# Monitoring to estimate numbers and productivity of territorial Curlews

### 1.1. Introduction

This document provides an introduction to recommended fieldwork protocols for the mapping/counting of territorial Curlews, and for estimating productivity of Curlew populations. The actual survey methods are available in the Appendix.

### 1.2. Why monitor Curlews?

By population monitoring, we broadly mean here estimating the **number of pairs** and their **productivity** (i.e. breeding success, typically measured as fledglings per pair per year) on a **repeated annual basis**.

These two variables are fundamental for Curlew conservation. By mapping and monitoring the number of pairs we can assess distribution and population changes through time. Monitoring productivity is also vital because we know that Curlew decline is primarily driven by decreases in productivity, while survival (of birds from fledging through adulthood) is high and has been stable in recent years[1]. Further, most curlew conservation action involves interventions that aim to boost productivity (rather than survival), and we need to know whether these actions are working.

By using similar methods each year, across different sites, we can compare Curlew populations in time and space. This is essential if we are to understand why Curlews are declining and what works for their recovery. For example, there is growing evidence showing that predator control measures can improve Curlew productivity. However, to increase this evidence base and to assess the efficacy of predator control measures at individual sites, we would ideally measure productivity between sites/periods where control measures are used and where they are not; this comparison requires the data to be consistent in time and space.

### 1.3. Why suggest revisions to Curlew monitoring methods?

There are two established methods, referred to as *O'Brien and Smith* and *Shepherd and Brown* after their authors, plus other standardised breeding season monitoring methods such as the BTO Breeding Bird Survey (BBS). They are fundamentally sound, and there is merit in sticking with established methods because it means data can be compared over multiple years. However, these methods were not designed specifically for Curlews, but for monitoring breeding waders of open country (including Lapwing, Redshank and Snipe); to that extent, they are a compromise, especially in terms of survey timing.

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[1] *Cook et al. (2021). Temperature and density influence survival in a rapidly declining migratory shorebird. Biological Conservation 260. DOI: 10.1016/J.BIOCON.2021.109198.*

Curlew fieldworkers have raised various concerns about the efficacy of the two main published methods, and consequently there is a proliferation of 'bespoke' approaches in use across the country. This means that data are not easily comparable across projects/areas and this in turn limits our ability to draw conclusions about Curlew trends and the success (or otherwise) of conservation actions.

There may well be occasions when multi-species work is the priority, but an increasing number of groups and individuals are now focused specifically on monitoring breeding Curlews, and this creates an opportunity to greatly strengthen Curlew conservation by synthesising data and drawing conclusions across multiple sites about what works for Curlews.

In addition, we know that monitoring wader productivity is very challenging, even for well-resourced projects, and yet we know that productivity is the critical demographic variable driving Curlew decline. On the upside, recent intensive studies have improved our understanding of breeding Curlews and how best to study them. With all this in mind, and considering the impetus provided by various Curlew conservation initiatives, we think that this is the right time to develop and promote a standardised and Curlew-specific monitoring protocol.

**1.4. General features of a good monitoring method**

- Gives reasonably accurate estimates
- Repeatable – i.e. different observers would have arrived at (approximately) the same answer if doing the same survey at the same time
- Efficient (maximum amount of good data for minimum effort)
- Works across all landscape types (enclosed, unenclosed) and habitat types
- Works across different population densities, from small groups consisting of single pairs/small clusters in a landscape, to high density, semi-continuous populations
- Scalable from single fields to whole landscapes
- Scalable in that useful and consistent information can be gained by both light-touch and very intensive projects
- Does not require expensive equipment or high levels of expertise
- Does not have significant negative impacts on wildlife or farming

**1.5. Specific issues**

Any new survey and monitoring methodology, specifically for Curlews, would benefit from being comparable to the established methods mentioned above, and that are described in the key reference book[2].

We are aiming for a method that allows a reasonably unbiased and precise *estimate* of territorial pairs. It is counter-productive to aspire to a complete census of territorial pairs, because that can only be achieved with very high effort intensity (or very small populations) - since this cannot be achieved everywhere, this makes comparisons between areas impossible.

