# INFO ENTRY

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/**In-depth
  + 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

|  |  |
| --- | --- |
| **info\_id** | design\_camera\_arrangement  **02\_02\_camera\_arrangement** |
| **question** | Headers:  \*\*<font size="4"><span style="color:#2F5496">How does this relate to study design?</font></span>\*\*  \*\*<font size="4"><span style="color:#2F5496">How does that work?</font></span>\*\*  \*\*<font size="4"><span style="color:#2F5496">Why do we care?</font></span>\*\*  > \*\*Select "Unknown" if you’re not sure.\*\*  This section will be available soon! In the meantime, check out the information in the other tabs!  :::{figure} ../03\_images/03\_image\_files/00\_coming\_soon.png  :width: 300px  :align: center  :::  {bdg-link-primary-line}`Spatial count<https://ab-rcsc.github.io/rc-decision-support-tool\_concept-library/02\_dialog-boxes/03\_14\_mod\_sc.html>` |

## Note banner

<!--

:::{info}

replace me with text

:::

-->

## # Study area

## Overview

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

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

Remote [camera locations](#camera\_location) (or [sample stations](#sample\_station)) and their spatial arrangement are integral components of any study design; these choices will affect the user’s ability to draw inference(s) about the species or question of interest. There are many species-specific characteristics (e.g., body size, behaviour, rarity, etc.) and environmental factors (e.g., vegetation cover, snow depth) that influence the [detection probability](#detection\_probability) and probability of occurrence of a species, as well as the size of the area that should be surveyed (e.g., {{ ref\_intext\_becker\_et\_al\_2022 }}; {{ ref\_intext\_hofmeester\_et\_al\_2019 }}; {{ ref\_intext\_iknayan\_et\_al\_2014 }}; {{ ref\_intext\_steenweg\_et\_al\_2019 }}). When there are multiple [Target Species](#target\_species), a mix of study designs may be valuable ({{ ref\_intext\_iannarilli\_et\_al\_2021 }}; {{ ref\_intext\_vanwilgenburg\_et\_al\_2020 }}).

The [objectives](#survey\_objectives) of the [survey](#survey) will determine the most appropriate study design ([Appendix A - Table A2](https://ab-rcsc.github.io/RCSC-WildCAM\_Remote-Camera-Survey-Guidelines-and-Metadata-Standards/1\_survey-guidelines/1\_10.1\_AppendixA-Tables.html)). There are five commonly used study designs in camera studies: [simple random](#sampledesign\_random), [systematic random](#sampledesign\_systematic\_random) (grid), [stratified random](#sampledesign\_stratified\_random), [clustered](#sampledesign\_clustered) (including [paired design](#sampledesign\_paired)) and [targeted](#sampledesign\_targeted) (or opportunistic) (Wearn & Glover-Kapfer 2017). A [convenience sampling](#sampledesign\_convenience) study design is also used when it is impractical to use another design. Sampling design can occur hierarchically, where one approach is used at a larger scale (i.e., to select grids to place cameras within), and another approach is used at a smaller scale (i.e., to select the location within each grid to place the camera). Refer to the following literature for additional recommendations on study design: {{ ref\_intext\_burton\_et\_al\_2015 }}; {{ ref\_intext\_cusack\_et\_al\_2015 }}; {{ ref\_intext\_fisher\_burton\_2012 }}; Kolowski and Forrester, 2017; {{ ref\_intext\_kolowski\_forrester\_et\_al\_2017 }}; {{ ref\_intext\_oconnell\_et\_al\_2011 }}; {{ ref\_intext\_rovero\_et\_al\_2013 }}; {{ ref\_intext\_steenweg\_et\_al\_2015 }}; {{ ref\_intext\_wearn\_gloverkapfer\_2017 }} and WildCAM’s ["sampling design & effort section section"](https://wildcams.ca/library/camera-trapping-papers-directory/) of their resource library (<https://wildcams.ca/library/camera-trapping-papers-directory/>).

