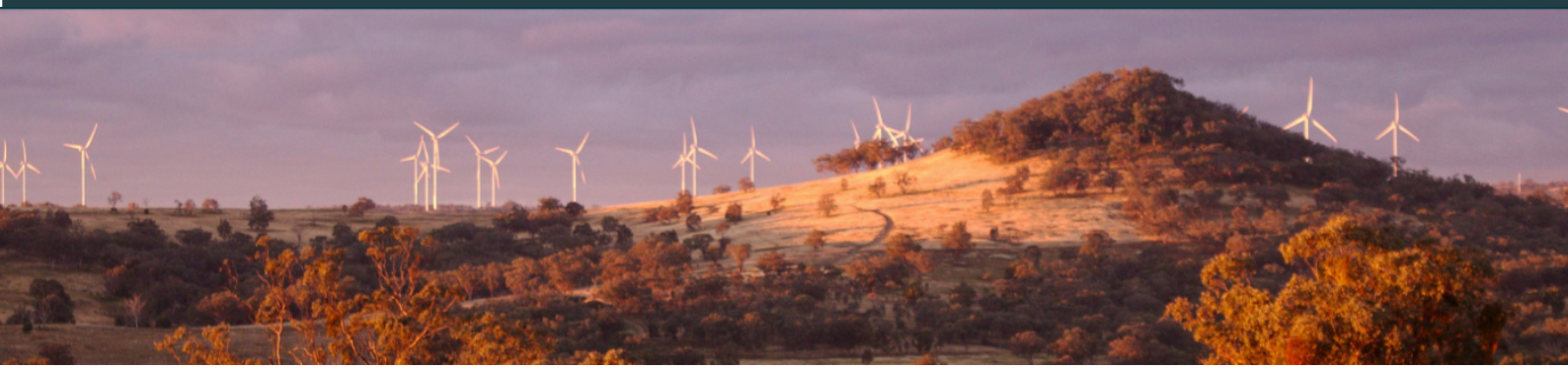
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Australian Collision Risk Framework

Collision Risk Model Tool User Guide

This guide provides step-by-step instructions for using the Australian Collision Risk Framework (ACRF) CRM tool, including data inputs, summary statistics, and interpretation of results. A Collision Risk Model is a quantitative model that uses numerical survey data to estimate the long-term average annual number of bird or bat collisions. CRMs work best when flight activity (flights per area per time) can be directly measured or reliably modelled and should ideally include uncertainty (confidence intervals).

Please note the data and examples shown in this guide are to illustrate the use of the online tool interface only and do not represent any recommendation about inputs or real-world scenarios.

Prerequisites

The ACRF CRM tool is a simplified version of the **collision** R package (Stark et al. 2026), which is one of the recommended open-source, stochastic CRM packages available for use. It is designed to support analysis during site data collection; however, several analysis tasks are required prior to use.

Note on data collection

The ACRF CRM tool assumes that field data have been collected on-site using point-count or line-transect methodology.

For CRM application, the minimum dataset includes:

- **Survey data** - date, duration in minutes, and location information for each point count or transect survey

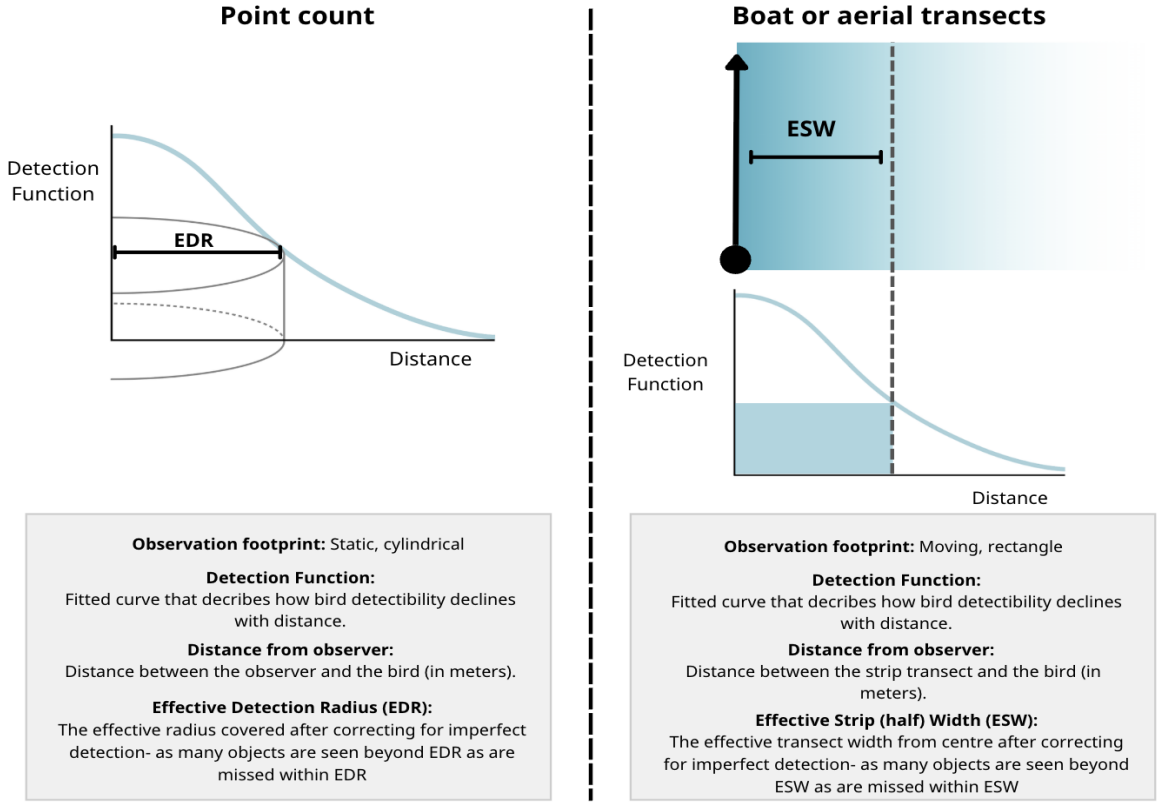
- **Observation data** - each observation must be linked to a survey and include, at minimum:
  - Species identification
  - Height at first detection. If using binned data, bins should be as fine as practicable and consistent with species-specific survey protocols.
  - Distance at first detection (observer distance for point counts or perpendicular distance for line transects). If distances are binned, bins should be kept as small as practicable and aligned with specifies-specific survey protocols.
    - Note on fixed transect surveys: Distance estimation is not applicable for fixed transect surveys (e.g. digital aerial surveys). For human-observer surveys, truncation should be avoided where possible to allow validation of the detection effectiveness along the transect.
  - Number of individuals in the observation (or flock size)
- **Turbine parameters** – turbine specifications (e.g. hub height, rotor diameter, and other fixed parameters) are required. Most turbine specifications are treated as fixed inputs, except for rotor speed (RPM), which can vary. In such cases, both the mean and standard deviation should be supplied by engineers (or calculated from supplied distributions). If variability is not available, RPM can be entered as a fixed value by setting the standard deviation to 0.

