White Storks *Ciconia ciconia* nesting in Sussex

Stephen Chapman, Şeniz Mustafa and Laura Vaughan-Hirsch

Summary

This paper describes an innovative project to introduce a wild free ranging population of White Storks in Sussex. It presents a timeline of the project from start in 2016 and nesting activities in 2020-2023. An analysis of diet is presented based on field observations and an examination of pellet samples. Post breeding dispersal of young is discussed. Information was assembled from a large amount of data submitted by volunteers, from social media, GPS tracking and camera traps.

1. Introduction

The story of Knepp is told in detail in the best-selling book ***Wilding***, (Tree 2018). It tells the journey of a bold transition from arable and dairy farming to a new landscape with a mosaic of unfenced fields honed only by grazing herds of Longhorn cattle, Exmoor ponies, Tamworth pigs and three species of native deer. What has not changed is the Low Weald Sussex marl, laggs and flood waters that come with heavy rains, a constant reminder again this winter that this was never going to be agricultural land like that enjoyed by others with larger fields on well-drained loamy soil.

Against this background a pioneering partnership of private landowners and nature conservation charities set out to create a self-sustaining wild population of White Storks in southern England. But why storks? With an aim to promote a greater engagement between the public and wildlife in the countryside, the highly visible, sociable and charismatic White Stork with a history of nesting in close association with man, was the obvious choice. The ecological requirements for White Storks seem to be the same everywhere, namely open, not too much wooded and somewhat wet land such as valleys of rivers and streams … cultivated country, pastures and meadows, provided that they are not too dry or too much drained [Haverschmidt 1949]. That sums up the Knepp Estate and the Low Weald landscape.

White storks are a charismatic species. Their presence would excite and inspire greater interest amongst wider society in the conservation of nature as a lost part of our cultural heritage. During their breeding season White Storks can nest in large colonies and by doing so present a significant spectacle.

The successful wild nesting at Knepp in 2020 is the first nesting in Britain for 600 years (Pitches 2020 and Chapman & Groves 2020). White Storks have not nested in Britain since the record of a pair nesting on St Giles Cathedral, Edinburgh in 1416 (Witherby et al 1943). A local ornithologist William Borrer, MBOU writing in 1891 (Borrer 1891) stated the White Stork rarely appeared in the county. He mentions a number of birds shot from Pevensey to Selsey. Birds recorded in Sussex in the nineteenth century were quickly shot by trophy hunters for collectors and museums. Such sightings and killings are documented in John Walpole-Bond's 1938 book ***A History of the Birds of Sussex***. Looking at records from 1841 to 1900, eleven were spring occurrences and seven were late summer. Half of these ended up shot. In a more enlightened era three young White Storks ringed as nestlings in Frøstrup, Denmark were shot, this time with a camera, in Newlyn, Cornwall in September 1971 (Bottomley 1972). The ring numbers read by telescope identified their origin. This one observation illustrates well the wanderings of young birds, and how they move together, of which more later.

2. Background and Timeline

More recently the White Stork as mapped in the Report on scarce migrant birds in Britain in 2002 (Fraser et al 2005) showed the distribution of White Storks in Britain in that year. Only birds thought to be newly arrived (or at least previously unrecorded) and wild were mapped. The relatively high numbers seen in counties along the east coast of England suggests that reintroduction schemes in the Low Countries and Germany may well account for a proportion of the 53 records, a total which made 2002 the second-best year since 1958. Against this background of sightings DEFRA confirmed this species is a regular vagrant which has attempted to breed in the British Isles and therefore no license was required for a reintroduction of the species under the Wildlife and Countryside Act (1981) [1]. It is possible that White Storks were breeding residents in Britain until the late 15th century. The town of Storrington in 1185 was formerly called 'Storca-tun', old English for "homestead with storks". It is likely that human persecution combined with habitat destruction were major factors in the species extinction (Gow et al 2017).

The project today is a partnership between two Sussex landowners, Cotswold Wildlife Park (CWP), Warsaw Zoo and Roy Dennis Wildlife Foundation. It is being undertaken through a phased release programme which follows the methodology used by a Swedish reintroduction which started in the 1980s and developed into a three-phased programme (Rimberth 2013).

Wing-clipped storks were introduced into open-topped pens in 2016 and these birds attracted continental White Storks. Within weeks of release into a pen at Knepp, one captive stork escaped and proceeded to wander around southern and eastern England. This individual then crossed the Channel to Brittany before returning to Knepp.