Note that we refer to different configurations of cameras more generally as study design and sampling design; however, the term “[\*\*Survey Design\*\*](#survey\_design)“ is how the study design is referred to when it applies to an individual [survey](#survey). There may be multiple [Survey Designs](#survey\_design) for [surveys](#survey) within a [project](#project); the [Survey Design](#survey\_design) should be reported separately for each [survey](#survey) within a [project](#project). When the [Survey Design](#survey\_design) is hierarchical, “Hierarchical (multiple)\\*” should be reported and additional details should be included in the [Survey Design Description](#survey\_design\_description). Refer to the [AB Metadata Standards](https://ab-rcsc.github.io/RCSC-WildCAM\_Remote-Camera-Survey-Guidelines-and-Metadata-Standards/2\_metadata-standards/2\_0.1\_Citation-and-Info.html) (RCSC, 2024) for more information.

(TOC\_surv\_guidelines\_fig\_3)=

```{figure} ../03\_images/03\_image\_files/rcsc\_et\_al\_2024\_camconfig.png

:align: center

```

\*\*Figure 3.\*\* Examples of sampling designs: (a) simple [random](#sampledesign\_random), (b) [systematic](#sampledesign\_systematic\_random), (c) [stratified](#sampledesign\_stratified) (each grid cell is a stratum), and (d) [clustered](#sampledesign\_clustered) (adapted from {{ ref\_intext\_schweiger\_2020 }}).

::::::

::::::{tab-item} Random (or “simple random”)

\*\*Random (or “simple random”) design\*\* ([Figure 3a](#TOC\_surv\_guidelines\_fig\_3)) – cameras occur at randomized locations (or sample stations) across the [study area](#study\_area), sometimes with a predetermined minimum distance between [camera locations](#camera\_location) (or [sample stations](#sample\_station)). A [random design](#sampledesign\_random) may help reduce biases that arise from selecting [camera locations](#camera\_location) deliberately. It may also allow the user to make inferences about areas that were not surveyed when employing use-based approaches (e.g. [occupancy models](#mods\_occupancy) [{{ ref\_intext\_mackenzie\_et\_al\_2002 }}]; [intensity of use](#intensity\_of\_use) methods [{{ ref\_intext\_keim\_et\_al\_2019 }}]). Some [modelling approaches](#mods\_modelling\_approach) (e.g., [random encounter and staying time [REST]](#mods\_rest); {{ ref\_intext\_nakashima\_et\_al\_2017 }}) and [random encounter models [REM](#mods\_rem); {{ ref\_intext\_rowcliffe\_et\_al\_2008 }}, 2013]) require a simple [random design](#sampledesign\_random) ([Appendix A - Table A2](https://ab-rcsc.github.io/RCSC-WildCAM\_Remote-Camera-Survey-Guidelines-and-Metadata-Standards/1\_survey-guidelines/1\_10.1\_AppendixA-Tables.html)).

A disadvantage of using a simple random design is the tendency to see fewer animals (i.e., is less efficient) when animals are [clustered](#sampledesign\_clustered) or exhibit habitat preferences, and the possibility of missing rare habitat types. The proportion of different strata (e.g., habitat types) sampled should be the same as (or close to) the true proportion in the [study area](#study\_area). For example, if the [study area](#study\_area) consists of 25% young deciduous forest, then 25% of randomly selected sites should be within young deciduous forest, on average.

::::::

::::::{tab-item} Systematic

\*\*Systematic design\*\* ([Figure 3b](#TOC\_surv\_guidelines\_fig\_3)) – [camera locations](#camera\_location) occur within a regular pattern (e.g., a grid pattern) across the [study area](#study\_area).

