# 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
* **Assumptions, Pros, Cons**
  + Only for modelling approaches; can ignore otherwise (leave table here)
  + [WILL BE HERE, BUT INSERTED DIRECTLY FROM CSV FILE (THUS NO INPUT NEEDED)]
* **Advanced**
  + If the topic doesn’t warrant inclusion, you can leave as NULL
* **Figures**
  + Placeholders here as “filename” can leave in if not <5 images
* **Video**
  + no “<” before the URL text and a “>” after URL in this case
  + ref\_id in this example is not correct, just for illustrative purposes
* **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
* **References / Glossary** 
  + items in-text above (IGNORE FOR NOW)
* **Notes**
  + (future ref / not included in markdown conversion)

## Topic Info

"

ANALYTICAL INNOVATIONS

2021

\*Mammalian Biology, 102\*, 581–590. (2022)

Moeller & Lukacs, 2021

moeller\_lukacs\_2021

Moeller, A. K.,& Lukacs, P. M. (2021) spaceNtime: an R package for estimating abundance of unmarked animals using camera-trap photographs. \*Mammalian Biology, 102\*, 581–590. <https://doi.org/10.1007/s42991-021-00181-8>

* Yu, Hongmin, Zhixue Lin, and Fanrong Xiao. “Role of Body Size and Shape in Animal Camouflage.” *Ecology and Evolution* 14, no. 5 (May 2024): e11434. <https://doi.org/10.1002/ece3.11434>.

Mammalian Biology

|  |  |
| --- | --- |
| **info\_id** | sp\_size |
| **question** | **Question:** What is the approximate size of the Target Species?  Discuss influence of body size on design choices + Include mention of potential season effects on movement / HR + motility; movement; home range size |

## Overview

Here are a few examples of comparable species for each body size options:

* \*\***Small**\*\*: rodents and similarly sized species in the “Mustelidae” family [i.e., weasels, badgers, otters, martens, wolverine, etc.])
* \*\***Medium**\*\*: small and mid-sized species, ~< 33 lbs (or 15 kilograms), such as meso-carnivores (i.e., Red, fox, Coyote) {{Roemer et al., 2009}}
* \*\***Large**\*\*: bears or ungulates (i.e., large mammals with hooves, such as White-tailed deer, Elk, Moose, etc)
* \*\***Multiple**\*\* - \*select this option if your study includes multiple Target Species that vary in body size.\*

