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The Habitat Condition Assessment Tool: Instructions

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

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Photo on title page and back 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 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 – Entering Image Assessments

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

1 Project information

1.1 Overview

The *Habitat Condition Assessment Tool (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 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 transformed ecosystem in which all native species have been removed, and 1 – ecosystem with highest integrity as might have existed prior to European colonisation). Experts also provide condition scores for a set of calibration images (an Image Assessment) to enable their site condition assessment scores to be calibrated across experts and locations. You will have the option for your assessments to be de-identified prior to publication if you wish.

Your contributions to HCAT will support 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. The HCAS and HCAT data are also important inputs to ecosystem state and transition modelling, which is providing information to support management of ecosystems to improve outcomes for biodiversity. It is anticipated that coverage of Australia's ecosystems will be extended through a rolling series of regional elicitation campaigns. Your site condition assessments will be a valuable addition to a national library of site condition assessment data supporting research, natural resource planning, monitoring, and reporting.

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[1]. The current version of HCAT has been updated to address previous feedback and to introduce improvements to the original HCAT method and interface.

For more background, download the Round 2 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.

[1] Pirzl R, Dickson F, White MD, Williams KJ, Sinclair S, Brenton P, Warnick A, Raisbeck-Brown N, Liu C, Lyon P and Mokany K (2019) A National Reference Library of Expert Site Condition Assessments: Development and evaluation of method. Report to the Department of the Environment and Energy. CSIRO, Canberra, Australia. DOI: https://doi.org/10.25919/6txs-vy29.

White MD, Hollings T, Sinclair SJ, Williams KJ, Dickson F, Brenton P, Raisbeck-Brown N, Warnick A, Lyon P, Mokany K, Liu C and Pirzl R (2023) Towards a continent-wide ecological site condition database using calibrated expert evaluations. Ecological Applications 33(1), e2729. DOI: https://doi.org/10.1002/eap.2729.

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/). This link can also be found in your invitation email.

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 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**. Instructions are also available on the Home Page of the HCAT portal.

d) **Enter your Image Assessments** – In this section of the HCAT you are asked to provide a condition score for a suite of photographic habitat images (Section 5). During this step 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 or by uploading data through a pre-formatted spreadsheet (Section 6).

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 are accessed via alternative buttons on the HCAT home page:

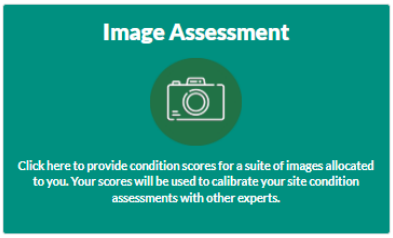
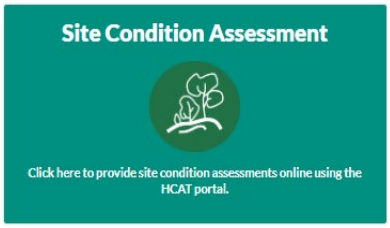


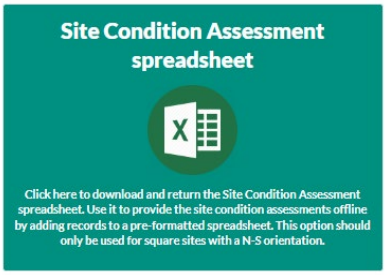
Image Assessment

Contribute condition scores for 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. For details, see Section 6.3 of this document.

You must **complete both Image Assessment and Site Condition Assessment** tasks 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 condition. A site can be any size or shape that meets these criteria.

4.2 Definition of 'condition'

Overall ecosystem condition scores are assigned to individual sites. A site's overall ecosystem condition is scored between 1 and 0:

- A score of '1' applies to a site with the highest 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[2].

4.3 How to estimate a condition score

The overall site condition score is defined as an equivalence between the condition of your site and the probability of instead getting either the highest (1) or lowest (0) condition for the site in a lottery. You can provide your estimate of condition using the following steps:

1. Consider the state of the site at the time of your assessment.
2. Using the definitions above (Section 4.2), imagine what your site would look like if it was in the highest condition (score = 1) and the lowest condition (score = 0).
3. Now consider you are given the option to exchange or swap the condition of your site for a lottery that randomly returns either the highest (1) or lowest (0) condition with a certain probability. What probability of getting the highest condition for your site would make you indifferent to participating in this lottery?

