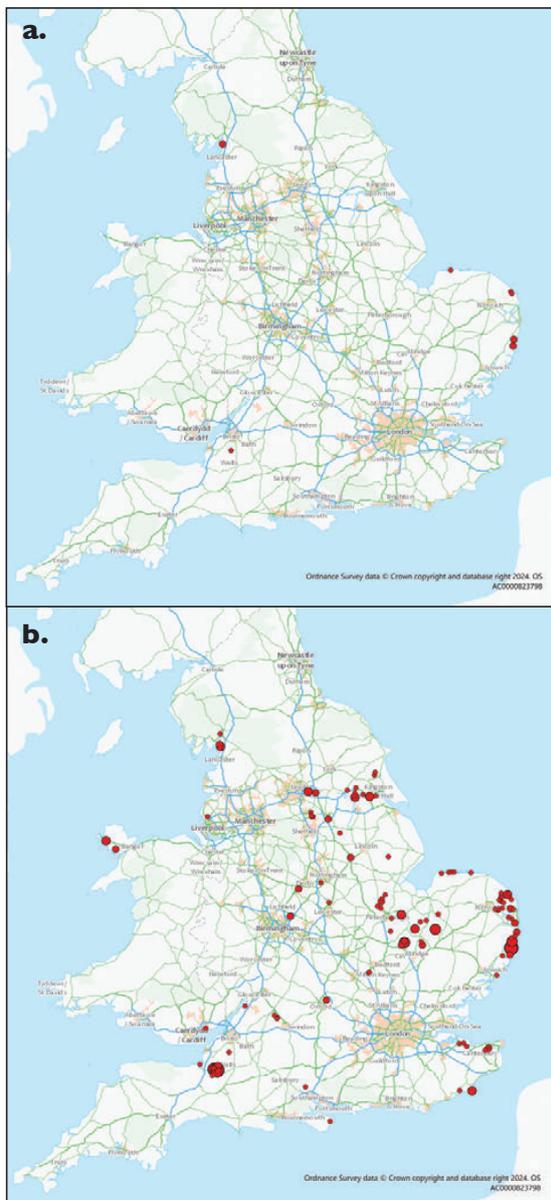


Fig. 2. The distribution of booming male Eurasian Bitterns in **a)** 1997 (11 birds at seven sites) and **b)** 2023 (236 birds at 110 sites). Note the spread inland during this period, particularly to the northwest and southwest of former key sites.

increase in Bittern productivity. With this knowledge, a concerted conservation effort began in earnest in the early 1990s, with many organisations (statutory, voluntary and private) contributing to a recovery programme, which was led by the RSPB and Natural England as part of their Action for Birds in England partnership. Two particular projects, both funded from the EU LIFE-Nature fund, enabled large-scale work across a number of sites.

From 1996 to 2000, ‘LIFE 1’ focused on restoring some 350 ha of reedbed on 13 of the larger sites in England. Most of the sites were in the core Suffolk and Norfolk breeding area for Bitterns and the number of booming males on these sites has since increased from four in 1997 to 31 in 2011 and 57 in 2023. From 2002 to 2006, ‘LIFE 2’ saw at least 300 ha of new reedbed created and a further 350 ha restored across 19 sites in order to produce a strategic network of sites stretching away from the core East Anglian sites. The number of booming males on these sites increased from 11 in 2002 to 39 in 2011 and to 86 in 2023. The Environment Agency’s Habitat Compensation Programme, which seeks to replace habitats that are lost as a result of coastal squeeze or tidal inundation, funded the creation of several reedbeds at inland locations, including the Wissey Wetlands in Norfolk, which are intended to replace habitats at risk from rising sea levels on the Norfolk coast.

The most recent estimate of the current area of reedbed in the UK is between 5,000 and 6,000 ha. Over the last 30 years, at least 1,200 ha of this has been restored to some degree, while over 1,500 ha has been newly created at an approximate cost of £10m. Of the 900 or so sites contributing to the reedbed total, only about 50 are greater than 20 ha, but these support the greater part of the UK Bittern population.

The Bittern population is estimated to be about 236 booming males at around 110 sites in 2023, following many years of steady increase (fig. 1; fig. 2). The number of nesting

females mirrors the trend for booming males, but the number recorded is much lower, the reasons for which are discussed later.

Maintaining the Bittern population in the UK

Notwithstanding the success achieved between 1997 and the current time, it would be a mistake to believe that the gains in the number of Bitterns in the UK will be sustained without further action. A number of threats and issues remain. Firstly, Bitterns have still not reoccupied all of their historical range in the UK, being scarce in Wales and absent from Scotland and Northern Ireland. Secondly, the impact of climate change threatens many key sites. And thirdly, but perhaps most importantly, natural succession continues to proceed apace. These issues are discussed in more depth below.

Additionally, a significant number of booming males are at what appear to be marginal sites; and the number of recorded nests remains much lower than the total number of booming males. Might we therefore be seeing a peak in the population, with a surplus of males occupying suboptimal habitat and a much lower number of productive females? We need to better understand these issues and to tackle the threats if we are to ensure that recent successes are sustained and that Bittern numbers will not decline once again.

Reoccupying the historical range

The LIFE 2 project sought the development of a strategic network of reed-rich wetlands stretching both northwestwards and southwestwards from the species' East Anglian stronghold. Fig. 2 shows that, despite considerable success in achieving this aim, the network needs to extend further westwards and northwards if the former range of the Bittern in the UK is to be reoccupied, for example to Scotland and Northern Ireland, where Bitterns bred during the nineteenth century but do not breed today. Reedbeds of significant size are relatively scarce in Scotland and few, if any, are managed with Bitterns in mind.

There may, however, be opportunities to manage existing habitat in Scotland for breeding Bitterns. For example, the tidal

reedbeds on the Tay Estuary have traditionally been considered unsuitable for breeding Bitterns. However, experience on the Humber Estuary, where habitat has been created for breeding Bitterns within and around a series of tidal reedbeds, suggests otherwise, with a pair breeding here in 2013. Loch of Strathbeg, North-east Scotland, is another site which, if managed appropriately, could surely support breeding Bitterns. An increasing population of European Beavers *Castor fiber* in Scotland might also help to provide suitable habitat for Bitterns by damming up rivers and creating lakes that will succeed to natural, early stage reedbed.