The accompanying document "*Australian Collision Risk Framework – CRM Methodology*" provides more details about these parameters.

Analysis to prepare inputs

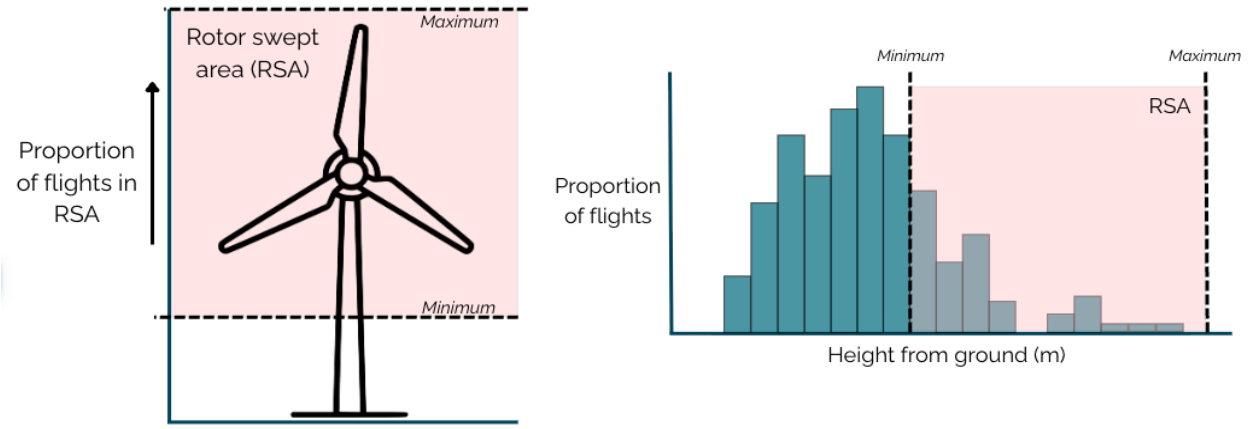
Before using the CRM online tool, the following inputs must be calculated:

1) **Encounter Rate (observed movements per minute):** Calculate the encounter rate as the number of at-risk bird movements per minute of active survey effort (i.e. individual movements below maximum rotor height recorded per minute) with associated standard error. The encounter rate is used to calculate a distance-corrected flight flux.
2) **Effective detection half width in meters:** Estimate the effective detection radius (EDR; point counts) or effective strip (half) width (ESW; line transects). This corrects for imperfect detection with increasing distance from the observer. This is typically done by fitting a detection function (Miller et al. 2019; Buckland et al. 2001) and estimating EDR/ESW with associated uncertainty (e.g. via bootstrap methods). Suitable implementations include the **Distance** R package (Miller et al. 2019) or equivalent statistical software, ideally in consultation with a statistician.