To help visualise this condition scoring method you may wish to use the thought exercise in **Box 1**, which provides a practical interpretation of probability. Remember, we want *your* estimate of condition: there's no "right" score otherwise. Scoring using probability will incorporate any uncertainty you may have around your score. This method was adopted for this reason and because it provides a consistent interpretation of condition for use in a range of analyses[3].

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

[3] For further reading on the rational for this method, see Appendix A. This is not required reading; it is included for interest.

Box 1: How to visualise the condition scoring method

This box provides an operational definition of probability for application to condition scoring.

Think of a jar containing a proportion of green and white balls:

Green: Represents the highest condition state (1).

White: Represents the lowest condition state (0).

The condition score you provide for each site will be the probability of randomly drawing a green or white ball from the jar. This probability is equal to the proportion of green balls in the jar. The probability of drawing a green ball (i.e., the proportion of green balls in the jar) reflects the degree to which the condition of the site resembles the highest or lowest possible overall condition state. If there is an equal proportion of green and white balls, there is 0.50 probability (or 50% chance) of randomly drawing a green (1) or white (0) ball from the jar. If 90% of the balls are green and 10% are white, then the probability of drawing a green ball is 0.90, and there is a 0.10 probability of drawing a white ball. If all the balls are white, then there is a 0% of drawing a green ball and a 100% chance of drawing a white ball. If your site is in high condition, your score will be closer to 1. Using the analogy above, you are more likely to pick a green ball. If your site has been significantly modified, your score will be closer to 0. In that case, you are more likely to pick a white ball.

Table 1. Examples of estimating an overall site condition score. The condition score is defined as an equivalence between the condition of your site and the probability of instead getting either the highest or lowest condition for the site in a lottery draw, that is, the chances of picking either a green (1) or white (0) ball. Images generated using AI tools.

Condition = 1	Condition = 0.7	Condition = 0.5	Condition = 0.2	Condition = 0
				
My site is in the highest possible condition. I won't accept any lottery that gives any chance of swapping for a site with condition = 0	My site is relatively intact but shows some signs of modification, I would accept a lottery that gives a 70% chance of swapping for a site with condition = 1 and a 30% chance of swapping for a site of condition = 0	My site is modified and in moderate condition, I'll accept a lottery that gives equal chances (50%) of swapping for a site in either the highest or lowest condition	My site is highly modified; I'll accept a lottery that gives a 20% chance of swapping for a site with condition = 1 and an 80% chance of swapping for a site of condition = 0	My site has been completely transformed; I won't accept a lottery that gives any chance of swapping for a site with condition = 1
Example: A healthy coral reef with diverse fish, coral, and invertebrate populations.	**Example:** A forest with some past logging activity, but still maintains a good diversity of native trees, shrubs, and animals. Regeneration is occurring, and soil quality is acceptable.	**Example:** A grassland with significant weed invasion, reducing the diversity of native plants. Some native grazers persist, but at lower numbers. Soil erosion is evident.	**Example:** A river system with substantial pollution, leading to fish kills and reduced aquatic life. The riverbed has excess sediment, and the riparian zone has been partially removed.	**Example:** A former wetland drained and converted to intensive agriculture. The original wetland plant and animal life are no longer present.

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, and the minimum area concept defined by the species-area relationship)
   - 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 try **NOT** to introduce the following considerations. We acknowledge they are important, but they will not be dealt with in this data collection protocol:
   - 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 its capacity over time to recover function and structure.

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 species and their interactions over time. We also recognize that reference conditions (i.e. a score of 1) may still be achieved in contemporary landscapes that are actively managed, and that reference conditions do not require an absence of people.

5 Entering Image Assessments

5.1 Image allocation

In this section you will be asked to provide a condition score for a suite of photographic images. We allocate images to you based on the Major Vegetation Groups (MVG) and Hutchison geographic 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[4].

