## Topic Info

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## Overview

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## In-depth

```{include} include/00\_coming\_soon.md

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## Figures

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| **Image** | **file\_name** | **Caption (if applicable)** | **ref\_id** |
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## Video

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## Analytical tools & resources

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## References / Glossary

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| Refs | keys\_here |

## Notes

* Leorna, S, and T Brinkman. “Camera Trap Sampling Protocols for Open Landscapes: The Value of Time-Lapse Imagery.” *CONSERVATION SCIENCE AND PRACTICE*, February 19, 2024. <https://doi.org/10.1111/csp2.13094>.

## Camera Settings

Consideration of the camera settings is an important step when designing asurvey. It is recommended that cameras are set to capture images rather than videos unless the objective is related to monitoring specific animal behaviour. By default, camera traps are set to record images when an animal is detected by the motion and/or infrared sensor(s). An example of the settings available in a Reconyx camera is included in Appendix 1 - Table 3; some examples of the ideal settings for reaching different objectives are included in section 5.1.

### Photos per Trigger (aka “Number of images”)

The **Photos per Trigger** setting describes the number of photos taken eachtime the camera was triggered (e.g., 1, 3, etc.). If the Photos per Trigger is set to take multiple images (>1), when the camera is triggered, it will take the set number of images, regardless of whether the animal remains in the detection zone.

The value set for the Photos per Trigger setting often appears in the image metadata as **Sequence**, which describes the order in which the image was taken in a **series** (e.g., “1 of 1”, “1 of 3”, etc.). However, it is important to note that “Sequence” is also used to describe the order of images in user-defined series when defining a “detection event.”

### Quiet Period Setting

The Quiet Period Setting provides thetime, in seconds, between shutter “triggers.”

### Trigger Sensitivity

The Trigger Sensitivity setting is a critical feature of camera traps and is responsible for how sensitive a camera is to activation (“triggering”) via the infrared and/or heat sensors (if applicable, e.g., Reconyx HyperFire cameras have a choice between ‘low,’ ‘low/medium,’ ‘medium,’ ‘medium/high’ and ‘high’ sensitivity). Fast trigger speeds are less necessary if attractants (e.g., bait or lure set or camera directed to a carcass) are present (Rovero et al., 2013).

### Trigger Speed

The delay between sensing an animal and taking an image or sequence of images.

### Flash Type

There are two types of **white flash**: Xenon white flash and white LED flash. A Xenon flash is created when current passes through two electrodes inside a “flash tube” (Wearn & Glover-Kapfer, 2017). When Xenon gas floods the tube, light and an audible sound are briefly emitted. Xenon flash types require a brief recovery period (~30 seconds) and thus are less effective when the goal is to collect continuous images or videos at night (Wearn & Glover-Kapfer, 2017). LEDs are the more efficient, silent (less invasive) alternative that does not require a recovery period between firing (Xenon flash cameras require at least 30 seconds). However, LED flashes are less powerful and tend to reduce the effective detection distance and more often result in blurry images (Wearn & Glover-Kapfer, 2017). **Infrared (IR)** flashes use LEDs that emit energy in the infrared or near-infrared range (Wearn & Glover-Kapfer, 2017). Near-IR flashes are not completely invisible (e.g., Meek et al. 2014a; Newbold & King, 2009) and thus are also referred to as “low glow” flashes (Wearn & Glover-Kapfer, 2017). **Black flashes** (or “no-glow” flashes) do not emit any light and thus are less noticeable to wildlife and thus reduce the chance that wildlife will react. Cameras with black flash capability are ideal for REM (due to the necessity to estimate movement speed). However, they are generally more expensive.

Some flash types might be less invasive than others. There is evidence to suggest that IR flashes may be less noticeable to wildlife (e.g., Sharma et al., 2010; Schipper, 2007; Wegge et al., 2004). However, the extent to which is not clear. Henrich et al. (2020) evaluated the effects of black flash vs. standard IR on the behaviour of two deer species; they found that both species were more likely to react to standard IR flash than to black flash. However, there were disparities between the twostudy areas that suggested that these findings may have been confounded by variability in hunting pressure (Henrich et al., 2020). Wegge et al. (2004) found a reduction in the trapping rate of tigers in response to Xenon flash, yet the response materialized within five days of deployment. Wegge et al. (2004) and Sharma et al. (2010) both found a behavioural “trap-shy” response by tigers to white flash.

### Time-lapse

Time-lapse images are images taken at a regular interval (e.g., hourly or daily, on the hour). It is **critical** to take a minimum of 1time-lapse image per day at 12:00 pm (noon); doing so creates a record of camera functionality and local environmental conditions (e.g., snow cover, plant growth, etc.).