3) **Flight Height Analysis:** Fit a distribution to observed flight height data and use this to estimate the proportion of flights occurring within the rotor swept height (0-1), along with standard error. Observations should be truncated at turbine tip height to ensure that:

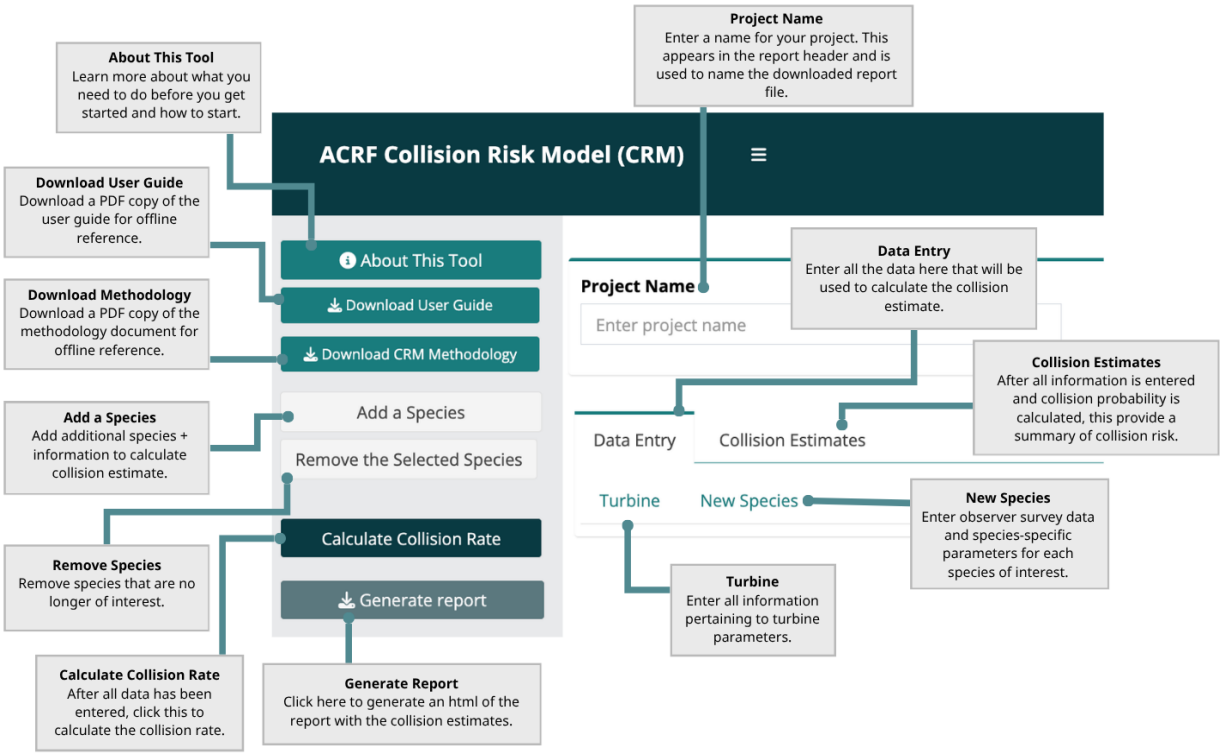
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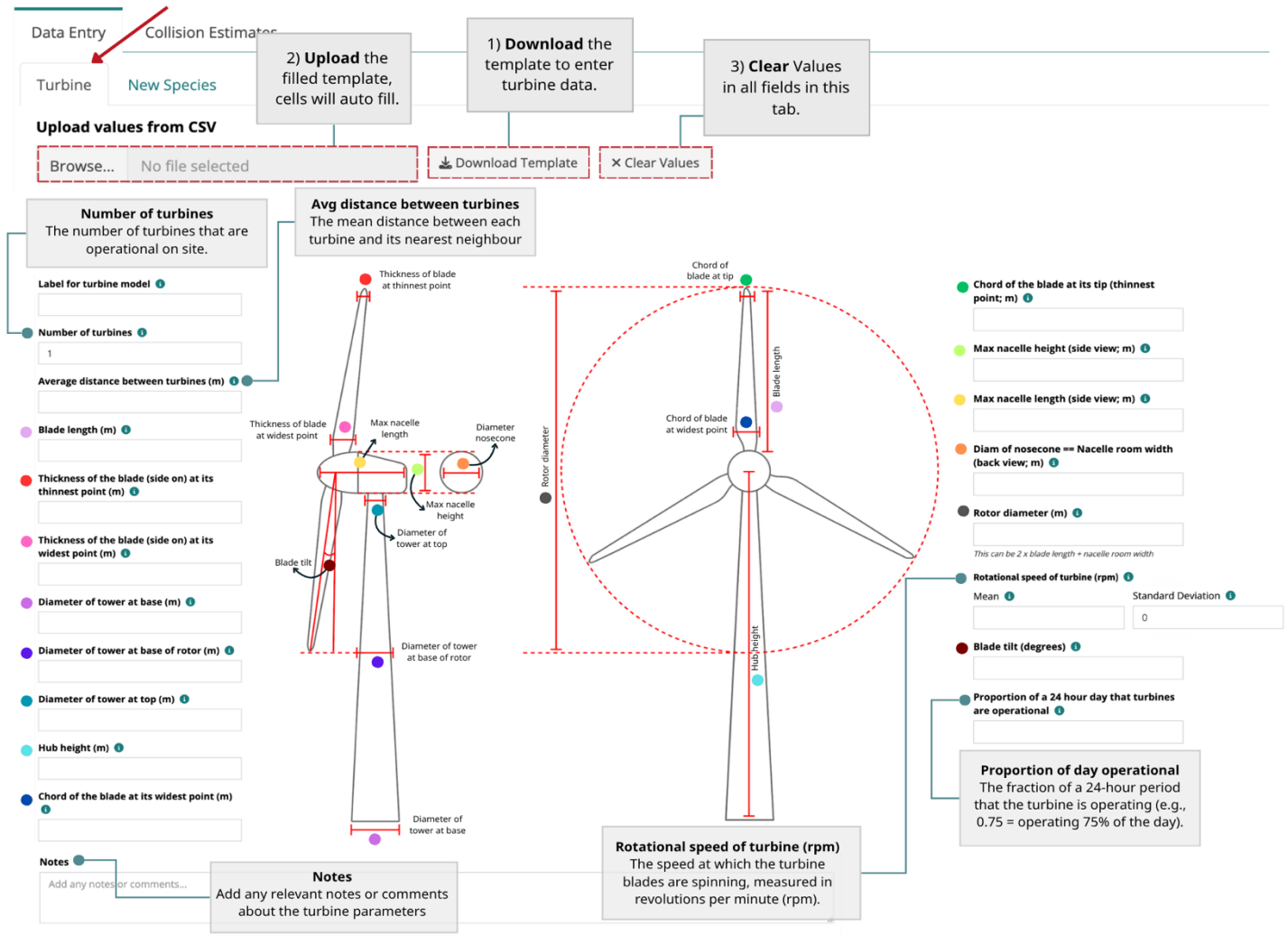


