A newly published paper presents an RSPB study on the response of Curlew to management interventions. Dr David Douglas, Principal Conservation Scientist, describes the results and their implications for Curlew conservation.

It is well established that the plight of our Eurasian Curlew ('Curlew') is one of the highest conservation priorities at home and internationally, because of the severe population declines and because here we have responsibility for up to a quarter of the global breeding population. It is likely that loss and degradation of suitable breeding habitat to intensive agriculture and forestry has driven declines over the long-term, and the current low breeding success is due to high rates of nest and chick predation, which is itself partly due to these land use changes. Securing a future for Curlew will require the lowering of predation pressure at sites, alongside the provision of suitable breeding habitat. How can these aims be effectively achieved over the large areas that breeding Curlew require, for example farmland?

This is where RSPB's Curlew Trial Management Project comes in. This project tested whether the combined delivery of habitat management and legal predator control of foxes and crows was effective in improving Curlew nesting success and breeding abundance. The study took place across six UK study landscapes, each containing a trial site where the habitat and predator interventions were delivered, and a separate non-intervention (reference) site in the same landscape where management continued on a 'business as usual' basis (i.e. no Curlew-targeted habitat management and predator control). Sites were large (around 10km^2) and were a typical mix of Curlew breeding habitats for the UK uplands (enclosed grassland and open moorland) and were a mix of RSPB nature reserves and private farmland. Monitoring was the same at all sites and started with the collection of baseline data in the first breeding season before any interventions, with data collected for a further four years after interventions began (five years of data in total). During those five years, data was collected on vegetation condition, predator abundances, potential prey that might be associated with increased numbers of predators that could be easily recorded (non-native released gamebirds) and Curlew location, numbers and nesting success.

Breeding habitat improvements focused on reducing rush cover and the taller, denser vegetation that was less suitable for Curlew, by cutting *Juncus* rushes and mowing rank grassland and heather. This work was targeted within trial sites at the places where habitat condition needed most improvement to deliver what Curlew require. Predator control was delivered by skilled contractors prior to and during the Curlew breeding season, targeting Foxes and Carrion/Hooded Crows, as evidence exists that these species predate Curlew eggs or chicks; they can be legally killed within licenses for conservation purposes; and their abundances can be reduced through lethal control.

Our work aimed to answer the following questions:

Did our habitat management improve the breeding habitat for Curlew and did they use the managed areas?

Yes. Rush cover and vegetation density were reduced and Curlew used those newly managed areas during the breeding season.

Did predator control reduce the numbers of foxes and crows on sites where they were controlled relative to sites with no targeted management?

No. Although there was variation between sites, Fox abundance declined at an overall rate of 25% per year on trial sites and 7% per year on reference sites (Fig. 1a). Despite these relatively large differences, the statistics were not significant. The story was similar for crows, with a 20% per year decline on trial sites compared to 10% per year declines on reference sites (Fig. 1b) and no statistical significance. In trying to understand these patterns we found that fox and crow numbers also appear to be influenced by other site effects such as the numbers of gamebirds present and the amount of woodland. This suggests that the responses of these predators to lethal control are dependent on complex site-specific context, meaning that consistent responses to lethal control are difficult to guarantee.

Did the combined effect of our habitat and predator interventions in this study result in better nesting success and more Curlews on trial sites?

No, as there were no detectable differences in either nesting success (Fig. 1c) or breeding numbers (Fig. 1d) between our trial sites compared to our reference sites, likely because of the complex site-specific factors mentioned above.

