## File from = 01\_20\_sp\_detprob\_cat\_entry.docx

**sp\_det\_prob\_cat**

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(i\_**sp\_det\_prob**\_cat)=

# Target species - Detectability

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### ::::::::{admonition} Click here for more information

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\*\*Target species - Detectability\*\*

<br>

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

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

<br>

\*\*{{ term\_detection\_probability }}\*\*: {{ term\_def\_detection\_probability }}

#### 

#### This question is asking about how easily you can detect the Target Species if it is present (i.e., “detectability”); simply put, how likely are you to detect an individual that is present.

#### Detection probability (aka detectability) is defined as the probability (likelihood) that an individual of the population of interest is included in the count at time or location \*i\*.

[insert info on how this relates to study design recommendations; ideally, modelled using project data]

Detection probability categories are defined as follows:

- \*\*Low\*\*:

- < 0.1 ({{ ref\_intext\_tobler\_powell\_2013 }})

- < 0.05 (Shannon et al., 2014 }})

- 0–0.37 ({{ ref\_intext\_chatterjee\_et\_al\_2021 }})

- \*\*Medium\*\*:

- 0.37–0.67 ({{ ref\_intext\_chatterjee\_et\_al\_2021 }})

- \*\*High\*\*:

- 0.67–1 ({{ ref\_intext\_chatterjee\_et\_al\_2021 }})

- > 0.5 ({{ ref\_intext\_mackenzie\_royle\_2005 }})

- \*\*Unknown\*\*: select this option if you’re not sure of the detection probability of your Target Species (single or multiple species)

- \*\*Multiple\*\*: select this option if your study include multiple Target Species.

::: {note}

In order to determine the appropriate sampling design for your [Target Species](), we must consider detection probability.

Species are often detected "imperfectly," meaning that they are not always detected when they are present (i.e., imperfect detection, e.g., due to cover of vegetation, cryptic nature or small size) (MacKenzie et al., 2004). Imperfect detection results in “false absences” and may lead to incorrect conclusions from the data. Understanding and correcting for sources of “false absences” is often thought of in terms of probabilities. Detection probability is the probability (likelihood) that an individual from the population of interest is included in the count at time or location \*i\* ({{ ref\_intext\_mackenzie\_kendall\_2002 }}). Detection probability can be influenced through multiple processes and at multiple scales.

For example:

- "Species living in groups have a higher chance of triggering the camera when they pass in front of the camera, and carnivores are known to cover a larger distance than species of other feeding guilds" (Garland, 1983)

- Species vary in emissions of infrared radiation, which can inflate relative detection rates of warmer, larger species (Wearn & Glover-Kapfer, 2017).

[insert note about relating to site]

:::

#### ::::::

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

Before study design choices are made, there is one critical concept to understand in remote camera research, which may impact study design choices at all levels of the data hierarchy. Reliable use of remote cameras to detect wildlife species hinges on the [assumption](/09\_glossary.md#mods\_modelling\_assumption) that what is captured on the cameras accurately reflects what is present on the landscape. However, species are often detected "imperfectly," meaning that they are not always detected when they are present (i.e., [imperfect detection](/09\_glossary.md#imperfect\_detection); e.g., due to cover of vegetation, cryptic nature or small size) (MacKenzie et al., 2004). [Imperfect detection](/09\_glossary.md#imperfect\_detection) can occur because the camera failed to capture an individual present at the site or because the animal was simply not present during the [survey](/09\_glossary.md#survey) period (Martin et al., 2005).

[Imperfect detection](/09\_glossary.md#imperfect\_detection) results in “false absences” and may lead to incorrect conclusions from the data. Understanding and correcting for sources of “false absences” is often thought of in terms of probabilities. [Detection probability](/09\_glossary.md#detection\_probability) is the probability (likelihood) that an individual from the population of interest is included in the count at time or location \*i\* (MacKenzie & Kendall, 2002). [Detection probability](/09\_glossary.md#detection\_probability) can be influenced through multiple processes and at multiple scales. Understanding the sources of “false absences” and factors that affect [detection probabilities](/09\_glossary.md#detection\_probability) is an essential step when designing a study, deploying cameras and analyzing camera data.

The detection probability of an animal by a camera depends on three \*\*conditional probabilities (Pr) of detection\*\* that may operate alone or potentially in combination ([Figure 1](#TOC\_surv\_guidelines\_fig\_1)).

