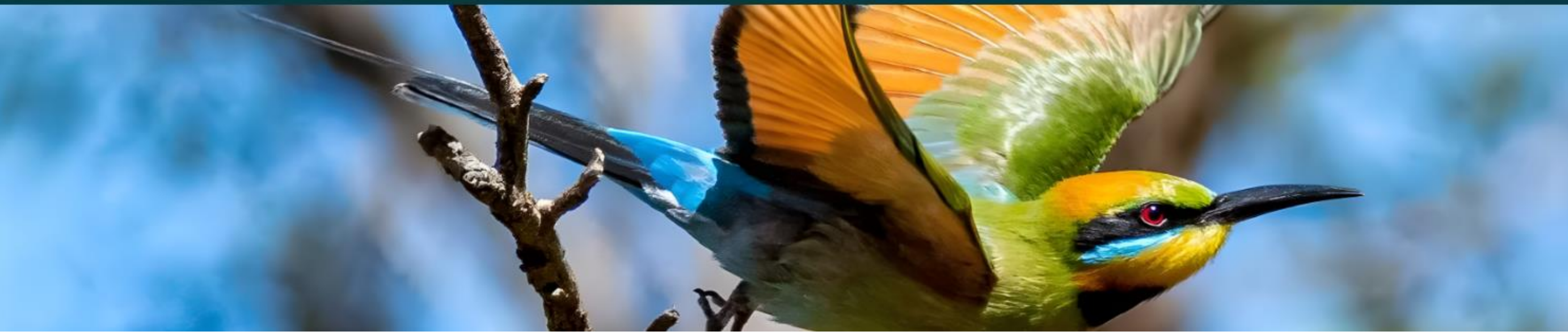
Australian Government

Department of Climate Change, Energy, the Environment and Water



Australian Collision Risk Framework

DRAFT Collision Likelihood Score

In many circumstances, where data are lacking even after sufficient survey effort, a quantitative collision risk modelling approach is not feasible. This is not to say that no or a low number of observations indicates a negligible likelihood of collision, rather, it is more difficult to assess collision risk. In such cases and after an appropriate risk assessment pathway has been selected, a qualitative risk likelihood assessment should be used. Here, we outline the ACRF Collision Likelihood Score (CLS) which has been designed to offer a consistent approach to assessing collision risk likelihood. The method expands recent regional-level models (BirdLife International 2025) but is explicitly aimed toward project site-level assessment. As such it incorporates inputs drawn from on-ground survey effort, species functional traits and site-level habitat assessments.

We present the theoretical foundations and structure, and present three case studies covering terrestrial and marine birds, and echolocating bats. The calculation can be applied to other species through the related application. While this assessment was designed for listed, migratory and marine overfly species under the EBPC Act, it is complementary to the wide range of bird and bat species found within and surrounding Australia.

Process of development

Context and motivation

This tool has been specifically developed as part of the Australian Government funded Australian Collision Risk Framework (ACRF). Compiling a review of related research (Stark and Thompson 2026) highlighted a substantial gap in existing methods to assess collision likelihood in a systematic, qualitative way.

Regardless of survey effort, there is often the inability to obtain a precise quantitative estimate of the number of expected turbine collisions each year. Such lack of data can be attributed to a species being:

- absent on site temporarily (e.g. migratory or nomadic species)
- cryptic (e.g. white-throated needletail *Hirundapus caudacutus*)
- nocturnal where standard observation would not directly feed into a quantitative collision risk model (e.g. owl species).

The absence of a consistent approach has led to variation in how bird and bat collision risk at wind farms is assessed. As a result, different projects may apply different methods, which can reduce the efficiency of assessments and create challenges in developing cumulative impact models.

There has recently been a number of high quality, comprehensive regional level studies that incorporate multi-criteria assessments of a range of collision risk drivers (e.g. Reid, Baker & Woehler (2025)), but these are not strictly applicable to site-level assessment.

To address this gap the authors propose a standard methodology for site-level risk assessment. Where possible, a quantitative Collision Risk Model (CRM) is advised to provide maximum precision, but this tool fills a gap when that is not feasible.

Literature review

To formulate the CLS, we researched the current use of qualitative assessments at Australian wind farms. Qualitative assessments were mainly found within Bird and Bat Management Plans (BBMPs) and included two main methods to determine collision risk likelihood:

- A formal qualitative assessment using a risk matrix (a visual tool that assigns risk based on different combinations of likelihood and consequence criteria) as an output or, in rare cases, a scoring system
- General qualitative discussion

As a whole, we found a lack of consistency in terms of both structure and terminology when assessing collision risk likelihood. While most used a typical risk matrix, the method to establish the likelihood of risk is based on varying numbers of components combined with differing degrees of confidence (e.g. site-collected data, expert opinion, scientific and grey literature). Components included in such assessments included:

- Habitat suitability
    - Either on site and/or within vicinity of wind farm site
    - References to food sources and keystone structure e.g. wetlands, nesting locations
- Flight behaviour
- Foraging behaviour
    - Known and likely flight height profiles in relation to rotor swept area
- Activity
    - Presence, number of observations, number of individuals, number of calls, occurrence within a specific distance of the wind farm site
- Home range
- Site context
    - Details on the section of the wind farm and/or landform (e.g. valley) where observations were made
- Body size and manoeuvrability
- Social behaviour
- Migration status

In addition to scanning existing site-specific qualitative assessments, we reviewed published risk assessment frameworks that contained, to differing degrees, wind farm collision risk. These assessments were targeted at terrestrial birds, seabirds and bats. Both Australian and international frameworks were reviewed.