In December 2016 came the first cohort of White Storks imported by truck from Warsaw Zoo, Poland. These were injured now mostly flightless birds that had survived crashing into power cables. After a period in quarantine at the CWP these were transferred to a six acre securely fenced fox-proof pen including a lake draining into the adjacent Lancing Brook, a tributary of the Adur. The strategy to grow the population, with an ambition of 50 breeding pairs by 2030, was to supplement these non-fliers with juvenile birds reared at the CWP, also habituated in the enclosed area at Knepp before release. Storks are usually faithful to their natal site and so the nesting population would grow over time, as indeed it has. Details of the phases of the introduction programme were published in The Sussex Bird Report 2020 (Chapman & Groves 2020).

Each year in August cohorts of juveniles were released: 2019 24, 2020 19, 2021 27, 2022 33 and in 2023 33.

Today the Sussex population of birds ringed is now 400, including the current Knepp cohort of 24 flightless birds. In general, we see that the juveniles leave Sussex and cross the Channel mostly via Dover and a couple of times from the Isle of Wight, see Map. About 20-30 birds may be seen flying at Knepp in the winter months and many more in summer once juveniles fledge.

Wadhurst Park Estate is a satellite operation which in 2018 received flightless birds from Poland into a similarly secure fenced area. Today there are 15 flightless birds. Numbers of flyers there vary seasonally and average around 20. By tracking ring numbers, we know there is a regular interchange between Knepp and Wadhurst. In 2023 for the first time three juveniles fledged successfully at Wadhurst. It is the only other site in Sussex where storks are nesting.

[1] For a detailed discussion on storks in Britain see Cheke 2016.

The High Weald terrain at Wadhurst Park being a private estate has less footpaths and less public access. It has a large lake and more meadows and grassland which the storks make good use of, foraging for grasshoppers and other invertebrates. They spend a lot of time foraging out in their fields there. The project partners are establishing a core area for these birds to take up residency close to the English Channel.

3. Breeding at Knepp

At Knepp the storks nest almost exclusively in mature oaks *Quercus robur*. One exception being in 2021 when a pair built a nest on the chimney stack of the Castle, Fig 1.

Pioneer work in Denmark noted males reach maturity at an age of 3.8 years and the females at an age of 4.1 years. Rearing young at an age of only two years was seen to be a very great exception, both these birds being males (Haverschmidt 1949). At Knepp birds have nested at age two years, with two-year-old females nesting successfully with older males. Those that fail due to immaturity tend to stay as pairs and succeed in subsequent years as we recorded with several examples.

Fig 1 Nest on Castle chimney (*C Burrell*)

Juveniles are particularly adventurous and the most likely to embark on migration to continental Europe and North Africa and interact with wild populations. Some of these first-year birds have already crossed to the Continent, with several individuals reaching Morocco. The migration route is fraught with dangers – pylons, busy roads, large stretches of open sea. Several birds from Knepp have migrated and now returned. One male hatched in 2021 was reported in Morocco in November 2022 and returned to Knepp in March 2024, successfully breeding this year to produce two young.

As with other bird species the weather is a significant factor in the success or otherwise of nesting. For the White Stork, the winter weather is a factor too as the same nest may be used from one year to another. In 2022 the Sand School nest was destroyed by storms, see below.

2020

This was a key year in the project when two pairs nested successfully in the wild (Chapman & Groves 2020). One pair reared a single young from a clutch of four eggs, while a second pair in the middle of Pond Field reared three young from five eggs. The latter pair had made an unsuccessful breeding attempt in 2019. The more experienced four-year old Knepp female was from Poland. She paired with an unmarked male presumed to be a wild bird. The nest, in the crown of an old oak was first noted on 14th March. The two were seen sitting on the nest on 3rd April. On 8th April, a drone showed that there were five eggs. They hatched on about 6th May. The male was seen moving and eating eggshell, the female was seen returning to the nest and regurgitating food. Three chicks were ringed on 17th June. As with all Knepp ringed birds the chicks were ringed on the left tibia with a DARVIC ring having white lettering on blue and serials GB** plus a BTO ring on the right tarsus. Sightings of project rings are requested and may be logged on-line at www.whitestorkproject.org. On 9th July GB4H (largest chick and thought to be the oldest) made its first flight. On 13th, the two older birds joined a high-soaring group of 15 others.

