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POSTER

Monitoring Lapwing breeding success in the South West Peak

SARA D. J. BARRETT[1], RICHARD M. BLINDELL[2], TARA CHALLONER[2] & MARK J EDDOWES[3]*
[1] Natural England, UK
[2] Peak District National Park Authority, UK
[3] Eddowes Aviation Safety Ltd, UK
* Email: mark@eddowesaviationsafety.com

Following recent declines in breeding wader populations (Northern Lapwing *Vanellus vanellus*, Eurasian Curlew *Numenius arquata* and Common Snipe *Gallinago gallinago*) in the South West Peak, attention has been directed towards monitoring of breeding performance with the objective of informing conservation management. Efforts have focused on monitoring of Lapwing, which is the most practical subject, and has sought to determine nest and chick survival rates and their contributions to overall breeding performance, measured in terms of chicks fledged per pair. Surveys focused on monitoring nests at several key upland grassland sites to identify the causes of nest losses, supported by the deployment of nest cameras and thermocrons, small temperature loggers placed in the base of nests. Chick survival rates and overall breeding productivity were estimated by field observations that followed chick development to fledging. Initial survey work began in 2006 and more targeted monitoring work was undertaken from 2010 to 2013.

The observed primary breeding performance parameters, individual nest survival rate, proportion of pairs successfully hatching a clutch, the rate of chick survival to fledging and the number of chicks fledged per pair per annum, are summarized in Table 1.

Table 1 Summary of breeding performance parameters

	Nest survival rate (%)	Pairs hatching a clutch (%)	Chick survival rate (%)	Chicks fledged per pair
2010	49.75	90.18	32.11	1.04
2011	40.98	75.76	36.91	0.98
2012	28.80	60.23	43.22	0.93
2013	62.00	80.52	34.10	0.96
Average	43.68	76.67	35.69	0.98

Across all sites, the average nest survival rate was 44% but varied between sites and years. Predation by nocturnal mammals (Red Fox *Vulpes vulpes* and European Badger *Meles meles*) was the dominant cause of nest losses, responsible for 59% of losses. Disturbance by livestock was the second most common confirmed cause of nest loss, responsible for 14% of losses. However, it appears that a significant proportion of daytime losses of

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uncertain cause, comprising 19% of the total, may be livestock-related. Apparent corvid or other avian predation events were identified as being responsible for 3% of losses but avian predation may also have been responsible for a proportion of the daytime losses of uncertain cause. Flooding was responsible for 5% of losses.

With the laying of replacement clutches, the proportion of pairs successfully hatching a clutch was much higher than the individual nest survival rate at an average of around 80% and was more consistent than the nest survival rate between sites and years. The laying of replacement clutches can significantly limit the impact of individual nest losses. The empirically observed dependence of successful hatching a clutch on individual nest survival, based on the data from different sites in different years, as shown in Figure 1, was consistent with a theoretical model for clutch replacement based on an assumption of 90% replacement of first clutches and 50% replacement of second clutches, indicated by the literature.

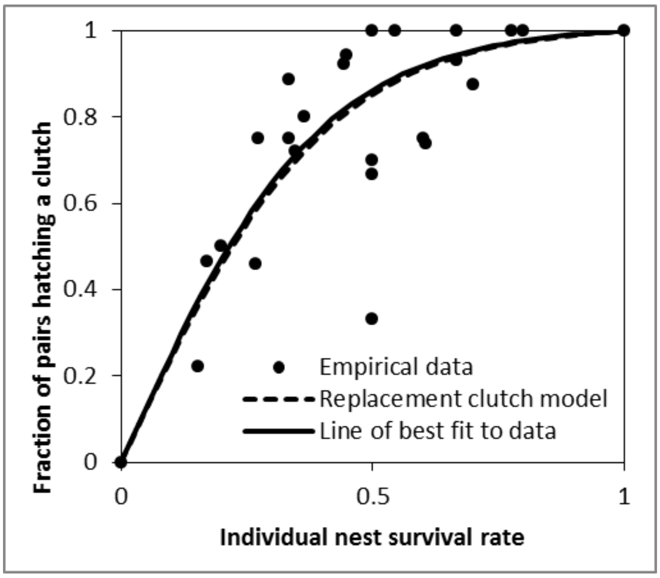

Figure 1 Dependence of hatching success per pair on individual nest survival rate

Despite the laying of replacement clutches, the proportion of pairs successfully hatching a clutch was more substantially affected at some sites where the rate of nest predation by mammals was somewhat higher than average and, in some cases, nest predation was devastating at the colony level. At one site where relatively high losses of nests to Badger and Fox predation have been encountered, a mammal exclusion fence was installed to protect an area of approximately 20 ha before the 2013 breeding season. Initial results from this site for 2013 indicate that this measure may be able to provide an effective improvement in breeding performance. Overall, however, given the extent to which the effects of lower levels of nest loss are offset by the laying of replacement clutches, more moderate nest loss rates may have a limited impact on overall breeding success.