AviStep

AviStep is a mapping tool used for energy planning based on bird sensitivity to factors such as habitat destruction, collision and displacement. The tool was developed by BirdLife International and relevant parties to be used in the development phase for strategic planning of sites and preliminary site evaluations (BirdLife International 2025). AviStep has been developed across multiple countries with some localised differences, including for offshore and onshore wind farms developments in Australia. The tool is underpinned by combining bird sensitivity scores with species distribution maps.

The collision likelihood aspect of AviStep's equation which is informed by a trait-based approach and is specified by the following components:

- **Flight behaviour:** based on the time spent within the rotor sweep zone
- **Foraging behaviour:** related to visual perception and eye positioning
- **Manoeuvrability:** based on a proxy derived from weight/wing length
- **Nocturnal Activity:** amount of time a species is spent active during the night

There are also additional components that can be added if relevant to the species:

- Very high flight speeds
- Flock-oriented flight patterns
- Frequently recorded victims of collision
- Species where energy infrastructure is considered a threat based on National Recovery Plans

Given offshore and onshore wind farms are assessed separately within AviStep, the equations do differ in the number and type of components. Each of the components within each of the respective equations are assigned as primary, aggravating or additional components which relate to how scores are derived (i.e. how each component is weighted using additive or multiplicative structures).

Impacts on birds and bats from onshore and offshore wind farms in Australia

Ross Analytics Pty Ltd and Latitude 42 Environmental Consultants Pty Ltd on behalf of the Department of Climate Change, Energy, the Environment and Water, designed an ecological risk assessment designed to assess the susceptibility of species to collision, displacement and barrier effects across both in onshore and offshore environments in Australia (Reid, Baker & Woehler 2025; Reid & Baker 2025). The assessment was developed using relative risk rankings of both birds and bats derived from literature review and expert elicitation to establish the negative interactions species are exposed to.

The resulting equation was additive, where higher weightings were added to components that were deemed to drive risk more heavily. The components of the equation which relate to collision risk likelihood include:

- **Flight height:** the time spent within the rotor sweep zone
- **Flight manoeuvrability/morphology:** based on a proxy derived from weight/wing length
- **Flight time (birds only):** proportion of year bird spends flying

- **Habitat specialisation:** the ability of a species to switch to an alternative feeding habitat as a result of disturbance or displacement was also included but not directly related to collision.

Developing a science-based approach to defining key species of birds and bats of concern for wind farm developments in Victoria

The Arthur Rylah Institute developed a science-based approach to assist decision makers with assessing turbine collision risk for birds and bat species across Victoria (Lumsden, Moloney, and Smales 2019). The approach was largely underpinned by expert elicitation where species experts assigned risk scores for a respective component for a target species. Individual expert assessments were then combined to produce a probability distribution for each component.

The collision risk likelihood aspect of the process was specified by the following components centred across a choice of three categories within (Low, Medium, High):

- **Frequency of flights within rotor swept area**
- **Habitat preference within general environments of wind farm site**

Acoustic analysis and bat call identification from Tathra, Western Australia

Specialised Zoological integrated a 12-point likelihood risk matrix for bat species for a proposed wind farm in Western Australia (Specialised Zoological 2025). The risk matrix considered two factors:

- **Flight height:** derived from field observations and general knowledge
- **Activity**: calculated from the frequency of detections across site-based surveys

Based on the risk matrix, three collision risk groupings were derived: Low, Medium and High.

Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index

Garthe and Hüppop (2004) developed a wind farm sensitivity index for seabirds in Germany.
A mix of empirical data and expert elicitation was used to score nine factors; each being scored on a 5-point scale. Factors of flight behaviour and general behaviour relating specifically to collision likelihood include:

- **Flight manoeuvrability**
- **Flight height**
- **Flight time**
- **Nocturnal flight activity**
- **Sensitivity towards disturbance by ship and helicopter traffic**
- **Flexibility in habitat use**

Based on flight behaviour, general behaviour and species status, an average for each group was taken and subsequently multiplied to give a sensitivity score.

The relative vulnerability of migratory bird species to offshore wind energy projects on the Atlantic Outer Continental Shelf: an assessment method and database

Robinson et al. (2013) developed collision sensitivity and population sensitivity rankings to identify bird populations of concern at offshore wind farms in the Atlantic Outer Continental Shelf. Six factors contributed to their collision sensitivity equation including:

- **Annual occurrence**
- **Nocturnal flight**
- **Diurnal flight**
- **Percent time in rotor-swept area**
- **Macro-avoidance**
- **Breeding and feeding time**

The equation was mostly multiplicative, whereby the additive combination of flight activity was divided by the percent time in RSA, and subsequently multiplied by annual occurrence, macro-avoidance and breeding and feeding time. Most of the factors were scored on a 5-point scale except for breeding and feeding time and percent time in rotor-swept area, which were scored on a 3-point scale. This method also included a level of uncertainty for four factors based on the level of variation in data from the literature.

