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The Habitat Condition Assessment Tool: Instructions for participants, version 3.0

Using expert knowledge to improve our understanding of the condition of Australia's native ecosystems

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Habitat Condition Assessment Tool: https://biocollect.ala.org.au/hcat

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Important disclaimer

Photo on title page: Hummock-grass (*Triodia scariosa*) mallee regrowth after fire. Tarawi Nature Reserve, south-west New South Wales. 2013. Photo by K. Giljohann.

Contents

How to use this document

This document contains background and instructions for using the Habitat Condition Assessment Tool (HCAT). This standardised training material aims to minimise ambiguities and provide a common interpretation of methodological approaches and implementation. Please read this document carefully and apply the method outlined when contributing your expert site-level ecosystem condition scores. For information on how assessments will be used, how your IP and privacy will be protected, and our ethical clearance for this project, please see the Research Participant Information Sheet. By contributing data through HCAT, you are agreeing to these privacy terms and conditions.

The document is divided into 6 sections, as follows.

Section 1 – Project information

Outlines the function and purpose of the HCAT and provides contextual information for contributing experts.

Section 2 – Getting started

Explains the steps required to establish accounts and logins for the project. Please check that you have completed all these steps.

Section 3 – Data entry overview

Provides an overview of the core data entry components.

Section 4 – Essential concepts for scoring condition

Provides detail on essential concepts required to provide condition scores for image and site condition assessments. Please read this carefully and refresh your understanding regularly if contributing data on multiple occasions.

Section 5 – Completing Image Assessments

Contains standardised guidance on how to enter an Image Assessment score for the calibration component of the project. Please read this entire section and refer to it if you need assistance during data entry.

Section 6 – Entering Site Condition Assessments

Provides standardised guidance on how to contribute a Site Condition Assessment. Please read this entire section and refer to it, if you need assistance during data entry.

For a list of key terms and definitions, please see the **Glossary** at the end of this document.

1 Project information

1.1 Project overview

The *Habitat Condition Assessment Tool* (HCAT*;* https://biocollect.ala.org.au/hcat) is a web-based platform hosted by the Atlas of Living Australia's BioCollect information system that enables experts with deep ecological knowledge and field experience to contribute site-level ecosystem condition scores. Using this tool, experts delineate areas they are familiar with and provide an overall ecosystem condition score for each area (a Site Condition Assessment). Each score is benchmarked against extreme end points (0 – completely removed or transformed habitat, and 1 – habitat with high ecosystem integrity as it might have existed prior to European colonisation). Experts also provide ecosystem condition scores for a set of calibration images (an Image Assessment), allowing their site condition assessment scores to be calibrated (i.e. bias corrected) across experts and locations.

Your contributions to HCAT will help build a national library of expert site condition assessments. It is our goal that this publicly available library will help support research, natural resource planning, and monitoring and reporting throughout Australia. Data collected through HCAT also supports ongoing development of the Habitat Condition Assessment System (HCAS), which uses satellite remote sensing and site data to estimate ecosystem condition across the Australian continent. Data collected via HCAT informs HCAS by providing contemporary examples where ecosystems are relatively intact, as well as sites where ecosystems have been modified; and may be used in model training, calibration and/or validation. Enhanced validation and calibration of HCAS may directly contribute to improved biodiversity assessment applications, such as the Nature Repair Market through the Ecological Knowledge System (EKS). HCAT data may also be used to improve conceptual models of ecosystem dynamics (via the Australian Ecosystem Models Framework). It is anticipated that coverage of Australia's ecosystems will be extended through a rolling series of regional and national expert elicitation campaigns to improve the conceptual models of ecosystem dynamics. The HCAT will be introduced to ecosystem experts through workshops, scientific conferences, social media, professional networks, and by direct invitation.

The HCAT was initially designed and tested in 2018 through a collaboration between the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW), CSIRO, the Atlas of Living Australia (ALA), and the Arthur Rylah Institute of the Department of Energy, Environment and Climate Action, Victoria. During that first round, invited experts were asked to contribute image and site condition assessments and provide feedback on their experiences with the tool (Pirzl et al., 2019; White et al., 2023). The current version of the HCAT has been updated to address previous feedback and to introduce improvements to the original HCAT method and interface. The first update to this instruction booklet (September 2024) introduced a utility theory-based approach to elicit site condition assessments. This second update (July 2025, HCAT version 3.0) supersedes the September 2024 version by re-introducing the intuitive scoring method based on subsequent user and expert feedback, which indicated that an intuitive approach was easier to comprehend and apply consistently. Other improvements made to the scoring system and website are retained.

For more background, download the revised and updated version 3.0 HCAT factsheet and Research Participant Information Sheet. You can also view the products from the first round of HCAT expert elicitation to improve our understanding of the condition of Australia's native ecosystems. For a list of key terms and definitions, please see the Glossary.

1.2 Scientific rationale

Reliable on-ground assessments of habitat quality (synonymous with condition, health and integrity) are essential for managing Australia's wildlife and ecosystems (Sparrow et al., 2020). Ecological scientists and practitioners possess invaluable knowledge, yet expert assessments are often fragmented and difficult to collect. Additionally, no universal method exists for measuring 'ecosystem condition'.

A measurable ecosystem condition scoring system typically uses three steps (e.g., Keith et al., 2020):

1) Selecting measurable ecosystem characteristics and metrics (also called condition variables) as relevant proxies of ecosystem quality;
2) transforming these variables into a comparable scale, reflecting their relationship (often nonlinear) with ecosystem quality; and
3) weighting and combining the transformed variables into an overall, defined ecosystem condition score.

The weightings in the scoring system, above, should reflect the proportional contributions of each condition variable and the interactions among variables to ecosystem quality in constructing the overall score. However, each step in this process involves subjective choices that emphasise different aspects of ecosystem quality to varying degrees, for example which characteristics of the ecosystem's structure, composition, and function to measure and how to weight them.