**Why does this matter?**

```{figure} ../03\_images/03\_image\_files/kays\_et\_al\_2021\_fig6.png

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```

## Advanced

Add some info here

## Figures

|  |  |  |  |
| --- | --- | --- | --- |
| **Image** | **file\_name** | **Caption (if applicable)** | **ref\_id** |
|  | kays\_et\_al\_2021\_fig6\_clipped.png | \*\*Kays et al. (2021) - Fig. 6\*\*: Relationship between trigger probability and body mass for four focal species (ascending order by weight: gray fox, raccoon, coyote, white-tailed deer). Error bars show standard deviation. Body mass values come from North Carolina animals in the mammal collections of the NC Museum of Natural Sciences | kays\_et\_al\_2021 |
|  | anile\_devillard\_2016\_fig2.jpg | figure2\_caption | anile\_devillard\_2016 |
|  | anile\_devillard\_2016\_fig3.jpg | figure4\_caption | anile\_devillard\_2016 |
|  | bodysize\_movement.png | figure4\_caption | bodysize\_movement.png |
|  | fisher\_et\_al\_2011\_fig6.png | figure5\_caption | fisher\_et\_al\_2011 |
|  | chatterhee\_et\_al\_2021\_table2.png | \*\*Chatterhee et al. (2021) – Table 2\*\*:  igure6\_caption | chatterhee\_et\_al\_2021 |

## Video

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| **caption** | **URL (no < / > before/after URL** | **ref\_id** |
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| vid4\_caption | vid4\_url | vid4\_ref\_id |
| vid5\_caption | vid5\_url | vid5\_ref\_id |
| vid6\_caption | vid6\_url | vid6\_ref\_id |

## Analytical tools & resources

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## References / Glossary

|  |  |
| --- | --- |
| **ref\_id** | **glossary\_keys** |
| {{ ref\_intext\_chatterhee\_et\_al\_2021 }}  {{Fisher  et al., 2011}}  {{Roemer et al., 2009}}  {{LaBarbera et al\_1989 }} | keys\_here |

## Notes

Not used

* Very small species (< 100 g) are sometimes detected by higherend camera traps on the market today (e.g. Fig 4-3), but detections will only be reliable at distances less than 2 m from the camera ({{Rowcliffe et al. 2011}})
* There is also some evidence that detection angles are smaller for species which move at faster speeds ({{Rowcliffe et al. 2011}}.
* Small species which routinely move at fast speeds, such as stoats and weasels, are likely to have especially small detection zones ({{Glen et al., 2013}}).
* "Most species with larger body sizes had moderate or high detection probabilities and thus required lower sampling efforts than smaller mammals. This makes sense, as larger-bodied animals are more likely to trigger the camera trap and have larger home ranges (Garland 1983) and daily movement distances, making them more likely to be detected at multiple cameras." (Chatterhee et al., 2021)
* “While occupancy was positively correlated with body size, detection probability was not significantly correlated with body size (r = 0.17, P = 0.49).” (Chatterhee et al., 2021)

**Why does this matter?**

* Detection process
  + Body size affects the detection process (O’Brien et al., 2011) and has been shown to bias estimates from relative abundance indices (Anile et al., 2016).
  + small mammals are often undetected due to their small size (O’Brien, Kinnaird, and Wibisono 2011; Anile and Devillard 2016)
* Dispersal ability / Home range size
  + “All other things being equal, larger species might be more easily trapped as they move more slowly than smaller species, or because their population density is higher (see Bengsen et al., 2011 and Rowcliffe & Carbone, 2008; Rowcliffe et al., 2008 on the importance of population density on trapping rates).”
  + **Larger species may require lower sampling effort** than smaller species; this is because their larger size increases the likelihood that they will trigger the camera (and thus generally larger species have a higher detection probability) {{ ref\_intext\_chatterhee\_et\_al\_2021 }}
  + When thinking beyond the camera's FOV, larger species generally also have larger home ranges {{Garland, 1983}} and daily movement distances, making them more likely to be detected at multiple cameras {{ ref\_intext\_chatterhee\_et\_al\_2021 }}
  + Species with higher dispersal ability (i.e., able to travel further distances) are also more likely to be absent during the survey (and therefore, may generally occur at a camera location, but weren’t detected when you were sampling)
* Body size affects how easy it is to detect an individual moving through the camera’s detection zone ([detectability]()); larger species can be detected farther away or occur at wider angles ({{Rowcliffe et al. 2011}}; {{Hofmeester et al. 2017}}). ;;;;; However, body size has been found to have the most important effect on detection zones, with larger species being detected at larger distances and wider angles ({{Rowcliffe et al. 2011}}; {{Hofmeester et al. 2017}}).
* Ofstad, E. G., Herfindal, I., Solberg, E. J., & Sæther, B.-E. (2016). Home ranges, habitat and body mass: Simple correlates of home range size in ungulates. *Proceedings of the Royal Society B: Biological Sciences*, *283*(1845), 20161234. <https://doi.org/10.1098/rspb.2016.1234>
* LaBarbera, M. (n.d.). Analyzing Body Size as a Factor in Ecology and Evolution.

# POPULATE MARKDOWN

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(i\_mod\_divers\_rich)=

# {{ name\_mod\_divers\_rich }}

### :::::::::{div} full-width

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

:::::{dropdown} Species richness (Alpha diversity)

::::{grid}

:::{grid-item-card} Assumptions

- {{ mod\_divers\_rich\_alpha\_assump\_01 }}

- {{ mod\_divers\_rich\_alpha\_assump\_02 }}

- {{ mod\_divers\_rich\_alpha\_assump\_03 }}

- {{ mod\_divers\_rich\_alpha\_assump\_04 }}

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:::{grid-item-card} Pros

- {{ mod\_divers\_rich\_alpha\_pro\_01 }}

- {{ mod\_divers\_rich\_alpha\_pro\_02 }}

- {{ mod\_divers\_rich\_alpha\_pro\_03 }}

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:::{grid-item-card} Cons

- {{ mod\_divers\_rich\_alpha\_con\_01 }}