In Northern Ireland, several sites hold reedbeds over 10 ha in size, including Lough Neagh, Portmore Lough and Lough Erne, yet Bitterns remain rare, non-breeding visitors. Many of these reedbeds could be significantly enhanced for Bitterns with suitable management.

Increasing populations in northwest England and on Anglesey raise the chances of colonisation of Scotland and Northern Ireland. Indeed, there is already evidence of, for example, recolonisation in Cumbria and Northumberland.



David Tipling

292. Eurasian Bittern, November 2008.

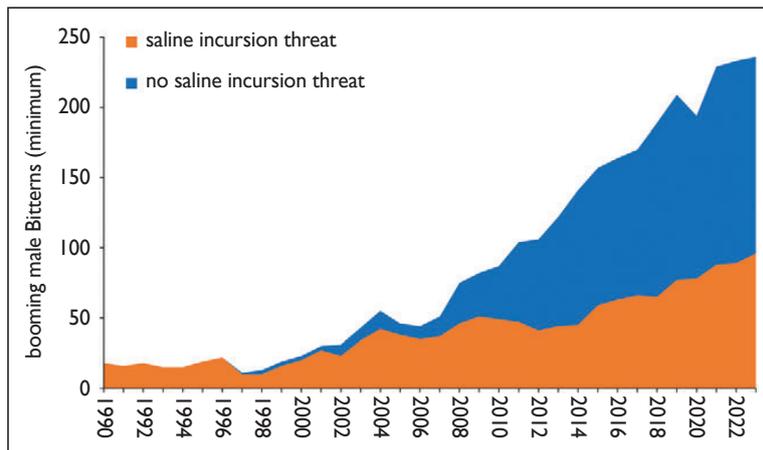


Fig. 3. Booming Eurasian Bitterns under threat of saline incursion. The increasing number of birds in areas with no threat represents the spread of Bitterns to inland areas.

Climate change

The potential impact of climate change on wetlands and reedbeds is a major threat to both breeding Bitterns and the survival of this habitat in general. In the 1990s, virtually all of the UK’s breeding Bitterns were at coastal locations at risk of loss from sea-level rise (Gilbert *et al.* 2010). Whilst the threat at these locations remains, the spread of Bitterns to inland sites had reduced concerns that the loss of these coastal reedbeds would lead to the loss of Bitterns from the UK. Regardless, around 40% of booming males are still at sites with a threat of saline incursion (fig. 3).

Extremes of weather, drought and flooding will have a significant impact on reedbeds. Measures that can deal with these events – such as upgraded water control structures to retain or release water – need to be in place to

better aid the creation and management of larger and more sustainable reedbeds; this includes ensuring that sites are well connected to rivers within their wider flood plains.

When looking at the broad picture across Europe (fig. 4), where many countries have undertaken similar conservation measures to aid breeding Bitterns (White *et al.* 2006), it is clear there has been a significant spread north and west between 1972–95 and 2013–17. Trends in the Netherlands, for example,

have been similar to those in the UK, with an increase of around 4% per annum. The Dutch population was estimated at around 600 booming males in 2022 (Boele *et al.* 2023). By contrast, there seems to have been a retraction in range across southwest Europe, notably in France. This underlines the potentially increasing importance of the UK population and, in particular, the value in looking at improving and creating more northerly sites in the UK.

Reedbed quality, natural succession and management plans

Reedbeds are prone to succession, with habitat quickly becoming unsuitable for Bitterns as a result of drying out, scrub development, etc. While the population and range of the Bittern in the UK have expanded considerably, the rate at which numbers have increased, and whether

these numbers have been sustained, varies across the country, possibly in relation to the scale of the conservation interventions made to maintain the quality of reedbeds and to slow or halt succession.

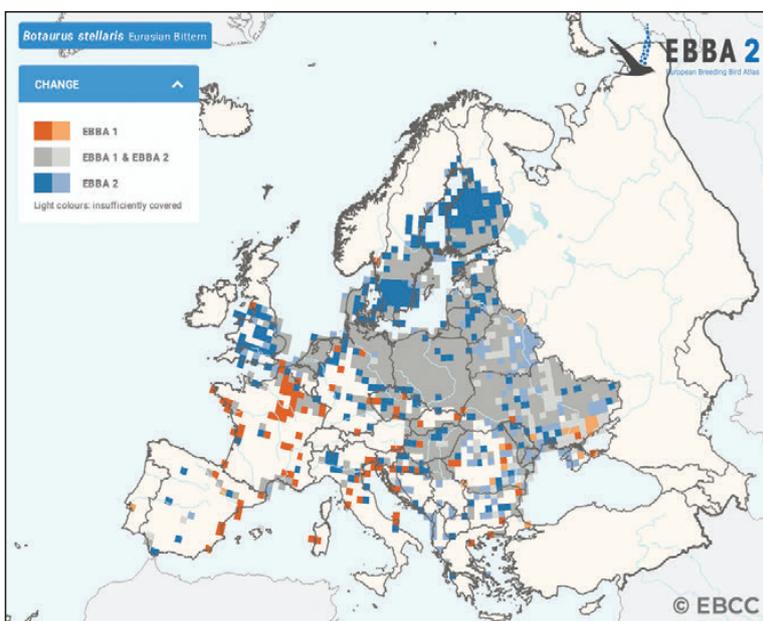


Fig. 4. Change in distribution of breeding pairs of Eurasian Bitterns in Europe between the first European Bird Atlas (EBBA I 1972–95) and the second (EBBA2 2013–17). Orange squares denote areas where breeding no longer occurs; grey squares areas where birds were breeding during both periods; and blue squares for formerly unoccupied areas where breeding now occurs. © EBCC

Clearly, the long-term future of the species in the UK is dependent on a commitment to the continued management of reedbed habitat; yet the degree of commitment (notably through financing) varies considerably between sites. To better understand these issues, Graham White and Graham Hiron, with the help of the managers of each site, undertook an audit of 29 key sites in 2023.