Rather than attempting to eliminate this subjectivity, the HCAT method recognises expert judgment as fundamental to assessing ecosystem condition. Over many years of field observation and training, members of the ecological science and practitioner community in Australia have developed a deep understanding of how Australia's ecosystems work (Cook et al., 2014; Keith, 2017). For these reasons, the HCAT approach places ecological expertise at the centre of its ecosystem site condition data collection system. Ecosystem experts, with diverse backgrounds and expertise, may make different subjective choices (e.g. selecting, prioritising, transforming, and weighting condition variables) if asked to independently develop a system of ecosystem condition scoring. Each system would likely be valid and might highlight aspects of ecosystem quality that others may overlook. The HCAT method asserts that the subjectivity and noise associated with creating a measurable condition scoring system, which requires experts to make decisions about which variables to consider and how to weight them, is likely similar to the subjectivity and noise associated with a well-informed expert simply intuiting a score (Cook et al., 2014, 2010).

The HCAT method therefore asks expert's to provide their ecosystem condition score based only on the given definitions of 'site' and 'ecosystem condition' when a score is equal to zero ('0') or one ('1'), and provides guidance on what site-level factors an expert should consider when intuiting that score (as outlined in Section 4).

2 Getting started

2.1 Check list of steps

To participate in this project, you will need to:

a) **Click on the link to open the HCAT portal** (https://biocollect.ala.org.au/hcat/).

b) **Log in or create your Atlas of Living Australia (ALA) user account** – This provides you with access to the HCAT data capture tools. If you have an existing ALA account, simply click on the HCAT link, click "Log in" at the top right of the screen, and enter your account details to access HCAT. If you do not already have an account, click 'sign-up' and follow the prompts to create an account. You will receive an activation email (be sure to check your junk mail folder) to activate your account. Once you have activated your account, return to the HCAT portal and login using your new ALA details.

c) **Read all instructions in this document**– It is important that you do this **before entering your assessments**. This ensures consistency and reliability in scoring. Instructions are also available on the Home Page of the HCAT portal.

d) **Complete your Image Assessments** – In this section of the HCAT you are asked to provide a condition score for a given suite of photographic habitat images (Section 5). You will also be asked to consent to the terms of participation and indicate if you wish all your contributions to be de-identified. Details of data use, IP, privacy and ethics permits are available in the Research Participant Information Sheet.

e) **Contribute Site Condition Assessments** – Enter individual Site Condition Assessments directly within the HCAT, by uploading data through a pre-formatted spreadsheet, or by contacting us directly with alternative data formats (Section 6). Site assessments should be entered only after Image assessments are completed.

2.2 For assistance

- Check supporting information via "Project Information" and "Instructions – Read me" from the HCAT homepage.
- Use the online help available within the HCAT via this icon .
- Check the relevant sections of this guidance document.
- Email expertconditionassessments@csiro.au – this email address is monitored by the project team and your enquiry will be directed to the appropriate team member.

3 Data entry overview

You will be asked to contribute two types of assessments, **Image Assessments** and **Site Condition Assessments**. Image Assessments are performed online within the HCAT. Site Condition Assessments can either be a) performed online within the HCAT, or b) entered offline into a pre-formatted spreadsheet and then uploaded to the HCAT when completed.

These options can be accessed from the HCAT homepage using the respective buttons:

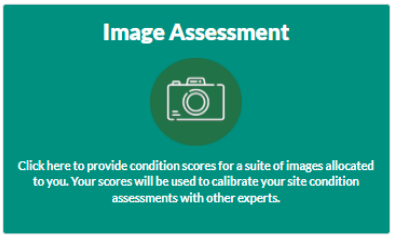
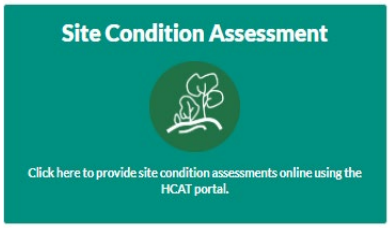


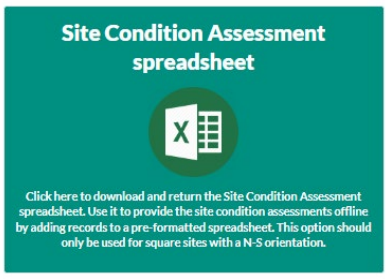
Image Assessment

Complete condition scores for the given photographic images of habitats. For details, see Section 5 of this document.



Site Condition Assessment

(a) Contribute condition scores, spatial locations, and ancillary information for site/s with which you are familiar online within the HCAT. For details, see Section 6.2 of this document.



(b) Alternatively, contribute condition scores, spatial locations, and ancillary information for site/s with which you are familiar offline by adding records to a pre-formatted spreadsheet and uploading to the HCAT when completed. This option is only available for square-shaped sites with a North-South orientation. For details, see Section 6.3 of this document.

Both Image Assessment and Site Condition Assessment tasks will need to be completed for your contributions to be used in further research and natural resource management. Detailed guidance on entering data for each is provided below (Sections 5 and 6).

Mandatory fields are marked with *

Online help is available via

4 Essential concepts for scoring condition

4.1 Definition of a 'site'

In HCAT, a site is defined as a specific location with a geographic boundary (i.e. not a point) and uniform (i.e. homogenous) condition. A site can be any size or shape that meets these criteria. Sites can include multiple ecosystem types, so long as they are uniform in condition.

4.2 Definition of 'condition'

Overall ecosystem condition scores are assigned to individual sites with uniform condition.

A site's overall ecosystem condition is scored between the extreme end points of 1 and 0:

- A score of '1' applies to a site with the highest ecosystem integrity, as might have existed prior to European colonisation, and its characteristic composition, structure, functioning, and self-organisation are intact and lie within its natural range of variability.
- A score of '0' applies to a completely transformed site in which all native species have been removed. The site's functioning and self-organisation are now entirely different compared to any of its original characteristic forms [1].