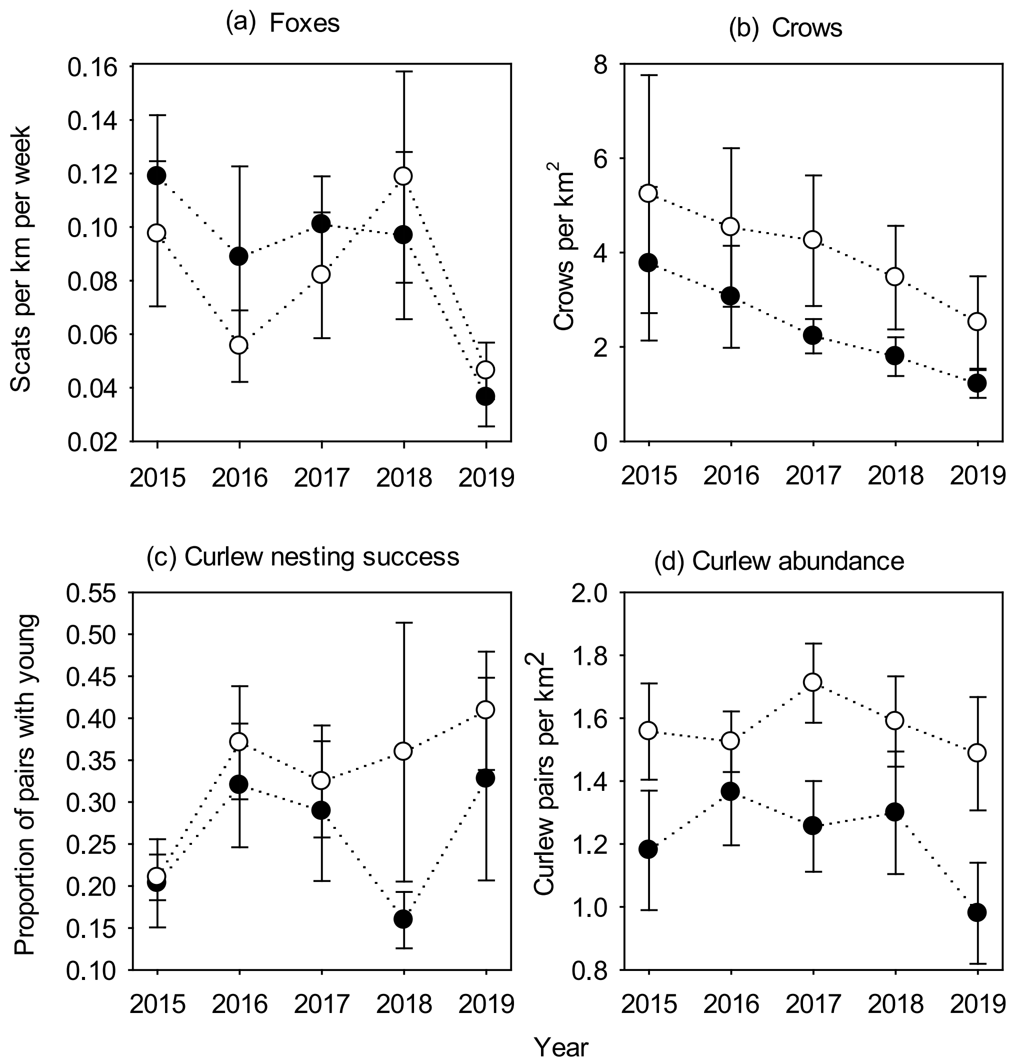

Fig. 1. Changes in indices of Fox, Crow and Curlew numbers, and Curlew nesting success, between trial sites (filled circles) and reference sites (open circles) across five years of the Curlew Trial Management project. The baseline year was 2015 with four subsequent years of interventions on trial sites (2016-2019) and associated monitoring on trial and reference sites.

Did the combined effect of our habitat and predator interventions result in more waders of other species on trial sites?

Yes. ‘Red-listed’ Lapwing increased by 10% per year on trial sites and declined by 13% on reference sites and these changes were statistically significant. We cannot be certain what caused this increase in Lapwing, e.g. whether it was due to increased breeding success or because birds were attracted into the trial sites by improved conditions, or a combination of the two. Snipe also increased by 4% each year on trial sites and showed no change on non-intervention sites, but these changes were not statistically significant.

How do these results inform future curlew conservation?

We improved breeding habitat where it was most needed and Curlew responded to those improvements, so reducing rush cover and vegetation density in a targeted way provides a means for managing upland enclosed pasture and moorland to attract breeding Curlew. These results could inform the design of future agri-environment habitat options for Curlew.

The lack of a difference in changes in Fox and Crow numbers between trial and reference sites could relate to:

1. A lower intensity of predator control relative to other studies that deployed year-round control and additional techniques that are not used by RSPB on ethical or welfare grounds.
2. Differing starting densities of predators across sites, because the effectiveness of lethal control at reducing predator densities can depend on how many you have at the start.
3. Additional influences on fox and crow abundance which could affect the ability to reduce their abundances through lethal control, such as non-native gamebird

abundance and woodland in the landscape (or other factors that we did not measure). These influences suggest that changes in predator abundances in response to lethal control are likely to be dependent on local context, and consistent responses to deployment of interventions such as lethal control cannot be guaranteed.