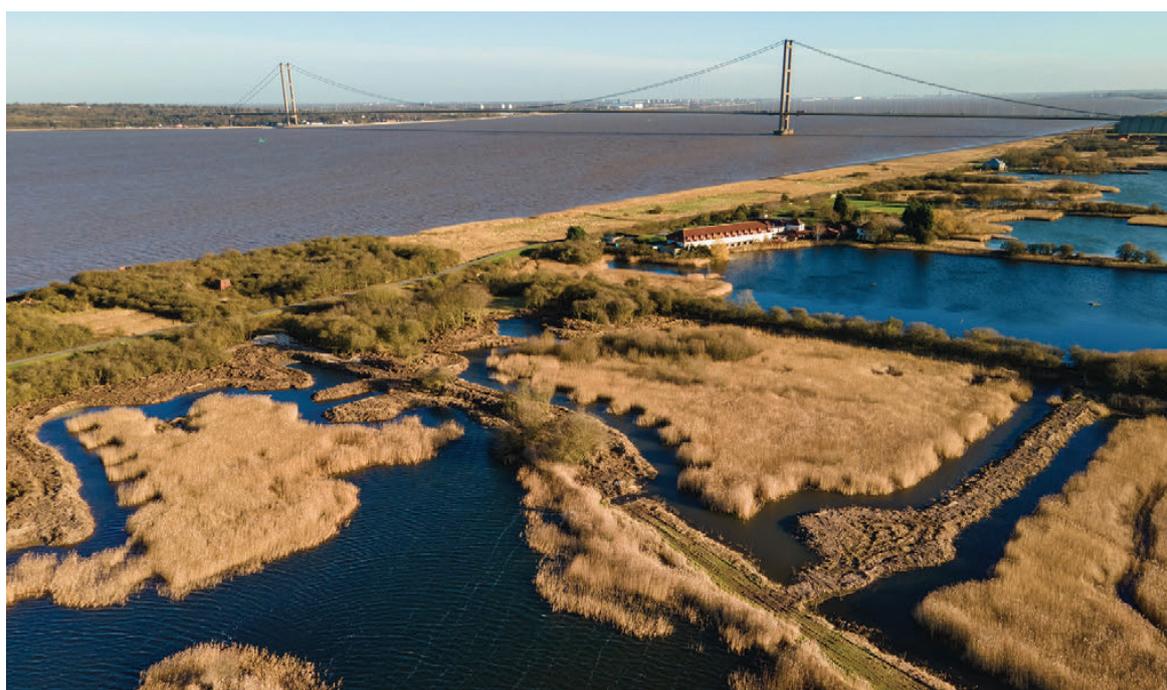
Recent and current management of each site was documented, along with trends in the number of Bitterns. Where possible, the condition of reedbed habitat was assessed using standard methods. This involved examining factors such as drying out and scrub encroachment, as well as recording the area of open water and depth, knowledge of fish populations and the quality of the reed itself. Reed age, height, density, stem thickness and litter depth were measured at various sampling points. Fish surveys were undertaken at seven sites.

The 29 reedbed sites audited totalled 2,147 ha of reedbed, supporting 140 booming Bitterns and 47 nests in 2023. Of the reedbed total, 1,176 ha had undergone some restoration, while 971 ha was newly created. A total of 25 sites had management plans in place, with 20 containing specific numerical targets for Bitterns. Bitterns were present at all sites, 13 supporting increasing numbers of booming males and 16 where numbers were considered to be stable.

We assessed reedbed management overall as good (sufficient to maintain suitable conditions for Bitterns over the next 5–10 years) at 23 sites, with six of these sites requiring no change and 17 requiring just small improvements (such as increased area or frequency of reed cutting or more frequent ditch management). At the six other sites assessed, reedbed management required significant reinvigoration of efforts to restore suitable conditions for breeding Bitterns.

Worryingly, just five of the 29 sites claimed that they had adequate funding for current management such that they could anticipate implementing their future management plans. Additionally, 11 sites indicated that they required extra funding for major restoration works and, more significantly, 13 sites claimed they had insufficient budget to achieve targets within their current management plans. Management budgets had been cut at several sites; at others, while budgets and staffing had been maintained, costs had increased and some sites had increased significantly in extent. Besides being needed for increased maintenance works and major restoration (including climate change adaptation), funding was required for machinery purchase and maintenance, fish surveys, project management and management plan preparation.

Recommendations for management were provided at each site. The two commonest



Lincolnshire Wildlife Trust

293. Far Ings, Lincolnshire.

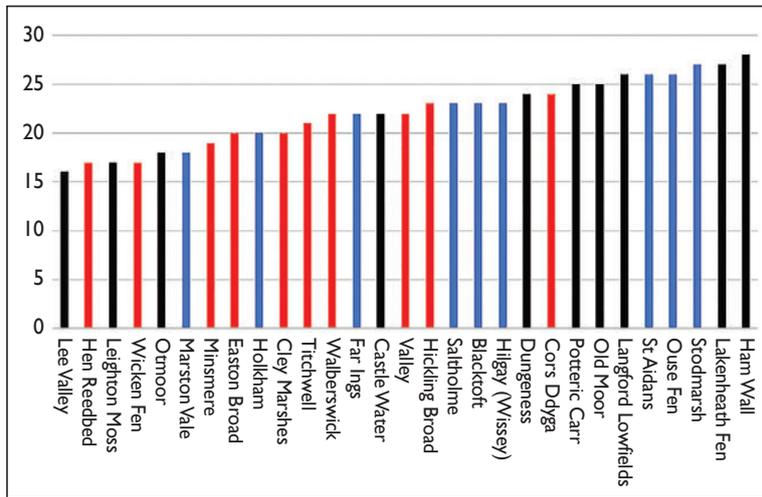


Fig. 5. Scores for audited sites for long-term suitability for Eurasian Bitterns. Red = LIFE 1 sites; black = LIFE 2 sites; blue = sites not in either LIFE project.

management recommendations concerned access to food for breeding Bitterns. This involved measures to ensure an adequate population of fish, and measures to ensure the appropriate management of the reedbed ditch and pool networks so that Bitterns can access the fish. Critical to both is action to slow and reverse ecological succession, which increases the amount of reed litter and reduces water depth. While scrub control was widely undertaken, removal of reed litter was not.