4.3 How to estimate an overall condition score

Provide your estimate of the overall ecosystem condition of the site by integrating all the local condition factors and characteristics that you consider important when determining a score (see Section 4.4 for guidance on site-level condition factors to consider).

The overall site-level ecosystem condition scores you provide should be intuitive and internally consistent across all sites you score and align with the definitions of the extreme endpoints of 1 and 0 (as described in Section 4.2 above). Scores should apply to the site overall, not to the highest or average condition available within the site.

By 'intuitive', we mean that you, as the expert, decide (without having to defend or rationalise that decision) what ecosystem characteristics to consider and how to weight and aggregate them when estimating the overall ecosystem condition of the site.

In Section 6.3.5 you will be introduced to how to score the independent contributions of four ecosystem characteristics to overall ecosystem condition.

[1] Definitions were informed by the System of Environmental Economic Accounting—Ecosystem Accounting (https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_f124_web_12dec24.pdf.) and the Australian Ecosystem Models Framework (https://doi.org/10.25919/f61q-1386).

4.4 Site level condition factors to consider

In scoring each site, focus on the local 'site level' condition of the ecosystem at the time of the observation:

a) Consider only the properties at the site; not any relationship to the surrounding area.

b) Consider the condition of the site in any/all of the following terms:

- the physical and chemical properties of the soil and water (e.g. soil structure, nutrients, pH, salinity, hydrology, geomorphology) that sustain the ecosystem and its components
- the structure of the ecosystem, and its capacity as habitat for native animals or plants (irrespective of the context of the site, and whether those species presently live there)
- the balance between native and exotic species
- the resident plant species richness/diversity (given ecosystem type)
- the abundance of species or life-forms that you consider ecologically relevant to the ecosystem type
- the ecological processes and functions (e.g. water and nutrient cycling, regimes of disturbances and recovery) occurring at the site.

c) Please avoid introducing the following considerations. We acknowledge they are important, but they will not be dealt with in this data collection protocol:

- the conservation significance of native species or ecosystems that may or may not occupy the site
- the actual dollar cost of managing or improving the ecosystem or any of its components
- consideration or anticipation of the likely future for the site (whether good or bad)
- the liability or danger the site poses to other sites (e.g. as weed or pest harbour; as a fire hazard)
- any unrealised effects (e.g. predictions, time-lags) of the land use at the site, or any surrounding sites
- any unrealised effects of the context of the site (e.g. degree of 'landscape fragmentation')
- ecological dynamics driven by disturbance regimes to which ecosystems have adapted over evolutionary timeframes, including disturbance regimes driven by Indigenous land management. Natural or benign perturbations (consequences of fire, flood, storm, etc.) are not considered to impair habitat condition, unless such disturbances are unseasonal, or at frequencies and intensities outside the bounds of presumed regimes prior to European colonisation. For example, a post-fire ecosystem with a fire-killed over-storey may still exhibit high levels of integrity if the fire was within bounds of the ecosystem's capacity over time to recover function and structure.

In addition to the overall ecosystem condition score, you will also be asked to provide a condition score for specific Ecosystem Characteristics (see section 6.3.5, Table 1) and drivers that negatively impact the condition of the site (see section 6.3.6, Table 2).

We acknowledge that ecosystems are dynamic and may manifest in alternative ecological states according to a range of natural perturbations (i.e. 'endogenous' disturbance regimes). However, in any of these characteristic states, the ecosystem is presumed to provide the necessary habitat components (structures and functions) for the persistence of all constituent native species and their interactions over time. We also recognise that high levels of ecosystem integrity (e.g. approaching a condition score of 1) may still be achieved in contemporary landscapes that are actively managed, and that maintenance of ecosystem integrity does not require an absence of people.

5 Completing Image Assessments

5.1 Image allocation

In this section you will be asked to provide a condition score for a suite of photographic images (approximately three to eight images). We allocate images to you based on the Major Vegetation Groups (MVG) and Hutchison geographic agro-climatic classifications that you nominate as being within your area of expertise. Scoring these images will enable your Site Condition Assessments to be calibrated with other participants.

By determining whether individuals tend to routinely provide higher or lower condition scores relative to other experts, the 'bias' associated with each expert's scores can be estimated and used to adjust their site condition scores (Pirzl et al., 2019; White et al., 2023).

The images presented will**:**

- represent ecosystems in geographic areas with which you are familiar
- include examples in different condition states
- also be scored by other participants who nominate similar areas of expertise (i.e. broad vegetation and geographic groupings, as above). Ideally, each calibration image that you score will also be scored by 2-4 other experts, although this will depend on how much overlap in expertise there is among participants.

Your approach to scoring each image should apply the essential concepts outlined previously in Section 4. Given the images provide only limited information on the condition of the location, you are not aiming to assess the true condition of the site, and you should only spend a few minutes considering what you can assess visually and scoring each image.

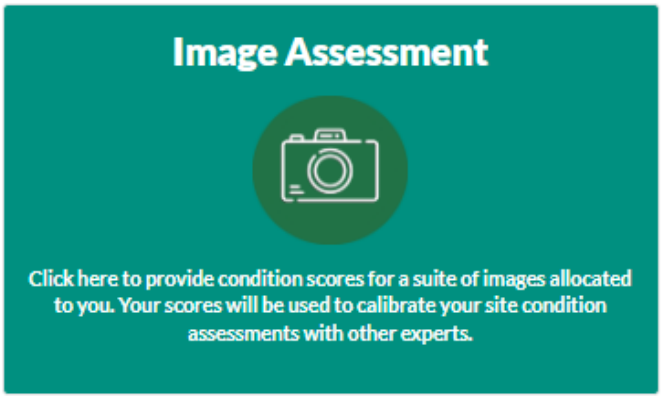
You will only be asked to perform the image assessment task once for your suite of images.