[2]*Gilbert et al. (1998). Bird Monitoring Methods: A Manual of Techniques for Key UK Species. Pelagic Publishing.*

An understanding of breeding phenology (seasonal timing) and behaviour is important to ensure that survey visits are timed appropriately, and to make sense of registrations plotted on a map; exact seasonal timing will vary between sites.

Birds are much easier to detect before incubation commences. During territory establishment and courtship, both members of a pair will frequently be together, active, and noisy. During incubation, one bird is hiding out of sight, and the off-duty bird may fly substantial distances to feed. Apart from territory defence, they are deliberately secretive during this period. In some habitats, vegetation growth can be substantial by mid-April, making detection harder. If birds fail early in incubation, they may depart the area, or re-nest, causing further confusion.

**1.6. What's different and what issues remain?**

The methods we are suggesting are not radically different to existing methods - there is no magic alternative to visiting sites and counting birds!

Perhaps the most important modifications we would suggest are:

- We believe that counting territorial pairs of Curlews should take place **before incubation starts**. This makes sense in relation to Curlew behaviour and detectability, and ease of detection before vegetation grows.
- We think that monitoring productivity is best achieved by **frequent, timed, and rather short, repeat visits** that are clearly focused on detecting behavioural signs – primarily from the adults – of continued brood presence. This is in preference to fewer, longer visits that aim to confirm sightings (and counts) of broods.
- Hence, intensive effort is needed pre-incubation and after hatching, with relatively little activity during incubation.
- While projects may be attempting to find and monitor nests and chicks for research purposes, these activities should not be confused and merged into general repeat monitoring of the population size and productivity. Where this happens, it tends to result in non-standardised and non-comparable data.
- For standardised monitoring, **there is no need to 'prove' breeding, hatching, or fledging** by finding actual nests or chicks, and no need to expend extra fieldwork effort in finding that proof. The idea of standardised monitoring methods is that they allow projects to make **plausible assumptions** to get a robust, comparable **estimate** of key metrics.

**1.7. Who do we hope will use the methods?**

We would like to create method(s) that are adopted as widely as possible across Curlew projects and other fieldwork efforts in England. Curlew projects vary from small, informal, volunteer-led grassroots operations, sometimes with relatively little experience, through to large, funded projects managed by conservation organisations with highly trained fieldworkers. It should be noted that other low-intensity methods are available for practitioners, e.g. farmers and gamekeepers, such as the BTO Wader Calendar and BTO Trapline Surveys.

We stress that this is work in progress, not a new established method. Further, any new method may not be suitable for existing projects that have been using a particular monitoring method for several years and might feel that continuity of datasets is the most important thing, and therefore do not wish

to change. It may also not be suitable for projects that are aiming to capture data on multiple wader species and may therefore wish to continue with established multi-species methods.

### 1.8. Metrics

*1.8.1. Apparently Occupied Territories*

The metric we are ideally aiming to estimate is the **number of apparently occupied territories** in a defined study area/population. Territorial pairs include pairs that hold territory but do not attempt to breed (i.e. do not lay eggs), plus those that breed (i.e. lay eggs) but fail to fledge chicks, plus those pairs that successfully fledge chicks.

The term 'breeding pairs' (confirmed, probable or possible) is not used here because:

1. It is ambiguous. Sometimes it is used with the same meaning as territorial pairs above, sometimes to mean only those that attempted to breed (whether successful or unsuccessful) and sometimes to mean only those that bred successfully.
2. Confirming whether a territorial pair has attempted to breed is difficult and requires an extra level of fieldwork (finding nests or chicks) that is not possible for many. Hence, failing to confirm a breeding attempt often says as much about how much fieldwork effort was possible as it does about what the birds did.
3. Most importantly, adult Curlews that make no breeding attempt in a particular year (referred to as *deferring breeding*) are still part of the population, and therefore we need to include them in our surveys; when we calculate productivity as *number of fledglings divided by number of pairs*, and use this in population models to predict how much productivity we need to achieve population stability, we are including these deferring birds in the 'number of pairs' estimate.