Other recommendations given included combating saline inundation, problems with hydrology and ‘problem species’, such as

Greylag Geese *Anser anser* and Red Deer *Cervus elaphus*, and using grazing animals to diversify reedbed structure.

Each site was given a score of up to 30 points for its long-term suitability for breeding Bitterns, including the reedbed quality assessment, the need for increased management and climate change adaptation. Fig. 5 shows that sites within the LIFE 1 project (where works were largely undertaken during 1996–2000) were amongst the lower scoring sites, reflecting primarily successional issues

such as deep reed litter and overgrown ditches or pools. By contrast, LIFE 2 sites (the targets of more recent action during 2002–2006), many of which were newly created, were in much better condition. The highest scoring sites were Ham Wall in Somerset, Stodmarsh NNR in Kent and Lakenheath Fen in Suffolk/Norfolk, all newly created and undertaking excellent management with Bitterns in mind. Lower scoring sites were not necessarily poorly managed, but the assessments indicated they had, for a variety of reasons, rather less potential for supporting breeding Bitterns in the medium- to long-term.

Steve Hughes



294. Sunrise from the Avalon hide at Ham Wall, Somerset 2022.



David Tipling

295. Eurasian Bittern, Lakenheath, Norfolk/Suffolk, June 2022.

Discussion

Management is essential

Most reedbeds are isolated from the rivers that feed the flood plains they are located on, and so management to maintain ideal conditions for Bitterns is essential to counter natural succession. Without regular flooding or a flow of water through them from an associated river, reedbeds would otherwise become progressively drier, leading to the loss of areas of open water and, in turn, fish and other Bittern food items. Eventually, with no management at all, the reedbed would turn to dry scrub.

Appropriate management techniques are well known and clear in setting out requirements (e.g. White *et al.* 2014). Rotational cutting of reed maintains the structure of the reedbed and may slow succession, but more extensive interventions are required to reverse succession. Reedbed-lowering, for example, removes the accumulated reed litter and underlying substrate, but it is expensive and spoil can be difficult to dispose of.

We found that the UK's older reedbeds are amongst those with the most urgent need for restorative work. Ditches and pools have been maintained at many of them, and this has allowed Bitterns to continue breeding at the sites by preserving healthy fish populations, but an invigorated restoration programme is a high priority amongst the management actions at many of these sites.

Management and restoration is costly. Estimates of the costs of managing 1 ha of reedbed vary, depending on site conditions and the length of the rotation; basic cutting may be £1,000 to £1,500 per ha but, with the addition of some restoration work, such as ditching or bed-lowering, costs may increase to around £7,000 per ha. Basic costs for reedbed creation are estimated at around £5,000 per ha at current rates. Our audit identified a minimum of 200 ha of reedbed in need of some level of restoration, requiring a budget in excess of £1 million.

Water-depth in reedbeds

Bitterns require at least some depth of water across the reedbeds they frequent. Guidance issued as a result of research conducted in the 1990s advised a target of 30 cm depth of water across the entire reedbed. We now realise that this advised depth should be regarded as a minimum requirement. Bitterns tend to nest in the part of the reedbed with the deepest water, with nests recorded in areas with water up to 1 m deep. Research in Poland (Polak 2007) showed water depth at nest sites varying from 10 to 97 cm, with a mean of 44.7 cm. The early tranche of sites restored in the UK mostly followed the original 30-cm guidance, and now require further restoration after many years of leaf-litter accumulation has lowered this depth. We recommend increasing water

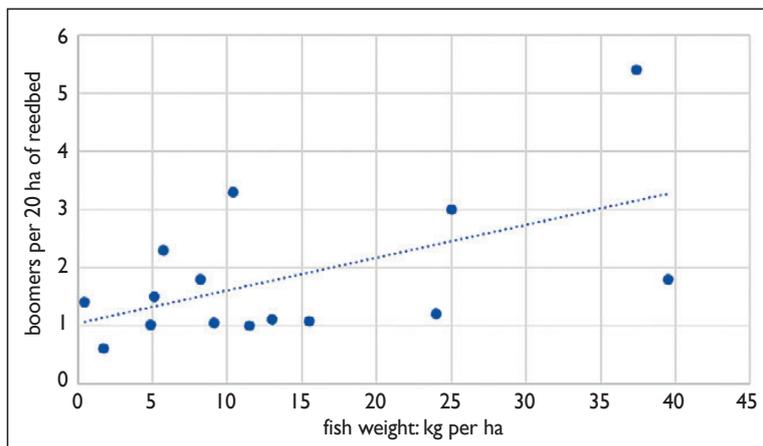


Fig. 6. Density of booming Eurasian Bitterns compared with fish weight (<300 gm).

levels to 50–70 cm wherever possible, thus creating better conditions for Bitterns and lengthening the time interval before further intervention is required.

Why are some sites punching above their weight?

The original rule of thumb used in promoting Bittern recovery was that individuals required around 20 ha of reedbed for a territory (Gilbert *et al.* 2005b). While this is essentially still correct, the ‘rule’ can be refined to become ‘a Bittern requires 20 ha of diverse wetland habitat, including reedbed and a healthy fish population’. This is because we now better understand the importance of a healthy fish population relative to the size of reedbed area. While our audit revealed that booming Bitterns were associated with

reedbeds over a range of sizes, with one booming male per 3.3 to 40 ha of reedbed, the relationship between density of territories and density of fish appeared to be much stronger (fig. 6). Indeed, the site punching most above its weight was RSPB Old Moor, Yorkshire, with three booming males (and three nests) present in just 11 ha of reed. This site has an extremely high length of reed/water interface per hectare, a large extent of total

wetland habitat and the highest fish density of any of the sites surveyed. By contrast, sites with poor fish populations, even those associated with a large area of reed, tended to support a lower density of Bitterns.