5.2 Consent

Prior to starting the Image Assessment, you will be asked to declare your consent to participate in this project and if you would like your Site Condition Assessments to be de-identified. Note that image assessment scores are for internal use only, are treated as confidential to the participant, and the results are not shared or published outside of the project team. For specific details about what you are consenting to, please read the Research Participant Information Sheet.

5.3 Image Assessment

To access the Image Assessment task, **click on the Image Assessment button** located on the HCAT home page.



1. You will be presented with a list of Major Vegetation Groups (MVG) and Hutchison geographic agro-climatic classes. Please select all groups and classes in which you have expertise. Note that images of wetlands and coastal habitats are not included in this version of HCAT.
2. Select if you would like your Site Condition Assessments to be de-identified or not.
    - If you select "Identify my data", your name will be credited with your Site Condition Assessments in the publicly available HCAT data collection (accessed through the CSIRO Data Access Portal) and may also be credited in possible future materials (e.g. publications, reports, presentations).
    - If you select "De-identify my data", only members of the HCAT project team and select ALA developers will be able to see your name associated with the Site Condition Assessments that you provide. When your contributions are included in publicly available HCAT data collection, your contributions will be anonymised, using a code to replace your name.
    - Your Image Assessments will not be made public regardless of your selection—they are used for internal calibration purposes only. Only members of the HCAT project team and select ALA developers will be able to see your name associated with these.
    - **Note** that once a selection is made, there will not be an option to change your decision within HCAT. If you change your mind about whether you want your contributions to be credited or de-identified you can contact the project team at expertconditionassessments@csiro.au, to request that change. Once your data have been published it will not be possible to make this change.
3. Check the box stating that you have read, understood, and accepted the privacy, IP and ethics arrangements for this project. Details are provided in the Research Participant Information Sheet.
4. Click "Request Records" and HCAT will automatically select a list of images for you to assess.
5. Open and assess each of the images presented in your list.

a) Under the “Action” column, click the pencil icon  and open a new page where you can provide a score for that unique image.

b) For each ecosystem image, enter your estimate of the overall condition for that photo.

c) Use the ‘upper’ ecosystem condition bound and the ‘lower’ ecosystem condition bound boxes to reflect your uncertainty in the overall ecosystem condition score you have provided for the image. These bounds do not represent variability in condition within the image. This image assessment allows calibrations to be applied to site condition scores (White et al., 2023).

d) Score condition using the guidelines in Section 4 (Essential concepts for scoring condition).

e) You can click on the image to enlarge it and view it in high resolution.

f) Select “Yes” to indicate whether you have completed the assessment.

g) Click “Submit” to enter your response and then close the page to return to the full image list.

h) To return to the full image list, click “My Data” in the banner menu at the top of the page, and select the next image in the list.

i) Repeat this process (5a-g) for each image in your list until all Image Assessments are complete.

After scoring all the listed images, your Image Assessment is complete. You can then return to the HCAT home page by clicking the “Home” link in the banner menu at the top of the page and begin your Site Condition Assessments.

You can view and edit your Image Assessment scores any time by clicking the “My Data” link in the banner menu at the top of the page.

6 Entering Site Condition Assessments

Once you have completed your Image Assessments, you may begin entering Site Condition Assessments. Contribute as many (or as few) Site Condition Assessments as you like. Additional assessments can be added at any time.

6.1 Choosing your sites

- Include sites with which you are already familiar based on your field experience.
- A site is defined as having uniform (i.e. homogenous) condition but does not need to be of a single ecosystem type (see Section 4.1). You will need to spatially define the site before assigning a condition score.
- If this is your first time entering a Site Condition Assessment, the first two sites you contribute should be a site with the highest level of condition that you know of, and a site with the lowest level of condition that you know of, informed by the definitions given in Section 4 (Essential concepts for scoring condition). These sites need not have a score of 1 or 0, respectively, but should be the sites that you are familiar with that you would score closest to a 1 or 0. This sets your internal standards for self-scaling all subsequent scores. You may repeat this exercise at any time, especially when contributing Site Condition Assessments for quite different geographic areas or ecosystem types.

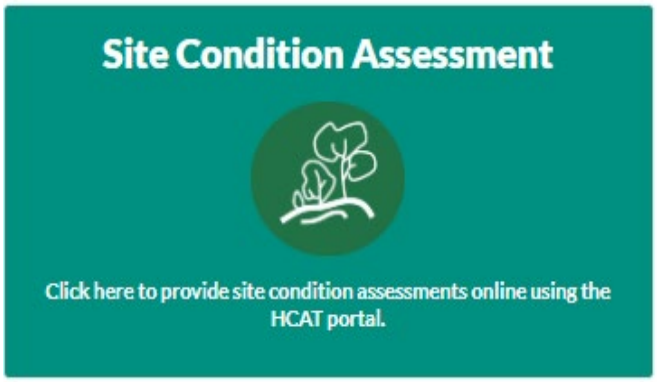
6.2 Three options to enter Site Condition Assessments

1. Enter individual Site Condition Assessment records online directly within the HCAT (Section 6.3 below). This option may be preferred if you would like to enter each site individually, have relatively few sites to contribute, or the sites are complex polygons.
2. Upload multiple sites simultaneously using a customised Site Condition Assessment spreadsheet (Section 6.4 below). This option may be preferred if you have many sites to contribute for which you have pre-recorded data (e.g. location, date assessed) or want to enter multiple assessments for the same site at different points in time. If this is the case, we provide a downloadable preformatted spreadsheet into which you can copy site information from existing records and add your personal site condition assessments, then upload the spreadsheet into the HCAT when completed. You may also email the completed spreadsheet to expertconditionassessments@csiro.au. **The spreadsheet is presently only available for square-shaped sites with a North-South orientation.**
3. Contact us via expertconditionassessments@csiro.au to discuss alternative bulk data formats. This option may be preferred if you have pre-existing site condition assessments or data that you would like to provide but is difficult to enter using either options 1 or 2 (e.g. alternative formats such as .TIFF, large spreadsheets of non-square plots).