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::::::{tab-item} Overview

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“Species richness is simply the number of species in an area ({{ rtxt\_wearn\_gloverkapfer\_2017 }})

Species diversity is more complex, and includes a measure of the number of species in a community, and a measure of the abundance of each species. Species diversity is usually described by an index, such as Shannon's Index H'.” {{ rtxt\_pyron\_2010 }}

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::::::{tab-item} Advanced

Parameters**:**

- \*\*α-richness (alpha richness)\*\*: species richness at the level of an individual camera location {{ rtxt\_wearn\_gloverkapfer\_2019 }}

- \*\*γ-richness (gamma richness)\*\*: species richness across a whole study area {{ rtxt\_wearn\_gloverkapfer\_2019 }}

- \*\*β-diversity (betadiversity)\*\*: the differences between the communities or, more formally, the variance among the communities {{ rtxt\_wearn\_gloverkapfer\_2019 }}

<br>

\*\*Observed \*vs\* estimated species richness\*\* (from {{ rtxt\_wearn\_gloverkapfer\_2019 }}):

- \*\*Observed species richness\*\*: the sum of the number of species seen (e.g. {{ rtxt\_kitamura\_et\_al\_2010 }}; {{ rtxt\_pettorelli\_et\_al\_2010 }}; {{ rtxt\_ahumada\_et\_al\_2011 }}; {{ rtxt\_samejima\_et\_al\_2012 }})

- Observed species richness will not, in general, be a reliable index of actual species richness because, even if sampling effort is strictly controlled, the detectability of species will vary across samples

- \*\*Estimated species richness\*\*: when the “sum of the number of species seen” is adjusted based on corrections for “imperfect detection” (i.e. the fact that some species in a given sample may have been missed)

- (e.g. {{ rtxt\_tobler\_et\_al\_2008 }}; {{ rtxt\_kinnaird-&-obrien-2012 }}; {{ rtxt\_brodie\_et\_al\_2015 }}; {{ rtxt\_yue\_et\_al\_2015 }}; {{ rtxt\_wearn\_et\_al\_2016 }})

- The \*\*two principal ways of estimating species richness from remote camera data \*\* are (from {{ rtxt\_wearn\_gloverkapfer\_2019 }}):<br>

- non-parametric estimators ({{ rtxt\_gotelli\_chao\_2013 }}), which use information about the rarest species in the sample to provide a minimum estimate of the number of true species (e.g. {{ rtxt\_tobler\_et\_al\_2008 }}),

- or 2) occupancy models ({{ rtxt\_mackenzie\_et\_al\_2006 }})

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::::::{tab-item} Visual resources

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\*\*Pyron (2010) - Figure 1\*\*: Species evenness and species richness for animalcule communities

<!-- Both communities contain five species of animalcules. Species richness is the same. The community on the left is dominated by one of the species. The community on the right has equal proportions of each species. Evenness is higher when species are present in similar proportions. Thus the community on the left has higher species diversity, because evenness is higher. -->

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\*\*Vandooren (2016) – Figure 1\*\*: Species accumulation curves. Species richness is the asymptote of a species accumulation curve, which expresses the dependence on sampling effort of the number of species sampled from an assemblage….

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\*\*Loreau et al. (2010) – Figure 4.\*\* Species accumulation and rarefaction curves. Species accumulation curves show the number of species obtained by successively censusing either individual organisms (individual-based accumulation curves) or samples (sample-based accumulation curves). Smoothed species rarefaction curves represent the statistical expectation of the corresponding accumulation curves. Credit: Rob Colwell, after Gotelli and Colwell (2001)

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\*\*Loreau et al. (2010) – Figure 3.\*\* The various levels of organisation and components that define the multiple facets

of biodiversity

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Abundance, species richness, and diversity

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Species accumulation and rarefaction curves

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Using vegan to calculate alpha diversity metrics within the tidyverse in R (CC196)

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Species abundance tools in Genstat

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Species Diversity and Species Richness

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Field Ecology - Diversity Metrics in R

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::::::{tab-item} Shiny apps/Widgets

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\*\* iNEXTOnline \*\*

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::::::{tab-item} Analytical tools & resources

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| R package | Chapter 9 Community composition | \- | <https://bookdown.org/c\_w\_beirne/wildCo-Data-Analysis/composition.html#estimated-richnes> | {{ rbib\_wildco\_lab\_2021b }} |

| R package | R package “vegan | \- | <https://cran.r-project.org/web/packages/vegan/index.html> | {{ rbib\_oksanen\_et\_al\_2024 }} |

| Program | EstimateS | Dedicated software for estimating diversity, using asymptotic or rarefaction methods. Mac version available | <https://www.robertkcolwell.org/pages/1407> | {{ rbib\_colwell\_2022 }} |

| R package | Package ‘iNEXT’ - Interpolation and Extrapolation for Species Diversity | The iNext package (INterpolation and EXTrapolation of species richness) - is both easy to use and rapid to compute. It also comes with a wealth of plotting functions - see the iNext Quick Introduction for a great walk through tutorial. Its core functionality is based on: Chao, Anne, et al. ”Rarefaction and extrapolation with Hill numbers: a framework for sampling and estimation in species diversity studies.” Ecological monographs 84.1 (2014): 45-67. | <https://cran.r-project.org/web/packages/iNEXT/iNEXT.pdf> | {{ rbib\_hsieh\_et\_al\_2015 }} |

| Exercise/Tutorial | 2.2: Measuring Species Diversity | Easy to interpet explanation of species richness vs evenness, species area curves, rarefaction, and how to calculate diversity | <https://bio.libretexts.org/Courses/University\_of\_California\_Davis/BIS\_2B%3A\_Introduction\_to\_Biology\_-\_Ecology\_and\_Evolution/02%3A\_Biodiversity/2.02%3A\_Measuring\_Species\_Diversity> | {{ rbib\_gerhartbarley\_nd }} |

| R package / Tutorial | Species Accumulation Curves with vegan, BiodiversityR and ggplot2 | Software for interpolation and extrapolation of species diversityRarefied Species Accumulation Curves (the simple way) | <https://rpubs.com/Roeland-KINDT/694021> | {{ rbib\_resource6\_ref\_id }} |

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{{ rbib\_brodie\_et\_al\_2015 }}

{{ chao\_et\_al\_2016 }}

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{{ rbib\_pettorelli\_et\_al\_2010 }}

{{ rbib\_project\_dragonfly\_2019 }}

{{ rbib\_pyron\_2010 }}

{{ rbib\_riffomonas\_project\_2022 }}

{{ rbib\_samejima\_et\_al\_2012 }}

{{ rbib\_styring\_2020 }}

{{ rbib\_tobler\_et\_al\_2008 }}

{{ rbib\_vsn\_international\_2022 }}

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