# INFO ENTRY - QUESTION INFO

**ENTRY NOTES:**

* green = does not need to be editted
* yellow = info for the inputter
* ref\_id = “refs\_glossary\_2024-08-09.xls > “references” tab
  + if the reference not present, either add it (if you’re confident that you can follow the format), or add a comment in this doc with the info and I will adjust
* **images – file name in** “refs\_glossary\_2024-08-09.xls > “references” tab
* Ignore everything in the “POPULATE MARKDOWN” section
* Size of columns in tables and text format do not matter; see note on bold and italize below
* Any content with “glue}`` prefix or surrounded by “{{“ / “}}” indicates where text will be inserted from the keys
* You may see “<br>” throughout, you can ignore these
* additional formatting notes (optional)
  + \*\***bold**\*\*
  + \**italics*\*

## Topic Info

If the topic is NOT related to a question, you can leave “question” as NULL

“question” here is more for your reference

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| **info\_id** | i\_cam\_strat\_covar |
| **question** | Do you plan to strategically place camera locations to include multiple habitats or otherwise differing categories (e.g., different land cover types, or near vs. far from a disturbance)  If so, how many covariates? (e.g., 5 different habitat types would be 5 covariates) |

## Assumptions, Pros, Cons – if modelling approach

Only for modelling approaches; can ignore otherwise (leave table here)

[WILL BE HERE, BUT INSERTED DIRECTLY FROM CSV FILE (THUS NO INPUT NEEDED)]

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| **Assumptions** | **Pros** | **Cons** |
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## Overview

Do you plan to strategically place camera locations to include multiple habitats or otherwise differing categories (e.g., different land cover types, or near vs. far from a disturbance)

If so, how many covariates? (e.g., 5 different habitat types would be 5 covariates)

[OBJECTIVES- relative abundance, species diversity & richness, behaviour]

Cassie – suggestions for above red text for consistency and simplicity/clarity: be consistent – use either “habitat types” or “land cover” not both for simplicity and clarity; use strata vs. covariates. Also 5 different habitat types = 1 covariate and 5 strata. I use “covariate” at the beginning and then strata for means to address confounding variable…

Refs need to be added and things put in correct format which I can do. Need feedback first on content.

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A covariate is an independent variable (i.e. of direct interest), or an unwanted, confounding variable that, if not accounted for, can lead to biased, inaccurate conclusions. In remote camera studies, confounding factors that affect the ability to detect wildlife are especially important to address to help ensure reliable, robust results.

Several factors impact the ability of cameras to detect wildlife, including animal characteristics (e.g., home range size), environmental variables (e.g., landscape features), set-up protocols (e.g., camera height and density), and camera specifications (e.g., trigger speed) (Hofmeester et al., 2018). The study’s objectives, spatial scale, and target species will determine the most influential factors. For example, when estimating density for multiple species, differences in species traits and environments (e.g., habitats) may lead to variation in imperfect detection, the inability to tease apart detection probability from other factors (e.g., habitat preference), and erroneous estimates of occurrence and abundance (Burton et al., 2015; Dénes et al., 2015; Kays et al., 2021). Careful consideration of factors that may cause detection bias when designing studies can be an effective and efficient way to partially avoid detection biases. It can also prevent the need to try to subsequently correct the variable of direct interest (e.g., relative abundance) or use covariates in an advanced statistics framework.

Study Design - Stratification

Camera locations and their spatial arrangements are integral components of any study design and strongly influence detection probability and likelihood of species occurrence. In a stratified design, the study area is divided into smaller strata according to distinct features (e.g., habitat types, disturbance classes). Cameras can be then randomly or strategically placed across the study area according to these strata. Generally, a random placement is recommended for species diversity and richness, relative abundance, and behaviour objectives; however, the optimal design for a given study will be influenced by the expected variation in detection probabilities, available resources, and the relative importance of the pros and cons for each design. For example, an optimal study design may be considered that that provides the greatest precision for the lowest cost. Stratification in general can help minimize detection bias, optimize sampling effort, and ultimately result in more precise estimates.