Collision and displacement vulnerability to offshore wind energy infrastructure among marine birds of the Pacific Outer Continental Shelf

Kelsey et al. (2018) created three different vulnerability equations relating to effects of offshore wind farm developments: population, collision and displacement. These equations were focussed on 81 marine species in the Pacific Outer Continental Shelf. Factors relating to collision vulnerability included:

- **Nocturnal flight activity**
- **Diurnal flight activity**
- **Macro-avoidance of turbines**
- **Percentage of time within rotor-swept area**

Values for all these factors were sourced from the literature. Uncertainty around these values was also estimated based on the quality, number of data sources examined, how recent the data was, and if proxy species were used. Each factor was scored on a 5-point scale except for percent time within the rotor-swept area which was scored on a 3-point scale. The collision vulnerability equation was additive, combining the average of flight activity with macro-avoidance and percent time within rotor-swept area.

Avian sensitivity to mortality: Prioritising migratory bird species for assessment at proposed wind farms

Desholm (2009) developed an Environmental Sensitivity Index for seabirds within the Baltic Sea. Unlike many other frameworks, the aim of this index was to avoid correlation between variables and thus only included two factors likely to drive wind farm-related mortality: relative abundance and adult survival, of which relative abundance was the sole factor related to collision risk likelihood.

Equation development

Initially, the CLS equation was designed to be fully additive for usability purposes. However, we found this structure did not reflect risk appropriately (e.g. a flightless species could still be scored as likely to collide despite not being at risk of dynamic rotor collision). Subsequently, we added both additive and multiplicative components to the equation (Table 1). This structure was based on the AviStep equation with regards to how certain components (primary, aggravating and additional) were deemed as either additive or multiplicative. Sensitivity checking was undertaken to ensure the equation's components were weighted appropriately as well as to confirm the scaling factor was stable. Further, the CLS equation also includes direct site-based measures of species activity (e.g. counts of species at a specific site or number of echolocation calls). While our approach does not include species distribution maps like AviStep's approach, the CLS provides a more in-depth assessment of the proposed wind farm site.

Table 1: Components of the ACRF Collision Likelihood Score equation, including how each component is applied mathematically within the equation.

Component	Component metric/s	Structure	Factor type
Activity	Species observations, Suitable habitat, Keystone features	Multiplicative	Primary
Flight height	Flight height (within rotor-swept area)	Multiplicative	Primary
Duration of exposure	Seasonal exposure	Additive	Additional
Propensity to evade collision	Collision history	Additive	Additional

Other considered components

In addition to the components selected for our final equation, we considered a range of other components, including:

- **Daily activity:** while initially daily exposure was included in the equation (i.e. the proportion of the day a species is active for) there was a lack of the variation in this component based on the current state of knowledge. Species were mostly either diurnal or nocturnal, with some species also crepuscular. This did not allow for a five-point scale to be established which would allow enough granularity whilst maintaining simplicity. Only having two or three categories would not allow the user to fully discriminate between the levels of risk therefore not allowing for a robust component.
- **Manoeuvrability:** even species with great manoeuvrability can collide with turbines. Creating a linear risk gradient for this term is not appropriate. Additionally, there are a number of methods to calculate this manoeuvrability from different species morphometrics.
- **Flight time across a year**: while longer flight durations will increase exposure to collision, in the context of a site-based assessment this was not necessarily relevant, especially for migrating

species which are unlikely to be on site all year. Where available we have provided these data in the species data repository but not directly in the equation.

- **Very high flight speeds:** flight speed data are not readily available for many species so to ensure the equation was applicable to all listed species this component was not included in the final equation. Where available we have provided these data in the species data repository but not directly in the equation.
- **Flock-oriented flight patterns**: likely only relevant for specific species and given our aim was to create an equation for hundreds of species this was not deemed to be appropriate. If any of the above or other components are relevant and would better predict a specific species risk likelihood, we highly recommend incorporating such components.

Guiding principles of the ACRF Collision Likelihood Score

Here we outline the three main guiding principles of the CLS.

1. Identify

Identify all species that cannot be quantitatively analysed (i.e. data poor) but are still deemed as having collision risk likelihood. Identify any existing data outside site-collected that data that may inform assessment. At this stage, you should also confirm that survey effort is sufficient or if proxy species can be used.

2. Contextualise

Analyse where and when observations took place across the proposed wind farm site. Understand how these observations relate to the proposed wind farm site and species activity more broadly, e.g. habitat suitability, reason for observation, timing of observation.

3. Evaluate

Assign collision risk likelihood using the CLS equation (detailed below). It should be stated, when submitting a CLS, whether any previously assigned risk ratings have been revised and why. For example, Species X was originally assessed as having a very likely collision risk likelihood; however, after moving turbines away from key nesting sites, the collision risk likelihood was reduced to possible. Doing so, provides a transparent chain of events and highlights how relative collision risk likelihood has been managed.