Steps to using the tool

Access the ACRF CRM tool from here.

- Fill in the Project Name field at the top of the app.
    - The data entry tab includes two areas of inputs required
    - Turbine specifications
- Species and Observer data - added by selecting "Add a Species" from the right and entering data on the "New Species" tab.
- If you add a species in error, it can be removed using the “Remove the Selected Species” button.
- Help is provided for each input. Hover over the ‘?’ icon to access information about each input.
- Input values are validated against accepted ranges. Fields that fall outside the expected range will be highlighted. Correct these before clicking “Calculate Collision Rate”.
- When all data is entered, click “Calculate Collision Rate” to run the model. Results can then be accessed and downloaded from the “Collision Estimates” tab.
- Once results are ready, click “Generate Report” to download an HTML report of all inputs and collision estimates.

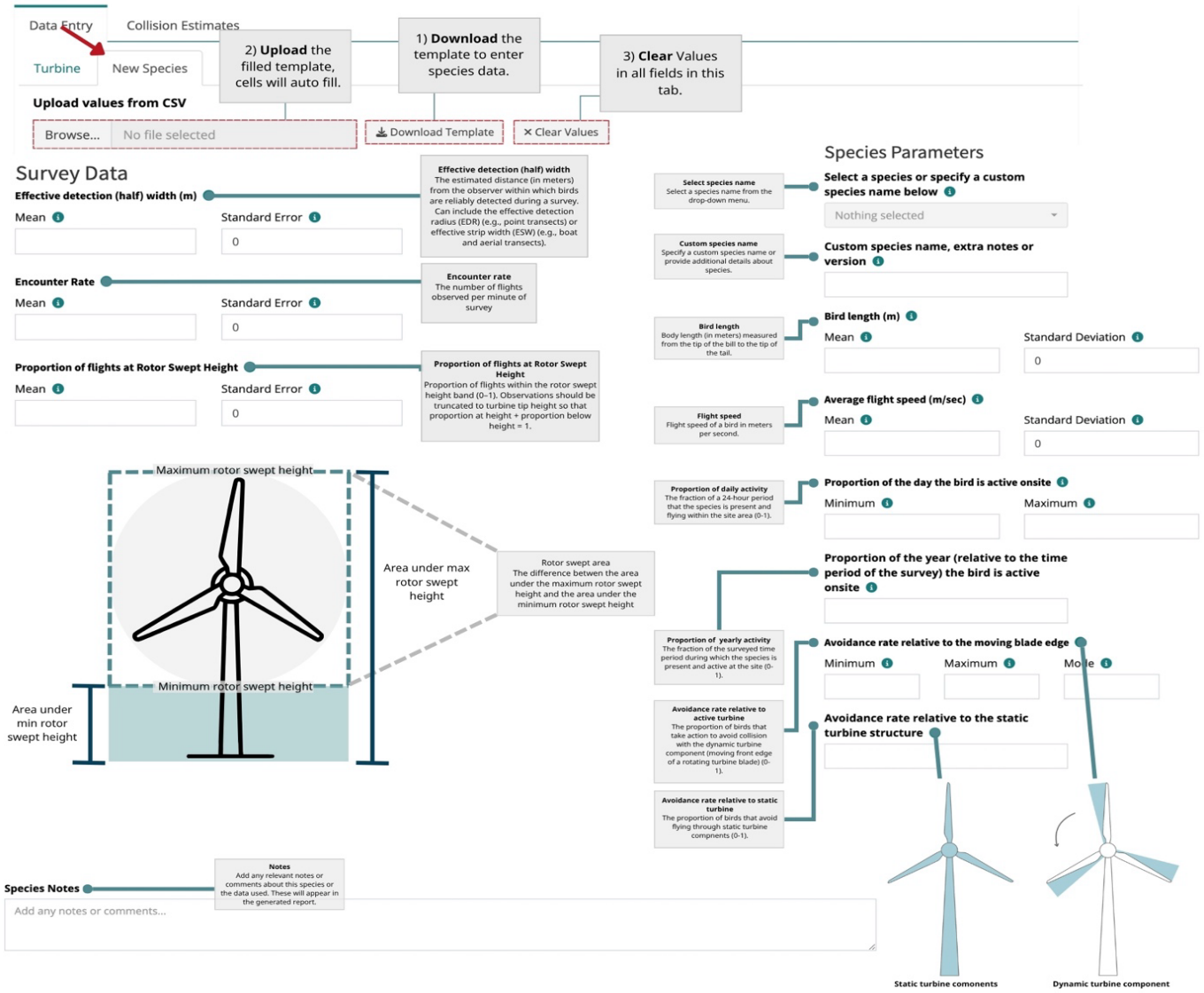




1. Turbine

Under the Data Entry tab select the Turbine tab. Download the template for turbines and fill in the information. Upload the template which will fill the cells. Alternatively, enter the data manually in the cells. By default, the application calculates the likelihood of collision for one turbine. Adjust “Number of Turbines” for whole wind farm estimates.

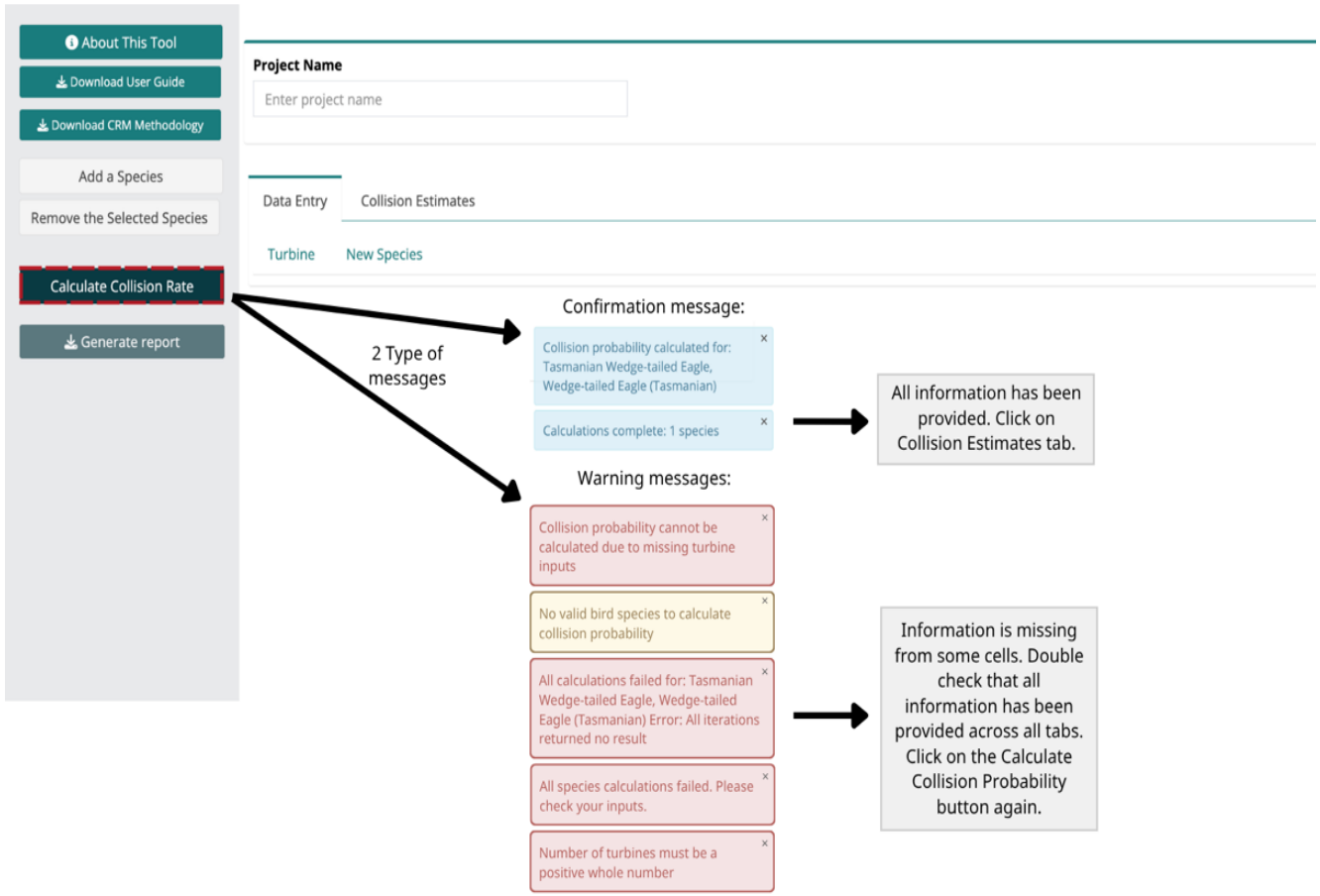
After uploading, a pop-up will confirm how many values were updated. If any expected columns were left empty or are missing from the template, they will be listed under "The following column(s) were not filled" - this is a warning only. If any required turbine fields are listed, check your template and re-upload or enter the values manually before proceeding.