Note that you can use any of these methods to enter Site Condition Assessments. For example, you may enter some Site Condition Assessments directly via the HCAT online portal, other sites via the spreadsheet and further sites by contacting us directly.

6.3 Creating a new Site Condition Assessment within the HCAT portal

To create a new Site Condition Assessment online directly within HCAT, click on the **"Site Condition Assessments" button** located on the HCAT homepage.



6.3.1 Record details

When starting a new Site Condition Assessment record, the assessor's name and data-entry date are automatically populated from your ALA login details.

- Use the Condition Assessment Date section of the data capture tool to record the date or time period to which your Site Condition Assessment applies.
- You don't need to give exact dates – you can enter a date accurate to year, month or day.
- If the assessment applies across a period of time—that is, you are confident that the site has remained in the same condition across a number of months or years—enter an end date for the assessment period. If your assessment applies to a point in time only, leave end date blank.

6.3.2 Site location

You can define the spatial boundaries of the site (1) using the mapping tool embedded in the Site Condition Assessment form, or (2) by entering the Latitude and Longitude coordinates (in datum WGS84) that define the spatial boundaries of the sites (this option is only available for square sites with a North-South orientation). Note that entering a site as a point location is not valid for this purpose. Sites are defined as having uniform (i.e. homogenous) condition and do not need to be of a homogenous ecosystem type (see Section 4.1).

Using the mapping tool:

1) You can zoom and pan the map to navigate to your site.

2) Use the drawing icons  ,  , or  to delineate your site polygon. A polygon can be of any size and shape, and you can edit it. Double click to complete the polygon.

3) You can switch between terrain, satellite and infrastructure layers to assist with orientation and delineation, using the icon in the top right corner of the map  .

4) There **is no maximum site size**, however the site should be of a size that allows you to be confident that condition is homogenous across the entire polygon (see *Definition of a 'site'* in Section 4.1).

5) If in doubt about the precise location of site boundaries, draw an internal polygon rather than a bounding polygon to ensure your condition estimate is homogenous, as far as possible.

Entering Latitude and Longitude coordinates:

1) This option can only be used to enter square sites with a North-South orientation

2) Click "Add coordinates manually"

3) Enter the Latitude and Longitude (WGS84 decimal format) coordinate of one corner or the centre point (centroid) of the site

4) Select the coordinate location (i.e. SE, NE, SW, NW, centroid)

5) Enter the area of the site (Site Area) and specify the units (m^2 or ha) of area measured (Site Area Units)

6) If your coordinates are not in WGS84 decimal format, a free coordinate conversion tool can be found at: https://www.ngs.noaa.gov/NCAT/.

6.3.3 Site photo

This section is optional. If you have photos of the site and you are willing to make them available, you can upload them by clicking the **"Add Images" button** and selecting the photos you wish to share. Alternatively, you can drag and drop the photos into the designated area. For each photo, provide a file name, the date the photo was taken, attribution for the photo (i.e. photographer, if they have agreed to be named and provided permission to publicly share the image), and select the Creative Commons (CC) License that applies to the photos from the associated drop-down menu[2]. You can also provide notes about the photos, including any relevant context (e.g. if the photo was taken shortly after a natural perturbation or disturbance).

By contributing photos, you are giving permission for the HCAT team to use these photos in scientific applications, including future publications, research and analysis (subject to attribution and other conditions of the selected CC license). These photos may also be used to help grow our Image Assessment library which is periodically published via CSIRO's Data Access Portal (e.g. Warnick et al. 2019).

[2] For more information on the different CC License options please visit https://creativecommons.org/share-your-work/cclicenses/.

Please avoid uploading photos that include the image of a person/s unless you have permission for their image to be published and that permission is clearly stated in the notes section.

6.3.4 Site condition score

Enter a numeric score between 0 and 1 for your estimate of the condition at the site, informed by the definitions and instructions given previously in Section 4 (Essential concepts for scoring condition). You may use as many decimal places as you consider necessary.

6.3.5 Ecosystem characteristics underpinning site condition

Ecosystem characteristics are the physical and biological properties associated with the ecosystem that contribute to its overall condition (i.e. ecosystem integrity). In addition to an overall site condition score, please provide your estimate of a condition score between 0 and 1 for each of the 'ecosystem characteristics'[3] listed in Table 1 for your site.

Table 1 Definitions of ecosystem characteristic to be scored for all site condition assessments. Each characteristic should be scored between 1 and 0 using the definitions given Section 4 (Essential concepts for scoring condition).

ECOSYSTEM CHARACTERISTIC	DEFINITION
Physical properties	The physical and chemical properties of the soil and water (e.g. soil structure, nutrients, pH, salinity, hydrology, geomorphology) that sustain the ecosystem
Species composition	The array and relative proportion of organisms (e.g. plants and animals)
Structural diversity	The physical organisation of all living and non-living structural elements of the ecosystem, including demographic stages, trophic levels, vegetation strata, ground cover, and spatial diversity
Ecosystem function	The ecological processes and interactions among living and non-living elements within an ecosystem that drive the flow of energy and matter

Each characteristic should be scored using the definitions and instructions in Section 4 (Essential concepts for scoring condition). For each characteristic, the lowest condition (0) and highest condition (1) are defined as in Section 4.2. The condition of each ecosystem characteristic is then assessed by applying the same steps as in Section 4.3, where overall condition is replaced with the condition of the specific ecosystem characteristic of interest (e.g. "condition of species composition").

