Written by Anna Field
with thanks to Gareth Jones, Robin Husbands, Jerry Lewis & Ed Drewitt for ringing records and recoveries

Gloucestershire Raptor Monitoring Group
Goshawk monitoring project

Introduction

Gloucestershire is one of the UK's strongholds for Goshawk with over 100 known sites, contributing over 15% of the UK's total breeding birds (currently estimated at 620 pairs by Woodward *et al.* (2020)). The majority of these are found in the Forest of Dean, with an increasing number of pairs scattered throughout the county. Members of the Gloucestershire Raptor Monitoring Group (GRMG) have been monitoring the population for over 20 years, gathering a wealth of information on the distribution of breeding pairs, timing of breeding and productivity. The Goshawk's secretive lifestyle has, however, limited the number of ringing recoveries to a handful of records of dead and injured birds during this time. In 2017, we sought to address this by starting a colour ringing project, coupled with the use of trail cameras at nests and baited winter sites to re-sight ringed birds. In the four breeding seasons that have followed, 312 Goshawk chicks have been colour-ringed in Gloucestershire and adjacent counties[1] from 142 successful nests[2]. This is a significant proportion of those ringed nationally – in 2019, GRMG ringed 95 chicks in Gloucestershire and Herefordshire, comprising 29% of the total chicks ringed in the United Kingdom in that year (Robinson *et al.* 2020).

Figure 1 *Colour ringed male Goshawk chick from a nest in the Cotswolds (Photo: Mark Sharples)*

Colour ring recoveries

As expected, it took a couple of years for any of our ringed birds to be recorded as breeding adults as Goshawk do not usually breed until their second year or later. In 2019, the first of our colour-ringed chicks were re-sighted as breeding birds. A female 'ABF' successfully bred at a site in the Forest of Dean. She was ringed as a chick from a brood of three in 2017 at a site 15km away. Another female 'AAI' successfully bred at a second site in the Forest of Dean in 2019, and again at the same site in 2020. She was ringed as a chick from a brood of four in 2017 at a site 3km away. A third female 'ATI' raised three chicks at another site in the Forest of Dean in 2020. She was ringed as a chick from an amazing brood of five in 2018 at a site only 2km away from her nest site.

[1] The majority of nests were in Gloucestershire with a few in Herefordshire and Wiltshire
[2] Covid-19 restrictions meant less nests were monitored than usual in 2020.

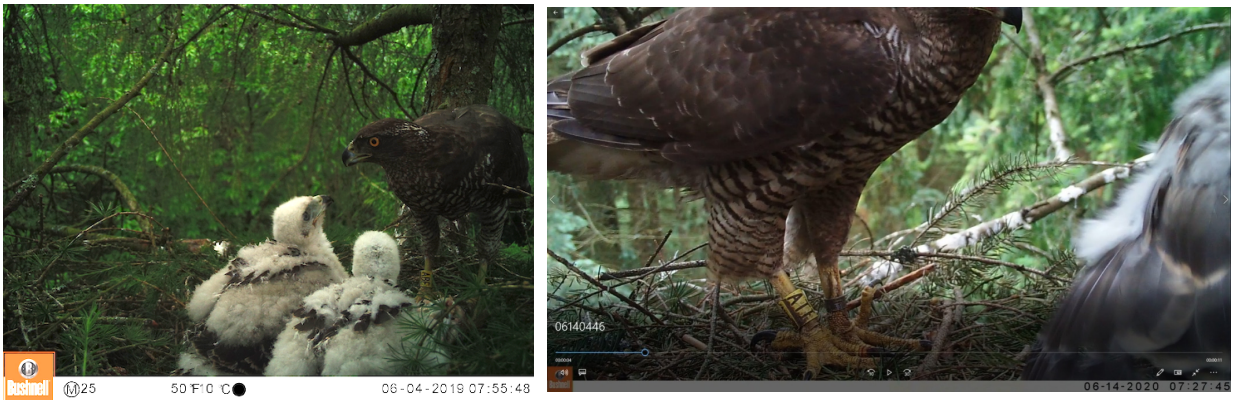

Figure 2 *Our first few colour-ring re-sightings on nest trail cameras – all breeding females*

Colour ringing also increases the chance of recoveries from other avenues as it makes birds more obvious to observers. A member of the public recently reported a large raptor with a yellow colour ring on Cotswold farmland in 2020, presumably one of our colour-ringed Goshawk. Since 2017, four birds have been reported to have hit residential windows, one was hit by a car in Gloucester, two have been found injured and taken into care and another nine have been found dead – at least two of which are suspected to have been persecuted.

