



## Australian Collision Risk Framework

# DRAFT Collision Risk Model (CRM) Tool User Guide

*This guide provides step-by-step instructions for using the 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 number of bird or bat collisions per year. CRM works best when flight activity (flights per area per time) can be measured or reliably modelled and should ideally include uncertainty (confidence intervals).*

## 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 CRM packages available for use. Although it is designed to enable self-assessment during site data collection there are a number of analysis tasks required prior to using the tool.

### Note on data collection

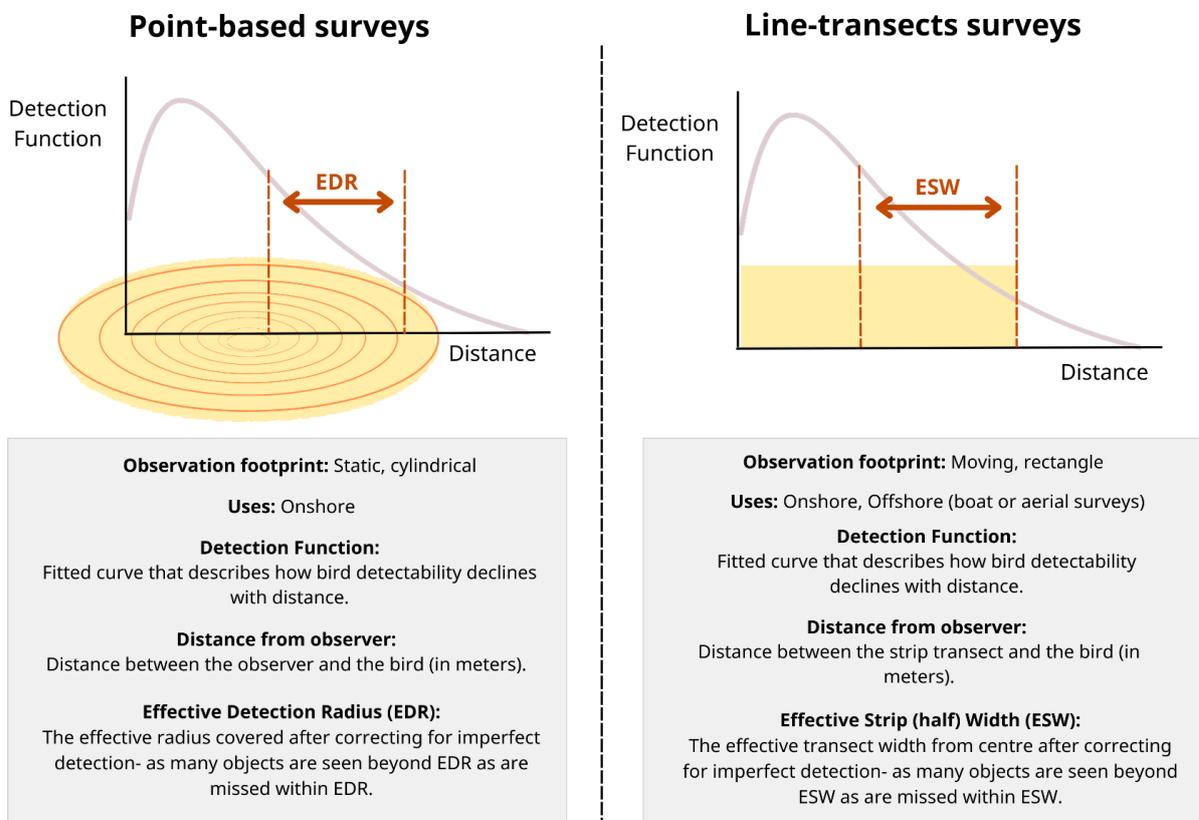
Note the CRM tool assumes specific data has been collected on-site using point-transect or line-transect methodology. There are a number of current projects under the [Renewables Environmental Research Initiative \(RERI\)](#) that will provide detailed advice on survey methods and data standards. For the purpose of CRM, the minimum data set includes;

- **Survey data** - date, duration in minutes, and location information for each point survey or transect count
- **Observation data** - each observation should be linked to a survey and include at minimum:
  - Species name
  - Height at first observation (Note: If using binned data, ensure height bins are as small as practicable and refer to species-specific protocol recommendations)
  - Distance from observer / right-angle distance from line transect of species (or flock) at first observation. (Note: We advise against truncating in the field. If distances are binned, bins should be kept as small as practicable and align with specific survey protocol recommendations)
  - Number of individuals in the observation
- **Flight path data** (optional) - if flight path data is to be collected it should be recorded from the start to the end of the flight observation. Note the ACRF CRM online tool does not account for spatial variation across sites, but we note this option for completeness.

