Australian Government
Department of Climate Change, Energy, the Environment and Water

Australian Collision Risk Framework

DRAFT Onshore survey guide

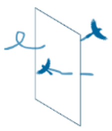
This guide describes survey methods for bird and bat baseline surveys undertaken during pre-construction site investigations and impact assessments. It outlines survey design considerations for collecting quantitative and/or qualitative data for input into collision risk assessments. The guide links onshore survey methods to the collision assessment risk criteria and collision likelihood inputs that are defined in the Australian Collision Risk Framework (ACRF). It provides a checklist to help ensure survey designs are suitable to collect fit-for-purpose data suitable for collision risk assessment, though a collision risk model or collision likelihood score.

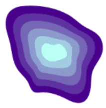
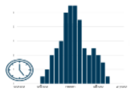
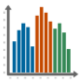
This document provides guidance, but it is not mandatory. There may be circumstances where users decide to take an alternative approach to this guidance, such as to account for new scientific information or emerging best practice. This should be well-documented and justified in any assessment documentation.

What data are needed?

Robust collision prediction requires site-specific data on birds' and bats' exposure to collision, including the duration of that exposure (Table 1). These data are combined with published information on species' morphology, flight behaviour and propensity to avoid collision to inform a Collision Risk Model (CRM) or a Collision Likelihood Score (CLS).

Table 1: Summary of risk metrics and data inputs needed from site studies. Red are primary quantitative metrics and black are supporting, qualitative evidence.

Risk metric	**Data inputs** (red/purple - primary quantitative metric and black are supporting, qualitative evidence)
 Rate and density of flights on-site (flight flux)	**Measurement of movements per area in a fixed time via formal surveys identified to species** • Presence / absence of species in multi-season site survey • Historical and regional records • Species distribution maps
Distribution of flight heights 	**Direct site measurement of flight heights** • Foraging strategy (e.g. canopy, open air) • Literature values flight height distributions

Spatial use patterns within site 	**Direct flight path recording** **Flight activity within different habitats and spatial modelling** **Ecological model (e.g. ‘flat’ distribution of activity)** • Quality and extent of suitable habitat onsite • Distance to keystone features (e.g. roost sites, nest sites)
Daily activity 	• **Site-based records** • **Literature values** • Species activity type (diurnal, nocturnal etc)
  Seasonal patterns	• **Site-based records representative of the whole period of on-site activity** • Recorded seasonal activity from public observation repositories

Method suitability

Table 2 provides an overview of the applicability of common data collection methods for generating evidence to support each risk metric required for a collision risk assessment. Some methods may be used in combination, depending on the species considered. The table is intended as a general guide only. The suitability of any method will depend on **site conditions, study design and data quality standards.** Survey designers should evaluate the specific requirements of the species and sites under consideration. Further details on survey methods and collision risk assessment types are provided in the *Glossary and more information* section below.

Table 2: Quick guide to applicability of different survey methods to the inputs needed for collision risk assessment.

Method	Applicable	Flight Flux	Height	Spatial	Daily	Seasonal	Model type
Visual	Diurnal species	+	+	+ Species and field method dependent	+	+	Quantitative
Acoustic	Birds and echolocating bats	? Relative	? Relative	+	+	+	Qualitative
Playback	Bird species*	~ Presence only	~	? Limited	~	+	Limited use
Targeted habitat	All species	~ Presence only	+	~	~	+	Limited use
Capture	All species	~ Presence only	~	? Limited	~	+	Limited use
Radar	All species	~ No species ID	+	+	+	+	Limited use
Imaging	All species	+	~	+	+	+	Limited use
Telemetry	All species	~	? Limited	? Limited	? Limited	? Limited	Limited use
Digital aerial	Diurnal species	+	+	+	+	+	Quantitative
Spotlighting	Nocturnal species	~	~	+	? Limited	+	Limited use
Genetics	All species	~	~	+	~	+	Limited use

Key: *+= Yes, method can provide a robust measure with a degree of error | ?= Limited/Relative Data, Limited refers to the method possibly providing the input but unlikely to yield a robust measure, Relative refers to the method providing the relevant input but not on an absolute scale | ~ = No, the method does not provide a valid way to estimate the relevant input.*

Primary survey types

Currently the most common and broadly applicable method for diurnal birds remains visual point-based counts. For nocturnal birds and echolocating bats acoustic surveys can provide some information about relative activity, but there exists no common method for counting individual flights to the species level, which limits modelling to qualitative collision likelihood scores only. Emerging combinations of methods, such as radar+acoustic, thermal+acoustic, or visual+gps offer promising opportunities but research and development is required to confirm the suitability for these for any given site.