Metal ring recoveries

The high quality of today's trail cameras has also made it possible to read metal rings on breeding adults on a few occasions. Following careful review of over 30,000 images, the adult female from a breeding pair in the Cotswolds was found to have been ringed in 2012 in the New Forest – a fascinating long-distance dispersal of 102km. According to the BTO's Online Demography Report: Bird Ringing & Nest Recording in Britain & Ireland in 2019 (Robinson *et al*. 2020), there have only been a handful of movements over 100km recorded in the UK – the longest being a movement of 218k from Bamford, Derbyshire to Kielder Forest, Northumberland. However, it is worth noting that all of these other recoveries were of dead or sick birds – ours is the first bird confirmed to have dispersed over 100km to breed.

Figure 3 *Nest trail camera images are of sufficiently high quality to enable metal rings to be read on some birds. This female was found to have been ringed as a chick in the New Forest, a dispersal of 102km*

The metal ring on a female at another site in the Forest of Dean was read on trail camera images from a baited site in January 2019 and was found to have been ringed as a chick in 2014 at a site 6km away. She went on to raise two chicks at a nearby nest in 2019 but is assumed to have died last winter as the nest was taken over by a new colour-ringed female 'ATI' in 2020.

We have several more breeding birds, female and male, with metal rings on that we have so far been unable to read on trail camera images – demonstrating the value of colour ringing the birds.

Diet

The trail cameras have revealed a huge amount of fascinating information on diet. Although it can be tricky to identify a well-plucked avian prey item delivered at high speed to a nest, thanks to Ed Drewitt's superb identification skills we have recorded a wide variety of species: sparrowhawk *Accipiter nisus*, tawny owl *Strix aluco*, barn owl *Tyto alba*, jackdaw *Corvus monedula*, crow *Corvus corone*, rook *Corvus frugilegus*, jay *Garrulus glandarius*, woodpigeon *Columba palumbus*, feral pigeon *Columba livia domestica*, stock dove *Columba oenas*, lesser black-backed gull *Larus fuscus*, red-legged partridge Alectoris *rufa*, pheasant *Phasianus colchicus*, coot *Fulica atra*, woodcock *Scolopax rusticola*, lesser spotted woodpecker *Dryobates minor*, great-spotted woodpecker *Dendrocopos major*, blackbird *Turdus merula*, song thrush *Turdus philomelos*, mallard *anas platyrhynchos,* rabbit *Oryctolagus cuniculus* and brown rat *Rattus norvegicus*. But perhaps the most interesting discovery has been the high proportion of grey squirrel *Sciurus carolinensis* brought to many nests – in some cases, by far the most frequent item and constituting more than two-thirds of all prey items. Research elsewhere tells a similar story: analysis of prey found at or near Goshawk nests in Breckland found Grey Squirrel made up 52% of the 129 prey items, woodpigeon 19% and corvids 17% (BTO 2018). Good news for Forestry! We are currently analysing all the diet data collected and intend to write an article focussed on this interesting topic.

Figure 4 *The remains of at least 15 squirrels in a Goshawk nest from which chicks have recently fledged (Photo: Mark Sharples)*

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Behaviour

The images and videos from the nest trail cameras have also recorded some fantastic behaviour. At one Cotswold nest in 2020 a chick died, apparently from natural causes, but the female went on to feed the remains to the surviving chick as shown in Figure 5 (not for the faint-hearted!). Trail camera images from the same nest showed the breeding male to be a first-year bird, still in juvenile plumage. The previous year's male presumably died during the winter. Both chicks were under-weight at ringing and the trail camera showed that the rate of prey being brought to the nest was very low (less than one item per day), presumably the cause of the chick's mortality and due to the male's inexperience.

Figure 5 *(a) Female Goshawk feeding the remains of a dead chick to its sibling and (b) Male Goshawk breeding in its first year*

A trail camera on a nearby nest picked up a female goshawk with an eye defect known as a coloboma, where some of the tissue making up the iris has not developed normally, giving the iris a keyhole appearance. In humans this can affect light sensitivity and may have an adverse effect on overall vision but is not usually severe (RNIB 2020). As this bird has survived to adulthood and is breeding successfully it is unlikely to be having a significant effect on its vision or hunting ability.