\*\*Systematic random\*\* – [camera locations](#camera\_location) are selected using a two-stage approach. Firstly, grids are selected systematically (to occur within a regular pattern) across the [study area](#study\_area). The location of the camera within each grid is then selected randomly. This method is similar to the [simple random](#sampledesign\_random) design. The same advantages apply in terms of unbiased landscape representation, and the same [modelling approaches](#mods\_modelling\_approach) can be used. The disadvantage of using a [systematic random](#sampledesign\_systematic\_random) (or [simple random](#sampledesign\_random) design) is that rare habitat types may be missed.

\*\*Systematic non-random\*\* design – sets of [clustered](#sampledesign\_clustered) cameras can be deployed within a [systematic non-random](#sampledesign\_systematic) approach (i.e., “systematic clustered” or “systematic paired”) to assess the effects of disturbance along a gradient, over time, at multiple scales and/or with control (i.e., reference) [sample stations](#sample\_station). \*\*Hierarchical Before-After Dose-Response (BADR)\*\* is one such method that requires cameras to be placed within a systematic non-random approach, where [camera locations](#camera\_location) occur along transects or in [clustered](#sampledesign\_clustered) arrays ([sample stations](#sample\_station)), selected using a nested spatial hierarchy of sampling to control for variability in land-use type and large-scale patterns ({{ ref\_intext\_bayne\_et\_al\_2022 }}). The [study area](#study\_area) is divided into land-use regions based on land-use type, then into landscape units, which are assessed for environmental variability to determine where [sample stations](#sample\_station) should be placed ({{ ref\_intext\_bayne\_et\_al\_2022 }}). The “Before-After” component of BADR incorporates the phase of stressors (i.e., proposed or current development) ({{ ref\_intext\_bayne\_et\_al\_2022 }}). The “Dose-Response” component of BADR controls for the variable distribution of activity (and the potential impacts) by incorporating control (or reference) [sample stations](#sample\_station) and/or by placing cameras in [sample stations](#sample\_station) along a gradient of disturbance ({{ ref\_intext\_bayne\_et\_al\_2022 }}).

::::::

::::::{tab-item} Stratified

\*\*Stratified random design\*\* ([Figure 3c](#TOC\_surv\_guidelines\_fig\_3)) – the area of interest is divided into smaller strata (e.g., habitat type, disturbance levels), and then a proportional random sample of sites is selected within each stratum (e.g., 15%, 35% and 50% of sites within high, medium and low disturbance strata). This design can help ensure that the sample adequately reflects the major or uncommon strata of interest and may be an efficient approach when users are limited by accessibility constraints ({{ ref\_intext\_wearn\_gloverkapfer\_2017 }}). This design can also be used to increase precision if animal densities are known to be highly variable ({{ ref\_intext\_junker\_et\_al\_2021 }}) or when a species is expected to occur in certain habitat types more often ({{ ref\_intext\_gillespie\_et\_al\_2015 }}). For example, studies that wish to assess species richness, or [occupancy](#occupancy) rates for a particular species, amongst strata would use a [stratified random](#sampledesign\_stratified\_random) design.

::::::

::::::{tab-item} Clustered / Paired

\*\*Clustered\*\* design ([Figure 3d](#TOC\_surv\_guidelines\_fig\_3)) – multiple cameras are deployed at a [sample station](#sample\_station). The distance between cameras ([camera spacing](#camera\_spacing)) will be influenced by the chosen sampling design, the [Survey Objectives](#survey\_objectives), the [Target Species](#target\_species) and data analysis. A [clustered design](#sampledesign\_clustered) can be used within a [systematic](#sampledesign\_systematic) or [stratified](#sampledesign\_stratified) approach (i.e., systematic clustered design or as a clustered random design) ({{ ref\_intext\_wearn\_gloverkapfer\_2017 }}). A [clustered design](#sampledesign\_clustered) is common when users are interested in individual identification, such as [density](#density) estimation from [marked](#typeid\_marked) or [partially marked populations](#typeid\_partially\_marked) (e.g., [spatially explicit capture-recapture [SECR](#mods\_scr\_secr); {{ ref\_intext\_borchers\_efford\_2008 }}; {{ ref\_intext\_efford\_2004 }}; {{ ref\_intext\_royle\_young\_2008 }}] or [spatial mark-resight [SMR](#mods\_smr); {{ ref\_intext\_doran\_myers\_2018 }}]). A [clustered](#sampledesign\_clustered) design can also be used in an [occupancy framework](#mods\_occupancy) (O'Connell & Bailey, 2011; {{ ref\_intext\_pacifici\_et\_al\_2016 }}) when interested in measures of species richness ({{ ref\_intext\_obrien\_et\_al\_2011 }}).