Weather considerations

For several of the supplied survey methods, high quality collision risk input data is dependent on favourable weather conditions. However, and to differing extents, bird and bat species are still active in unfavourable conditions. With ecologists unable to survey in these unfavourable conditions, an understanding of a species' collision risk is limited and will not be fully understood without the combination of other technology not hampered by weather. For example, visual surveys are not conducted in high winds or heavy rainfall, but birds may still be flying in these conditions for which risk cannot be estimated. This is where a combined survey approach may be needed such as telemetry. Telemetry data can be collected in all weather conditions and while sample size is not likely to be sufficient to inform collision risk on its own, telemetry can provide data across conditions not possible for visual surveys.

Integrating technology in project screening and survey design

Although traditional survey methods, such as visual observation for birds, remain the primary means of generating data for these inputs, emerging technologies can complement these methods.

Radar, for instance, provides round-the-clock coverage, and can capture flight direction, speed, bird density, and height. Optical, thermal and infrared imaging can help discriminate birds from bats, support species identification, and document flight behaviour. Telemetry and digital aerial surveys can yield important insights into movement patterns and flight activity, including seasonal patterns in habitat use.

More advanced platforms, such as AI-integrated multi-sensor systems combining radar, cameras, acoustic devices, and automated detection and classification, can enhance the resolution and interpretability of baseline data. However, the use of technology does not replace the need for structured, probabilistic, site-wide survey designs. Currently, the systems described cannot produce the replication or sample size, or provide species identification with sufficient certainty, and are therefore most effectively applied when their strengths directly address recognised gaps in traditional survey methods. Their contributions should be used to complement, contextualise and refine datasets generated through traditional methods, rather than supplant them. When integrated in this way, the use of technology can support and improve the robustness of collision risk assessment.

Survey Design Checklist

This checklist is intended to support the selection of appropriate survey methods and ensure all key aspects of the survey program have been considered prior to data collection.

Alignment with Collision Risk Assessment Inputs

- Is it clear whether each collision risk input will be informed **quantitatively or qualitatively**?
- Has **each collision metric input** (e.g. flux, height, spatial use, temporal variation) been captured by **one or more survey methods**?
- Are **all relevant bird and bat species** adequately covered by the selected methods?
- Have **multiple survey methods** been considered or employed together to better inform CRM inputs where appropriate?

Spatial Coverage

- Have **key habitats, movement corridors, flyways, and dispersal routes** been identified?
- Are survey locations selected using an appropriate spatial design (e.g. **random, systematic, stratified**)?
- Do the selected methods adequately capture **landscape context**, including:
  - Visibility
  - Topography
  - Accessibility constraints
- Have appropriate **impact and control sites** been identified to support post-construction comparisons?
- Have **viewshed analyses** been undertaken where relevant?

Temporal Coverage

- Do the selected survey methods capture **daily variation in activity** (e.g. across a 24-hour period)?
- Are **diurnal and nocturnal activity patterns** of all relevant species captured?
- Do the methods capture **seasonal and migratory patterns**, including across multiple years where required?
- Are **survey duration, frequency, and timing** sufficient to capture peak activity periods (e.g. migration events)?
- Has **observer fatigue** been considered and addressed in the survey design?

Appropriate Survey Methods

- Have all **relevant species** been identified during **Stage 1 Site identification**?
- Are the selected methods capable of detecting:
  - Diurnal species
  - Nocturnal species
  - Cryptic or low-detectability species
- Are survey methods appropriate for the **scale, complexity, and risk profile** of the project?

Quality Standards

- Are survey methods **designed to be repeatable**, particularly to support post-construction comparisons?
- Have potential **detection biases** been identified and addressed or documented (e.g. distance correction, availability bias)?
- Have **data handling, storage, and management procedures** been defined, including:
  - Standardised data templates
  - Secure data storage
  - Quality assurance and version control processes

Surveyor Competency

- Are survey personnel **appropriately experienced** with the relevant taxa and survey methods?
- Do survey personnel have access to **appropriate and calibrated equipment**?
- Have **standard operating procedures (SOPs)** been developed and implemented?
- Have survey personnel been trained in **key measurement and recording protocols** to ensure consistency across surveys?

Documentation of Survey Methods and Results

- Will survey reports include **detailed descriptions of methods**, survey effort, and limitations?
- Is survey effort clearly documented to support **comparability with post-construction monitoring**?
- Do reports provide sufficient methodological detail to allow **independent evaluation** of results and conclusions?

Glossary and more information

Collision Likelihood Score (CLS)

A structured, **qualitative** assessment of collision likelihood risk using ranked criteria. CLS combines species activity, flight height, seasonal exposure, and collision history to generate transparent risk ratings. CLS is appropriate when data are insufficient for a CRM, during early project stages, or when collision risk is clearly very low or very high.