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 with similar expertise. 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 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

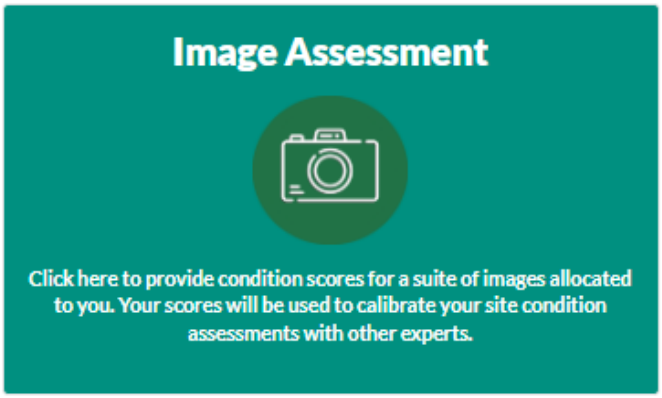
Prior to starting the Image Assessment, you will be asked to declare your consent to participate in this project and if you would like your Site Condition Assessments to be de-identified. Note that image assessment scores are for internal use only, are treated as confidential to the participant, and 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.

[4] White MD, Hollings T, Sinclair SJ, Williams KJ, Dickson F, Brenton P, Raisbeck-Brown N, Warnick A, Lyon P, Mokany K, Liu C and Pirzl R (2023) Towards a continent-wide ecological site condition database using calibrated expert evaluations. Ecological Applications 33(1), e2729. DOI: https://doi.org/10.1002/eap.2729.

White MD, Raisbeck-Brown N, Williams KJ, Warnick A, Mokany K, Brenton P, Sathya Moorthy S and Pirzl R (2019) Habitat condition data for Australia from expert elicitation. v2. Data Collection. CSIRO, Canberra, Australia. DOI: https://doi.org/10.25919/5c7da9661dbcc.

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 all relevant publicly available material using HCAT data (e.g. publications, reports, presentations, or data repositories).
    - 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 you provide. When your HCAT data are included in publicly available material, 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 and validation 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 must contact the project team directly at expertconditionassessments@csiro.au, as soon as possible. Once your data have been published (at least 2 months later) it will not be possible to make a 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 condition for that photo.

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

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

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

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

g) 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

h) 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 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 your Image Assessments 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 throughout the campaign. The HCAT will remain open beyond the campaign period to receive further contributions from existing and new participating experts.

6.1 Choosing your sites

- Include sites with which you are already familiar based on your field experience.
- A site must be homogenous in condition and should also be a relatively homogenous ecosystem type. You must be able to spatially define the site and assign it a condition score. If you are unsure about the bounds of the ecosystem type, it is more important to ensure the site is homogenous with regard to its condition.

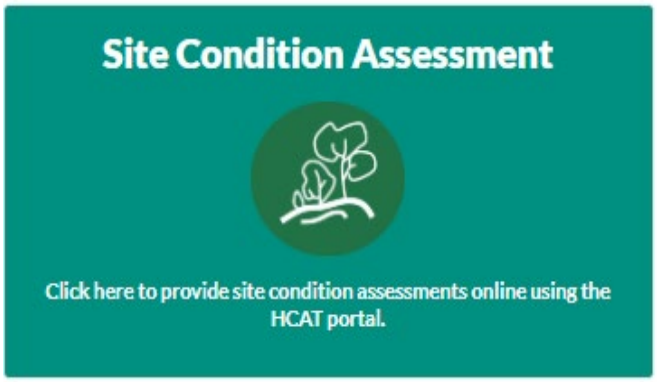
6.2 Three options to enter Site Condition Assessments

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. This option 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 or all methods to enter site condition assessments. 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 record, the assessor 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 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 must be homogenous in condition and should also be homogenous in ecosystem type.

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 must be of a size that allows you to be confident that condition is homogenous across the entire polygon, and ideally the ecosystem type too.
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 select the Creative Commons (CC) License that applies to the photos from the associated drop-down menu[5]. 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.

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.

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

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).

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'[6] listed in Table 2.

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").

Table 2 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

[6] 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.

6.3.6 Drivers that negatively impact the condition of a site

In addition to condition, you can also provide details of the anthropogenic drivers at the site.

. 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)[7]. 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 3 provides definitions for each driver[8]. 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 best estimate of the impact of each driver on the overall condition of the site.

- 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 is defined as an equivalence between the impact of the driver at your site and the probability of instead getting the highest (1) or lowest (0) impact of the driver in a random lottery. You can estimate each impact score using a similar method as described in Section 4 with the following steps:

1. Consider each driver's influence on the site.
2. Image two scenarios – the site without the driver (= 0) and the site where the driver has the maximum possible impact (= 1).
3. Now consider you are given the option to exchange or swap the driver's impact level at your site for a lottery that returns either no driver impact (lowest impact of 0) or instead the maximum possible impact of the driver on the condition of the site (highest impact of 1). What probability of getting the highest level of impact would make you indifferent to participating in this lottery?