We acknowledge that even 'number of apparently occupied territories' is imperfect: Territories may be occupied by unpaired adult birds at breeding sites, or by immature birds (one-year olds) that are countable but are not actually part of the adult breeding pool. This is an inaccuracy that we acknowledge but cannot easily deal with except in extremely closely monitored populations.

*1.8.2. Productivity*

Ideally, we are seeking to measure **fledglings per occupied territory**. This metric is useful for assessing productivity against what is needed for the population to be stable (via population models). However, an *index* of productivity – i.e. a relative measure that is not intended to be completely accurate - can still be useful. If the index is obtained by using a standardised and repeated method, it can be used to make valid comparison between sites and years. An index can be calibrated against true productivity.

### 1.9. Outline of suggested method

We propose a three-tier method, as follows:

- **Tier 1:** informal visits to potential sites during the territory establishment period, to obtain a general picture of **site occupancy**. These can then be built upon in Tier 2 to obtain pair estimates, but on their own form a useful basis for mapping populations.

- **Tier 2:** formal, standardised visits to sites during the immediate pre-incubation phase, to estimate **number of territorial pairs.**

- **Tier 3:** formal, standardised visits to sites during the chick-rearing phase to estimate **the number of broods successfully fledged.**

This approach is scalable, in that it is not necessary for all three tiers to be completed. Tier 1 can be used to map site occupancy without following it with the more detailed work in Tier 2. Tier 2 can be used to estimate territorial pairs without using Tier 1 beforehand. Tier 3 is focussed on productivity and is not needed if the aim is only to estimate territorial pairs, and not productivity.

## Appendix: Methods

It is recommended that all fieldworkers read the introductory notes of this guidance, and the relevant sections of the Curlew Fieldworker Toolkit that are available at the link below:
https://www.curlewrecovery.org/resources

## Tier 1

Informal visits to potential sites during the territory establishment period, to obtain a general picture of **site occupancy**. These can then be built upon in Tier 2 to obtain pair estimates, but on their own form a useful basis for mapping populations.

**Output**: Presence/absence of territorial birds in defined study sites, with an idea of where they are focusing on within those sites.

**Who**: Observers with relatively little time and/or experience who might undertake Tier 1 only, or projects that wish to undertake preliminary work to focus search area before undertaking more detailed Tier 2 fieldwork.

**When:** During early territory establishment, before incubation commences (timing will vary between regions, but is typically from March through to mid-April).

**How**:

1. Define the bounds of the survey site (s)
    - Define the area you are going to survey **before surveying commences**. There is no particular method proposed for deciding the location and extent of the survey area, but you must define it before you start.
    - If this step is not completed, then if Curlews are not recorded in a particular place, it is not clear whether they were absent, or the site was simply not surveyed.
    - It is possible to change the survey areas as you go through the season, in response to events. For example, if Curlews are found just outside the survey site, then in future visits you could expand the survey site to include the area where they were, but this change must be recorded.
    - The survey area can be any size, and there can be multiple separate sites in your overall survey area.

2. Divide up the parcels within the site(s)
    - In enclosed sites, each field/parcel should be given a unique identifying code. In unenclosed sites, each square kilometre should be given a unique identifying code. Each Curlew that you find on each visit will need to be attributed to one or more of these coded fields or kilometre squares.

3. Visit the site(s)
    - It does not matter what time of day, how long, or how many visits there are, as long as each visit is recorded (date, time, observer) (including those with zero curlews). It could for example

be repeat visits to a site by volunteers, or casual observations by people who use the site during the course of other activities (e.g. farmers, keepers).

- It does not matter how you view the site, e.g. from a stationary viewpoint or by traversing the site on foot, as long as you feel that you have had a decent view of all of the defined area.
- The more visits the better. In general, multiple brief visits is better than a few long ones, but this is not always easy to achieve in practice.