4. Although we did not initiate lethal predator control on reference sites, it is likely that limited amounts occurred on, or adjacent to, some of these sites. This could have reduced predator numbers over the duration of the study, however, we do not consider this a major influence on overall differences between trial and reference sites.
5. Whether the complex site-specific factors mentioned above meant that only six sites limited our ability to detect possible effects of the interventions.

The difficulty in increasing Curlew nesting success on trial sites relative to reference sites demonstrates the challenges in reducing predation pressure. The UK's densities of crows and foxes are notably high in a European context. The lack of response in Curlew breeding numbers most likely relates to the lack of response in nesting success, as breeding success is the main demographic driver of population change. But curlew also don't start breeding until they are at least 2-3 years old, and don't always return to breed at the sites where they were hatched, meaning that even if breeding success had increased, we would have expected a lag in the response in breeding numbers, perhaps indicating that more study years would have been needed to detect such an effect. Unfortunately, the study was cut short by the national Covid lockdown, when research and monitoring had to be curtailed.

The main evidence we have for positive effects of predator control on breeding waders remains that delivered on grouse moors, as a by-product of producing Red Grouse to be recreationally shot. On grouse moors, predator control is deployed at a high intensity, year-round, using a wide range of techniques, targeted at a wide range of species, and is undertaken at sites over many years. Grouse moor gamekeepers operate under conditions where their employment is often tied to the surplus of grouse they produce to be shot, which must be a strong incentive to deliver intensive predator control. Grouse moors also have less woodland than other upland areas (and are therefore less 'predator friendly' to begin with) and many sit within landscapes where neighbouring sporting estates are also practising intensive control, with this scale effect potentially important. These factors almost certainly combine to influence the intensity and effectiveness of predator control on grouse moors.

Could this model of delivery be replicated and sustained outside grouse moors?

We think this would be extremely difficult, because the costs would be huge; the killing of large numbers of native animals that would be required might be unpalatable to large sections of society; it might prove hard to tie livelihoods so closely to systematic predator control; the scale effect of large numbers of neighbouring land holdings all conducting control would be difficult to achieve; and many upland landscapes have existing, and growing, areas of woodland. There are calls for the adoption of lethal predator control within agri-environment schemes as a conservation tool for breeding curlew. However, our results suggest that further work is required to establish what such a model, providing sufficient certainty of levels of effectiveness to deliver for curlew (and therefore also return on public investment), and reproducibility across sites, might look like.

The management actions in our study were not cheap, with habitat management costing around £135 per hectare and predator control costing £21.61 per hectare. Investment in agri-environment scheme options aiming for national-scale population recovery of a species such as Curlew will need to be enormous, given their wide distribution across Great Britain and Northern Ireland. The debate around the adoption of predator control within agri-environment schemes must recognise the high cost and the risk that this cost does not guarantee a response from the target bird species, since it may depend on other land use activities such as presence of forestry and non-native gamebirds in the local landscape.

In the EU funded Curlew LIFE project, we are building on the results of this study to deliver Curlew conservation. For example, in Northern Ireland and Wales, where Curlew face a high risk of extinction, we are adding nest fencing to habitat and predator control interventions and have early signs that this is boosting Curlew breeding success. On RSPB land, we have identified 24 key Curlew reserves where delivery for the species is a priority. This includes better understanding why predator control is more effective on some sites than others, to inform its targeted use.

Over the medium and long term, rather than perpetual predator control at high cost and sometimes limited effectiveness, we suggest a focus on addressing the human-induced causes of high generalist predator densities, such as foxes and crows, which are not fully understood but could include:

Factors that influence food availability for generalist predators:

- The productivity of farmland (length of the growing season) which may influence prey abundance or diversity and consequently predator populations
- Livestock farming including scavenging or predation of animals and their feed
- The presence of non-native gamebirds in the UK countryside providing additional food resource
- High abundance of rabbits, deer and other food resources

Landscape configuration that favours generalist predators:

- Forestry and agricultural influences on landscape fragmentation
- Roads and tracks which could facilitate site access and provide carrion
- High-density urban fox populations which could affect abundance in the wider countryside

Lack of apex predators:

- The extirpation of predators including Lynx and Wolves and illegal suppression of those that remain, including some raptors

Research into the relative importance of these potential drivers of high predator abundance, and whether they can be alleviated through landscape-scale interventions to reduce the carrying capacity for predators, is required urgently to make progress with large-scale, sustainable recovery of species that are limited by these predators.

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