2. New Species

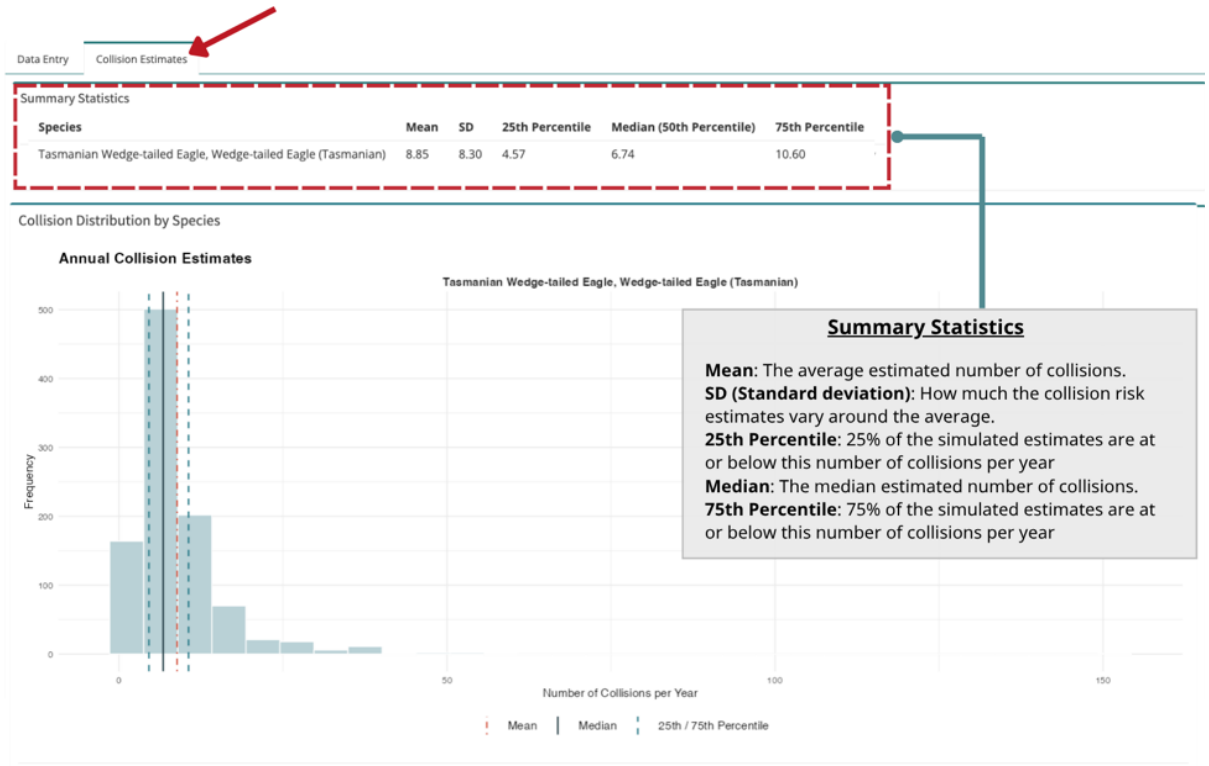
Click the New Species tab. This tab contains two sections – Observer survey Data and Species Parameters. Upload the template which will fill in the cells. Alternatively, enter the data manually in the cells. Only add data from a species that was observed at the site during surveys. To add a species, click “Add a Species” from the sidebar. A new tab will appear where you can enter data. Repeat for each additional species observed at the site.

After uploading, a pop-up will confirm how many values were updated. If any columns in the template were left empty or are missing from the template, they will be listed under “The following column(s) were not filled” - this is a warning only. Optional fields such as “sp_note” (custom species name/notes) can safely be left blank.



3. Calculate Annual Collision Rate

After all information is filled out in the Turbine and New Species tab(s), click the Calculate Collision Rate button. The app will automatically switch to the Collision Estimates tab once the model has finished running. If any species calculations fail, an error notification will appear identifying which species was affected. Check the input data for that species and re-run the model. If all species complete successfully, results will be displayed immediately in the Collision Estimates tab.



4. Review Collision Estimates

The Collision Estimates tab contains your summary statistics for collision estimates, including the mean, standard deviation, median, and inter-quartile range (IQR; as given by the range between the 25th and 75th percentiles). The collision distribution by species (blue histogram) is also provided.

It is important to note that this collision estimate is a product of its inputs and therefore is only as good as the input data.

5. Interpret results

The mean is interpreted as the long-term annual expected collision rate and is the appropriate statistic for cumulative and long-term projection. The median, and IQR percentiles can be thought of as representing the variability of the number of collisions. If there is low uncertainty in the inputs and low environmental variability the median and mean will be close, the standard deviation and IQR small. If there is high environmental variability (e.g. in migrating or flocking species) the IQR will be larger, indicating higher expected inter-annual variability. Over the long term we expect the average rate of annual collisions to approach the mean.

