

Assigning nest fates

Every nest that has been monitored regularly should be assigned a nest fate. Preliminary assessments should be made in the field, with as much detail as possible written down. Final assignments should be made at the end of the field season, to ensure that all fates are assigned using a common standard, and that everyone who has been collecting data is using the same methods. Often information that is not available in the field (e.g., from iButtons) can alter your understanding of what happened, hence the need for careful reassessment at the end of the field season.

Determining nest fates can be tricky and if you are unsure it always helps to discuss the series of events for a given nest with other members of the field crew. (These discussions also increase consistency in the way that fates are assigned.) We have, however, developed a series of rules for assigning fates, and the consistent use of them is critically important. Note that the different fates are not mutually exclusive (e.g., a nest can lose contents to flooding and still produce fledglings), so one nest can fall into multiple categories. Overall the guidelines below have been designed to be conservative, such that, when there is any doubt, nests will be placed in one of the uncertain categories. Doing this can be frustrating when you feel confident that you “know” what happened. But, a guess is a guess even if well informed, and our goal is to eliminate variation in the judgment calls of different people as much as is possible, even if it means we have to admit that we are not certain about a larger proportion of the nests. The fate categories listed below are simplified in a dichotomous key that leads to a categorical fate assignment for each visit (which can include partial failures). When using the key, refer to this SOP for the full details on what constitutes evidence for each fate category.

In some cases, it is possible to use auxiliary data, such as re-captures, re-sights or behavioral observations, as evidence for assigning fates. Examples are provided below, highlighted in blue. Fates assigned using these auxiliary data should be recorded in a separate column because, in most cases, they can only provide evidence of success, not failure, and therefore might bias fecundity estimates if effort is inconsistent across sites (e.g. if some sites have more banding effort in the late summer or fall).

At this stage a lot of people have been over these guidelines many times, but if you identify major flaws in the rules, please bring them up with Chris Elphick or one of the other project PIs. The odds are good that we have identified, discussed *ad nauseum*, and done what we can to account for them, already. But, it is also possible that we might have missed something important.

Fate categories and the evidence required for them are as follows:

Flooded – Note that flooding does not always wipe out an entire nest; partial flooding loss happens, and should be noted. Flooding should be assigned when there are losses prior to the earliest likely fledging date (i.e., prior to when chicks are 8 days old, when the hatch date equals day zero), and at least one of the following conditions applies:

- the nest is observed to be underwater during a high tide and a subsequent nest check confirms that the nest is empty (= complete failure due to flooding) or has fewer contents (= partial failure due to flooding);
- the nest is found with intact eggs outside the nest (presumably after floating out) following a spring tide or heavy rainfall;

- the nest is found with intact cold or dirty eggs in the nest immediately after a high tide or heavy rainfall, and eggs do not subsequently hatch;
- the nest is found with a combination of the intact eggs outside the nest and intact cold or dirty eggs in the nest immediately after a high tide or heavy rainfall, and eggs do not subsequently hatch;
- the nest is found with intact dead chicks in, or close to, the nest following a spring tide or heavy rainfall (note that chicks should be inspected carefully for injuries that could have caused death, see Depredation, below);
- the nest is found with barely-alive nestlings (usually in a rigid posture, with wings and legs stretched out, head up, unable to move) the morning after a flooding event, and the nestlings are eventually found dead in or near the nest;
- the nest is found to be empty and soaking wet immediately (next day) after a high tide, and was known to have been active immediately prior to the high tide (care should be taken in these cases; this assignment should only be used when you are certain that the loss of nest contents coincided with the high tide);
- [iButton data indicate that nest temperatures matched ambient, starting immediately after nest flooding.](#)

Depredated – In this circumstance, we are defining depredation as the killing of eggs or nestlings by another animal, which includes killing without the intent to ingest (e.g., a marsh wren poking holes in eggs or killing nestlings). Additional information that might indicate the perpetrator should be noted in the “comments” field. As with flooding, partial depredation is possible, with only some of the nest’s contents removed or destroyed by a predator on a single visit. If this happens, it should be noted. (Note too that partial nest loss means that it is possible for a nest to suffer both depredation and flooding). Depredation should be assigned when there are losses prior to the earliest likely fledging date (i.e., prior to when chicks are 8 days old), and:

- the nest is found with its structure disturbed (pulled apart);
- the nest is found with obvious depredation remains (e.g., remnant body parts, broken egg shells, dried yolk, etc.);
- dead chicks or eggs are found with injuries that likely resulted in death (if you are unsure about the severity of an injury then do not assign this failure cause);
- the nest is found empty, or with partial loss, on a day when the tides could not have accounted for the losses (check the observed high water measures on the web to make sure that there were no elevated tides due to rainfall, which sometimes occurs even when there is not a high spring tide predicted; checking iButton data may also be helpful). This is the most common scenario leading to an assignment of depredation.