Please note, data feeding into a CLS must be informed by up-to-date and targeted field surveys for the relevant target species, rather than be used as a replacement for field surveys.

Structure of the ACRF Collision Likelihood Score

Four components factor into the CLS. Each component is based on the key inputs that are fed into a quantitative collision risk model. For each component used in the assessment, we strongly advise retaining a record of where information was sourced from to obtain an indicative level of uncertainty.

Core equation

Using the values from each component outlined below, collision risk likelihood for a species can be calculated using the following formula:

$$CollisionLikelihoodScore$$

where:

A is Activity and includes:

- Species observations
- Suitable habitat
- Keystone features

H is Flight height and includes:

- Flight height (within rotor-swept area)

D is Duration of exposure to turbines and includes:

- Seasonal exposure

C is Propensity to evade collision and includes:

- Collision history

So, the fully expanded equation is:

$$CollisionLikelihoodScore = [\ (SpeciesObservations + SuitableHabitat + KeystoneFeatures)\ /\ 3]\ *$$

$$FlightHeight + SeasonalExposure + CollisionHistory$$

$$FlightHeight + SeasonalExposure + CollisionHistory$$

Each of the five components of the equation have possible values that range from 0 - 5. The highest value that could be produced from the raw scores is 35, given the multiplicative part of the section. The raw scores within the equation are then scaled to an intuitive score out of 100, using 35 as the scaling factor, where higher scores (or those closer to 100) indicate a higher collision risk likelihood.

$$CollisionLikelihoodScore\_Scaled = [CollisionLikelihoodScore\ /\ 35]\ *\ 100$$

Activity (A)

Activity is defined as direct and indirect measures of species presence within and in proximity to the proposed wind farm site. Activity is a proxy for the rate and density of flights on site as used in the quantitative and semi-quantitative assessments. Three sub-components make up Activity:

- Species observations
- Suitable habitat
- Keystone features

Species observations (A1)

Species observations refer to the presence and count of observations of the target species within and in proximity to the proposed wind farm site.
To calculate this component the user may collate data from:

- The proposed wind farm location including (but not limited to):
  - Bird utilisation surveys (terrestrial, boat-based and digital aerial)
  - Targeted surveys/searches
  - Scats, tracks or other traces
  - Nest searches
  - Acoustic detectors (e.g. count of bat echolocation calls)
  - Thermal cameras
- Nearby wind farms
- Scientific or grey literature
- Previous records from open-source repositories
- Species distribution models

Table 2: Scoring options for the species observations sub-component.

Category	Raw score
Species observed on site (multiple occasions or individuals)	5
Species observed on site (single occasion)	4
Species observed within vicinity of site (10,000m from site boundary)	3
Historical records (>10 years since observation) of species on or within vicinity of site (10,000m from site boundary)	2
Species not observed on site but within species distribution	1
Species distribution does not overlap with site and no current or historical records	0

Please note if Species distribution does not overlap with site and no current or historical records is selected, a CLS is not warranted. A Subject Matter Expert (SME) should also confirm if a CLS is not warranted.

Suitable habitat (A2)

Suitable habitat is defined by the proportion of habitat within the proposed site that offer resources to a species. While vegetation can be a part of the definition of habitat, it does not necessarily equate to suitable habitat unless it offers suitable resources. Conversely, habitat does not necessarily have to be vegetation. For example, aquatic areas or caves can support species without vegetation. Habitat may also include non-native vegetation e.g. plantations that are used as supplementary habitat by species.

Determining the amount of suitable habitat for seabird species remain difficult but there are an array of potentially important physical, biological and behavioural drivers (Dunn et al. 2024; Vilchis, Ballance, and Fiedler 2006; Trevail et al. 2021):

- Water depth
- Water/surface temperature
- Tidal stratification (vertical gradient)
- Ocean front strength (horizontal gradient)
- Chlorophyll-a concentration
- Foraging routes
- Proximity to human-related activities (recreation, fishing pressure, protected areas, shipping lanes)

To calculate this sub-component the user should use:

- Site-based habitat/vegetation mapping
- Species habitat preferences

Table 3: Scoring options for the suitable habitat sub-component.

Category	Raw score
>50% of site composed of suitable habitat	5
>25-50% of site composed of suitable habitat	4
>10-25%% of site composed of suitable habitat	3
>5-10% of site composed of suitable habitat	2
>0-5% of site composed of suitable habitat	1
0% of site composed of suitable habitat	0

Keystone features (A3)

Keystone features refer to critical resources needed for a species to persist. Examples of keystone features include maternity caves, wetlands and roosting trees. The distance from these keystone features from a wind farm site correlates with how and where target species are likely to occur.

The important aspect of this component is to consider the chance that species could reasonably enter or pass through a site while accessing a keystone feature. This includes aspects of habitat that are not on site necessarily but may be nearby and contain activity.

To calculate this sub-component the user should use:

- distance from the nearest location within the wind farm site to the keystone feature, as opposed to the centre of the wind farm or an average distance from turbines.