Fish surveys

Where sites seem to be underperforming, an informative first step is to investigate the fish population. Fish surveys are important in providing information on the populations of different species and an overall insight into the quality of the underwater habitat. The best sites for high fish density have reed extending out into water that is at least 1–2 m deep and with a gradient of at least 1:1 to 1:2 from the edge of the reeds. Poorer sites have shallow water (50 cm or less) at the edge of the reeds with minimal or no aquatic macro-

Graham White



296. Pool along a reedbed margin, Old Moor, Yorkshire, April 2023. Such pools can create good habitat for fish.



Graham White

297. Minsmere, Suffolk, August 2023. Although the reedbed at Minsmere is ageing, good ditch management maintains an excellent fish population.

phytes or underwater structure. Species such as Rudd *Scardinius erythrophthalmus*, Three-spined Stickleback *Gasterosteus aculeatus* and European Eel *Anguilla anguilla* are known to be important for breeding Bitterns, but Perch *Perca fluviatilis*, Pike *Esox lucius* and Common Roach *Rutilus rutilus*, which are taken by Bitterns in late winter, may assist birds coming into breeding condition, so a diverse fish population should be sought.

Nest success

Alongside the number of booming males, the key performance indicator for Bittern reedbeds is the number of successful nests. The Bittern is a polygynous species, with the female doing all of the nest attendance and feeding of the young. The number of females feeding young is therefore likely to be a better measure of breeding performance than booming males, as many males may fail to attract a mate or may move to a new site once mating is complete.

A method of monitoring the number of nests was developed in the early 1990s and involves recording the feeding flights of the females (Gilbert *et al.* 1998), although it is not always clear if all nests are detected, and this method is certainly more difficult to carry out than counting booming males. For example, 75 booming males were recorded in the UK in 2008 but only 39 confirmed nests (Wotton *et al.* 2008). In 2023, a total of 236 booming males were recorded (at 110 sites)

but only 74 confirmed nests (at 52 sites). Lakenheath and Minsmere are amongst the best-monitored sites and, in 2023, surveys recorded 11 booming males and six nests and 14 booming males and five nests, respectively. It is also plausible that feeding flights may be shorter or less frequent on sites where fish availability is greater. It should also be noted that there is now no formal nest monitoring at a substantial proportion of sites and the intensity of monitoring has likely declined in recent years.

It is interesting to note that smaller sites seem to have a higher ratio of nests to booming males. Monitoring might be easier at such sites, or smaller sites with healthy fish populations might indeed support more productive Bittern populations. We recommend further exploration of appropriate Bittern monitoring methods, including the use of drones with thermal-imaging cameras, as both the number of boomers and the number of nests with young are informative and useful attributes of the Bittern population and should continue to be reported.

Problem species

Red Deer and Greylag Geese cause regular damage to reedbeds that is detrimental to breeding Bitterns. Red Deer are present in reedbeds in Norfolk and Suffolk and at Leighton Moss. They can create deep, wet tracks through the reedbed. Small numbers are not a cause for concern and can, indeed, create

channels that enable fish to access the reedbed and thus become available to Bitterns. However, large numbers will create such a density of tracks that disturbance to breeding Bitterns is likely. At Leighton Moss, large numbers of Red Deer used to shelter in the reedbeds, which provided refuges from shooting on neighbouring land, and tracks were present every metre or so. A programme of culling between 2015 and 2020 reduced deer numbers and this was likely one of the factors that enabled Bitterns to return to breed at the site.

Greylag Geese are growing in number and will nest in a wide variety of habitats, including reedbeds. They also often gather to moult on reedbed pools, where they can eat back the reed margin, sometimes significantly, and may cause a replacement of reed by less edible reed-mace *Typha* spp. on the reedbed/pool margins. They can be a serious hindrance where attempts are being made to establish new reed. On some sites, the impacts have been reduced by lowering water levels in summer to make the reedbeds less attractive to moulting geese and this technique may prove effective.

Habitat or species conservation?

During the early phases of recovery action, it was not uncommon to encounter negative comments about the significant resources being expended on 'just' a single species. Yet, to the many involved in the work, action for Bitterns was as much about the creation of a network of well-managed wetlands, free from saline

inundation, and far less advanced in their succession to non-wetland habitats. Bittern conservation has been a great success but, arguably, the benefit to wetland habitat conservation generally has been even greater, with the sites where action was taken now home to a great diversity of wildlife (White *et al.* 2014). We sought to quantify the benefits to other wildlife as part of our audit, but information for other key species proved difficult to obtain.

Although reedbeds support a rather limited flora and fauna, they do support a number of specialist species (see table 1), including some that are range-restricted and some that are declining. Several species of moths, for example, are closely associated with reedbeds, including Reed Leopard *Phragmataecia castaneae*, Reed Dagger *Simyra albovenosa*, Brown-veined Wainscot *Archanara dissoluta*, White-mantled Wainscot *A. neurica*, Fenn's Wainscot *Protarchanara brevilinea*, Obscure Wainscot *Leucania obsoleta* and Twin-spotted Wainscot *Lenisa geminipuncta*. Unfortunately, most managers of long-established sites had little information on populations of such species, other than presence or absence, and we were unable to relate the extent and intensity of management to wider conservation gain. However, we could find no evidence of a species lost or population depleted by action targeted at Bitterns – a fear of many at the commencement of operations that sought to reduce the extent of old, dry, deeply littered reed with which many species are traditionally associated.