A [clustered](#sampledesign\_clustered) design can be a cost-efficient approach to increase the number of replicates at each site (especially when accessibility is limiting; {{ ref\_intext\_galvez\_et\_al\_2016 }}) and to reduce measurement error and improve precision (Clarke et al., 2019). However, [spatial autocorrelation](#spatial\_autocorrelation) may occur with this design ({{ ref\_intext\_moqanaki\_et\_al\_2021 }}), depending on the [camera spacing](#camera\_spacing).<!-- (see [section 6.2.7](#TOC\_surv\_guidelines\_pseudoreplication)).-->

* *Cluster Sampling (Hines et al. 2010):*[*https://doi.org/10.1890/09-0321.1*](https://doi.org/10.1890/09-0321.1)

\*\*Paired design\*\* – a form of “[clustered design](#sampledesign\_clustered)“ where two cameras that are placed closely together to increase detection probability ("paired cameras"), to evaluate certain conditions ("paired sites,” e.g., on- or off trails), etc. Paired placements can help to account for other variability that might occur (i.e., variation in habitat quality). For some [objectives](#survey\_objectives), pairs of cameras might be considered subsamples within another sampling design (e.g., [simple random](#sampledesign\_random), [stratified random](#sampledesign\_systematic\_random), [systematic](#sampledesign\_systematic)).

::::::

::::::{tab-item} Targeted

\*\*Targeted design\*\* – cameras are placed in areas that are known or suspected to have higher activity levels (e.g., game trails, mineral licks, etc.). This design is useful when monitoring rare or cryptic species that are unlikely to be detected with other designs. This design is commonly used when estimating densities of [marked populations](#typeid\_marked) (e.g., [spatially explicit capture-recapture [SECR](#mods\_scr\_secr); {{ ref\_intext\_borchers\_efford\_2008 }}; {{ ref\_intext\_efford\_2004 }}; {{ ref\_intext\_royle\_young\_2008 }}]) or behaviour studies. It is, however, important to understand that [targeted](#sampledesign\_targeted) sampling may impede one’s ability to make inferences beyond the [survey](#survey) area. For some [objectives](#survey\_objectives), [targeted](#sampledesign\_targeted) sampling may be used within another sampling design (e.g., a [stratified random](#sampledesign\_stratified\_random) sample of game trails and seismic lines; {{ ref\_intext\_keim\_et\_al\_2021}}).

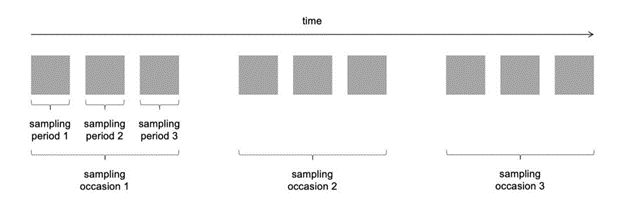
::::::