Chick survival rates were around 33% and again varied widely between sites and years. Field observations of the numbers of chicks surviving as a function of age indicate that daily survival rates increase considerably as chicks

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get older. The survival data fit an exponential expression of the form exp $(-\alpha\, t^n)$, where $n = 0.5$, as shown in Figure 2. This functional form implies a higher loss rate at younger ages and the daily loss rates decreased from about 10% at 1 day old to about 2.5% at 10 days old and to about 1% at 35 days old.

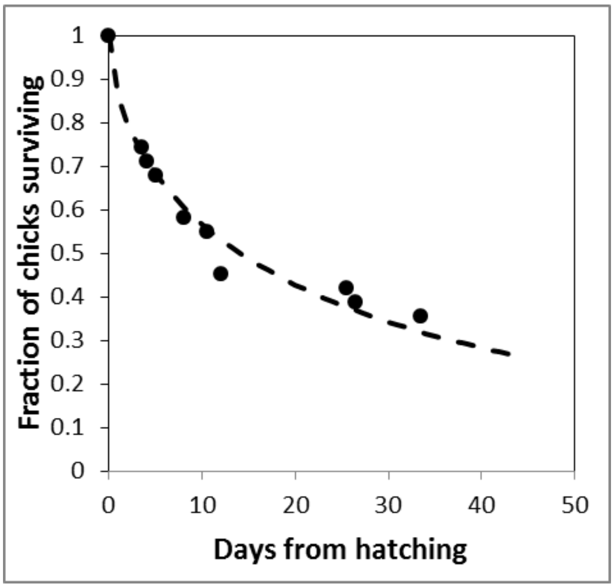

Figure 2 Chick survival as a function of chick age

Overall breeding productivity across the study sites was fairly constant throughout the 4-year study period at about 1 chick per pair per annum. This rate exceeds the value of 0.6–0.8 chicks per pair estimated to be required to maintain a stable population, having regard to the available data on annual survival rates of adults and juvenile birds. Chick survival rates were relatively high in years when nest survival rates were relatively low and vice versa, with the observed negative correlation between chick survival and nest survival, shown in Figure 3, leading to the observed stable overall breeding productivity across the 4-year study period.

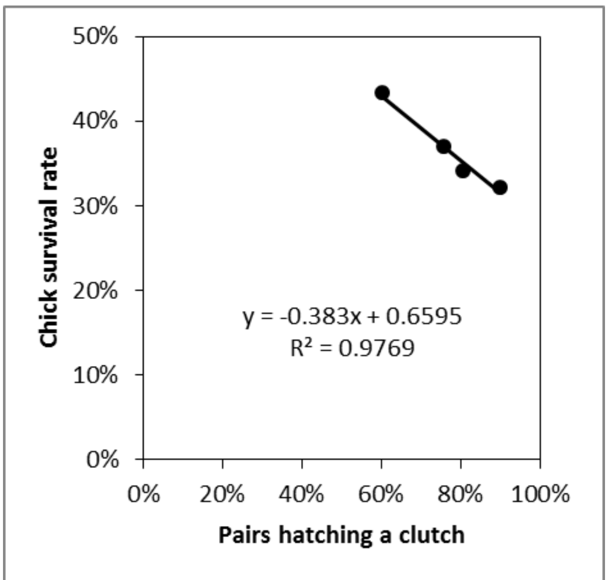

Figure 3 Between-years chick survival versus nest survival rates

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Given the relatively high overall proportion of pairs successfully hatching a clutch, chick survival appears to be the more significant factor limiting breeding success. Measures to improve chick survival would therefore appear to offer considerable conservation management potential. However, unlike nest loss and its primary causes, which were well characterized by the available field observations, chick survival was difficult to quantify reliably and the causes of losses were not readily identifiable. In the absence of site-specific information on chick loss, data from previous studies at other sites, for example those that have employed radio-tagging to determine the causes of chick loss, may help to inform conservation management strategy. However, this approach may fail to effectively target the more important factors operating at individual sites. Further and more detailed chick survival research at the individual site level may be beneficial. These observations highlight the challenges associated with effective site-specific conservation management which merit further and more detailed consideration.