4. Record the visit

- Each time the site is visited, record:
    - Who made the visit.
    - Date and time of start and end.

5. Record any Curlews

- For each Curlew or group of Curlews that are clearly together, map their presence by noting which field/kilometre square they were in when first detected.
- This can be done by simply noting down the code for the field/kilometre square, or by marking the birds' position on a map (which can be a paper map or on a phone/tablet).
- For each registration of Curlew(s), record the number of birds associating together. This can be ambiguous, e.g. foraging Curlews may be well separated as they feed but come together in a flock if flushed. Base the decision on their behaviour, but do not worry about it too much.
- If it is possible to identify whether the birds are males or females, then do so, but this is not at all essential and should not be done unless you are reasonably confident.
- Record the behaviour of the birds under one or more of the following categories (if the bird is seen doing more than one activity, you can record more than one):
    - Feeding
    - Loafing/roosting (i.e. stationary, apparently resting)
    - Commuting flight (i.e. flight that is apparently not courtship/display)
    - Display/courtship/copulation (including flight displays)
- Where Curlew(s) appear to move between fields/kilometre square during a visit, make sure this is recorded, in order to avoid double-counting.

**Handling the data:**

Retain all the raw data records. If these are kept, then the data can be re-interpreted in future as we learn more about the best way to do so. In general, the aim will be to:

- Estimate which Curlew registrations related to territorial pairs and which to migrants.
- Estimate which Curlew registrations in different parcels (on the same or separate visits) relate to the same or different territorial birds.
- Use this information to derive an estimate of the number of sites that are occupied by territorial pairs and potentially the number of territorial birds.
- Note that these are only estimates! We will produce some 'decision-rules' that we think allow us to make sensible estimates from the pilot data. Sometimes these will give the 'wrong' answer, but that is inevitable in bird surveying.

## Tier 2

Formal, standardised visits to sites during the immediate pre-incubation phase, to estimate **number of territorial pairs.**

**Output**: Estimated number of territorial pairs in defined study areas.

**Who**: Observers and/or groups that have the ability to make timed, repeat visits.

**When:** During territory establishment, shortly before incubation commences, after Tier 1 visits if appropriate (typically during mid-April); this timing should remove most transients/migrants from the population.

**How**:

1. Define the search sites
    - This should be done in the same way as with Tier 1, and ideally uses the same areas as Tier 1 (or a subset of them if desired).
    - It is possible to omit areas that were unoccupied in Tier 1 surveys if they appeared not to be occupied, and/or if there is not capacity to visit all sites.

2. Visit the study sites
    - Make a minimum of two visits to the site - these visits must be separated by at least seven days.
    - It is OK to make more than two visits, but it is essential that all visits and timings are recorded, including those with no Curlew sightings.
    - In enclosed sites, vantage point observation is the default method, but you can move around to ensure that all of the area is seen.
    - In unenclosed areas, walked transects are necessary. In which case it becomes similar to Brown & Shepherd but with fieldwork earlier in season
    - Try to standardise the survey effort in terms of the time spent observing a field/kilometre square. We suggest 15 mins as a reasonable period to observe a defined parcel of land, e.g. a field with clear boundaries, but this can be flexible depending on local circumstances.
    - If multiple parcels can readily be viewed simultaneously from the same vantage point, then it is OK to survey them simultaneously (i.e. in the same ~15 min period), but only do so if you are confident that it is going to be possible.
    - If a parcel is too big to observe from a single location, or the topography doesn't allow it, then observe each part of the parcel for ~15 mins from separate locations; observers will need to use discretion when observing unenclosed areas to ensure appropriate coverage.

3. Record the visit
    - Each time the site is visited, record:
        - Date and who made the visit.
        - For each parcel, record time of start and end of observations.