There may be multiple keystone features on or in proximity to the proposed wind farm site. As a precautionary approach to risk, assess the nearest keystone feature.

Please note keystone features refer to critical resources that species cannot persist without. This is compared to suitable habitat (e.g. eucalypt forest, freshwater areas) which refers to more general conditions that species use to persist.

Table 4: Scoring options for the keystone features sub-component.

Category	Raw score
0 - 500m from keystone feature	5
>500 - 1,000m from keystone feature	4
>1,000 - 5,000m from keystone feature	3
>5,000 -10,000m from keystone feature	2
>10,000m from keystone feature	1
No keystone features relevant to the target species	0

Flight height (H)

Flight height is defined as the proportion of flight activity that occurs within the rotor-swept area (RSA). Rotor swept area refers to the area in between the minimum and maximum heights of a turbine blade and is calculated by using the following equations:

- RSA (minimum) = Hub height - (Rotor diameter/2)
- RSA (maximum) = Hub height + (Rotor diameter/2)

Note: in offshore settings, hub height should be referenced to sea level. This is given that flight heights are usually measured relative to the water's surface.

To calculate this component the user may collate data from:

- The proposed wind farm location
- Nearby wind farms
- Scientific or grey literature
- Proxy species
- Expert elicitation

***Table 5: Scoring options for the flight height component*.**

Category	Raw score	Reid&Baker birds	Reid&Baker bats
>60% of flights within the rotor swept area	5	Group J: Aerial foragers, falcons	
>40-60% of flights within the rotor swept area	4	Group G: Waterbirds (most ducks, herons & allies, cormorants), Sulids, frigatebirds, tropicbirds, gulls & terns, birds of paradise, Group H: Arboreal pigeons, owls, Accipiters, orioles, bee-eaters, rollers, wood swallows, cuckoo-shrikes, starlings, Group I: Nectivorous parrots (canopy feeders)	Group E: Open space aerial foragers and commuters, e.g. sheath-tailed bats and flying foxes
>20-40% of flights within the rotor swept area	3	Group E: Nightjars, waterbirds, whistlers, shrike-thrushes, currawongs, Group F: Generalist foragers - Cuckoos, parrots, corvids	Group C: Close clutter aerial foragers that typically feed below canopy height, e.g. leaf-nosed and horseshoe bats, Group D: Outer canopy foragers, e.g. free-tailed bats
>5-20% of flights within the rotor swept area	2	Group C: Galliformes, frogmouths, quail & button-quail, rails, kingfishers, ground parrot, lyrebirds, non-migrant passerines (finches, treecreepers, chats, thrushes, finches, Australian robins and flycatchers), Group D: Shorebirds, migratory passerines (honeyeaters, pardalotes, gerygones, fantails, flycatchers, larks, wagtails), terrestrial pigeons	Group B: Foliage gleaners that capture non-flying prey, e.g. long-eared bats
>0-5% of flights within the rotor swept area	1	Group B: Megapodes, stiff-tailed ducks, grebes, Procellariform seabirds, facultative ground foragers (scrubwrens, thornbills, logrunners, quail-thrush, whipbirds, mud-nesters)	
0% of flights within the rotor swept area	0	Group A: Flightless, obligate understory foragers	Group A: Trawlers that capture prey on the surface of water bodies. e.g. Large-footed Myotis

Please note Reid & Baker refers to the ecological risk assessment frameworks contained within Reid, Baker, and Woehler (2025) & Reid and Baker (2025) and provides an expert elicitation index for the percentage of time that species would be expected to fly within the typical swept area of turbine blades.

Duration of exposure (D)

Duration of exposure is defined as how long temporally a species is exposed to turbine collision. Specifically, duration of exposure refers to seasonal exposure, defined as the proportion of time a species is likely to be present on site across a year. To calculate this component the user should use data from:

- Migratory status/migration patterns
- Breeding and non-breeding timing
- Seasonal/weather-driven patterns

Table 6: Scoring options for the duration of exposure component.

Category	Raw score
Present on site >80 - 100% of the year (e.g. resident species)	5
Present on site >60 - 80% of the year (e.g. migratory species with extended use including using the site for breeding and overwintering)	4
Present on site >40 - 60% of the year	3
Present on site >20 - 40% OR Weather-driven species (e.g. irruptive species with irregular presence)	2
Present on site >0 - 20% (e.g. migratory species flying through, vagrant species)	1

Propensity to evade collision (C)

Propensity to evade collision is defined as a species' ability to avoid turbine blades (or the wind farm in the case of macro avoidance) based on its behaviour and morphology. Given species-specific avoidance rates are unavailable for most species (but see Hull and Muir (2013)), a more general approach, using post-construction collision monitoring data, is more appropriate.

To calculate this component the user should collate data on:

- Collision history

Table 7: Scoring options for the propensity to evade collision component.