A lower score (closer to 0) suggests the driver has minimal impact on site condition because you will only accept a low chance of getting a site experiencing the maximum impact scenario. A higher score (closer to 1) signifies a stronger impact, as you are happy to accept a high chance of getting a site experiencing the maximum impact scenario.

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

[8] 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 3 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 that may be linked to global warming (e.g. habitat loss, shifting and alteration). Other severe climatic or weather events outside the natural range of variation (e.g. droughts, temperature extremes, storms and flooding) likely related to climate change

Points to consider when scoring driver impact

Remember, we want *your* impact estimate; there is no "right" score otherwise. Scoring using probability will incorporate any uncertainty you may have around your score. We acknowledge that the 'highest possible impact' of a driver may manifest differently across different habitat types, therefore, it is up to you as the expert to imagine what the highest possible impact of a given threat may be within the context of the site (i.e. a score of 1) and score accordingly.

Note that a high impact score for a specific driver does not mean a site must 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) 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.

6.3.7 Comments

Please provide any additional information about your site condition assessment in the comments section. This can include an expanded explanation for you score or context for the site, such as: your scores are based on empirical data; the site is part of a monitoring network or other collection; 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 during and following the campaign period.
- 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.)

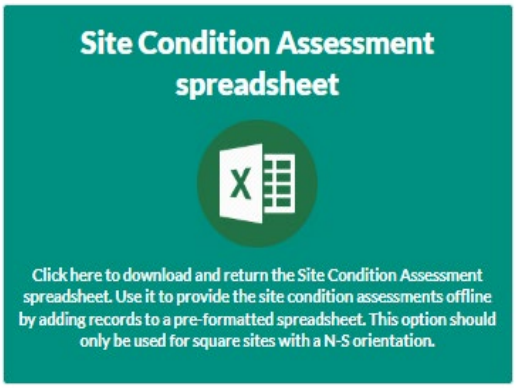
6.4 Upload Site Condition Assessments using a pre-formatted spreadsheet

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 must 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 permission of the data owner to share the data), and therefore have the right to upload the data.

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 spreadsheet **Title** and **Description** you provided when you attached the spreadsheet.

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).

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.

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.

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 climatic factors. 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 NIVS 6.0.

Probability – The probability (or chance) of an event occurring is recorded as a number between 0 and 1; the larger the probability or chance (i.e. closer to 1), the more likely an event is to occur.

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, https://data.mendeley.com/datasets/kpm44drn73/2. DOI: 10.17632/kpm44drn73.2.

Pirzl R, Dickson F, White MD, Williams KJ, Sinclair S, Brenton P, Warnick A, Raisbeck-Brown N, Liu C, Lyon P and Mokany K (2019) A National Reference Library of Expert Site Condition Assessments: Development and evaluation of method. Report to the Department of the Environment and Energy. CSIRO, Canberra, Australia. DOI: https://doi.org/10.25919/6txs-vy29.

Warnick A, Raisbeck-Brown N, Mokany K, Williams KJ, White MD, Metcalfe D, Prober SM, Dickson F, Sparrow B and Pirzl R (2019) Australian habitat image collection. v1. Data Collection. CSIRO, Canberra, Australia. DOI: https://doi.org/10.25919/5ce5e29fe1e81.

White MD, Hollings T, Sinclair SJ, Williams KJ, Dickson F, Brenton P, Raisbeck-Brown N, Warnick A, Lyon P, Mokany K, Liu C and Pirzl R (2023) Towards a continent-wide ecological site condition database using calibrated expert evaluations. Ecological Applications 33(1), e2729. DOI: https://doi.org/10.1002/eap.2729.

White MD, Raisbeck-Brown N, Williams KJ, Warnick A, Mokany K, Brenton P, Sathya Moorthy S and Pirzl R (2019) Habitat condition data for Australia from expert elicitation. v2. Data Collection. CSIRO, Canberra, Australia. DOI: https://doi.org/10.25919/5c7da9661dbcc.

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

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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.