In August, a cohort of juveniles from the CWP were released to fly free from the fenced pen. Six with GPS tags crossed the Channel and two successfully made it to Morocco. The Sussex weather over the summer was very hot. Birds managed this by sitting panting open-billed and sheltering young from the sun. Adults bringing water to chicks in hot sunny weather was reported from the Netherlands and Germany (Haverschmidt 1949). We did not see this behaviour even in temperatures regularly in the thirties during July.

2021

This year seven nests were built in the wild, again in oaks, except one pair which built a nest on the Castle chimney. Egg laying started earlier later than in 2020, in April. A severe hailstorm at point of hatching may have impacted outcomes. Overall, 17 of 30 eggs hatched, the lowest rate of hatching, since nesting began see Table 1. Finally, 14 juveniles fledged.

GB2D aka Marge starts a return flight from Morocco following her original route south but stops in central France.

2022

On 18th February Storm Eunice destroyed the nest by the Sand School, one of the most successful nests in 2021 built by a Polish pair. Undeterred the same pair quickly rebuilt and fledged two young from a clutch of four eggs, Fig 2. A severe unseasonal storm at the end of May destroyed one nest with the loss of four chicks.

Fig 2 Sand School nest rebuilt 2022 (*S Chapman*)

Deviating from the norm at Knepp the pair from the Castle chimney in the previous year moved to nest in a tall cedar *Cedrus* on the drive up to the Castle. After laying four eggs, three hatched but at ringing only one chick was present.

The largest chick from each nest, assumed to be the oldest as incubation starts after the first egg is laid, is fitted with a GPS tracker. As an example of their post fledging dispersal a 2019 fledged female GB46 (aka Doris) was recorded in Wiltshire, Norfolk, the Netherlands and Scotland before returning to nest, albeit not fledging any young.

Thanks to the detailed monitoring by the team of volunteers we know how variable development can be. One nest fledged on day 58 after hatching, compared to last year when day 64 was earliest. Average time to fledging was 66 days compared to 69 days in 2021. A late starter was in the nest until Day 89.

For the first time two pairs nested at Wadhurst Park, a project satellite site, with one pair raising a single chick.

2023

Winter storms brought down an oak containing a stork nest on the bank of Lancing Brook in New Barn lagg, the water washing away roots and high winds felling it. The pair rebuilt in an adjacent tree and fledged four young. A nest next to the Sand School was also destroyed in gales but rebuilt in a week in February and went on to successfully fledge four young.

There is a tendency for high chick mortality in seasons which are cold and wet (Kosicki & Indykiewicz, 2011). Strong winds and heavy rains were to impact the success of nesting in 2023.

On 12th April GB8N (two-year-old male) was nest building in an oak at the edge of the Pen. This is a juvenile from Pond Field upper (Nest1) in 2021.

Fig 3 Ground nest built by a flightless pair (*L Vaughan-Hirsch*)

The first ever ground nests were built at Knepp by the rehabilitated non-flying birds. The females were from the 2016 cohort from Poland, so at least seven years old. The males were later arrivals, five- and six-year-old birds. In total 26 chicks fledged including three from the two ground nests, Fig 3. There were many more nests this year, particularly in the Pen area, in addition to the two successful ground nests, four other new ground nests were built, three of which had eggs but didn't go on to successfully raise chicks. Leaf cover and a policy of minimizing disturbance in the Pen prevented observation, with bad weather also impacting the use of drones to monitor them.

An overview of the dates shows that we saw much earlier fledging in 2023. Completion observed five days earlier on average than previous years for the established nests - up to 10 days if we include all nests including first departures from the on ground nests.

The Pond Field nest with the same pair, successful in the previous three years, failed after confirmed sightings of four chicks for reasons we don't know.

It is encouraging to note that passing wild storks have already been attracted in by the presence of the released birds. This indicates that, in time, wandering storks from Continental Europe will give a further boost to the local population.

Three chicks fledge at Wadhurst Park.

4. Breeding Summary at Knepp

Table 1 summarises the annual outcomes from the first nests in 2020. The Reproduction Coefficient is the number of young reared divided by number of nests occupied by a pair of birds. The figures and variation mesh with those recorded by Haverschmidt for Holland, Oldenburg and Schleswig-Holstein from 1934 to 1940.

	Active Nests	Eggs	Chicks	Fledglings	Coefficient
2020	2	9	6	4	2
2021	7	30	17	14	2
2022	10	40	34	19	1.9
2023	20	49+	30+	26	1.3

Table 1. Summary of nests and outcomes at Knepp 2020-2023

The chronology of breeding at Knepp is shown in Table 2. Whilst the outcome for 2023 was low compared to earlier years, nesting started earlier.