Category	Raw score
Evidence of multiple collisions at the species level	5
Evidence of single collision at the species level	4
Evidence of collision at the genus level	3
Evidence of collision at the family level	2
No evidence of collision, high level of uncertainty	3
No evidence of collision, low level of uncertainty	1

Please note: No evidence of collision is separated into two categories: (1) species for which collisions may occur but for which no data are available due to post-construction fatality monitoring limitations and the absence of offshore wind farms in Australia (high uncertainty), this category is scored conservatively to reflect the level of uncertainty; and (2) species for which data are available within the species' distribution but no collisions have been recorded, indicating a lower likelihood of collision (low uncertainty).

Assigned collision risk scoring

Using the derived values from each component above, use the CLS equation to calculate the collision likelihood score (and associated rating) for each species (Table 8).

Table 8: Collision likelihood scores (scaled) and associated risk ratings.

Collision likelihood score (scaled)	Risk rating
>90	Very likely
>60-90	Likely
>40-60	Possible
>10-40	Unlikely
≤10	Very unlikely

Levels of evidence

For each component of the CLS the user should record the data source/s including, but not limited to:

- Empirically collected site-based (including additional data in proximity to site)
- Nearby wind farm data
- Scientific literature on the species of interest
- Expert elicitation
- Data from proxy species collected on site
- Historical records - species specific but may not reflect current or future conditions

Consider secondary sources if available.

The web tool associated with this methodology document has the option for the user to select the data source/s for each component. An output summary will be provided with the percentage of each data source selected. The summary will allow a self-assessment of if sufficient effort to collect and source data has been achieved.

Case studies

The aim of the case studies below is to offer a learning environment within the ACRF website for users to test their understanding and ensure all users inputs results in the same risk score.

Case Study #1: White-throated needletail Hirundapus caudacutus

Context

Territory Constructions in the ACT want to build a linear wind farm composing 54 turbines, mainly across ridgelines. They conducted standard bird utilisation surveys as well as targeted surveys for the white-throated needletail. After such surveys, 10 observations were made on site comprising 103 individuals. The 10 observations occurred in four consecutive months of the year (~30% of the year) with the species known to not be present given its migration path. All observations recorded birds flying through the site, with no foraging or stopping behaviours observed. No keystone features are known to exist across or within 10km of the site but 70% of the site is quite hilly, providing updraught conditions known to be used by white-throated needletail. Despite 70% of the site being potential habitat, the habitat is quite degraded and in poor condition. Despite limited observations on site, white-throated needletail have collided with wind farms in the past at other wind farms. To expand the evidence base, Territory Constructions also sought height profile information from Reid and Baker in which the white-throated needletail is placed in Group J: Aerial insect foragers, falcons indicating that >60% of flights are within the rotor swept area.

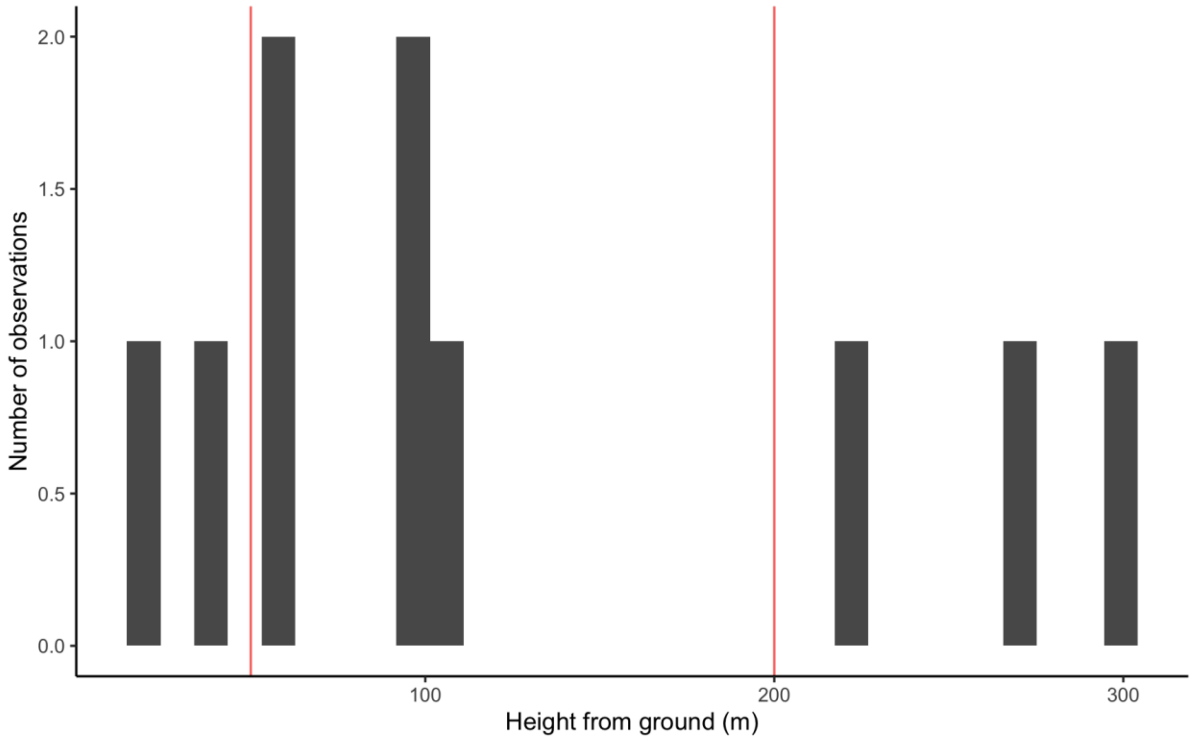


Figure 1: The distribution of flight heights recorded for the white-throated needletail. Red lines indicate rotor-swept height.