David Tipling

298. Eurasian Bittern, April 2009.

Table 1. Important species associated with reedbed habitat in Britain and their British IUCN status. Statuses given in parentheses are the species' status in England.

species	GB IUCN	species	GB IUCN
Water Vole <i>Arvicola amphibius</i>	EN	Silky Wainscot <i>Chilodes maritimus</i>	NE
Common Crane <i>Grus grus</i>	VU	Fenn's Wainscot <i>Protarchanara brevilinea</i>	NE
Bearded Tit <i>Panurus biarmicus</i>	LC	Flame Wainscot <i>Senta flamma</i>	NE
Common Reed Warbler <i>Acrocephalus scirpaceus</i>	LC	Obscure Wainscot <i>Leucania obsoleta</i>	NE
Marsh Harrier <i>Circus aeruginosus</i>	LC	Southern Wainscot <i>Mythimna straminea</i>	NE
Spotted Crake <i>Porzana porzana</i>	CR	Reed Dagger <i>Simyra albovenosa</i>	NE
Little Bittern <i>Ixobrychus minutus</i>	CR	Fen Ragwort <i>Jacobaea paludosa</i>	CR (CR)
European Eel <i>Anguilla anguilla</i>	CR	Fen Orchid <i>Liparis loeselii</i>	EN (EN)
Rudd <i>Scardinius erythrophthalmus</i>	LC	Crested Buckler Fern <i>Dryopteris cristata</i>	EN (EN)
Common Frog <i>Rana temporaria</i>	LC	Milk-parsley <i>Thysselinum palustre</i>	VU (VU)
Common Toad <i>Bufo bufo</i>	NT	Slender Sedge <i>Carex lasiocarpa</i>	LC (VU)
Desmoulin's Whorl Snail <i>Vertigo moulinsiana</i>	VU	Bladder-sedge <i>Carex vesicaria</i>	LC (VU)
Swollen Spire Shell <i>Mercuria 'confusa'</i>	VU	Whorl-grass <i>Catabrosa aquatica</i>	LC (VU)
Swallowtail <i>Papilio machaon</i>	VU	Large-flowered Hemp-nettle <i>Galeopsis speciosa</i>	VU (VU)
Norfolk Hawker <i>Aeshna isosceles</i>	EN	Water-violet <i>Hottonia palustris</i>	LC (VU)
Norfolk Damselfly <i>Coenagrion armatum</i>	RE	Frogbit <i>Hydrocharis morsus-ranae</i>	VU (VU)
Lesser Water Measurer <i>Hydrometra gracilentia</i>	VU	Holly-leaved Naiad <i>Najas marina</i>	VU (VU)
spider <i>Gongyliidiellum murcidum</i>	VU	Tubular Water-dropwort <i>Oenanthe fistulosa</i>	VU (VU)
spider <i>Marpissa radiata</i>	VU	Flat-stalked Pondweed <i>Potamogeton friesii</i>	NT (VU)
Bog Rove Beetle <i>Lathrobium rufipenne</i>	VU	Greater Water-parsnip <i>Sium latifolium</i>	EN (EN)
Trichoptera <i>Limnephilus pati</i>	CR (RE)	Least Bur-reed <i>Sparganium natans</i>	LC (VU)
Trichoptera <i>Limnephilus tauricus</i>	VU	Marsh Fleawort <i>Tephrosieris palustris</i>	RE (RE)
Small Dotted Footman <i>Pelosia obtusa</i>	NE	Water Germander <i>Teucrium scordium</i>	EN (EN)
Dotted Footman <i>Pelosia muscerda</i>	NE	Lesser Bladderwort <i>Utricularia minor</i>	LC (VU)
Reed Leopard <i>Phragmataecia castaneae</i>	NE		
Fen Crest <i>Brachmia inornatella australis</i>	NE		
Brown-veined Wainscot <i>Archanara dissoluta</i>	NE	LC = Least Concern; VU = Vulnerable; EN = Endangered;	
Twin-spotted Wainscot <i>Lenisa geminipuncta</i>	NE	CR = Critically Endangered; RE = Regionally Extinct;	
Fen Wainscot <i>Arenostola phragmitidis</i>	NE	NE = Not Evaluated.	

By contrast, the gains at newly created sites are more obvious. For example, Lakenheath Fen, which was a series of carrot fields and non-native poplar *Populus* plantations until 1996, supported up to 100 pairs of Bearded Tits *Panurus biarmicus*, two to three pairs of Common Cranes *Grus grus* and an average of ten pairs of Marsh Harriers *Circus aeruginosus* in addition to 11 booming Bitterns in 2023, as well as populations of Water Voles *Arvicola amphibius* and European Otters *Lutra lutra*. The results of the *Bringing Reedbeds to Life* project (2009–10) showed that reedbeds with a broad range of successional states supported the highest invertebrate diversity, with the overall numbers of invertebrate species and the numbers of reedbed and wetland specialist Diptera and moths similar in both restored areas and adjacent older areas of reedbed (Hardman *et al.* 2012).

One notable development has been that some wetland bird species – ‘climate refugees’ from deteriorating wetlands in southern and eastern Europe – have moved north and have colonised sites subject to significant restoration and creation undertaken in the name of Bitterns. These include Great White Egret *Ardea alba*, Cattle Egret *Bubulcus ibis*, Little Bittern *Ixobrychus minutus*, Glossy Ibis *Plegadis falcinellus* and Eurasian Spoonbill *Platalea leucorodia* (see Ham Wall case study).