::::::{tab-item} Convenience

\*\*Convenience design\*\* – [camera locations](#camera\_location) or [sample stations](#sample\_station) are chosen based on logistic considerations (e.g., remoteness, access constraints, costs). When cost is a key consideration, other more rigorous sampling designs (e.g., stratified; {{ ref\_intext\_vanwilgenburg\_et\_al\_2020 }}) that can incorporate cost should be considered first. One should be cautious when generalizing or drawing conclusions from data collected using [convenience sampling](#sampledesign\_convenience), given that estimates can be biased if the sample poorly represents the population of interest. The [convenience sampling](#sampledesign\_convenience) design can be used where the goal is to [survey](#survey) a specific location(s) without the intent to generalize to un-surveyed areas ({{ ref\_intext\_gillespie\_et\_al\_2015 }}; e.g., Kusi et al., 2020) or to [survey](#survey) an area following a report of the occurrence of a rare species. Both [randomized](#sampledesign\_random) (e.g., {{ ref\_intext\_found\_patterson\_2020 }}) or [targeted](#sampledesign\_targeted) approaches can be used within a [convenience sampling](#sampledesign\_convenience) approach, although the user should still be cautious about extrapolating inferences to areas (or habitat types in an [occupancy framework](#mods\_occupancy) [{{ ref\_intext\_mackenzie\_et\_al\_2002 }}]) that were not sampled and, therefore, not represented in the data ({{ ref\_intext\_gillespie\_et\_al\_2015 }}).

::::::

:::::::



clarke\_et\_al\_2023\_fig10\_clipped.png

## In-depth

This section will be available soon! In the meantime, check out the information in the other tabs!

:::{figure} ../03\_images/03\_image\_files/00\_coming\_soon.png

:width: 300px

:align: center

:::

## Figures

|  |  |  |  |
| --- | --- | --- | --- |
| **Image** | **file\_name** | **Caption (if applicable)** | **ref\_id** |
|  | figure1\_filename.png | figure1\_caption | figure1\_ref\_id |
| clarke\_et\_al\_2023\_fig11\_clipped.png | figure2\_filename.png | figure2\_caption | figure2\_ref\_id |
|  | iannarilli\_et\_al\_2021\_fig1.png | figure3\_caption | figure3\_ref\_id |
|  | junker\_et\_al\_2021\_fig6\_2.png | figure4\_caption | figure4\_ref\_id |
|  | junker\_et\_al\_2021\_fig6\_4.png | figure5\_caption | figure5\_ref\_id |
|  | kemp\_et\_al\_2022\_pg12\_fig1.png | figure6\_caption | figure6\_ref\_id |
|  | kemp\_et\_al\_2022\_pg13\_fig1.png | figure7\_caption | figure7\_ref\_id |
|  | kemp\_et\_al\_2022\_pg13\_fig2.png | figure8\_caption | figure8\_ref\_id |
|  | kemp\_et\_al\_2022\_pg14\_fig1.png | figure9\_caption | figure9\_ref\_id |
|  | kemp\_et\_al\_2022\_pg14\_fig2.png | figure10\_caption | figure10\_ref\_id |
|  | kemp\_et\_al\_2022\_pg28\_fig1.png | figure11\_caption | figure11\_ref\_id |
|  | kemp\_et\_al\_2022\_pg29\_fig1.png | figure12\_caption | figure12\_ref\_id |
|  | kemp\_et\_al\_2022\_pg30\_fig1.png |  |  |
|  | kemp\_et\_al\_2022\_pg30\_fig2.png |  |  |
|  | mccomb\_et\_al\_2010\_fig6\_3.png |  |  |
|  | moeller\_et\_al\_2018\_fig2\_clipped.png |  |  |
|  |  |  |  |
|  | wearn\_gloverkapfer\_2017\_fig7\_2.png |  |  |
|  | whittington\_et\_al\_2018\_fig1\_clipped.png |  |  |
|  | whittington\_et\_al\_2018\_fig2\_clipped.png |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Video