Note, that it is possible that we overestimate depredation relative to flooding as a result of these criteria, because we may miss occasions when nests go underwater, washing away eggs or nestlings at times when we are not expecting it. The use of iButtons in nests is the best way to reduce the chance of these errors.

Failed-unknown cause –No matter what rules we apply there is always a degree of uncertainty in assigning causes of nest loss. We try hard to be conservative in assigning fates and only do so when one of the criteria described above applies. Consequently, there are some cases when the situation is ambiguous and no specific fate can be assigned. Basically, this fate should be used whenever none of the others apply. Specific examples include:

- One or more eggs disappear at a time when flooding might have washed them out of the nest (but nest inundation is not confirmed, or >3 days passed between nest checks to be sure it is the

cause), female apparently continues to incubate, but eventually nest appears unkempt/abandoned, remaining eggs never hatch. This might be a situation where flooding occurred, some eggs washed away, while the others remained but died. Alternatively, it might be a partial depredation event. Going back to the tide data might help resolve some of these situations, but others will remain ambiguous.

- One or more eggs cracked (but, not punctured) in nest, no signs of disturbance or flooding;
- Eggs/nest intact, never hatch, possibly female has disappeared/abandoned/died. Again this scenario might imply death of eggs due to flooding, and tide records should be checked.
- Some (but not all) eggs in a nest fail to hatch. These unhatched eggs may have been unfertilized may have experienced prolonged water contact during laying/incubation, or may have suffered from any number of developmental defects. If these eggs flood out of the nest after the rest hatch, make a note of it, but at this point they have already failed, and hence cannot ‘fail’ again due to flooding.

Fledged – This assignment is only given if there is good reason to believe that chicks fledged from the nest. Due to partial nest losses, it is possible for a nest to be classified as fledged as well as having been flooded/depredated/unknown loss. Whenever possible you should estimate the number of fledglings produced from a nest (because a 4-fledgling nest is vastly different from a 1-fledgling nest, in terms of the birds’ population dynamics). Determining exactly how many young fledge is generally impossible, and our convention is to use the number of nestlings present in the nest on the last nest check before fledging is assigned. Assignment of fledging is made based on the following evidence:

- day 9+ visit finds an intact nest, well worn, with some droppings in the nest or immediately adjacent;
- fledglings present on day 9+ and gone at next nest check with no signs of nest failure (as defined above);
- banded nestlings (must be confirmed to be from the nest, e.g., by reading bands, radio, etc.) are re-sighted or re-captured after they leave the nest;
- the banded female (must be confirmed to be from the nest, e.g., by reading bands, radio, etc.) is observed exhibiting provisioning behavior in the vicinity of the nest within 7 days of the predicted fledging date. Make note of any female provisioning behavior no matter how long after the predicted fledging date;
- iButton data indicates that the nestlings departed the nest coincident with the high tide, when old enough to fledge (i.e., 9+ days old). This criterion may also be refined as we learn more about how to interpret iButton data, and about the behavior of nestlings during fledging.

Note that the timing information given above relates to sparrows. For species with precocial young (e.g., willets, ducks) evidence of successful hatching is taken to be equivalent to fledging. Post-hatching survival in these species is essentially impossible to estimate without the use of special methods (e.g., telemetry). If the nest was discovered during or prior to incubation, then check to make sure that the incubation period was long enough to allow fledging: **Willetts: +22 days; Mallard: +25 days; Clapper Rail: +18 days; Virginia Rail: +16 days.** Floating the eggs to determine the stage of development is also a good way to determine approximately how old a nest is when it is discovered (see Liebezeit et al. 2007).

Unknown fate – This category should be used when you cannot confidently assign the nest fate to any of the above categories. In general this situation will only arise when there is conflicting evidence right around the time the nestlings are due to fledge – e.g., birds disappear without trace, around a high tide but with no evidence that the nest was soaked, and slightly before fledging is anticipated (e.g., day 8), or when nest visits are delayed for some unforeseen reason shortly before fledging.

TWO TYPES OF ASSIGNMENT

For every nest there are two types of assignment that need to be made: (1) a single categorical variable that summarizes “overall” fate for the time between each visit to the nest and (2) quantitative fate information that describes what happens to individuals within the nest. The associated nest fate assignment key should be used to assign (1) for each visit from the list of 10 possible categories. Six of these categories (3, 5, 7, 8, 9, and 10) are “ultimate” fates, in that they describe the completion of the nest, which usually coincides with the last visit. This ultimate fate is synonymous with the “nest success” parameter used in most ornithological studies.