When reporting results, note that estimates represent unminimised collision risk unless curtailment has been factored into the rotational speed or operational hours inputs. In particular, the model does not apply curtailment as a standalone mitigation measure. Curtailment is only accounted for through the turbine rotational speed and the proportion of a day that turbines are operational. If these parameters do not reflect curtailment schedules, the resulting estimates should be treated as unminimised collision risk.

6. Generate report

After you've clicked Calculate Collision Rate, you can download an HTML of the report by clicking the Generate Report button. The report will provide all the inputs from each parameter and the estimated collision results. The report will be named using the project name (if entered) and the date and time it was generated.

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ACRF Collision Risk Model (CRM)

Test Project

1 Turbine Inputs

The following table summarises the turbine parameters used in the collision risk calculations.

Parameter	Value
Model ID	Example Turbine (Vestas V90)
Number of turbines	3
Average distance between turbines (m)	600
Blade length (m)	44
Blade thickness at narrowest point (m)	0.07
Blade thickness at widest point (m)	2.6
Tower diameter at base (m)	4.15
Tower diameter at base of rotor (m)	3.55
Tower diameter at top (m)	2.55
Hub height (m)	65
Max chord (m)	3.51
Min chord (m)	0.39
Max nacelle height (m)	4.05
Max nacelle length (m)	13.25
Nacelle room width (m)	3.6
Rotor diameter (m)	91.6
RPM mean	16.1
RPM standard deviation	2
Blade tilt (degrees)	6
Proportion operational (0-1)	0.98

2 Bird Inputs

The following sections summarise the observer survey and bird parameters entered for each species. Observer parameters (Effective Detection Width, Encounter Rate, Proportion at Rotor Swept Height) are sampled from normal distributions. Bird length and flight speed are sampled from normal distributions; proportion of day active is sampled from a uniform distribution; dynamic avoidance rate is sampled from a Beta PERT distribution. Proportion of year active onsite and static avoidance rate are used as fixed values.

Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)

Parameter	Value
Species	Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)
EDR - Mean (m)	512.47
EDR - Standard Error (m)	143.83
Encounter Rate - Mean	0.0362
Encounter Rate - Standard Error	0.00332
Proportion at Rotor Swept Height - Mean	0.95
Proportion at Rotor Swept Height - Standard Error	0.0155
Bird length - Mean (m)	0.945
Bird length - Standard Deviation (m)	0.2
Flight speed - Mean (m/s)	17
Flight speed - Standard Deviation (m/s)	3
Proportion of day active - Minimum	0.48
Proportion of day active - Maximum	0.52
Proportion of year active onsite	1
Dynamic avoidance rate - Minimum	0.88
Dynamic avoidance rate - Maximum	0.95
Dynamic avoidance rate - Mode	0.92
Static avoidance rate	0.9999

3 Collision Results

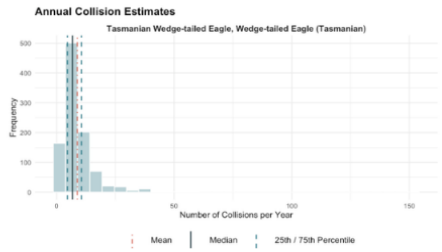
Disclaimer: The collision estimates presented in this report are model outputs and should be interpreted with caution. Results are sensitive to the quality and representativeness of the input data, and are intended to inform, not replace, expert ecological judgement.

3.1 Summary Statistics

The table below summarises the annual collision estimates across 1000 Monte Carlo iterations for 3 turbine(s). Results are shown as a total across all turbines.

Species	Mean	SD	25th Percentile	Median (50th Percentile)	75th Percentile
Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)	8.85	8.30	4.57	6.74	10.60