When scoring ecosystem characteristics, each characteristic should be assessed independently as a standalone measure and should not be interpreted as sub-scores contributing to a weighted or aggregated overall condition score. These individual scores provide a separate, unweighted

[3] These 'ecosystem characteristics' have been adapted from the 'National standards for the practice of ecological restoration in Australia' prepared by the Society for Ecological Restoration Australasia (SERA), which identifies these characteristics as key and universal attributes of ecosystem condition.

evaluation of specific ecosystem characteristics and are not intended to be combined into a composite measure of condition.

You may use as many decimal places as you consider necessary.

6.3.6 Drivers that negatively impact the condition of a site

If your overall site condition score is less than '1', you may wish to provide details of the anthropogenic drivers that caused the decline in condition. Drivers, in this context, refer to anything that negatively impacts the condition of the site that is outside the range of disturbance and variation to which an ecosystem has adapted over evolutionary timescales (i.e. 'exogenous' to the ecosystem)[4]. Scoring can include both primary (e.g. livestock grazing) and secondary (e.g. resulting soil erosion) drivers. It does not include natural or benign disturbances (consequences of fire, flood, storm, etc.), including pre-European colonisation disturbance regimes driven by Indigenous land management (i.e. 'endogenous' to the ecosystem). Table 2 provides definitions for each driver[5]. Scoring drivers is optional.

Scoring driver impact on condition

If you wish to do so, please provide a score between 0 and 1 that is your estimate of the impact of each driver on the overall condition of the site. This is the inverse of condition scoring.

- A score of 0 applies when the driver is absent or effectively absent and does not impact the condition of the site.
- A score of 1 applies when the driver has the highest possible impact that can be realised at this site.

Like the site condition score, the impact score for each driver should be intuitive and internally consistent across all sites that you score and align with the definitions of the extreme end points of 0 and 1 (as defined above). A lower score (closer to the end point of 0) suggests the driver has minimal negative impact on site condition, whereas a higher score (closer to the end point of 1) signifies a strong negative impact'.

You may use as many decimal places as you consider necessary.

[4] The concepts of endogenous and exogenous are outlined in the Australian Ecosystem Models Framework.

[5] Drivers have been adapted from the IUNC Threats Classification Scheme and Australian threatening processes, which outlines the most common threats and key threatening processes in Australia.

Table 2 Definitions and examples of the possible primary and secondary drivers impacting the condition of a site, based on the IUCN threats classification scheme and the Australian threatening processes

DRIVER	DEFINITION AND EXAMPLES
Habitat clearance and fragmentation	Habitat clearing for residential, agricultural (including silvicultural and grazing), commercial, industrial (e.g. mining) or infrastructure development or use. Note that logging and harvesting of native forests is included under 'Biological resource use'
Livestock grazing of native habitats	Grazing by domestic or semi-domesticated animals supported by native habitats (i.e. rangelands/ranching) and/or allowed to roam in the wild
Biological resource use	Consumptive use of 'wild' biological resources (e.g. hunting and collecting animals and plants including flowers and seeds; fishing and harvesting aquatic resources; clear-fell and selective logging and harvesting of native forests, including collection of firewood and post wood). Includes accidental mortality/bycatch and off-target damage
Human intrusions	Human activities that alter, destroy or disturb native habitats and species (e.g. military, recreational, research, tourism, vandalism)
Fire regime change	Increase in, or suppression of, fire frequency, intensity, or size outside of its natural range of variation as a result of human activities
Hydrological change	Changes to water patterns (e.g. flow) and salinity from their natural range of variation as a result of human activities (e.g. dams; weirs; water use, abstraction and diversion; flood pattern; impediments to tidal flow; changes to morphology)
Invasive non-native animals	Non-native and ecologically destructive animal species (e.g. feral)
Invasive non-native plants and fungi	Non-native and ecologically destructive plant and fungi species
Problematic or overabundant native species	Out-of-balance native species (e.g. excessive grazing pressure from over-abundant macropods, aggressive exclusion by over-abundant noisy miners) or native species introduced and invasive outside their original native range
Disease	Parasites and pathogens either of non-native origin (e.g. *Phytophthora cinnamomi*, Myrtle rust, Psittacine beak and feather disease), or if native then occurring outside their natural range of variation. Note that for diseases, it is the infective agent which is the direct threat
Pollution and nutrient enrichment	Exotic and/or excess materials, including garbage and solid waste (e.g. illegal dumping, oil spills, marine plastics); domestic and urban wastewater (sewage and run-off); industrial, agricultural, forestry, and firefighting chemicals (e.g. fertilizers, PFAS) and effluents; airborne pollutants (e.g. acid rain, smog); unnatural noise and light
Soil erosion and sedimentation	Unnatural rates of soil erosion or sedimentation (e.g. erosion from overgrazing, increased run-off and hence sedimentation due to conversion of forests to agricultural lands, landslip) because of human activities
Climate change and severe weather	Long-term climatic changes and/or severe climatic or weather events (e.g. droughts, temperature extremes, storms and flooding) outside the natural range of variation and likely linked to global warming

Points to consider when scoring driver impact

We acknowledge that the 'highest possible negative impact' of a driver on ecosystem condition may manifest differently across different habitat types, therefore, it is up to you as the expert to imagine what the highest possible impact (i.e. an impact score of 1) of a given driver on condition may be within the context of the site (not necessarily the highest possible impact globally) and score accordingly.

Note that a high impact score for a specific driver does not mean a site will always have a low overall condition score. For example, a hypothetical site may have a high number of invasive non-native animals, such as feral rabbits. You may believe that the impact of these invasive animals (e.g. carrying capacity) on site condition has reached a maximum and therefore assign a score of 1 to this driver. However, despite the high impact of invasive animals, other aspects of the site could still be relatively intact (such as its abiotic properties or vegetation structure), therefore a non-zero overall condition score might still be applicable. Similarly, a low to moderate impact score for multiple drivers could result, in your view, in a low overall condition score. Ultimately, this determination is up to you based on your experience and knowledge of the site and of drivers that have negatively impacted the condition of that site.