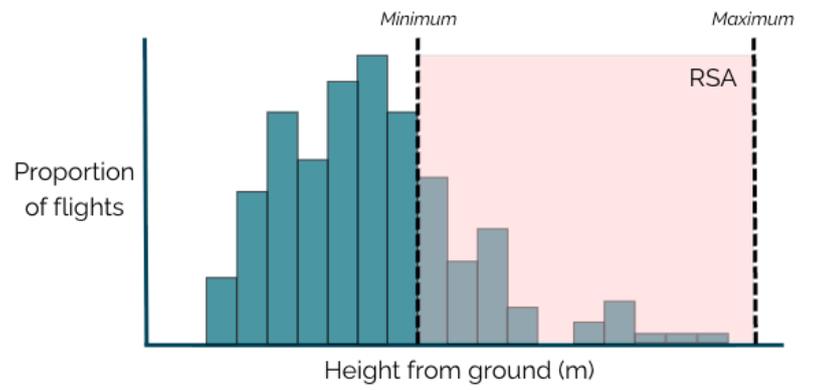
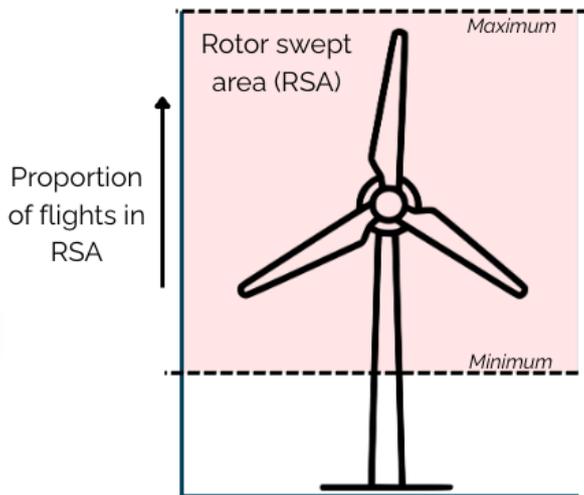
## Analysis to prepare inputs

Before using the CRM online tool, you must have completed the following analyses:

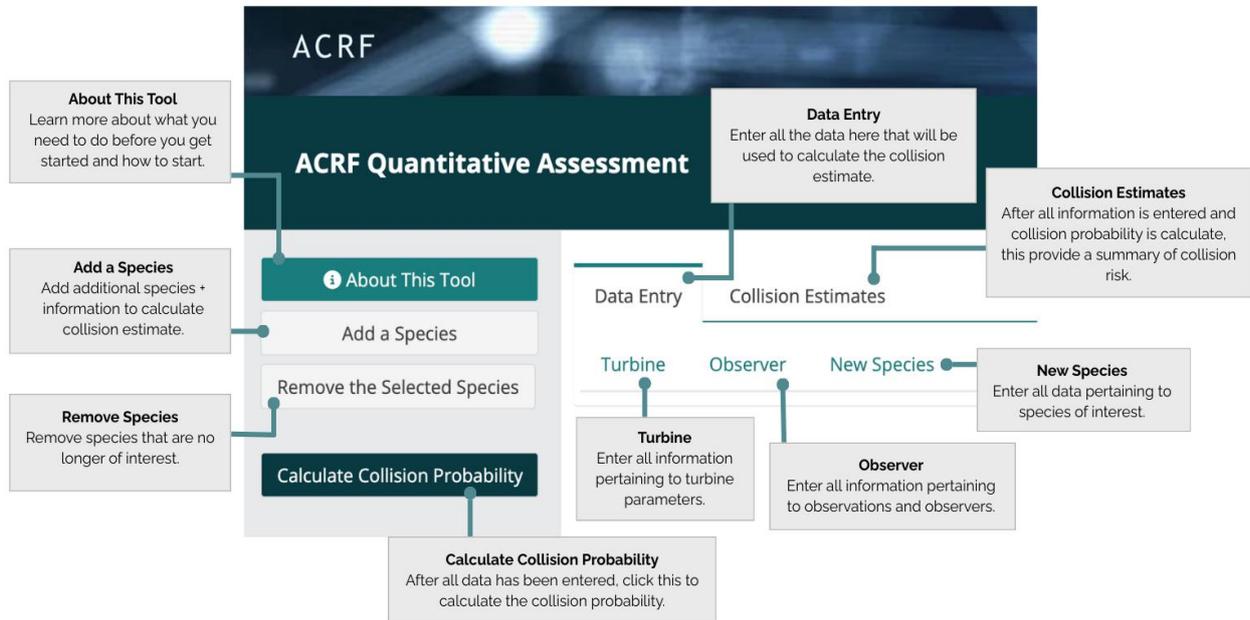
1. **Encounter Rate (observed movements per minute):** Calculated bird encounter rate per minute of active survey (individual movements recorded per min) with standard error. The encounter rate will be used to calculate a distance corrected flight flux.
2. **Distance Sampling Analysis (effective detection width in metres):** The CRM tool requires an estimate of the effective detection radius/area. This requires analysis to correct for imperfect detection as the distance from the observer increases. The standard approach to generate this value is by fitting a detection function (Miller et. al. 2019; Buckland et. al. 2001) to calculate Effective Detection Radius (EDR - for onshore point-based surveys) or Effect Strip Width (ESW - for transect surveys from boats or planes) with standard error using bootstrap methods. (e.g. {Distance} R package (Miller et. al. 2019) or consult a statistician)



3. **Flight Height Analysis:** Fit a distribution to the flight height survey observations and use this to extract
- Mean flight height in metres with standard error from survey observations.
  - Proportion of flights (from 0 to 1) below and within rotor swept with standard error.



## Steps to using the tool



Access the CRM tool from [here](#).

The data entry tab includes three areas of inputs required

- Turbine specifications
- Observer collected data, including the encounter rate, effective distances and height data
- Species are added by selecting “Add a species” from the right and entering species 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. Click on the ‘?’ icon to access information about each input
- When all data is entered the “Calculate Collision Probability” runs the model and the results can be accessed and downloaded from the “Collision Estimates” tab.

# 1. Turbines

Under the Data Entry tab select 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.

Data Entry | Collision Estimates

Turbine | Observer | New Species

Upload values from CSV

Browse... No file selected

Download Template

2) Upload the filled template, cells will auto fill.

1) Download the template to enter turbine data.

**Label for turbine model**

**Number of turbines**

**Blade length (m)**

**Thickness of the blade (side on) at its thinnest point (m)**

**Thickness of the blade (side on) at its widest point (m)**

**Diameter of tower at base (m)**

**Diameter of tower at base of rotor (m)**

**Diameter of tower at top (m)**

**Hub height (m)**

**Chord of the blade at its widest point (m)**

**Chord of the blade at its tip (thinnest point) (m)**

**Max nacelle height (side view) (m)**

**Max nacelle length (side view) (m)**

**Diam of nosecone == Nacelle room width (back view) (m)**

This can be 2 x blade length + nacelle room width

**Rotor diameter (m)**

**Rotational speed of turbine (rpm)**

**Blade tilt in degrees**

**Proportion of a 24 hour day that turbines are operational**

**Number of turbines**

The number of turbines that are operational on site.

**Rotational speed of turbine (rpm)**

The speed at which the turbine blades are spinning, measured in revolutions per minute (rpm).

**Blade tilt in degrees**

The angle of the turbine blades relative to their standard position, measured in degrees.

**Proportion of day operational**

The fraction of a 24-hour period that the turbine is operating (e.g., 0.75 = operating 75% of the day).

## 2. Observations

Click the Observer tab. Download the template for observations and fill in the information. Upload the template which will fill-in the cells. Alternatively, enter the data manually in the cells.