(TOC\_surv\_guidelines\_fig\_1)=

```{figure} ../03\_images/03\_image\_files/surveyguidelines\_detection\_probability-2023-05-04.jpg

:height: 700px

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```

\*\*Figure 1.\*\* Three conditional probabilities (Pr) of detection that may impact the [detection probability](/09\_glossary.md#detection\_probability) of an animal (or species) by a camera (adapted from Moeller et al. [2023], Hofmeester et al. [2019], and Findlay et al. [2020]).

Detection probability can be affected by species-specific characteristics, [Camera Model](/09\_glossary.md#camera\_model) specifications and set-up, and environmental variables (Hofmeester et al., 2019). For example, \*\*species-specific characteristics\*\* (individuals or populations), such as body size (e.g., O'Brien et al., 2011), behaviour (e.g., Caravaggi et al., 2020; Rowcliffe et al., 2011), and rarity can influence [detection probability](/09\_glossary.md#detection\_probability), with larger, bolder and more common species generally having higher [detection rates](/09\_glossary.md#detection\_rate). [\*\*Camera Model\*\*](/09\_glossary.md#camera\_model), specifications and set-up, such as the [Trigger Sensitivity](/09\_glossary.md#settings\_trigger\_sensitivity), [\*\*Camera Height\*\*](/09\_glossary.md#camera\_height), or [\*\*angle\*\*](/09\_glossary.md#camera\_angle) may affect [detection probability](/09\_glossary.md#detection\_probability) in that smaller species might not be detected or identifiable if the [Trigger Sensitivity](/09\_glossary.md#settings\_trigger\_sensitivity) is low, or the [Camera Height](/09\_glossary.md#camera\_height) or [angle](/09\_glossary.md#camera\_angle) is too high. The [\*\*Camera Direction\*\*](/09\_glossary.md#camera\_direction) could impact the probability of an animal triggering a camera if it is directed towards an object that impedes the [Field of View (FOV)](/09\_glossary.md#field\_of\_view) or image quality (e.g. due to sun glare). \*\*Environmental factors\*\* (e.g., vegetation cover, snow depth) may affect [detection probability](/09\_glossary.md#detection\_probability) and occurrence (e.g., Becker et al., 2022; Hofmeester et al., 2019; Iknayan et al., 2014; Steenweg et al., 2019). For example, a low number of detections in a densely vegetated site might be because of poor camera visibility or avoidance of this habitat by the species of interest.

Hofmeester et al. (2019) suggested there are \*\*six scales (orders) that may impact [detection probability](/09\_glossary.md#detection\_probability)\*\* and that should be considered within an explicit time period (adapted from Hofmeester et al. [2019]; [Figure 2](#TOC\_surv\_guidelines\_fig\_2)):

[Detection probability](/09\_glossary.md#detection\_probability) can be affected by species-specific characteristics, [Camera Model](/09\_glossary.md#camera\_model) specifications and set-up, and environmental variables (Hofmeester et al., 2019). For example, \*\*species-specific characteristics\*\* (individuals or populations), such as body size (e.g., O’Brien et al., 2011), behaviour (e.g., Caravaggi et al., 2020; Rowcliffe et al., 2011), and rarity can influence [detection probability](/09\_glossary.md#detection\_probability), with larger, bolder and more common species generally having higher [detection rates](/09\_glossary.md#detection\_rate). [\*\*Camera Model\*\*](/09\_glossary.md#camera\_model) \*\*specifications and set-up\*\*, such as the [Trigger Sensitivity](/09\_glossary.md#settings\_trigger\_sensitivity), [Camera Height](/09\_glossary.md#camera\_height), or [angle](/09\_glossary.md#camera\_angle) may affect [detection probability](/09\_glossary.md#detection\_probability) in that smaller species might not be detected or identifiable if the [Trigger Sensitivity](/09\_glossary.md#settings\_trigger\_sensitivity) is low, or the [Camera Height](/09\_glossary.md#camera\_height) or [angle](/09\_glossary.md#camera\_angle) is too high. The [Camera Direction](/09\_glossary.md#camera\_direction) could impact the probability of an animal triggering a camera if it is directed towards an object that impedes the [Field of View (FOV)](/09\_glossary.md#field\_of\_view) or image quality (e.g. due to sun glare). \*\*Environmental factors\*\* (e.g., vegetation cover, snow depth) may affect [detection probability](/09\_glossary.md#detection\_probability) and occurrence (e.g., Becker et al., 2022; Hofmeester et al., 2019; Iknayan et al., 2014; Steenweg et al., 2019). For example, a low number of detections in a densely vegetated site might be because of poor camera visibility or avoidance of this habitat by the species of interest.

Hofmeester et al. (2019) suggested there are \*\*six scales (orders) that may impact\*\* [detection probability](/09\_glossary.md#detection\_probability) and that should be considered within an explicit time period (adapted from Hofmeester et al. [2019]; [Figure 2](#TOC\_surv\_guidelines\_fig\_2)):

1) \*\*Distribution range\*\* (1st order; i.e., the physical or geographical range of a species)

2) \*\*Landscape\*\* (2nd order; i.e., the location of an individual’s home range within the geographic range)

3) \*\*Habitat patch\*\* (3rd order; i.e., usage of habitat components within an individual’s home range)

4) \*\*Microsite\*\* (4th order; usage of microhabitats such as food items/feeding patches/nest sites/movement trails, etc. within a habitat)

5) \*\*Camera specification / set-up\*\* (5th order; i.e., factors that affect the probability that an animal [triggers](/09\_glossary.md#trigger\_event) the camera if present)

6) \*\*Image\*\* (6th order; i.e., factors that affect correct identification of animals or individuals)

(TOC\_surv\_guidelines\_fig\_2)=