Figure 6 Female goshawk with an eye defect known as a coloboma of the iris

Another interesting behaviour picked up on a number of trail cameras is the propensity of adults to bring in greenery to the nest throughout the nesting period, sometimes several times a day. The aromatic compounds in the greenery are thought to have anti-parasitic properties and so play a role in keeping the nest site clean (Wimberger 1984).

Figure 7 Adult male goshawk bringing greenery to the nest site

Perhaps the most important behaviour that the cameras pick up is confirmation that the adults return to feeding chicks quickly after the ringing process. Although this has been shown to be the case in numerous studies, it is reassuring to see it for ourselves. In one case we even watched an adult bring food to a nest before the climber had finished descending from the tree. And, other than a few cursory glances (possibly at reflections), the trail cameras are duly ignored.

GPS satellite tagging

During the same period the British Trust for Ornithology (BTO) started their own Goshawk monitoring project using GPS satellite tags to better understand use of the countryside away from nesting areas – in particular home range size, seasonal movements and the extent of the Goshawk's reliance on non-forest habitat such as farmland (BTO 2018). Tagging was also hoped to provide data on dispersal and recruitment, as well as identifying the last known location of any birds that disappear in suspicious circumstances. Between 2016 and 2018, the BTO fitted 15 GPS satellite tags to Goshawk chicks in Thetford Forest. The data showed that young Goshawk tended to disperse into the nearby countryside, typically spending much of their first winter in farmland rather than forest, perhaps to avoid adult Goshawks holding forest territories. In late winter the young Goshawk started to return to woodland areas, in some cases making long exploratory journeys, presumably to search for vacant territories – though most did not breed until their second year.

In late 2018, the BTO approached us to see if we would be interested in extending their tracking project to Gloucestershire and we jumped at the opportunity to learn more about the ecology of our Goshawks. Thanks to generous donations and grants from the Gloucestershire Naturalists Society (GNS), Gloucestershire Ornithological Coordinating Committee (GOCC), BTO, Forestry England and a private donor we were able to purchase 8 'Movetec' GPS satellite tags to fit in 2019, all of which were successfully deployed on Goshawk chicks in the Forest of Dean and the Cotswolds under the careful guidance of BTO's Ian Henderson and Greg Conway.


Figure 8 The BTO providing training to Robin Husbands and Anna Field to fit tags and harnesses to Goshawk chicks (Photos: Ben Locke)

The tags take regular high precision GPS location fixes and store them until they are ready to transmit data via the mobile phone network. Tags are powered by an integrated solar panel which is expected to last around three years. They are attached using a Teflon backpack harness with a weak link that will allow the tag to fall off after about five years (once the battery has failed). Tags can recharge fully in just two hours with a full charge lasting four or five days. To preserve battery power (because of the Goshawk's shady lifestyle), the tags were programmed only to take location fixes five times per day and attempt to transmit data once every three days because it is better to get less data regularly than risk having large periods of time without getting any data because the battery is flat.

Out of those eight birds, two tags stopped transmitting shortly after leaving the nest (one is known to have died as the body was recovered and the other is assumed to have died of natural causes) and another five survived a number of months collecting valuable data but have now stopped transmitting at various points throughout their first year. One of these tags is suspected to have failed and the other four birds are assumed dead; two appear to have died in natural circumstances but one of the others is suspected to have been persecuted. Only one tag continues to transmit and we hope that now she has survived the perilous first 12 months she will go on to join the breeding population next year. As only around 40% of Goshawk chicks make it to their second birthday (Kenward 2006), we expected some mortality and loss of tagged birds but are disappointed to have lost so many.

The BTO will carry out and publish a detailed analysis of the tracking data in due course but we have noticed a few interesting things already. The Forest of Dean birds tended largely to stay within the extensive forest habitat available, perhaps because there was sufficient unoccupied woodland available for juveniles to avoid territorial adults. In contrast, one of the Cotswold birds ranged widely over farmland and wooded Cotswold valleys as was seen with the BTO's Thetford Forest birds. Unsurprisingly, all birds tended to avoid heavily populated areas. The GPS fixes show that one of the Forest of Dean females visited five nearby Goshawk nest sites during her explorations – perhaps already looking for an unoccupied territory. Our trail cameras occasionally show a third adult goshawk visiting a nest site late in the season once the chicks have fledged so perhaps this behaviour is not uncommon. The GPS fixes don't just record location data, information such as altitude and time are also captured. Timing of fixes and movements show more interesting behaviour: one of the Cotswold birds roosted in hedgerows rather than woodlands on several

occasions and other birds were found to move around at night – perhaps if disturbed for some reason.