The screenshot shows the 'Observer' tab in the 'Data Entry' section. A red arrow points to the 'Observer' tab. Two callout boxes provide instructions: '1) Download the template to enter observer data' and '2) Upload the filled template, cells will auto fill'. The 'Upload values from CSV' section includes a 'Browse...' button (highlighted with a red dashed box) and a 'Download Template' button. Below this are input fields for 'Effective detection (half) width' (Mean and Standard Error) and 'Flight Height' (Mean and Standard Error). Callout boxes define these terms: 'Effective detection (half) width' is the estimated distance from the observer within which birds are reliably detected; 'Flight height' is the vertical height in meters. To the right, there are three 'Proportion of flights below...' fields (Mean and Standard Error) for 'minimum rotor swept height', 'Rotor Swept Height', and 'Maximum Rotor Swept Height'. Callout boxes define these: 'Encounter rate' is flights per unit of survey effort; 'Proportion of flights below minimum rotor swept height' is the fraction of flights below the minimum height; 'Proportion of flights below Rotor Swept Height' is the fraction below the rotor height; 'Proportion of flights below Maximum Rotor Swept Height' is the fraction below the maximum height. At the bottom, a diagram of a wind turbine shows the 'Area under min rotor swept height' (shaded blue), the 'Area under max rotor swept height' (dashed blue outline), and the 'Rotor swept area' (the difference between the two).

### 3. Species

Click the New Species tab. Download the template for species and fill in the information. Upload the template which will fill-in the cells. Alternatively, enter the data manually in the cells.

The screenshot shows the 'New Species' form with several annotated fields:

- Navigation:** 'Data Entry' and 'Collision Estimates' are at the top. 'Turbine' and 'Observer' are active tabs. 'New Species' is the selected tab.
- Upload values from CSV:** A 'Browse...' button is highlighted with a red dashed box. A 'Download Template' button is also visible.
- Select species name:** A dropdown menu is currently set to 'Nothing selected'. An annotation explains: 'Select species name: Select a species name from the drop-down menu.'
- Custom species name, extra notes or version:** An empty text input field. An annotation explains: 'Custom species name: Specify a custom species name or provide additional details about species.'
- Bird length (m):** A 'Mean' input field. An annotation explains: 'Bird length: Body length (in meters) measured from the tip of the bill to the tip of the tail.'
- Average flight speed (m/sec):** A 'Mean' input field. An annotation explains: 'Flight speed: Flight speed of a bird in meters per second.'
- Proportion of daily activity:** A range selector with 'Minimum' and 'Maximum' buttons. An annotation explains: 'Proportion of daily activity: The fraction of a 24-hour period that the species is present and flying within the site area (0-1).'
- Proportion of the year (relative to the time period of the survey) the bird is active onsite:** A range selector with 'Minimum' and 'Maximum' buttons. An annotation explains: 'Proportion of yearly activity: The fraction of the surveyed time period during which the species is present and active at the site (0-1).'
- Avoidance rate relative to the leading edge of the blade:** A range selector with 'Minimum', 'Maximum', and 'Mean' buttons. An annotation explains: 'Avoidance rate relative to active turbine: The proportion of birds that take action to avoid collision with the moving front edge of a rotating turbine blade (0-1).'
- Avoidance rate relative to a static turbine:** An empty input field. An annotation explains: 'Avoidance rate relative to static turbine: The proportion of birds that avoid flying through the rotor area, even if the turbine blades are not moving (0-1).'

Additional annotations include: '2) Upload the filled template, cells will auto fill.' and '1) Download the template to enter species data.'

## 4. Calculate Collision Probability

After all information is filled out in the Turbine, Observer, and New Species tabs, click the Calculate Collision Probability button. Once that has finished running, click on the Collision Estimates tab. You will get one of two messages: Confirmation or Warning. Depending on which one you get you either need to re-check the data provided or proceed to the Collision Estimates tab.