6.3.7 Comments

Please provide any additional information about your Site Condition Assessment in the comments section, as this can be useful in later data interpretation.

For example, an expanded explanation for your score or context for the site, such as:

- your scores are based on empirical data;
- the site is part of a monitoring network or a specific project;
- the site is featured in a publication;
- or what you perceive the ecosystem type to be.

This section is optional, and what you provide here about the site and your condition assessment is up to you.

6.3.8 Submitting and editing data

- Clicking the '**Submit' button** at the bottom of the page will save and store your record.
- Only when all mandatory fields (*) have been completed can the record be submitted.
- Records with incomplete mandatory fields (*) cannot be saved. Navigating away from the data entry form without submitting your record will result in loss of all the data you have entered on the form.
- You can edit your submitted Site Condition Assessment records at any time.
- Your submitted records can be accessed via My Data in the banner menu. Review the filter panel on the left-hand side of the screen and set the 'Survey name' filter to Site Condition

Assessment to show your contributed records (without the 'Survey name' filter set the record list will show both Site Condition Assessment and Image Assessment records).

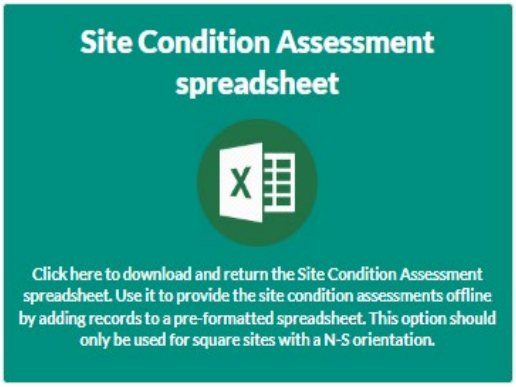
6.4 Upload Site Condition Assessments using a pre-formatted spreadsheet

If you have datasets of sites for which you can provide assessments, you may prefer to upload your assessments in a single spreadsheet instead of submitting each site individually within HCAT (as described in Section 6.2).

In that case, we provide a downloadable preformatted spreadsheet into which you can copy site location information from existing records and then add your personal site condition assessments. Each row of the spreadsheet represents a unique site assessment. These may be different sites, or the same site for which you are providing multiple condition assessments over different periods of time. The spreadsheet requests the same information as the online Site Condition Assessment form, but in a spreadsheet format.

Note that, in this version of HCAT, the spreadsheet is only an option for square-shaped sites with a North-South orientation. All other site configurations will need to be entered individually within the HCAT portal directly or contact us via expertconditionassessments@csiro.au to discuss alternative bulk data formats.

To enter your Site Condition Assessment records using the pre-formatted template, go to the HCAT home page and click on the **"Site Condition Assessments Spreadsheet" button.**



6.4.1 Download the spreadsheet and enter site condition assessments

On this page, click the "**Download Site Condition Assessment Spreadsheet" button** to download the spreadsheet.

Once you have downloaded the spreadsheet, you can enter individual Site Condition Assessments.

Each column is a different item of data requested as part of the site assessment (e.g. condition assessment date, overall condition score, a score for each ecosystem characteristic and

disturbance, etc.). **Please do not alter any of the column headings** as this will affect the automatic upload and listing in your 'My Data'.

1) Each column should be filled according to the instructions described in Section 6.3 (particularly 6.3.1, 6.3.2, 6.3.4–6.3.8).
2) To enter the location information of the site into the spreadsheet:
    a) Under the column headings "Latitude" and "Longitude", enter the respective Latitude and Longitude coordinate of one corner or the centre point (centroid) of the site.
    b) Specify the geodetic reference system (also known as the geodetic datum) of the coordinates.
    c) Select the coordinate location (i.e. SE, NE, SW, NW corner or centroid).
    d) Enter the area of the site and specify the units measured (i.e. m^2 or ha).

6.4.2 Upload the spreadsheet and record metadata

Once you have entered all the Site Condition Assessments you want to provide into the spreadsheet at that time, you can upload the file into HCAT by clicking on the **"Upload Completed Site Condition Assessment Spreadsheet" button**. This will take you to a new page, where you can attach the completed spreadsheet.

1) The spreadsheet itself will be saved as a unique data record. Your name and the date the spreadsheet is uploaded will be populated automatically.
2) Click the "Attach Document" option to attach the completed spreadsheet. When you attach the spreadsheet, you will be prompted to supply some additional information.

    Please give your spreadsheet a **Title** and provide a **Description** of the dataset. This can include information on the general location of the sites, or how the sites were surveyed (if applicable). Please select "Dataset" as the **Document Type**. You may add additional information under the relevant categories if you wish. For example, you can enter an **Attribution** for the underlying dataset, a **Citation** for the source of the data, or a **Licence** agreement specifying how the data can be reused (if relevant). If you leave these fields blank, we will assume that you are the data owner (or you have the permission of the data owner to share the data) and therefore have the right to upload the data and the data will be assigned a CC-BY attribution license.
3) Under **Dataset Metadata**, you will be asked to give the record a **Dataset name** and **Dataset description**. These can be identical to and copied from the spreadsheet **Title** and **Description** you provided when you attached the spreadsheet.

Alternatively, if you encounter any difficulties uploading the spreadsheet via the HCAT website, you can also email your completed spreadsheet to expertconditionassessments@csiro.au.

If you wish to submit additional sites later, you can download a new copy of the spreadsheet and upload additional files as a new data record. There is no limit on the number of spreadsheets you can upload.

A reminder that by uploading a Site Condition Assessment spreadsheet you are giving permission for the HCAT team to publish these data (de-identified if you choose) and to use these data in scientific applications, including future publications, research and analysis (See the Research Participant Information Sheet for details).