Problem statement

Territory Constructions want to understand the risk likelihood of collision but despite targeted survey effort were unable to collect data for quantitative collision risk modelling approach. Using the CLS we can use the information provided above to determine the risk score of the white-throated needletail at the proposed site.

Evaluation

Table 9: ACRF Collision Likelihood Score for the white-throated needletail.

Component	Evidence	Source	Category	Raw	Overall
Species observations	10 observations	Site-collected data	Species observed on site (multiple occasions or individuals)	5	
Suitable habitat	70% of the proposed site is suitable habitat	Site-collected data	Proposed site is composed of >50% of suitable habitat	5	
Keystone features	No keystone features	Site-collected data	No keystone features relevant to the target species.	0	
Flight height	50% observations within RSA and Reid and Baker placed in Group J	Site-collected data and expert elicitation	>60% of flights within the rotor swept area	5	
Seasonal exposure	On site 30% of the year	Site-collected data	Present on site >20 - 40% of the year	2	
Propensity to evade collision	Evidence of collision	Previous records	Evidence of collision at the species level	5	
Collision Likelihood Score					68-Likely

Collision likelihood score: ((5 + 5 + 0)/3) * 5 + 2 + 5
Collision Likelihood Score (scaled): (23.67/35)*100

Case Study #2: Pilbara leaf-nosed bat Rhinonicteris aurantia (Pilbara form)

Context

IronUnited Pty Ltd is planning to build a wind farm in remote north-west Western Australia. The plan has 200 turbines distributed relatively evenly across the site. The listed Pilbara leaf-nosed bat is known to be distributed across this area, but no individuals have been detected flying through the proposed site after sufficient survey effort with acoustic detectors distributed across the site. There are two known roosting caves across the landscape, one 2,000m from the proposed site and the other 20,000m. Thermal camera detectors have been placed at the cave entrances and recorded hundreds of individuals. No flight data are available for this species, but all bats are known to fly. The proposed site habitat is in fair condition with about 20% of the site composed of suitable habitat for the species including watercourses and Triodia hummock grasslands which could be used for foraging. As they are non-migrating, if they do occur on site, this could happen in any month of the year. Despite the fact they could be on site, there is no evidence of collision at the family level for this species.

Problem statement

IronUnited Pty Ltd wants to understand the risk likelihood of collision but despite their survey effort they are unable to collect enough data for a spatial relative risk modelling approach. Using the CLS, we can use the information provided above to determine the risk score of the Pilbara leaf-nosed bat at the proposed site.

Evaluation

Table 10: ACRF Collision Likelihood Score for the Pilbara leaf-nosed bat.

Component	Evidence	Source	Category	Raw	Overall
Species observations	Species observatory at roosting sites	Site-collected data	Species observed within vicinity of site (10,000m from site boundary)	3	
Suitable habitat	20% of the proposed site is suitable habitat	Site-collected data	Proposed site is composed of 10-25% of suitable habitat	3	
Keystone features	Keystone feature 2,000m from proposed site	Site-collected data	>1,000 - 5,000m from keystone feature	3	
Flight height	No site-based observations of height but Reid and Baker placed in Group C	Site-collected data and expert elicitation	>20-40% of flights within the rotor swept area	3	
Seasonal exposure	Resident species	ACRF Species Traits Search Tool	Present on site >80 - 100% of the year (e.g. resident species)	5	
Propensity to evade collision	No evidence of collision at family level	Previous records	No evidence of collision (high uncertainty)	3	
Collision Likelihood Score					49-Possible

Collision likelihood score: ((3 + 3 + 3)/3) * 3 + 5 + 3
Collision Likelihood Score (scaled): (17/35)*100

symbolix

Case study 3: Shy albatross Thalassarche cauta

Context

Blue Tides Consulting are managing the risk assessment process for a proposed offshore wind farm off the coast of Gippsland. Using boat-based surveys, they surveyed all seabird species occurring within the proposed site along transects. One species, the Shy Albatross, is of collision risk concern given its listing on the EPBC Act as Endangered. It is also listed on the marine flyover species list and EPBC Act Migratory list. Throughout a 2-year surveying period of boat-based survey, 300 observations of shy albatross were observed within the impact area. The breeding colonies known to be important to this species are more than 50km away indicating that no breeding is occurring near the site. The observations of the shy albatross were mainly of the species foraging at the sea surface for fish cephalopods, of which foraging habitat was available across the entire footprint of the proposed site. Rarely did the species fly more than 10m above the sea surface. The species has been observed across six months of the year which is supported by the eBird's weekly abundance model. There has been no evidence of collision for this species at the species, genera or family level.