The screenshot shows the 'ACRF Quantitative Assessment' interface. On the left sidebar, the 'Calculate Collision Probability' button is highlighted with a red dashed box. An arrow points from this button to a 'Confirmation message' box. Another arrow points from the same button to a 'Warning messages' box. The 'Confirmation message' box contains two items: 'Collision probability calculated for: Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)' and 'Calculations complete: 1 species'. An arrow points from this box to a text box stating 'All information has been provided. Click on Collision Estimates tab.' The 'Warning messages' box contains three items: 'Collision probability cannot be calculated due to missing bird inputs for: Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)', 'No valid bird species to calculate collision probability', and 'Collision probability cannot be calculated due to missing turbine inputs'. An arrow points from this box to a text box stating 'Information is missing from some cells. Double check that all information has been provided across all tabs. Click on the Calculate Collision Probability button again.'

ACRF Quantitative Assessment

Australian Government  
Department of Climate Change  
the Environment and Water

About This Tool

Add a Species

Remove the Selected Species

Calculate Collision Probability

Generate report

Data Entry Collision Estimates

Turbine Observer Species: Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) Template Data (Wedge-tailed Eagle)

Confirmation message:

- Collision probability calculated for: Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)
- Calculations complete: 1 species

All information has been provided. Click on Collision Estimates tab.

Warning messages:

- Collision probability cannot be calculated due to missing bird inputs for: Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian)
- No valid bird species to calculate collision probability
- Collision probability cannot be calculated due to missing turbine inputs
- Collision probability cannot be calculated due to missing observer inputs

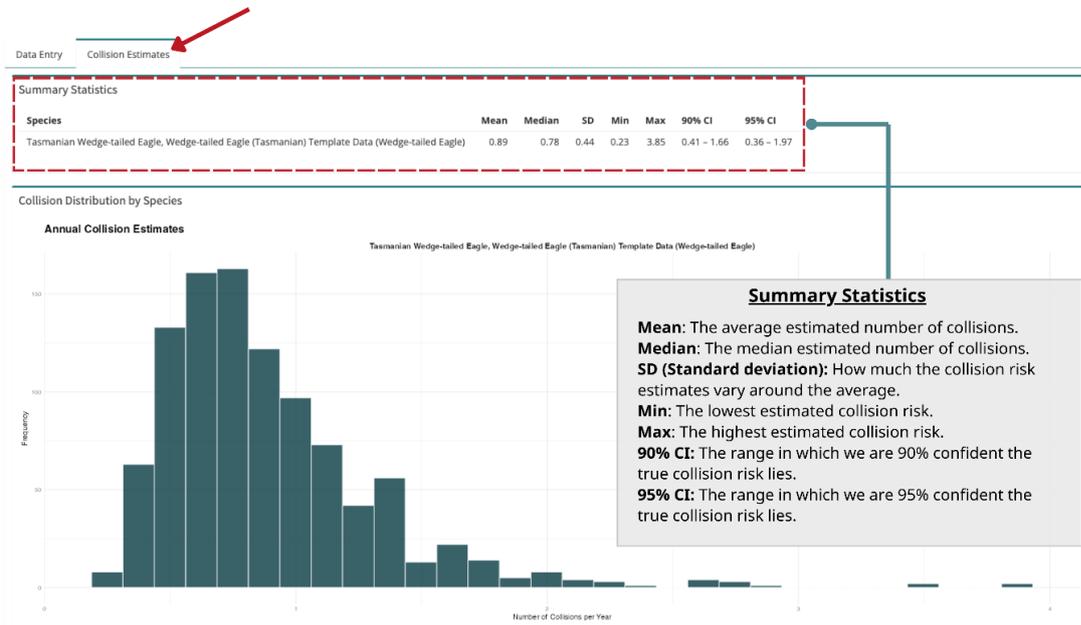
Information is missing from some cells. Double check that all information has been provided across all tabs. Click on the Calculate Collision Probability button again.

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## 5. Review Collision Estimates

The Collision Estimates tab contains your summary statistics for collision risk, including your mean and median annual collision estimates per turbine as well as a collision distribution by species (blue histogram).



## 6. Interpret Results

For the results above, we could say that turbine model X has a median estimated risk of 0.78 Wedge-tailed Eagles collisions per annum [0.36, 1.97] 95% confidence interval per turbine. These results were estimated for a single turbine. Note these numbers are entirely fictional and for the purpose of demonstrating the application only.

## 7. Generate report

After you've clicked Calculate Collision Probability, 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.