```{figure} ../03\_images/03\_image\_files/survey-guidelines\_detectionprob\_scale\_hofmeester-et-al.,-2019.png

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\*\*Figure 2.\*\* Spatial scales (1-6) and processes that determine the [detection probability](/09\_glossary.md#detection\_probability) (Hofmeester et al., 2019; abbreviated figure caption).

It is important to consider how all these factors and scales will impact study design. Unmeasured variation in [detection probability](/09\_glossary.md#detection\_probability) can result in the inability to differentiate the effects of [detection probability](/09\_glossary.md#detection\_probability) \*vs.\* habitat preference (Jennelle et al., 2002) and, in turn, cause erroneous estimates of occurrence and abundance (Burton et al., 2015; Dénes et al., 2015; Kays et al., 2021).

Factors that influence [detection probability](/09\_glossary.md#detection\_probability) at the microsite and camera specification / set-up scales are likely to result in the largest biases and thus warrant the most consideration (see Hofmeester et al. [2019] for details). Therefore, it is particularly important to consider \*how\* to place cameras to avoid such biases. Deploying cameras in a consistent fashion (e.g., carefully ensuring that cameras are always set at the same [Camera Height](/09\_glossary.md#camera\_height), orientation ([direction](/09\_glossary.md#camera\_direction)), and [angle](/09\_glossary.md#camera\_angle) is essential.

#### ::::::

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

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```{figure} ../03\_images/03\_image\_files/**survey\_guidelines/detection-probability-2023-05-04.png**

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<p>**\*\*Figure** 1.\*\* Three conditional probabilities (Pr) of detection that may impact the detection probability of an animal (or species) by a camera (adapted from Moeller et al. [2023], Hofmeester et al. [2019], and Findlay et al. [2020]). <p/>

###### ::::

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```{figure} ../03\_images/03\_image\_files/**detectionprob\_hofmeester\_et**\_al\_2019\_fig1.png

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<p>**Figure 2.** Spatial scales (1-6) and processes that determine the detection probability (Hofmeester et al., 2019; abbreviated figure caption). <p/>

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##### :::::

#### ::::::

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

| Type | Name | Note | Reference |

|:----------------|:---------------------------------------|:----------------------------------------------------------------|:----------------------------------------------------------------|

| **resource1\_type** | **resource1\_name** | **R package** for analyzing wildlife data with detection error | {{ ref\_bib\_**resource1\_ref\_id** }} |

| **resource3\_type** | **resource2\_name** | **resource3\_note** | {{ ref\_bib\_**resource2\_ref\_id** }} |

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<!—with urls

| Type | Name | Note | URL |Reference |

|:----------------|:---------------------------------------|:----------------------------------------------------------------|:----------------------------------------------------------------|:----------------------------------------------------------------|

| **resource1\_type** | **resource1\_name** | **R package** for analyzing wildlife data with detection error |

**<https:/**/github.com/psolymos/detect>

<https://peter.solymos.org/detect>

| {{ ref\_bib\_**resource1\_ref\_id** }} |

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#### ::::::

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

**{{** ref\_bib\_rcsc\_et\_al\_2024 }}

**{**{ ref\_bib\_chatterjee\_et\_al\_2021 }}

{{ ref\_bib\_mackenzie\_kendall\_2002 }}

{{ ref\_bib\_mackenzie\_royle\_2005 }}

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

{{ ref\_bib\_tobler\_powell, 2013 }}

{{ ref\_bib\_mackenzie\_kendall\_2002 }}

{{ ref\_bib\_mackenzie\_royle\_2005 }}

#### ::::::

#### ::::::{tab-item} Glossary

**keys\_here**

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