Glossary

Atlas of Living Australia (ALA) – The Atlas of Living Australia is a comprehensive online resource that brings together biodiversity data from across Australia, making it freely available for research, conservation, and education.

Australian Ecosystems Models Framework – a framework for systematically capturing ecological knowledge about the dynamics of Australian ecosystems in pre- and post-industrialisation contexts.

BioCollect – The BioCollect app, developed by the Atlas of Living Australia, is a citizen science tool for collecting and recording biodiversity data in the field.

Condition Score – The overall ecosystem condition score of the site or image between two extreme end points of 1 and 0. A score of '1' applies to a site with high ecosystem integrity within its natural range of variability as might have existed prior to European colonisation. Its characteristic composition, structure, functioning, and self-organisation are intact. A score of '0' applies to a completely transformed site in which all native species have been removed. The site's functioning and self-organisation are now entirely different compared to any of its characteristic forms.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) – An Australian government agency established in July 2022. It's responsible for a broad range of issues relating to Australia's sustainability and natural resources.

Driver – Anything that negatively impacts the condition of the site that is outside the range of disturbance and variation to which an ecosystem has adapted over evolutionary timescales (i.e. 'exogenous' to the ecosystem). It does not include natural or benign disturbances (consequences of fire, flood, storm, etc.), including pre-European colonisation disturbance regimes driven by Indigenous land management (i.e. 'endogenous' to the ecosystem).

Ecosystem characteristic – key and universal attribute of ecosystem condition, adapted from the 'National standards for the practice of ecological restoration in Australia' prepared by the Society for Ecological Restoration Australasia (SERA).

Ecosystem composition – the specific assemblage of biotic and abiotic components that characterize the ecosystem. This includes the presence, diversity, and relative abundance of native flora and fauna, as well as the physical attributes (e.g., soil type, hydrology) that define the ecosystem.

Ecosystem function – the ecological processes and interactions that sustain the ecosystem, including nutrient cycling, energy flow, and species interactions.

Ecosystem integrity – defines the level of intactness, completeness and integration in the structure, composition and function of an ecosystem with respect to the persistence of biodiversity. A system is said to have integrity if it can maintain its organisation (structure and function) overtime in response to environmental disturbance cycles (Kandziora et al., 2013; Kay, 1991).

Ecosystem self-organization – the natural ability of an ecosystem to develop, adapt, and regulate without external control.

Ecosystem structure- the physical and biological organization and architecture of the ecosystem, including its spatial arrangement, layering, and interactions among organisms.

Endogenous disturbance regimes – natural or benign disturbances that originate from within the ecosystem, driven by natural biological and ecological processes (i.e. consequences of fire, flood, storm, etc.). Within HCAT, this includes pre-European colonisation disturbance regimes driven by Indigenous land management. For example, seasonal flooding typical of floodplain ecosystems, savanna fire regimes, forest gap-disturbance dynamics.

Exogenous disturbance regime –Disturbances or changes driven by forces outside the natural biological and ecological processes of the ecosystem that can significantly alter the composition, structure or function of the site. For example, artificial barriers that disrupt natural waterflow, introduced grazing that alters the composition of native grasslands, large-scale clearing of forests.

Habitat Condition Assessment Tool (HCAT) – web-based platform hosted by the Atlas of Living Australia's BioCollect information system that enables experts with deep ecological knowledge and experience to contribute site-level ecosystem condition scores.

Hutchison geographic agro-climatic classes – The Hutchison geographic agro-climatic classes are a system for classifying land areas into zones with similar agricultural potential based on climate (Hutchinson et al., 2005). The classes reflect major patterns in plant growth, temperature, moisture indices, and seasonality.

Image Assessment – In this section of the HCAT you are asked to provide a condition score for a suite of photographic images. Scoring these images will enable your Site Condition Assessments to be calibrated with other participants.

Major Vegetation Groups (MVG) – The National Vegetation Information System (NVIS) classifies Australian native vegetation into major vegetation groups (MVG), which reflect the dominant vegetation occurring in a particular area. There are 33 MVGs in NVIS 7.0 (DCCEEW, 2024).

Native species –a species that is within its known natural range and occurs naturally in a given geographic region or habitat as a result of local natural evolution, as opposed to an introduced species or invasive species.

Site – a specific location with a geographic boundary (i.e not a point) and uniform condition. A site can be any size or shape that meets the main criteria of uniform condition.

Site Condition Assessment – In this section of the HCAT you are asked to contribute condition scores, spatial locations, and ancillary information for site/s with which you are familiar, either online within the HCAT or offline by adding records to a pre-formatted spreadsheet and uploading to the HCAT when completed.

HCAT products from Round 1

Liu C (2022) *R code for habitat condition score rescaling to make the scores more comparable across assessors (file: habitat_condition_score_rescaling.r)*. Mendeley Data, Online. DOI: https://doi.org/10.17632/kpm44drn73.2.

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More information: https://research.csiro.au/biodiversity-knowledge/projects/expert-knowledge-biodiversity/

Round 2 (version 3.0) information for participants

Munroe S, Giljohann KM, Brenton P, Hosack GR, Richards AE, Williams KJ (2024) *Habitat Condition Assessment Tool: Using expert knowledge to improve our understanding of Australia's native ecosystems*. Publication EP2025-2409. CSIRO, Canberra, Australia. Factsheet http://hdl.handle.net/102.100.100/706734?index=1.

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This project has been approved by CSIRO's Social Science Human Research Ethics Committee in accordance with the Australian *National Statement on Ethical Conduct in Human Research* (2007, updated 2023): ethics clearance 248/23 (participant selection and engagement) and 049/24 (expert elicitation).

CSIRO and DCCEEW acknowledge the Traditional Owners of the land, sea, and waters, of the area that we live and work on across Australia. We acknowledge their continuing connection to their culture and pay our respects to their Elders past and present. View CSIRO's vision towards reconciliation and DCCEEW's Statement of Commitment to First Nations people.

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