1. Categorical fates

This assignment relates to the factor that determined the “completion” of the nest, and is measured according to mutually exclusive categories. In other words it is the fate that relates to the last individual(s) in a nest.

- If any individual fledges, then the nest would be assigned an ultimate fate of “Fledged” (= “successful”).
- If no individual fledges, then the nest would be assigned an ultimate fate of “Completely flooded”, “completely depredated”, or “failed, unknown cause” (all of which = “unsuccessful”).
- If it is not certain whether any individuals fledge, then the nest would be assigned an ultimate fate of “unknown fate”.

The individual fates outlined below can be assigned when nest-level fates are assigned, or alternatively code can be written to compile them from visit-level fate assignments produced by the key, in which case it might be appropriate to have fewer categories.

2. Quantitative fates

This assignment allows us to summarize the factors that determine the fates of individuals in the nest. We will not always be literally tracking individuals, but we want to be able to summarize the fates of all nest contents through a set of summary variables. Under this scheme we need to use the guidelines above to determine the fate of each individual and the stage (egg vs. chick) at which the individual meets its fate. The variables we want to quantify are (color-coded by fate category: **flooding**, **depredation**, **unknown**):

- a) **Clutch size**: the maximum number of eggs known to have been in the nest. This will often be the total number of eggs seen at one time, unless there is additional information.
- b) **Brood size**: the maximum number of chicks known to have been in the nest. This is also equivalent to the minimum number of eggs that survived to hatch.
- c) **Fledglings**: the minimum number of chicks that fledge from the nest. See above for how to determine this number.
- d) **Number of eggs flooded from nest**: the total number of intact eggs found outside the nest. Broken eggs do not count if there is any indication of depredation; eggs that are simply cracked should be included.
- e) **Number of eggs flooded in nest**: the total number of intact eggs found in the nest immediately after a flooding event that are wet/cold and show no sign of subsequent incubation.
- f) **Number of unhatched eggs**: the total number of intact eggs found in the nest, that never hatch, but for which failure cannot be directly linked to a flooding event (see e above). This number

only includes failed-to-hatch eggs in a nest where at least some eggs hatched (in contrast to j below).

- g) **Number of eggs depredated:** the minimum number of eggs found showing evidence of having been taken by a predator – e.g., broken, egg shell pieces, yolk remains. Note that sometimes it may not be possible to tell how many eggs are involved so the minimum possible should be determined. E.g., traces of yolk alone would result in a minimum of one. Several fragments including two shell ends that clearly don't go together would indicate a minimum of two. Note: this number will include eggs that died from causes other than depredation that were later scavenged.
- h) **Number of eggs missing because of flooding:** the total number of individuals that are known to have disappeared during the egg stage because of a flooding event. When losses occur when there could have been eggs or chicks, they should be assigned to whichever category occupied the greatest percentage of unmonitored time.
- i) **Number of eggs missing because of depredation:** the total number of individuals that are known to have disappeared during the egg stage because of a depredation event. When losses occur when there could have been eggs or chicks, they should be assigned to whichever category occupied the greatest percentage of unmonitored time.
- j) **Number of eggs failed, unknown cause:** the total number of intact eggs found in or out of the nest, for which failure cannot be directly linked to a flooding event. Note that abandonment of these eggs might still be due to flooding. This number only includes eggs in a nest where no eggs hatched (in contrast to f above).
- k) **Number of eggs missing, unknown cause:** the total number of eggs that disappeared for which failure cannot be directly linked to a flooding event or depredation.
- l) **Number of chicks drowned:** the total number of intact dead chicks found in association with a nest known to have been flooded (see criteria above).
- m) **Number of chicks depredated:** the total number of chicks found dead and showing signs of physical injury (includes deaths by competition). Note: this number will include chicks that died from causes other than depredation that were later scavenged.
- n) **Number of chicks dead, unknown cause:** the total number of chicks found dead or missing from the nest before day 8, but for which the fate is uncertain.
- o) **Number of chicks missing because of flooding:** the total number of chicks that disappeared from the nest before day 8, for which failure can be directly linked to a flooding event.
- p) **Number of chicks missing because of depredation:** the total number of chicks that disappeared from the nest before day 8, for which failure can be directly linked to a depredation event.
- q) **Number of chicks missing, unknown cause:** the total number of chicks that disappeared from the nest before day 8, for which cause of failure is unknown.