|  |  |  |
| --- | --- | --- |
| **caption** | **URL (no < / > before/after URL** | **ref\_id** |
| vid1\_caption | vid1\_url | vid1\_ref\_id |
| vid2\_caption | vid2\_url | vid2\_ref\_id |
| vid3\_caption | vid3\_url | vid3\_ref\_id |
| vid4\_caption | vid4\_url | vid4\_ref\_id |
| vid5\_caption | vid5\_url | vid5\_ref\_id |
| vid6\_caption | vid6\_url | vid6\_ref\_id |
| vid7\_caption | vid7\_url | vid7\_ref\_id |
| vid8\_caption | vid8\_url | vid8\_ref\_id |
| vid9\_caption | vid9\_url | vid9\_ref\_id |
| vid10\_caption | vid10\_url | vid10\_ref\_id |
| vid11\_caption | vid11\_url | vid11\_ref\_id |
| vid12\_caption | vid12\_url | vid12\_ref\_id |
| vid13\_caption | vid13\_url | vid13\_ref\_id |
| vid14\_caption | vid14\_url | vid14\_ref\_id |
| vid15\_caption | vid15\_url | vid15\_ref\_id |
| vid16\_caption | vid16\_url | vid16\_ref\_id |
| vid17\_caption | vid17\_url | vid17\_ref\_id |
| vid18\_caption | vid18\_url | vid18\_ref\_id |

## Shiny

Shiny name = shiny\_name

Shiny caption = shiny\_caption

Shiny URL = shiny\_url

Shiny name = shiny\_name2

Shiny caption =shiny\_caption2

Shiny URL = shiny\_url2

## Analytical tools & Resources

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type** | **Name** | **Note** | **URL** | **ref\_id** |
| resource1\_type | resource1\_name | resource1\_note | resource1\_url | resource1\_ref\_id |
| resource2\_type | resource2\_name | resource2\_note | resource2\_url | resource2\_ref\_id |
| resource3\_type | resource3\_name | resource3\_note | resource3\_url | resource3\_ref\_id |
| resource4\_type | resource4\_name | resource4\_note | resource4\_url | resource4\_ref\_id |
| resource5\_type | resource5\_name | resource5\_note | resource5\_url | resource5\_ref\_id |
| resource6\_type | resource6\_name | resource6\_note | resource6\_url | resource6\_ref\_id |
| resource7\_type | resource7\_name | resource7\_note | resource7\_url | resource7\_ref\_id |
| resource8\_type | resource8\_name | resource8\_note | resource8\_url | resource8\_ref\_id |
| resource9\_type | resource9\_name | resource9\_note | resource9\_url | resource9\_ref\_id |
| resource10\_type | resource10\_name | resource10\_note | resource10\_url | resource10\_ref\_id |
| resource11\_type | resource11\_name | resource11\_note | resource11\_url | resource11\_ref\_id |
| resource12\_type | resource12\_name | resource12\_note | resource12\_url | resource12\_ref\_id |
| resource13\_type | resource13\_name | resource13\_note | resource13\_url | resource13\_ref\_id |
| resource14\_type | resource14\_name | resource14\_note | resource14\_url | resource14\_ref\_id |
| resource15\_type | resource15\_name | resource15\_note | resource15\_url | resource15\_ref\_id |
| resource16\_type | resource16\_name | resource16\_note | resource16\_url | resource16\_ref\_id |
| resource17\_type | resource17\_name | resource17\_note | resource17\_url | resource17\_ref\_id |
| resource18\_type | resource18\_name | resource18\_note | resource18\_url | resource18\_ref\_id |
| resource19\_type | resource19\_name | resource19\_note | resource19\_url | resource19\_ref\_id |
| resource20\_type | resource20\_name | resource20\_note | resource20\_url | resource20\_ref\_id |
| resource21\_type | resource21\_name | resource21\_note | resource21\_url | resource21\_ref\_id |
| resource22\_type | resource22\_name | resource22\_note | resource22\_url | resource22\_ref\_id |
| resource23\_type | resource23\_name | resource23\_note | resource23\_url | resource23\_ref\_id |
| resource24\_type | resource24\_name | resource24\_note | resource24\_url | resource24\_ref\_id |
| resource25\_type | resource25\_name | resource25\_note | resource25\_url | resource25\_ref\_id |

## References / Glossary

|  |  |
| --- | --- |
| **ref\_id** |  |
| Refs |  |

## Notes