4. Record any Curlews

- Record all Curlews that are detected.
- For each Curlew or pair/group, record:
    - Which parcel (field/km$^2$) it was present in when first detected
    - Record position in the parcel on a map
    - Sex, if possible to determine (only if you are confident)
    - Behaviour in the following categories (separately for each individual; record all behaviours that were seen in the observation period, it does not have to be just one):
        - Feeding
        - Loafing/roosting (i.e. stationary, apparently resting)
        - Commuting flight (i.e. flight that is apparently not courtship/display)
        - Display/courtship/copulation (including flight displays)
        - Vocalisations

**Handling the data:**

- Retain all the raw data records. If these are kept, then the data can be re-interpreted in future as we learn more about the best way to do so.
- In general, the aim will be to combine all the data to estimate how many territories were occupied immediately prior to the incubation period.
- Further consideration will be needed about how we convert a set of mapped registrations from multiple site visits into an estimate of number of territories, and this is best done when we get the first season of raw data. We will need to think in particular about how to decide whether birds seen in nearby parcels, on the same or different occasions, are the same or different birds, and ultimately how to combine data from more than one visit (e.g. do we use the data from the visit with the highest count, or merge data from multiple visits).

## Tier 3

Formal, standardised visits to sites during the chick-rearing phase to estimate **the number of broods successfully fledged.**

**Output**: Number of fledged broods and relative index of productivity (possibly also number of fledglings and timing of failures).

**Who**: Observers and/or groups that have the ability to make timed repeat visits and have completed Tier 2 surveys.

**When:** From the early hatching period (likely to be late May or early June, but variable between years and sites) to fledging (mid-July).

**How:**

1. Define the study area
    - Use the same site definitions that were used in Tier 2.
    - Visit sites at which occupied territories were identified during Tier 2.

2. Visit the study sites
    - There should be a minimum of two visits, and if resources allow then ideally undertake repeat visits every 7-10 days until mid-July to provide greater confidence in productivity data (noting that Curlews with chicks can sometimes go undetected for long periods).
    - Each visit should be relatively brief and primarily involves vantage-point surveying. Observers can move around the site to ensure all-round observation. At sites with long grass and/or limited visibility, if no adult response is detected after ~15 mins then quickly walk a route through the field/parcel that will provoke an alarm response from any adult Curlews present; do not attempt to locate or flush chicks, be careful where you put your feet to avoid trampling chicks, and do not enter the field/parcel if potential predators are visible, e.g. corvids, raptors, foxes.
    - Sites should be visited throughout the period of chick-rearing if possible.

3. Record the visit
    - Each time the site is visited, record:
        - Date and who made the visit.
        - For each parcel, record time of start and end of observations.
    - All visits must be recorded, including ones with zero detection.

4. Record any Curlews
    - The aim is to detect ***evidence that a breeding attempt is ongoing***
    - Record the following info for any Curlews that are detected:
        - Which parcel (field/$km^2$) it was present in when first detected
        - Record position in the parcel on a map
        - What was seen/heard (these are non-exclusive categories, for each bird that is detected, record all that apply):

    - presence of one or more adult birds.
    - alarm/defence behaviour – especially vocalisations – that are indicative of chick presence (these likely to be in response to disturbance events).
    - sightings of chicks (record how many and their size relative to adults (¼, ½, ¾, adult-size).
- There is no need to do more than this. For example, if you see adults, there is no need to stay and search for chicks.
- To allow comparability and to reduce disturbance, do not make more than one visit per week (unless nests are being monitored or chicks are being radio-tracked).

**Handling the data:**

- Retain all the raw data records. If these are kept, then the data can be re-interpreted in future as we learn more about the best way to do so.
- Further consideration will be needed about how we convert the data from repeated visits into estimates of productivity. One simple productivity index we can derive is the number of pairs that appear to be rearing chicks by the late chick-rearing phase divided by the number of pairs identified in Tier 2. We can also examine the repeated visit data to look at apparent chick survival (and we can use statistical approaches to account for the fact that sometimes we will miss a chick-rearing pair that is present).
- We will also need to consider how to decide whether birds detected in nearby parcels, on the same or different occasions, are the same or different birds.
- Data derived from this method need to be analysed separately to 'supplementary information' that might be obtained from nest/chick monitoring or more frequent visits by enthusiastic observers.