	2020	2021	2022	2023
Building & Pair Confirmed - Start Date		13-Feb	14-Feb	02-Feb
Mating First Observed		20-Feb	25-Feb	05-Feb
Sitting First Observed	03-Apr	21-Mar	17-Mar	15-Mar
Eggs Confirmed	08-Apr	25-Mar	28-Mar	27-Mar
Eggs Confirmed - Avg Clutch	4.5	4.3	4	2.5
Regurgitation Confirms Hatch		25-Apr	20-Apr	20-Apr
Chicks Confirmed		30-Apr	26-Apr	25-Apr
Chicks Confirmed - Avg Clutch	3	2.4	3.4	1.5
Chick first standing visible		09-May	26-Apr	29-Apr
Chick(s) first left unattended		25-May	17-May	19-May
Actual Ringing	17-Jun	10-Jun	14-Jun	12-Jun
First Fledging	09-Jul	05-Jul	29-Jun	02-Jul
Latest Fledging		01-Aug	25-Jul	21-Jul
Fledglings - Avg/nest	2	2	1.9	1.3

More detailed information may be found at https://www.whitestorkproject.org/

5. Food/diet

Observations by volunteers report seeing frogs, snakes and rabbits brought to nests to feed young. Fledglings were noted taking grasshoppers or bush crickets (Orthoptera) amongst Fleabane *Pulicaria dysenterica* and Ragwort *Senecio jacobaea*. During the winter months we noted birds commonly feeding on earthworms *Lumbricidae*

White storks are widely known as generalist and opportunistic predators (Chenchouni et al., 2015; Surdo et al., 2022), which can be seen in their diet at Knepp Estate. Through pellet analysis (n=19) of flying individuals, their foraging diet is found to predominantly consist of invertebrates such as worms. Similarly to other diet analyses (Antczak et al., 2002; Cheriak et al., 2014; Vrezec, 2009), the most frequent are beetles (*Coleoptera*). The most abundant family are ground beetles (Carabidae) such as *Poecilus cupreus, Pterostichus melanarius,* and *Carabus violaceus.* Other frequent families include click beetles (Elateridae), such as *Agriotes linneatus*, and predacious diving beetles (Dytiscidae), such as *Dytiscus marginalis.* Other beetle families observed were carrion (Silphidae), scarabs (Scarabaeidae), pill (Byrrhidae) and weevil (Curclionidae) beetles.

The white storks often feed on blue bottle fly (Caliphora vomitoria) maggots and fly (Diptera) puparium, which can be linked to foraging amongst dead or decaying matter by the presence of necrophilous carrion beetles (Hoermann et al., 2021) in their diet. More occasional orders include Hymenoptera (e.g. ants) and aquatic snails (Basommatophora) such as the great ramshorn (*Planorbarius corneus*). More rare species are spiders (Araneae), mammals such as field voles (*Microtus agrestis*) and grasshoppers (Orthoptera).

Vegetation is frequently consumed; however, this is likely due to their foraging amongst vegetation such as water bodies and agricultural meadows (Johst et al., 2001; Orlowski et al., 2019) rather than for dietary purposes (Milchev et al., 2013). From their diet, we can begin to predict the habitats in which the white storks are foraging, such as grasslands, meadows, water bodies and arable fields.

The diet of the storks is supplemented daily with sprats, chicks and meat trim from the Knepp Wildland butchery to support the non-flying individuals, and to boost reproductive success during the breeding season. Furthermore, stones are occasionally consumed and may act as gastroliths (Rosin & Kwiecinski, 2011).

6. Behaviour

It is not all sweetness and light in the competition between storks especially young birds. On 24th April 2022 four birds were reported attacking the sitting female on the Sand School nest. The male returned and took over incubation. The female injured with blood on head but seemed OK. However it is worth noting more broadly that we have recorded adult aggression towards incubating females as well as aggression between developing young themselves,

We have noted in the post-breeding period in 2023 that possession of nests and some nest building is commonplace. This behaviour was not noted in earlier years. During November and December many of the nests were in possession by pairs of adults that had used them for nesting earlier in the year.

7. Post breeding dispersion of young and adults

In 2023 eight of the young were satellite tagged. By mid-September GBE4 made it to Morocco while two others were in France and Spain. The commonest cause of death in Knepp storks, tracked or reported, is collision with power lines: for example, in Kent, Falmouth, Malaga, Madrid, La Rochelle and Sainte-Radégonde-des-Noyers.