In a stratified random study design, the different strata are sampled in proportion to their availability in the study area. For example, if the study area consists of 75% coniferous forest, 75% (or close to) of randomly selected sites should occur within coniferous forest, on average. Camera placement is independent of animal distribution. This approach helps ensure representation of across the range of habitat types (or other strata categories) in the entire study area but may result in fewer overall detections relative to other study designs. A simple random design may also not adequately address some biases in detection probability due to environmental factors (e.g., vegetation denseness) and require subsequently correcting for these biases in a statistical framework. Standardizing other sampling components (e.g., camera set-up protocols) as much may help reduce some other study-specific biases.

In a stratified non-random study design, the different strata are sampled in proportion to specific criteria, as determined by the study objective (e.g., behaviour). For example, more cameras may be strategically placed in strata known or suspected to have higher activity, that are more common, and/or that have higher expected variance within a stratum. By allocating sampling effort in strata that have higher likelihood of detection, are larger, and/or more variable, overall effort may be reduced and precision of estimates improved. However, there are several important disadvantages to using a non-random study design, including the possibility of missing individuals/species/behaviours entirely, and the inability to make inferences to the entire study area.

Number of Strata

The number (and selection of) strata appropriate for a given study area will depend on the study’s objectives, heterogeneity, spatial scale, target species, and available resources. For example, a study estimating abundance of a wide-ranging species that is patchily distributed across a study area with a diversity of habitat types will typically have more strata than that for the same species in a more homogenous environment, or homogenous distribution. Sampling effort (e.g., number of cameras, camera days) will increase with the number of strata. Wearn & Glover-Kapfer (2017) recommended at least 20 camera locations, and ideally 50 locations, per strata (or covariate) for reasonably precise estimates of species diversity, richness, relative abundance, and behaviours.

## Advanced

If the topic doesn’t warrant inclusion, you can leave as NULL

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It may not always be possible to address biases of confounding variables in the study design phase (e.g., using stratification, complex hierarchically structured designs) or by using standardized field and reporting protocols over time and space. Examples of these instances include when collecting data on multiple species concurrently across seasons (but see \_\_\_), or when using data from different studies and sampling protocols. To address these situations, one needs to either correct for the metric of interest (e.g., relative abundance) or using use covariates in an advanced statistics framework to address known or suspected confounding variables. A common approach to correct for detection biases when estimating relative abundance, for instance, is to quantify effective detection range for example (e.g., Hofmeester et al. 2017a, Rowcliffe et al. 2011). Alternatively, covariates can be used in simple multiple linear regression models and/or much more complex hierarchal (or structured) models. For example, detection probability can be modeled with covariates to obtain separate estimates for different study-specific factors introducing detection biases (e.g., habitat type, season, sex). Regression models have the limitation of only addressing single processes, and therefore are unable to differentiate between detection and ecological processes (e.g., movement versus abundance), while interpretation of hierarchal models may be complicated. Refer to \_\_\_ for examples of applying covariates or hierarchal models, respectively to species diversity and richness, relative abundance, and behaviour, respectively. See Esteveo et al. (2017) for fitting of habitat covariates in co-occurrence models to estimate occupancy and detection of one species in the presence of another [3, 4, 13, 14, 17].

## Figures

Placeholders here as “filename” can leave in if not <5 images

Hofmeester et al. 2018 – Table 1 – “when to control for” field relative to animal characteristics that influence detection. Species, season, site. Table 4 – environmental variables of CT location that influence detection. Fig 2 – questions that lead to selection of covariates.

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## Video

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## Analytical tools & resources

The ref\_id should be included in the reference column (and the full text reference in the master reference file). If you aren’t sure if the reference is in the master doc, add the full text ref as a comment.

Please add a “<” before the URL text and a “>” after (e.g., <http://www.somesitelink.com>)

Type can be something similar to: Article, App/Program, R package

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## References / Glossary

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## Notes

(future ref / not included in markdown conversion)

# POPULATE MARKDOWN

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## Info

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## :::::{dropdown} \*\*Assumptions, Pros, Cons\*\*

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:::{grid-item-card} \*\*Assumptions\*\*

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:::{grid-item-card} **\*\*Pros\*\***

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## ````{tab-item} Visual Resources

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## ````{tab-item} References

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## ````{tab-item} Glossary

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