Please note while a CLS can be completed for this species given the large number of observations a collision risk model is also advised.

Problem statement

Blue Tides Consulting wants to understand the risk likelihood of collision and have enough observations to undertake a quantitative collision risk model. Before that however, they want to understand the main drivers for the collision risk likelihood and if there are appropriate mitigation options to reduce such risk. Using the CLS, we can use the information provided above to determine the risk score of the shy albatross at the proposed site.

Evaluation

Table 10: ACRF Collision Likelihood Score for the Shy albatross.

Component	Evidence	Source	Category	Raw	Overall
Species observations	Multiple species observations	Site-collected data	Species observed on site (multiple occasions or individuals)	5	
Suitable habitat	100% of the proposed site is suitable habitat	Site-collected data	Proposed site is composed of >50% of suitable habitat	5	
Keystone features	Keystone feature more than 50,000m from proposed site	Site-collected data	>10,000m from keystone feature	1	
Flight height	No observations were within RSA	Site-collected data	0% of flights within the rotor swept area	0	
Seasonal exposure	Migratory species observed 50% of the year	Site-collected data and eBird weekly abundance model	Present on site >40 - 60% of the year	2	
Propensity to evade collision	No evidence of collision at family level	Previous records	No evidence of collision (high uncertainty)	3	
Collision Likelihood Score					14-Unlikely

Collision likelihood score: ((5 + 5 + 1)/3) * 0 + 2 + 3

Collision Likelihood Score (scaled): (5/35)*100

References

BirdLife International, 2025. AVISTEP: the Avian Sensitivity Tool for Energy Planning. Technical Manual Version 2. Cambridge, UK: BirdLife International, 186 pp. DOI: 10.5281/zenodo.17639248

Desholm, Mark. 2009. "Avian Sensitivity to Mortality: Prioritising Migratory Bird Species for Assessment at Proposed Wind Farms." Journal of Environmental Management 90 (8): 2672–79. https://doi.org/https://doi.org/10.1016/j.jenvman.2009.02.005.

Dunn, Ruth E, Robin Freeman, Malcolm A Nicoll, Julia Ramsden, Alice M Trevail, Hannah Wood, and Stephen C Votier. 2024. "From Route to Dive: Multi-Scale Habitat Selection in a Foraging Tropical Seabird." Marine Biology 171 (6): 124.

Garthe, Stefan, and Ommo Hüppop. 2004. "Scaling Possible Adverse Effects of Marine Wind Farms on Seabirds: Developing and Applying a Vulnerability Index." Journal of Applied Ecology 41 (4): 724–34.

Hull, Cindy L, and Stuart C Muir. 2013. "Behaviour and Turbine Avoidance Rates of Eagles at Two Wind Farms in Tasmania, Australia." Wildlife Society Bulletin 37 (1): 49–58.

Kelsey, Emma C, Jonathan J Felis, Max Czapanskiy, David M Pereksta, and Josh Adams. 2018. "Collision and Displacement Vulnerability to Offshore Wind Energy Infrastructure Among Marine Birds of the Pacific Outer Continental Shelf." Journal of Environmental Management 227: 229–47.

Lumsden, Lindy, Paul Moloney, and Ian Smales. 2019. Developing a Science-Based Approach to Defining Key Species of Birds and Bats of Concern for Wind Farm Developments in Victoria. Arthur Rylah Institute for Environmental Research, Department of Environment.

Reid, Keith, Barry Baker, and Eric Woehler. 2025. "Impacts on Birds from Offshore Wind Farms in Australia." Department of Climate Change, Energy, the Environment and Water.

Reid, Keith, and G Barry Baker. 2025. "Impacts on Birds and Bats from Onshore Wind Farms in Australia: An Ecological Risk Assessment." Department of Climate Change, Energy, the Environment and Water.

Robinson Willmott, JC, G Forcey, and A Kent. 2013. "The Relative Vulnerability of Migratory Bird Species to Offshore Wind Energy Projects on the Atlantic Outer Continental Shelf: An Assessment Method and Database." Final Report to the US Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 207: 275.

Stark, Elizabeth, Thompson, Eliza. 2026. "Australian Collision Risk Framework: Review of current practice and species data. Department of Climate Change, Energy, the Environment and Water, Canberra, 2026. CC BY 4.0.

Trevail, Alice M, Jonathan A Green, Mark Bolton, Francis Daunt, Stephanie M Harris, Peter I Miller, Stephen Newton, et al. 2021. "Environmental Heterogeneity Promotes Individual Specialisation in Habitat Selection in a Widely Distributed Seabird." Journal of Animal Ecology 90 (12): 2875–87.

Vilchis, L Ignacio, Lisa T Ballance, and Paul C Fiedler. 2006. "Pelagic Habitat of Seabirds in the Eastern Tropical Pacific: Effects of Foraging Ecology on Habitat Selection." Marine Ecology Progress Series 315: 279–92.

Zoological, Specialised. 2025. “Acoustic Analysis and Bat Call Identification from Tathra, Western Australia.” Unpublished report by Specialised Zoological for Umwelt (Australia) Pty Ltd.

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