For the six birds that survived to independence, the average distance of fixes from the nest site ranged from 1.9km to 5.9km – the greatest being our wandering Cotswold bird. The longest distance of a fix from the nest ranged from 11.1km to 16.5km – this time the greatest being a short exploratory trip into Wales by one of our Forest of Dean birds. Our male birds travelled slightly further afield than our female birds.

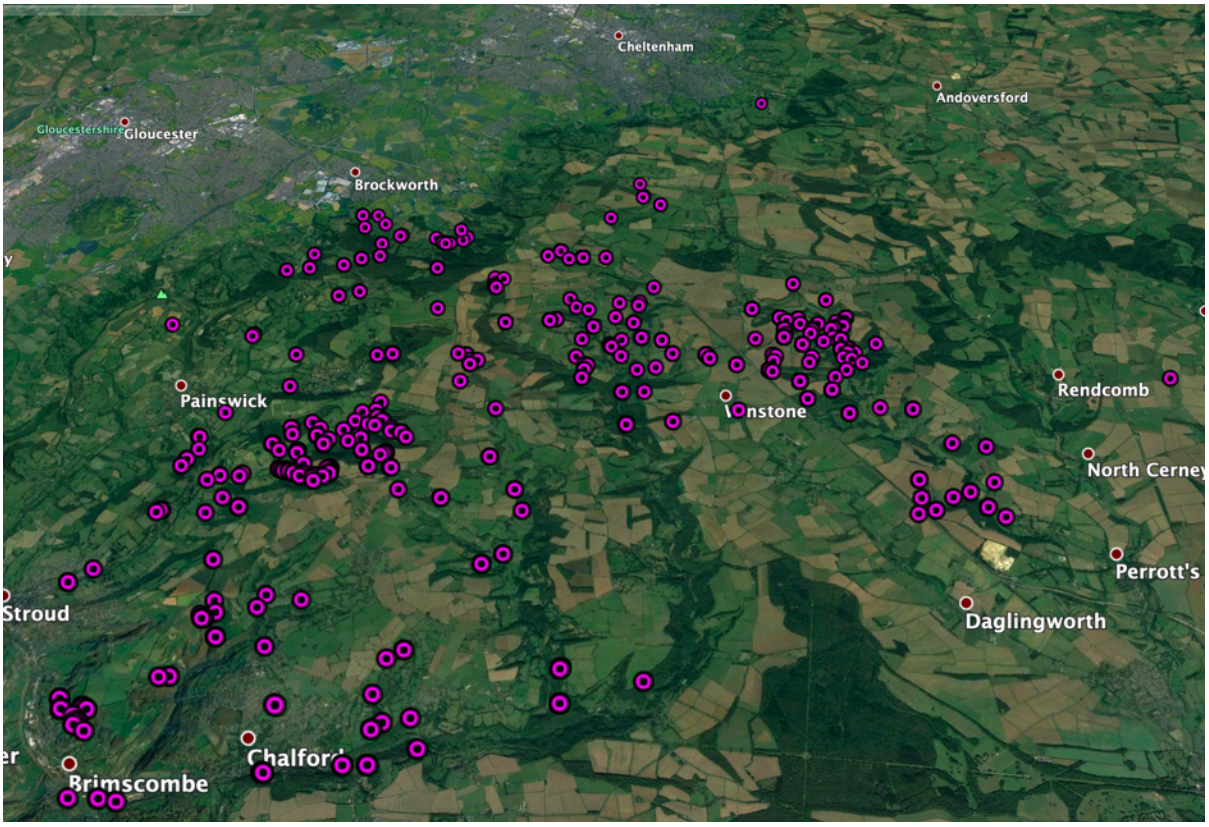

Figure 9 Movements of one of the Cotswold birds in the months following fledging. Nest site not shown.

Future plans

A decision was made to suspend the tagging aspect of the project in 2020 due to Covid-19 restrictions however we are currently exploring funding options for 2021 and hope to tag a further eight birds from a range of locations to help unravel more secrets of this fantastic bird. We also look forward to more ring recoveries as more colour ringed birds are recruited into the breeding population.

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