Wintering Bitterns

Reedbeds are not only of value to Bitterns during the breeding season. From late summer onwards there is a regular influx of Bitterns into the UK, with the arrival of birds that will go on to overwinter. These come from migratory populations in Scandinavia, the Baltic and eastern Europe. Wotton *et al.* (2011) estimated a wintering population in

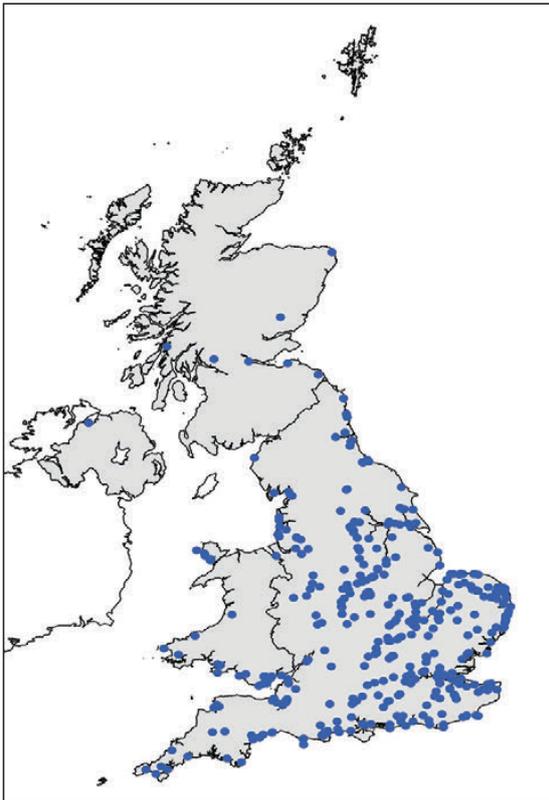


Fig. 7. Locations with wintering Bitterns, winter 2009/10 (from Wotton et al. (2011)).

2009/10 of some 600 Bitterns in the UK, which included an estimated 208 resident UK-breeding Bitterns. There were records from nearly 400 sites, the majority in England (fig. 7). There are suggestions that numbers of migrant Bitterns wintering in the UK may have declined. In the Lee Valley, Hertfordshire/Essex, for example, wintering Bitterns have declined from a peak count of 12 in 2003 to four birds in 2023. Climate change is thought to be the main reason, with fewer birds moving from the Continent owing to milder winters.

Recommendations for future management

We now know that breeding Bitterns require the following:

Large wetlands Large sites greater than 20 ha, with wet reedbed, a good length and variation of reed/water interface and a good gradation from wet reed to macrophyte-rich water in ditches or pools ideally up to 2 m deep are perfect for breeding Bitterns. The original view that 'a Bittern requires 20 ha of reedbed' is basically correct but can be widened to 'a Bittern requires 20 ha of diverse wetland habitat, including reedbed'. Smaller wetlands

can be very productive, but ideally need to be close to other sites to promote dispersal.

Wet reedbeds A minimum of 20–30% of the site should consist of open water with sufficient depth, structure, connectivity and macrophyte assemblage to support a sustainable fish population. The water level across the reedbed will ideally be at least 50–70 cm deep in spring. Bitterns will preferentially nest in the wettest areas, where they are more secure from predation.

Fish A sustainable and diverse fish population, including such species as Rudd, Roach, Eel, Perch, Pike and Three-spined Stickleback, is essential. Deep-water refuges within reedbeds are important to maintain fish populations.

The following actions are recommended to maintain and promote further increase of the Bittern population in the UK:

- Regular management of all reedbeds supporting breeding Bitterns is essential. This needs to include reed cutting and, in particular, ditch and pool management, regularly maintaining a depth of water of at least 50–70 cm over key reedbed areas, and ditches and pools having target depths of at least 2 m with good internal connectivity.
- Sites with booming males but with few if any known nesting attempts should be prioritised for targeted management, especially those which are 10 ha or more in extent. Although we know that larger wetlands are best, small wetlands with good fish populations can perform well, especially if there are other wetlands within close range. Such sites can punch above their weight.
- Fish surveys on key sites are to be encouraged, in order to understand populations and to determine whether fish introductions should be considered.
- Management plans should include aims to future-proof sites, with clear climate change adaptation measures. These will include developing large, diverse and connected sites, controlling invasive species, maintaining water quality and moving inland at coastal sites.
- Areas where Bittern management can be introduced or intensified should be identified with emphasis on those areas

likely to better support Bitterns in the face of accelerating climate change, notably in northern England, Scotland and Northern Ireland.

- Consider another landscape-scale reedbed habitat creation project to create 400 ha of new habitat across a minimum of eight sites/areas, which could support 20 booming males and associated wetland specialists.
- Maintain monitoring at key sites and look to develop a means of undertaking another full national survey (last undertaken in 2011) to cover booming and nest monitoring, not least as number of nests producing young is the key indicator of success.
- The Bittern should be included in the list of bird species to be covered by the updated UK Scarce Breeding Bird Surveys (a replacement of SCARABBS) and the use of drones and other novel techniques for Bittern nest monitoring through a proposed research project should be investigated.
- The fact that reedbeds benefit a wide range of specialist wildlife should be promoted with associated encouragement towards effective monitoring of a wider diversity of specialist reedbed taxa so that future management can embrace what might be required to maintain or enhance their populations by increasing numbers or expanding range.
- Targeted monitoring could usefully embrace other reedbed-associated birds such as Spotted Crake *Porzana porzana*, Common Crane, Little Bittern, Marsh Harrier, Bearded Tit and Common Reed

Warbler *Acrocephalus scirpaceus*, as well as a suite of animals and plants which have been formally assessed as Vulnerable, Endangered, Critically Endangered or Regionally Extinct in GB (see table 1). In addition, monitor the species which are key food items for Bitterns, including fish such as Eel, Rudd and Three-spined Sticklebacks, as well as the macro-moths known to be associated with reedbeds.

After 20 years of targeted conservation action, the UK Bittern population is in a great state – the best it has been for 150 years – but the species is not thriving in all parts of its range, and remains absent as a breeding bird in Northern Ireland and Scotland. Many key sites are no longer as well managed as they might be and at most of them management needs to be enhanced to provide what we now know to be the ideal conditions for Bitterns. Critically, many sites lack the resources to meet the commitment required. The future of other sites is threatened by climate change and by pollution. The pace of reedbed creation has slowed down, although some key sites are still being expanded. Without action – both now and in the future – the gains made will not be sustained and we may see, for a third time, the steady decline of this most charismatic species. However, we are confident that taking the actions we have identified in this paper will secure not only the future of the habitat and its associated species – most notably the Bittern – but also the legacy of the concerted conservation programme of the 1990s and 2000s.

