

# 1 **S1 Appendix. Timing of fox breeding events**

## 2 **Methods**

3           Cubs become vulnerable to detection during lamping when they are weaned and  
4 active above ground away from the earth. To account for cub recruitment into the detectable  
5 fox population, the time at which this occurs must be defined. In Britain, mating occurs  
6 December-February and following a gestation period of 52 days, most births occur between  
7 mid-March and mid-April [1]. Female foxes lactate for four weeks following the birth of  
8 cubs, and the cubs are fully weaned at 6-8 weeks of age [1]. At about six weeks of age the  
9 cubs begin to emerge from the earths, initially only exploring the area around the earth  
10 entrance, but become active away from the earth by eight weeks [2]. While most cubs are  
11 born in late March, we considered the assumption that all cubs are weaned in one two-weekly  
12 time-step and become detectable at the same time was too rigid. A more realistic approach  
13 would be to specify a weaned cub distribution incorporating variation around the mean date  
14 of recruitment to the detectable fox population to allow for some early or late litters across an  
15 estate.

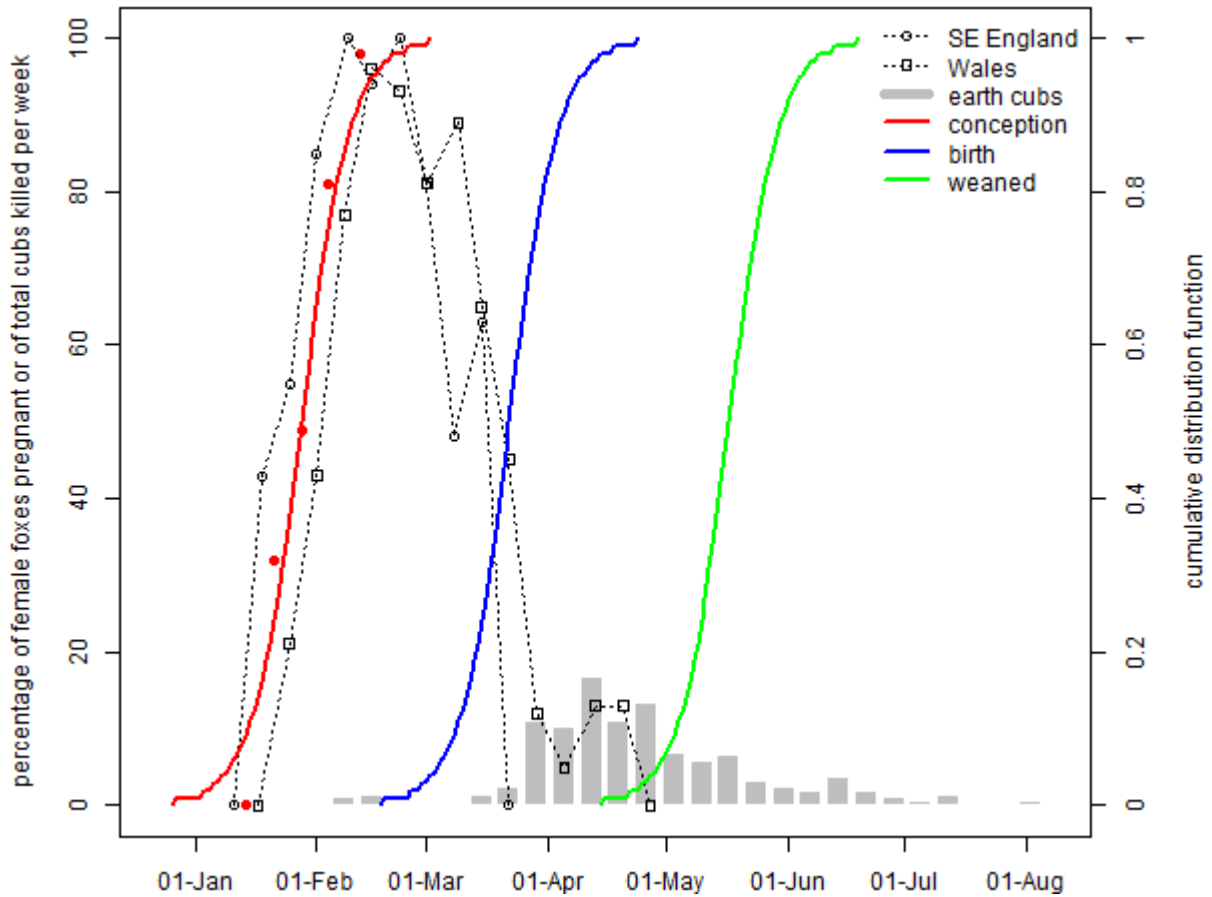
16           The first step in obtaining this distribution was to use data from fox populations in SE  
17 England and Wales describing the probable conception dates of female foxes killed during  
18 pregnancy [2]. These data were summarised by taking the mean date and percentage of  
19 paired sampling points ( $n=5$ ) on the ascending limb of the curves, i.e. the percentage of  
20 females that had conceived over time across both populations). Next, assuming that these  
21 mean data points followed a logistic distribution, the 'fitdistr' function from the MASS  
22 package [3] in the R statistical software [4] was used to estimate the maximum likelihood  
23 values of the parameters describing the cumulative distribution function of the logistic

24 distribution. This cumulative distribution was taken to describe the distribution of conception  
25 events in the female fox population over time.

26         Given the distribution of conception events it was trivial to project this forward in  
27 time, first to a distribution of cub births by assuming a gestation period of 52 days [1], and  
28 then to a distribution of cub weaning by assuming that all cubs were weaned and active away  
29 from the breeding earth at eight weeks of age (56 days). As expected, the mean of the  
30 distribution of births was in late March. This distribution was then used to calculate the  
31 proportion of cubs weaned on a given day and thereby vulnerable to lamping in the detectable  
32 population. These proportions were then aggregated into a two-weekly time step  $t$  for use in  
33 the model, with  $w_t$  defined as the proportion of weaned cubs entering the detectable  
34 population during  $t$  (the values of  $w_t$  sum to 1).

## 35 **Results and Conclusions**

36         The estimated distribution of conception events from the data in Lloyd [2] is shown in  
37 Fig A, together with the projected distributions of births and weaned cubs. Under these  
38 projections, >50% of cubs born on an estate would be recruited to the ‘detectable’ weaned  
39 population during the third and fourth weeks of May, with >80% recruiting during May.  
40 These projected distributions are supported by data from 74 estates across Britain on the  
41 numbers of cubs killed per week at breeding earths ( $n=626$  cubs, unpublished data, GWCT).  
42 This shows that very few cubs were killed before the start of the projected distribution of  
43 births (<1%) and that only a small proportion of cubs were killed at earths following the end  
44 of the projected distribution of weaned cubs (<5%). We conclude that the projected  
45 distribution of weaned cubs provides a suitable description of the timing of when cubs would  
46 become active away from breeding earths.



47

48 **Fig A. Timing of fox breeding events.** Data from two British fox populations on the  
 49 percentage of female foxes that were pregnant at different times during the breeding season [2]  
 50 are summarised, with mean dates and percentages (red points) used to fit a cumulative logistic  
 51 distribution to show the percentage of the female population that had conceived over time. The  
 52 distribution of births was obtained assuming a gestation period of 52 days, from which the  
 53 distribution of weaned cubs was obtained by assuming that all cubs were weaned at eight weeks  
 54 of age. The weaned distribution describes when cubs become vulnerable to lamping effort.  
 55 The histogram shows the percentage of total cubs killed at earths per week on 74 estates across  
 56 Britain ( $n=626$  cubs).

57 **References**

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