The youngest juvenile from the Pond Field nest in 2020 spent two nights on the ground as it lacked the power and coordination in flight to get high enough to get back into the nest but was not predated.

Once able to fly the juveniles will spend extended periods away from the nest. At the Pond Field nest in the evenings after arriving back at the nest in the hour before sunset they could be fidgety and unable to settle. Other days after preening they would settle heads down dozing with one or two sitting down.

All three young were last seen together on the nest on day 110, at sunset on 24th August. On 28th August there were two young birds settled on the nest, but it was too dark to read their ring numbers [Chapman & Groves 2020]. They never returned to the nest after this night.

Routine reporting on 25th August 2023 announced the storks to be on the move. The Knepp born satellite tagged birds had been as far north as London and south towards Battle but had not looked to cross the Channel yet and were meanwhile based at Wadhurst. Three of the four CWP bred birds released at Knepp with satellite tags were already across the Channel - two in southern France and one already into northern Spain. It is thought likely that the rest of the juveniles were with these birds in groups (two of the Knepp tagged birds were clearly travelling together) so likely many other Knepp birds were with the three tagged ones, although some certainly remained at Wadhurst.

In general data suggests that the adult birds stay at Knepp or move between Knepp and Wadhurst. Supplementary food put out for the non-fliers at both sites is an obvious attraction for them. Two nests at Knepp paired with partner birds originating from Wadhurst.

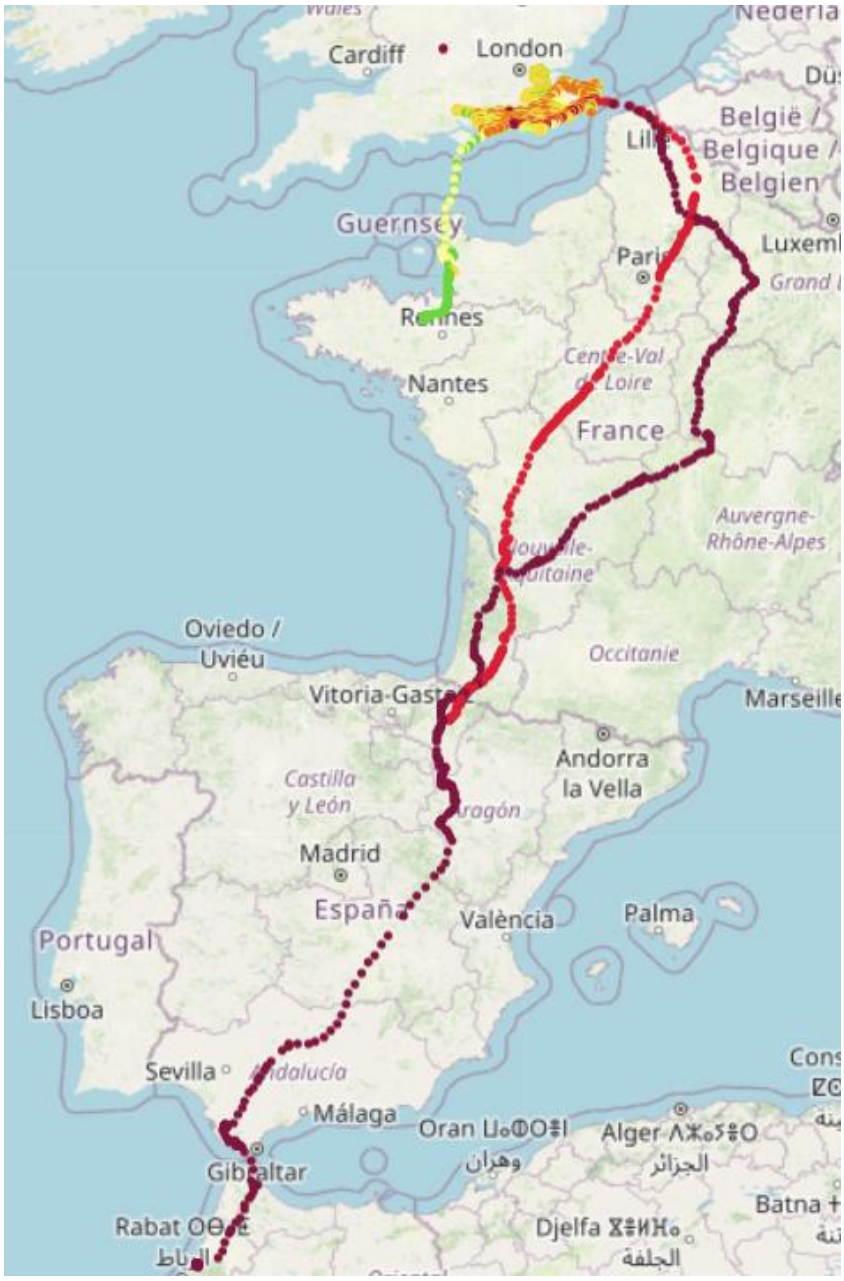
On 12th April, a male GB5J started another nest in the Pen. This three-year-old male was part of the 2020 release and had been spotted heading south through western France in September 2021, the first evidence of a UK bred bird migrating cross-Channel and returning to its release site.

