

Evidence essay · Observation and data

Missing observations are not zeroes

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ABSTRACT

A missing observation, a usable recording with no detections, and a signal obscured by noise support different conclusions. This essay uses hypothetical acoustic records to distinguish counts from effort-adjusted rates and to show why downtime must not become successful listening. It draws on Climate and Forecast conventions to discuss missing-value codes and separate quality flags, including the care needed for values below reporting limits. NOAA's observing-network assessment supplies context for uneven seasonal and spatial coverage. When gaps depend on weather or access, the remaining record may not represent the full conditions of interest. The practical recommendation is to preserve reasons for absence, coverage rules, method changes, and visible chart gaps, while distinguishing estimated values from measurements and never treating zero detections as proof of animal absence.

Keywords: missing data · observation effort · quality flags · detection limits · acoustic monitoring

Adapted from the Still North field journal. Original article. A source-based editorial text, not a report of original Still North research. Examples and imagery are illustrative.

A zero says that a defined measurement produced no recorded quantity. A blank says that a value is unavailable, unless the dataset defines it differently. Confusing those two states can turn a broken instrument into an ecological finding. It can also make a period with less observation look quieter, safer, or less eventful than one that was measured properly.

Consider a hypothetical acoustic survey. A recorder operates for an hour, its recording is usable, and the agreed review method detects no calls of the target type. Zero detections is a defensible entry. If the battery is flat, there is no comparable hour. If noise masks the relevant frequencies, the recording exists but its ability to support a detection claim has changed. None of these states proves that animals were absent.

Keep observation effort beside the count

Suppose, purely for illustration, one week contains ten detections in ten usable recording hours and another contains ten in one hundred. The totals match; the rates do not. Even a rate needs the definition of usable effort, including recording schedule, review coverage, and the detection procedure. Dividing by all calendar hours would quietly treat downtime as successful listening. Dividing by all recorded hours could hide masking or corrupted files.

Our account of listening for narwhals explains why a hydrophone records a soundscape rather than a population census. For a comparable time series, retain both the count and its exposure: the duration examined under the stated conditions. If a classifier changes, document the change and assess comparability before interpreting a jump as a change in animal behaviour.

Name the reason a value is absent

Not measured, not yet processed, rejected by quality control, below a detection limit, and withheld under a governance agreement are different meanings. A single

public-facing gap may stand for any of them, but the underlying record should preserve the distinction at the appropriate access level. Otherwise a later user cannot know whether to wait, exclude a period, change a method, or request permission.

The CF conventions on missing data explain how attributes such as `_FillValue` identify undefined or missing values in `netCDF`. Their flag conventions support separate descriptions of instrument status and quality assessments. The important principle travels to an ordinary spreadsheet: a code needs an explicit definition, and it must not be mistaken for a measured number.

A result below a laboratory reporting limit deserves particular care. It is not automatically zero, nor is it the reporting limit itself. Preserve the limit, unit, and qualifier. The analysis may need a method designed for such observations. Replacing every qualified result with a convenient number can create a spurious average and conceal the uncertainty that prompted the qualifier.

Ask whether the gaps follow the conditions

Missingness is especially troublesome when it depends on the thing being studied. Rough weather might prevent servicing or sampling. Cloud can obstruct an optical view. A route may be inaccessible during the very conditions a project hopes to understand. The remaining observations then describe the accessible conditions more faithfully than the full season.

The NOAA observing-network assessment describes uneven spatial and seasonal coverage, satellite limitations, and gaps in field validation. Those limits cannot be repaired by colouring an empty map cell to match its neighbours. An interpolated estimate may be useful, but its assumptions, source observations, and uncertainty need to remain visible.

Before calculating a monthly mean, inspect coverage across days, times, and conditions. State the completeness

rule and the number of accepted observations. There is no universal percentage that makes every monthly average representative: a missing storm peak and a scattered set of missing minutes have different consequences. A rule should reflect the quantity and decision, not simply produce a complete-looking chart.

Let a chart admit what it does not know

Leave a visible break where observations are unavailable, or distinguish estimates from measurements with a clear explanation. Include effort in a companion table or panel when changing coverage affects interpretation. Do not use the same pale colour for a genuine zero and no data. A reader should not have to open the processing code to discover that the quietest month was the month the recorder failed.

These are small editorial decisions with substantial consequences. The [Open observations guide](#) puts missing-value meanings alongside methods and calibration because all three govern what a number can support. A blank cell is not an embarrassment to conceal. Properly labelled, it tells the next observer where knowledge ends and the next useful question begins.

References

1. CF conventions on missing data (cfconventions.org)
2. flag conventions (cfconventions.org)
3. NOAA observing-network assessment (arctic.noaa.gov)