Collision Risk Assessment (CRA)

A multi-step process that assesses the likelihood and consequence of wind turbine collisions for bird and bat species. The CRA is designed to identify species at risk, inform the mitigation hierarchy and to support regulatory approval of onshore and offshore wind farm developments.

Collision Risk Model (CRM)

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).

Onshore Survey Methods

Method	Description	Key Points
Visual Surveys (point, transect, vantage point)	Direct observation of bird flight activity from fixed points or along transects during daylight.	- Core method for diurnal bird CRM - Must record flights within defined area and time - Requires distance and height correction - Limited for nocturnal or cryptic species
Acoustic Monitoring	Detectors record bat (and some bird) calls at ground level or at height.	- Primary method for bats - Captures nocturnal and seasonal patterns - Provides relative activity only - Limited height resolution and species discrimination
Playback	Broadcast of recorded calls to elicit responses from target species.	- Useful for presence/absence only - Limited collision risk value - Should be combined with other methods
Targeted Habitat Surveys	Focused surveys of key habitat features such as roosts, nests or wetlands.	- Improves detection in high-use areas - Provides spatial context - Not representative of site-wide risk
Capture Methods	Physical capture using nets or traps to confirm species identity.	- Accurate species identification - Labour-intensive - Does not provide collision risk inputs

Imaging (optical, infrared, thermal)	Camera systems detect birds and bats visually or thermally, including at night.	- Effective for nocturnal activity and flight paths - Species ID and height estimation may be limited - High data-processing effort
Telemetry	Individuals are fitted with GPS or radio transmitters to track movements.	- High-resolution movement data - Identifies flight paths - Small sample sizes limit population inference
Radar	Radar detects flying animals using radio waves across large areas and time periods.	- Strong for flux, height and migration - Operates day and night - Limited species identification without supporting methods
Digital Aerial Surveys	Aircraft-mounted cameras collect imagery over large or inaccessible areas.	- Useful in difficult terrain - Can support quantitative estimates if movement is measured - Species ID may be limited
Spotlighting	Night-time surveys using artificial light to detect eye shine.	- Simple presence/absence method - Very limited value for collision risk modelling
Genetics	Genetic material collected invasively or non-invasively to identify species e.g. scats, eDNA.	- Confirms species presence - No direct collision risk information - Supporting method only

Emerging Techniques

Technology in wildlife monitoring is expanding the tools available for baseline bird and bat assessments. Many established systems, such as radar, camera-based techniques, and acoustic monitoring, are being refined through improvements in sensor performance, enhanced data processing, and the combining of these systems in multi-sensor platforms.

The role of artificial intelligence

Artificial intelligence (AI) enables automated extraction of information from sensory data (e.g. imagery, acoustic) that would otherwise require extensive manual effort. For instance, AI-based software is now integrated with camera systems to support species-identification or acoustic monitoring to automate detection and classification of vocalisations. Although challenges remain, such as the need for large training datasets and performance may be inconsistent under complex conditions, AI-integrated tools and technology are an important complement to traditional survey methods.

The use of unmanned aerial vehicles in bird and bat monitoring

Unmanned aerial vehicles (UAVs) can carry remote-sensing instruments and collect high-resolution data over large or hard-to-reach areas. For birds, particularly congregating and other conspicuous species, UAV-derived data have been shown to support accurate and precise population estimates, often outperforming traditional survey methods while reducing disturbance associated with conventional aircraft and ground surveys. For bats, UAV-mounted acoustic detectors constitute a more recent innovation. Studies indicate that acoustic recording from UAVs can extend sampling into high or inaccessible airspace, but performance is currently constrained due to overlap between UAV noise and bat echolocation calls, and limited battery life, as well as potential behavioural responses caused by the UAV. Research suggests that quieter models, such as miniature UAVs or blimps, capable of supporting higher performing recording devices, or combining acoustic recording with other senses (e.g. thermal infrared imagery), may provide a promising direction for future monitoring.

Citation
Thompson, Eliza., Potter, Ashley, Stark, Elizabeth. 2026. "Australian Collision Risk Framework: Onshore Survey Guide. Department of Climate Change, Energy, the Environment and Water. CC-BY 4.0."

Last Updated: 30 Jan 2026

Contributors This work incorporates inputs provided by 2rog. Cover image by Rob Gration.

Funding
This work is funded by the Australian Government as part of the Renewables Environmental Research Initiative (RERI). The RERI is funded by the Department of Climate Change, Energy, the Environment and Water