Case studies

Far Ings

The Far Ings and Barton reedbed reserves, managed by the Lincolnshire Wildlife Trust (LWT), comprise a 90-ha chain of flooded clay pits with extensive open water and reedbeds interspersed with grassland, hedgerow and scrub on the southern shore of the Humber Estuary in north Lincolnshire. The pits and reedbeds are a legacy of the brick and tile industry which flourished between 1850 and 1959. LWT first purchased part of the site in 1983. The site was designated as a National Nature Reserve in April 2005.

The Humber bank clay pits were recolonised by Bitterns in the 1940s, where they bred continually between 1949 and 1978. In 1992–96 there was a concerted effort to improve the habitat at Far Ings to encourage Bitterns to return to breed. Channels were cut into the reeds and pools created, and elvers and other fish introduced. Bitterns returned to breed in Lincolnshire at Far Ings in 2000 making it one of the first successful reedbed restoration projects.

However, by 2015, almost all of the open shallow water at the site had disappeared owing to the spread of reed, although the reedbeds were still kept very wet to reduce willow *Salix* encroachment. As a result, the water became stagnant with no flow and probably with very few fish. A package of restoration and remedial works started in earnest in 2016/17, with the last phase completed in 2021/22. All water control structures were replaced and an open ditch system re-established. In the winter of 2016/17, North Lincolnshire Council purchased a Truxor reed-cutting machine. The use of this machine enabled old channels to be recut, and ditches and pools to be opened up. Much of the work involved cutting a long series of 15 m × 5 m bays into the reed edge, resulting in a 50% increase in the reed/water interface. The Truxor was also used to cut 2 ha of reed annually and to rake off debris. In 2018/19, ditches and channels were re-dug with a digger with an 18-m reach.

This excellent programme of restoration has transformed the site, much to the benefit of breeding Bitterns. Bitterns returned to breed again in 2017, when there was a single boomer and a nest with two fledged young. By 2023, there were four, possibly five, boomers, while four nests had been confirmed in the previous year. Work at Far Ings demonstrates that restoration work can bring quick results, but also that without considerable annual maintenance, conditions can deteriorate over a span of just a decade.

The Avalon Marshes

The Avalon Marshes wetland complex within the Somerset Levels and Moors is managed by a partnership of the Somerset Wildlife Trust, RSPB, Hawk and Owl Trust, and Natural England. The Marshes represent an ambitious and visionary conservation scheme that is fast becoming an exemplar in the UK. Reedbed creation began in the 1990s in areas formerly used for peat extraction, taking place in phases as peat extraction ceased. The complex of sites now extends to around 1,500 ha and includes reedbed, open water, wet woodland, wet grassland, fen and bog.

A 2018 breeding bird survey located a remarkable total of 50 booming Bitterns (Blacker 2018). However, the value of the Avalon Marshes to birds is far wider than for Bitterns alone. Population estimates for other key species included eight pairs of Garganey *Spatula querquedula*, 67 pairs of Common Pochard *Aythya ferina*, 423 pairs of Water Rail *Rallus aquaticus*, 56 pairs of Great Crested Grebe *Podiceps cristatus*, nine pairs of Marsh Harrier, 18 pairs of Bearded Tit, 273 pairs of Cetti's Warbler *Cettia cetti*, 1,007 pairs of Common Reed Warbler *Acrocephalus scirpaceus* and 182 pairs of Common Reed Bunting *Emberiza schoeniclus*. During the winter months the area is internationally important for wintering waterfowl while the reedbeds host a spectacular Common Starling *Sturnus vulgaris* roost of up to one million birds.

Colonising species from the south have been a key feature. Great White Egrets have now been breeding since 2012. In 2023 the number of nesting pairs, colony locations and fledged chicks continued to maintain its steady growth, with 88 young fledging from 53 successful nests and a total of 72 pairs attempting to nest. The number of Cattle Egrets roosting reached 660 in late 2023. After first breeding in 2017, Black-crowned Night Herons *Nycticorax nycticorax* have been present annually. Little Bitterns have been recorded annually since 2009 but do not yet seem to be established, with just a single record in 2023.

Reedbed creation at the RSPB site, Ham Wall, began in 1995. Clay bunds and sluices enable water levels to be controlled independently within and between 16 hydrologically isolated units. Since the first two 'booming' males were heard in 2008, numbers of Bitterns have risen to a peak of 22. Rudd were introduced to the site to increase food availability and the fish community now includes Rudd, Roach, Tench *Tinca tinca*, Perch, Pike and the non-native Sunbleak *Leucaspis delineatus*. An Eel pass was installed to allow these fish to access the reedbeds from the nearby South Drain.

Ham Wall was part of the *Bringing Reedbeds to Life* survey programme in 2009–10. The survey showed the importance of reedbeds for diverse invertebrate assemblages, with a total of 552 invertebrate species recorded, including 230 wetland and 22 reedbed specialists. In particular, Ham Wall had a high number of reedbed and wetland specialist Diptera.

Ham Wall has also seen some innovative reedbed 'rejuvenation'. This involves the conversion of mature reedbeds (the first to be created early in the reedbed restoration programme) to early successional habitat by drawing down water levels over an extended period, followed by intensive vegetation management and then reflooding. The rejuvenation of the first area took place between 2007 and 2012, when the reed was cut with a Softrak or grazed. This produced a short, marshy grassland allowing access for the reprofiling of ditches and pools. In 2012 the area was cut and the ditch edges cleared, followed by reflooding.

The wetland habitat is now more varied and includes open water, regenerating reed stands and enhanced ground topography. The shallow open water has produced excellent wintering waterbird habitat. A Bittern was recorded booming two years after the work was undertaken and several scarce and recent colonising species, including Great White Egret and Glossy Ibis, have utilised this area extensively for feeding. Water-level management to encourage reed recolonisation has also proved important in providing feeding for egrets and has helped drive the population expansion.

Overall, this method of reedbed rejuvenation has proved very successful in diversifying the reedbed and allowing all stages of wetland succession to be represented, with significant benefits for both wildlife and the visitor spectacle. It now forms the main management technique, in addition to small-scale cutting to improve viewing for visitors.

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