Appendix A: Mathematical definition of a site condition score

A.1 Introduction to utility theory

As a novel approach for the elicitation of ecosystem condition assessments, HCAT 2024 has applied utility theory to develop a structured elicitation procedure for ecological experts. Utility theory was developed in 1944 by von Neumann and Morgensten (1944, 1953)[9] to describe a normative approach for coherent decision making where there are multiple options (e.g. what is the best option from some well-defined set of alternatives?). 'Utility' measures the satisfaction or preference a person has between options. In this case however, rather than measuring preferences between hypothetical alternatives, a modified utility approach is being applied to elicit expert opinion on habitat condition. This technique was chosen because, in contrast with the original HCAT that asked experts to intuit a score, it provides a consistent and probabilistic interpretation of condition that supports decision analysis in a range of applications. It also incorporates any uncertainty that you may have around your score, and so removes the need for additional assessments such as self-scaling or condition bounds (which were mandatory components of the original methodology in the 2018 version of HCAT).

In this 2024 version of HCAT, a site condition score, *c*, is a number between zero and one. By definition, a condition score of one ($c = 1$) corresponds to the overall highest possible condition score, and a condition score of zero ($c = 0$) corresponds to the overall lowest possible condition score. The condition score for a site between these values (site = *s*), is equivalent to a probability of *c* of obtaining the overall highest possible condition score of one and a probability of $1 - c$ of obtaining the overall lowest possible condition score of zero.

Your condition score for site *s* is the value of *c* such that the following two "lotteries" are equivalent:

1. Obtain the condition of site *s* for sure (the "sure thing" lottery);
2. Obtain the highest possible condition with probability *c* or the lowest possible condition with probability 1-*c* (the "uncertain" lottery).

A.1.1 What is a lottery?

As applied in HCAT, a lottery is a thought exercise that allows you to define the condition of any site. The term "lottery" refers to a hypothetical random process that produces outcomes with certain probabilities. For example, the auxiliary experiment might entail an imaginary draw of a

[9] von Neumann J and Morgenstern O (1944) Theory of games and economic behaviour (first edition). John Wiley and Sons, New York, U.S.A.

von Neumann J and Morgenstern O (1953) Theory of games and economic behaviour (third edition). Princeton University Press, New York, U.S.A.

winning ticket from a collection of tickets. DeGroot (1970)[10] suggests spinning a "wheel of fortune". Pratt (1965)[11] suggest drawing a single-coloured ball from a jar filled with a proportion of balls that are coloured and the remainder uncoloured, as was described in Section4.3. The key point is that it's not the process used by the auxiliary experiment that is important, but instead the generated probabilities for obtaining outcomes. The expected condition score is *c* for both lottery 1) and lottery 2) above.

For site condition, the probability *c* in the uncertain lottery is the probability of obtaining the highest condition. The probability 1 – *c* is the probability of obtaining the lowest condition. Imagine a jar containing a proportion of *c* green balls with remaining proportion 1 - *c* being white: the lottery returns the highest condition if a green ball is drawn, and the lottery returns the lowest condition if a white ball is drawn. The condition *c* of site *s* is the probability of obtaining the highest condition in the uncertain lottery or a green ball from the jar.

A.2 Application to condition and drivers

Therefore, in the context of a lottery, the condition of a site *s* is equivalent to a probability of obtaining the highest and lowest conditions. For example, a site *s* with an estimated condition score, *c* = 0.9, is equivalent to a 90% chance of the highest level of condition and 10% of the lowest level of condition. If the condition score estimated for the site, s, is *c* = 0.1, this would be equivalent to a 10% of the highest level of condition and 90% of the lowest level of condition. The score *c* is the probability of obtaining the highest condition in the uncertain lottery.

Similarly, your driver score (Section 6.3.6) for the negative impact on the condition of site *s* is the value of *d* such that the following two "lotteries" are equivalent:

1. Obtain the impact of the driver of site *s* for sure (the "sure thing" lottery);
2. Obtain the highest possible impact of the driver with probability *d* or the lowest possible amount of the driver with probability 1-*d* (the "uncertain" lottery).

By asking you to consider the condition of a site as a probability of getting two extremes, the condition score for a site represents your assessment of the actual habitat condition but can also be used to infer the probability of that site being in the highest condition or lowest condition. As a result, uncertainty is inherent in the score you provide.

[10] DeGroot MH (1970) Optimal Statistical Decisions. John Wiley & Sons, New Jersey, U.S.A.

[11] Pratt JW (1965) Bayesian Interpretation of Standard Inference Statements. Journal of the Royal Statistical Society: Series B (Methodological) 27(2), 169-192

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