- {{ mod\_divers\_rich\_alpha\_con\_02 }}

- {{ mod\_divers\_rich\_alpha\_con\_03 }}

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:::::{dropdown} Species diversity (Beta diversity)

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- {{ mod\_divers\_rich\_beta\_assump\_03 }}

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- {{ mod\_divers\_rich\_beta\_pro\_03 }}

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:::{grid-item-card} Cons

- {{ mod\_divers\_rich\_beta\_con\_01 }}

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- {{ mod\_divers\_rich\_beta\_con\_03 }}

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:::::{dropdown} Species diversity (Gamma diversity)

::::{grid}

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- {{ mod\_divers\_rich\_gamma\_assump\_03 }}

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:::{grid-item-card} Pros

- {{ mod\_divers\_rich\_gamma\_pro\_01 }}

- {{ mod\_divers\_rich\_gamma\_pro\_02 }}

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:::{grid-item-card} Cons

- {{ mod\_divers\_rich\_gamma\_con\_01 }}

- {{ mod\_divers\_rich\_gamma\_con\_02 }}

- {{ mod\_divers\_rich\_gamma\_con\_03 }}

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### :::::::{tab-set}

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

\*\*{{ term\_mod\_divers\_rich }}\*\*: {{ term\_def\_mod\_divers\_rich }}

<br>

“Species richness is simply the number of species in an area ({{ ref\_intext\_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'.” {{ ref\_intext\_pyron\_2010 }}

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#### ::::::

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

Parameters**:**

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

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

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

<br>

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

- \*\*Observed species richness\*\*: the sum of the number of species seen (e.g. {{ ref\_intext\_kitamura\_et\_al\_2010 }}; {{ ref\_intext\_pettorelli\_et\_al\_2010 }}; {{ ref\_intext\_ahumada\_et\_al\_2011 }}; {{ ref\_intext\_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. {{ ref\_intext\_tobler\_et\_al\_2008 }}; {{ ref\_intext\_kinnaird-&-obrien-2012 }}; {{ ref\_intext\_brodie\_et\_al\_2015 }}; {{ ref\_intext\_yue\_et\_al\_2015 }}; {{ ref\_intext\_wearn\_et\_al\_2016 }})

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

- non-parametric estimators ({{ ref\_intext\_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. {{ ref\_intext\_tobler\_et\_al\_2008 }}),

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

#### ::::::

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

##### :::::{grid} 3

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###### ::::{grid-item-card} {{ ref\_intext\_pyron\_2010 }}

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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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###### ::::{grid-item-card} {{ ref\_intext\_gotelli\_colwell\_2011 }}

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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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###### ::::{grid-item-card} {{ ref\_intext\_molloy\_2018 }}

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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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###### ::::{grid-item-card} {{ ref\_intext\_loreau\_2010 }}

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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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###### ::::{grid-item-card} {{ ref\_intext riffomonas\_project\_2022a }}

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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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###### ::::{grid-item-card} {{ ref\_intext vsn\_international\_2022 }}

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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 \*\*

shiny\_caption

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#### ::::::

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

**Error! Not a valid filename.**

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

| R package | R package “vegan | \- | <https://cran.r-project.org/web/packages/vegan/index.html> | {{ ref\_bib\_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> | {{ ref\_bib\_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> | {{ ref\_bib\_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> | {{ ref\_bib\_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> | {{ ref\_bib\_resource6\_ref\_id }} |

| resource7\_type | resource7\_name | resource7\_note | resource7\_note | {{ ref\_bib\_resource7\_ref\_id }} |

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#### ::::::{tab-item} References

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{{ ref\_bib\_ahumada\_et\_al\_2011 }}

{{ ref\_bib\_baylor\_tutoring\_center\_2021 }}

{{ ref\_bib\_brodie\_et\_al\_2015 }}

{{ chao\_et\_al\_2016 }}

{{ chao\_et\_al\_2014 }}

{{ ref\_bib\_colwell\_2022 }}

{{ ref\_bib\_gerhartbarley\_nd }}

{{ ref\_bib\_gotelli\_colwell\_2001 }}

{{ ref\_bib\_gotelli\_colwell\_2010 }}

{{ ref\_bib\_hsieh\_et\_al\_2015 }}

{{ ref\_bib\_iknayan\_et\_al\_2014 }}

{{ ref\_bib\_kinnaird\_obrien\_2012 }}

{{ ref\_bib\_kitamura\_et\_al\_2010 }}

{{ ref\_bib\_mackenzie\_et\_al\_2006 }}

{{ ref\_bib\_mecks100\_2018 }}

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{{ ref\_bib\_pettorelli\_et\_al\_2010 }}

{{ ref\_bib\_project\_dragonfly\_2019 }}

{{ ref\_bib\_pyron\_2010 }}

{{ ref\_bib\_riffomonas\_project\_2022 }}

{{ ref\_bib\_samejima\_et\_al\_2012 }}

{{ ref\_bib\_styring\_2020 }}

{{ ref\_bib\_tobler\_et\_al\_2008 }}

{{ ref\_bib\_vsn\_international\_2022 }}

{{ ref\_bib\_wearn\_et\_al\_2016 }}

{{ ref\_bib\_wildco\_lab\_2021b }}

{{ ref\_bib\_yue\_et\_al\_2015 }}

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