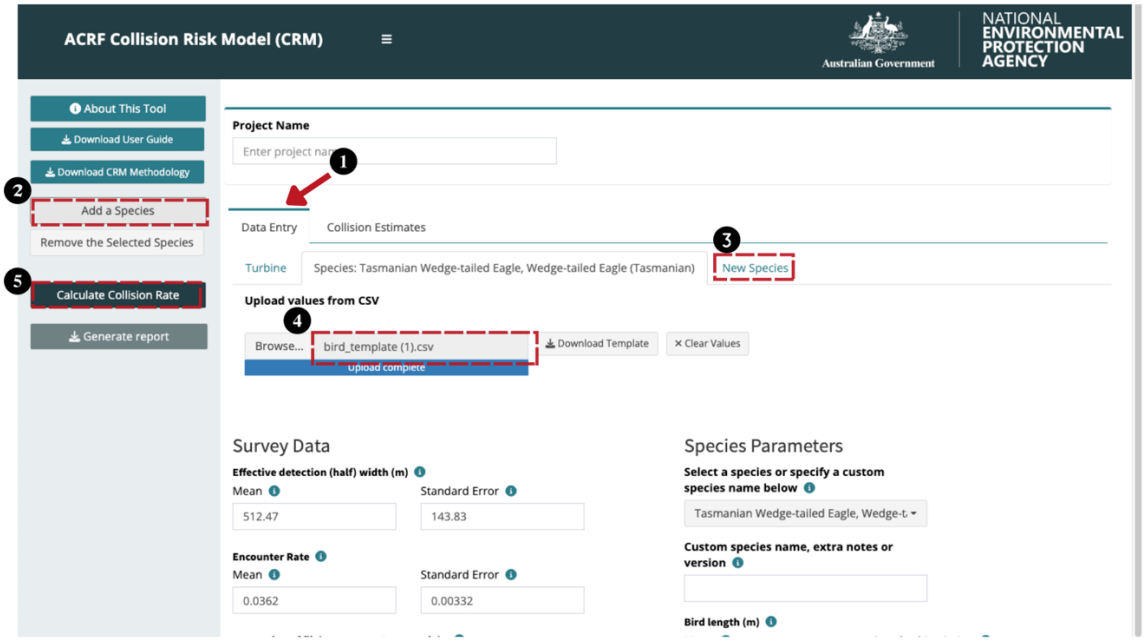
3.2 Collision Distribution



7. Adding / adjusting components and updating the report

Adding multiple species

You can add additional species at any time using the Add a Species button. Once data for new species is added, click on the Calculate Collision Rate button, which will update the Collision Estimates tab to include estimates for both species. Finally, click the Generate report button to generate an updated report. This will use the same set of observer inputs for both species. If you want to use species-specific observer inputs, you will need to use the collision R package directly or run the tool multiple times.

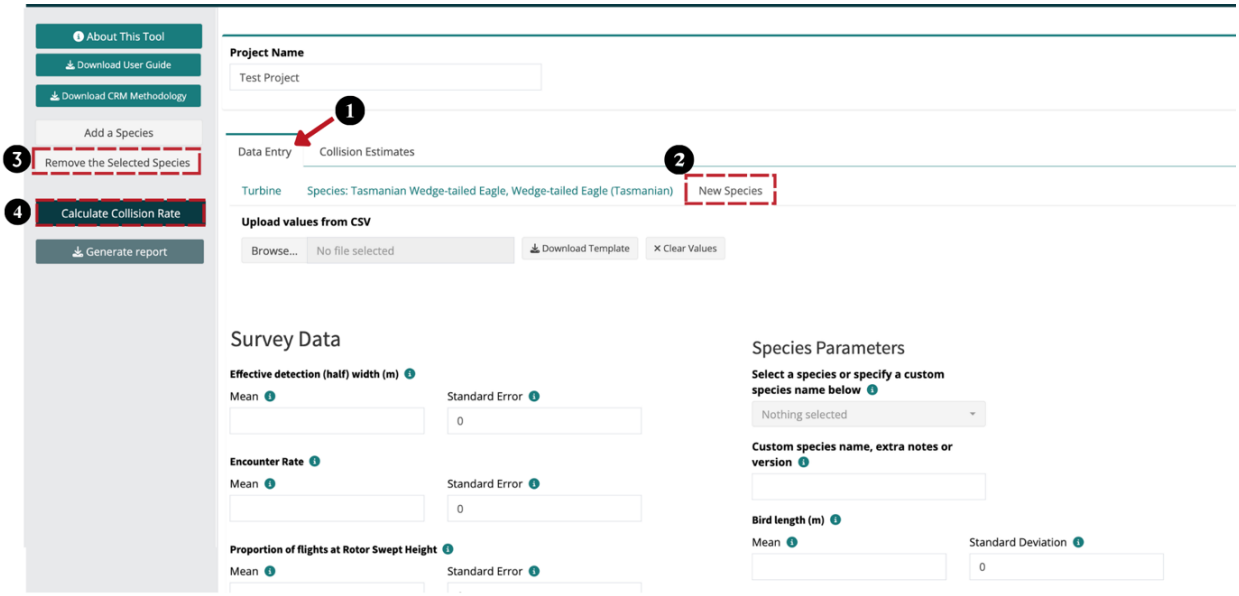


Adding different turbine specifications

You can add different turbine specifications to see how it changes the collision estimate. Navigate back to the Turbine tab. Adjust any of the turbine parameters and click the Calculate Collision Rate button. This will update the estimate in the Collision Estimate tab. Finally, click the Generate report button to generate an updated report.

Removing species

You can also delete species using the Remove the Selected Species button. Select the tab of the species you want to remove, click the Remove the Selected Species button, and click the Calculate Collision Rate to update the Collision Estimates tab. Finally, click the Generate report button to generate an updated report.



References

Buckland S, Anderson D, Burnham K, Laake J, Borchers D and Thomas L (2001) *Introduction to Distance* Sampling: Estimating Abundance of Biological Populations, Oxford University Press, doi:10.1093/oso/9780198506492.001.0001.

Miller DL, Rexstad E, Thomas L, Marshall L and Laake JL (2019) 'Distance Sampling in *R*', *Journal of Statistical Software*, 89(1), doi:10.18637/jss.v089.i01.

Stark E, Muir S and Yandell P (2026) 'collision: Per-turbine stochastic Collision Risk Model for predicting avian collision with on-shore and off-shore wind turbines'. R package version 1.1, Accessed 1 October 2026.

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