## ACRF Quantitative Risk Assessment

### 1 Turbine Inputs

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

| Parameter                              | Value                       |
|--|-----------------------------|
| Model ID                               | Example Turbine (Vesta V90) |
| Number of turbines                     | 1                           |
| 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                        |

### 3 Bird Inputs

The following sections summarise the bird parameters entered for each species. 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) Template Data (Wedge-tailed Eagle)

| Parameter                               | Value   |
|---|---|
| Species                                 | Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) Template Data (Wedge-tailed Eagle) |
| 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 - Mean           | 0.92  |
| Static avoidance rate                   | 0.9999  |

### 2 Survey Inputs

The following table summarises the survey-derived observer parameters. Stochastic inputs (Effective Detection Width, Mean Flight Height, Encounter Rate, and Height Distributions) are sampled from a normal distribution using the specified mean and standard error across Monte Carlo iterations.

| Parameter  | Value   |
|--|---------|
| Effective Detection (Half) Width - Mean (m)                  | 512.47  |
| Effective Detection (Half) Width - Standard Error (m)        | 143.83  |
| Mean Flight Height - Mean (m)                                | 240.575 |
| Mean Flight Height - Standard Error (m)                      | 14.54   |
| Encounter Rate - Mean  | 0.0362  |
| Encounter Rate - Standard Error                              | 0.00332 |
| Proportion below Rotor Swept Height - Mean                   | 0.0333  |
| Proportion below Rotor Swept Height - Standard Error         | 0.0155  |
| Proportion below Maximum Rotor Swept Height - Mean           | 0.2333  |
| Proportion below Maximum Rotor Swept Height - Standard Error | 0.0374  |

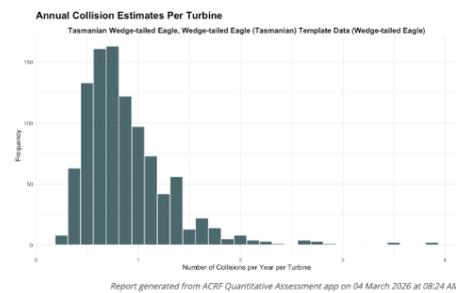
### 4 Collision Results

#### 4.1 Summary Statistics

The table below summarises the annual collision estimates across 1000 Monte Carlo iterations for 1 turbine(s). Results are shown as a total across all turbines.

| Species   | Mean | Median | SD   | Min  | Max  | 90% CI      | 95% CI      |
|---|------|--------|------|------|------|-------------|-------------|
| Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) Template Data (Wedge-tailed Eagle) | 0.89 | 0.78   | 0.44 | 0.23 | 3.85 | 0.41 - 1.66 | 0.36 - 1.97 |

#### 4.2 Collision Distribution





## 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 Probability 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 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 Probability to update the Collision Estimates tab. Finally, click the Generate report button to generate an updated report.

ACRF Quantitative Assessment

Australian Government  
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About This Tool

Add a Species

Remove the Selected Species

Calculate Collision Probability

Generate report

Data Entry Collision Estimates

Turbine Observer Species: Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) Template Data (Wedge-tailed Eagle) New Species

Upload values from CSV

Browse... No file selected Download Template

Select a species or specify a custom species name below

Nothing selected

Custom species name, extra notes or version

Bird length (m)

Mean Standard Deviation

Average flight speed (m/sec)

Mean Standard Deviation

Proportion of the day the bird is active onsite

Minimum Maximum

Proportion of the year (relative to the time period of the survey) the bird is active onsite

Avoidance rate relative to the leading edge of the blade

Minimum Maximum Mean

Avoidance rate relative to a static turbine

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## References

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. 2001. *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press, Oxford, UK.

Miller, D. L., Rexstad, E., Thomas, L., Marshall, L., & Laake, J. L. (2019). Distance Sampling in R. *Journal of Statistical Software*, 89(1), 1–28. DOI: 10.18637/jss.v089.i01

Stark, Elizabeth, Muir, Stuart, Yandell, Peggy (2026). *collision: Per-turbine stochastic Collision Risk Model for predicting avian collision with onshore and offshore wind turbines*. R package version 1.0.4, <<https://github.com/SymbolixAU/collision>>.

**Citation**

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