The chart below illustrates movements of birds tracked up to 11th December. It is clear from this that some birds have made the longer sea crossing from the Isle of Wight to France.

Gleaned from public sightings and social media we know that three young storks were seen over Pulborough Brooks regularly throughout the summer of 2023. GB0S a two year old male bred at CWP and released at Knepp, GB3U a one year old male fledged from Nest 2 at Knepp and GB6S, a one year old bird bred at CWP and released at Knepp.

All these birds were seen regularly from June 2023 foraging at the Brooks, often together, sometimes by themselves. They were also recorded at Knepp during this time, so they were travelling between the Brooks and Knepp. They were reported from June through to October then they are likely to have returned to Knepp. No further public sightings were reported since then, but they have been on seen on camera traps at Knepp.

On a couple of occasions in late August 2023 a group of up to 20 birds was reported as flying over the Brooks on a couple of different days. They may have been on their way to investigating migration routes.



8. References

Antczak et al., 2002 - The Food Composition of Immature and Non-Breeding White Storks in Poland

Borrer, William, 1891 The Birds of Sussex

Bottomley, J B 1972 British Birds 65: 4-5 plates 1-3

Chapman SE & Groves L 2020 The Sussex Bird Report 235-241

Cheke A, 2016 British Wildlife June pp 377-379

Chenchouni et al., 2015 - Trophic niche and feeding strategy of the White Stork *Ciconia ciconia* during different phases of the breeding season

Cheriak et al., 2014 - Diet variability in the White Stork *Ciconia ciconia* in eastern Algeria

Fraser, P. A & Thaler, E British Birds February 2005 – vol. 98, issue 2, pp 73–88

Gow, D. 2017 Feasibility Report for the Reintroduction of the White Stork *Ciconia ciconia* to England, Derek Gow Consultancy Ltd

Haverschmidt, Fr 1949 E.J. Brill Leiden, Holland

Hoermann et al., 2021 - Carcasses at Fixed Locations Host a Higher Diversity of Necrophilous Beetles

Johst et al., 2001 – Foraging in a patchy and dynamic landscape: Human land use and the White Stork

Kosicki & Indykiewicz, 2011 Effects of breeding date and weather on nestling development in White Storks *Ciconia ciconia* Bird Study 58(2): 178-185

Milchev et al., 2013 – Diet and foraging habitats of non-breeding White Storks *Ciconia ciconia* in Bulgaria

Orlowski et al., 2019 - Linking land cover satellite data with dietary variation and reproductive output in an opportunistic forager: Arable land use can boost an ontogenetic trophic bottleneck in the White Stork *Ciconia ciconia*

Pitches, Adrian British Birds - July 2019, 368–371

Pitches, Adrian British Birds - October 2020, 582-584

Rimberth, C. 2013. The Swedish White Stork Reintroduction Programme *A review of current achievements with implications for future management.* Online http://lup.lub.lu.se/student-papers/record/4053929

Rosin & Kwiecinski, 2011 – Digestibility of prey by the White Storks *Ciconia ciconia* under experimental conditions

Surdo et al., 2022 - Evidence suggests an opportunistic entomophagous diet of the White Stork *Ciconia ciconia* in Sicily during breeding and post-breeding periods

Tree, I. 2018. Wilding: the return of nature to a British farm. Picador, London

9. Acknowledgements

This project report would not be possible without the dedicated band of volunteers checking fence integrity daily and observing and reporting nesting behaviour so it is known when eggs are laid, when they hatch and hence when arrangements can be made to ring before they fledge.

We are also grateful to Tim Morgan reading an early draft and for managing and analysing large volumes of data submitted, to Kevin Harwood for collecting and analysing what is now terabytes of camera tracking images and to Penny Green for all her feedback on the text. The feeding analysis and data was supplied by Șeniz Mustafa, a Master's student at the University of Brighton.