Assessing Threatened Species in Queensland

A Practical Manual

Version 3.0

Queensland Government

Prepared by: Queensland Herbarium and Biodiversity Science, Department of Environment and Science

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Front cover image*: Aceratium ferrugineum* is known from a very restricted distribution in the Wet Tropics bioregion of north Queensland. The species is assessed as Near Threatened under the Nature Conservation Act 1992 and requires a reassessment using the Common Assessment Methodology. Image © Andrew Ford.

Back cover image: *Goodenia stirlingii* is restricted to the Wet Tropics and Einasleigh Uplands bioregion in north Queensland. The species was recently reassessed as Vulnerable using the Common Assessment Methodology. Image © Andrew Ford.

Leptospermum barneyense is known from a very restricted distribution on Mt Barney on the Country of the Danggan Balun People. The species was reassessed under the Common Assessment Methodology and endorsed by the Species Technical Committee as Endangered under Criterion B1ab(iii), due to climate-change induced fire regimes.

Image © Dr. Brodie Verrall.

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1 Introduction

1.1 Listing and changing the conservation status of Queensland species

All plant and vertebrate species native to Queensland (excluding most fish which are managed under the Queensland *Fisheries Act 1994*) are protected under the *Nature Conservation Act 1992* (*NC Act*). These taxa are assigned to various wildlife classes depending on their conservation status. Plants and vertebrates (excluding fish) are assigned a status of 'Least Concern', unless they have been assessed as eligible for a different wildlife class. A plant under the *NC Act* means any member of the plant or fungus kingdom. Fish and invertebrate taxa are only protected under the *NC Act* if they have been separately listed under a wildlife class. The Department of Environment, Science and Innovation (the Department) coordinates the process for species to be assessed and listed (or delisted) as under the *NC Act.*

The Species Technical Committee (STC) undertakes the expert assessment of species' listing nominations. Any subspecies, variety, race, hybrid, mutation or geographically separate population (hereafter 'species') can be nominated. Nominations can be prepared and submitted internally by State Government scientists, or externally by members of the public. Assessments can also be forwarded by other State/Territory or Federal jurisdictions responsible for listing species that occur in Queensland. The STC make recommendations to the Minister for the Environment and the Great Barrier Reef and Minister for Science and Innovation (the Minister) to list or change the wildlife class of a species. Once this has been approved, the species' updated class is then amended in the *Nature Conservation (Plants) Regulation 2020* or the *Nature Conservation (Animals) Regulation 2020.*

1.2 Common Assessment Method (CAM)

The Common Assessment Method (CAM) is a consistent approach to listing threatened species across all Australian jurisdictions (State, Territories and the C'wlth). Previously, species assessments were undertaken using different criteria, threat categories and scales of assessment, thus resulting in differences between lists and duplication of effort.

The Queensland Government is a signatory to the Intergovernmental Memorandum of Understanding – Agreement on a Common Assessment Method (CAM MOU) for listing of threatened species and threatened ecological communities. The CAM MOU outlines a standardised approach to species' assessments throughout Australia's State, Territory and Commonwealth jurisdictions. The approach is based on the International Union for the Conservation of Nature (IUCN) Red List categories and criteria. Under CAM, States and Territories lead the assessments for their respective endemic species, and the C'wlth leads assessments for cross-jurisdictional species. The Queensland Herbarium and Biodiversity Science is responsible for implementing CAM in Queensland.

To facilitate the implementation of CAM, Queensland amended the wildlife classes under the *NC Act* in August 2020. Species can now be listed in Queensland as Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) or Least Concern (LC). The CR, EN and VU categories are considered 'threatened'. (Prior to this, the CR category did not exist).

The IUCN does not have specific thresholds for NT. Rather, species can be considered NT where they "*do not qualify as threatened now, but may be close to qualifying as threatened, and to taxa that do not currently meet the criteria for a threatened category but are likely to do so if ongoing conservation actions abate or cease*". To avoid confusion, Queensland has introduced quantitative guidelines for the Near Threatened category.

Currently, the VU under D2 and NT categories are not present within C'wlth legislation. This means that a species can be listed as VU under D2 or NT in Queensland but remain not listed (Least Concern) under the *Environment Protection and Biodiversity Conservation Act (EPBC Act),* thus remaining 'misaligned'. Process is underway to introduce these categories to the C'wlth legislation, as part of the *EPBC Act* review. Conversely, the *EPBC Act* category of 'Conservation Dependent' is not available within the *NC Act.*

1.3 Using this manual

This manual is intended to be used alongside the Nomination to change the conservation status of a species under the *Queensland Nature Conservation Act 1992* form and the Guidance for using the nomination for to change the conservation class of a species under the *NC Act*. Each section in this manual aligns with those in the nomination form. This allows nominators to work sequentially through the nomination form, using the manual as a guide for each section.

Eucryphia wilkiei is restricted to elevations above 1000m on Mt Bartle Frere in the Wet Tropics bioregion. The species was recently reassessed using the Common Assessment Method as Critically Endangered due montane drying associated with future climate changes.

Image © Andrew Ford.

2 Collate background information

Start the assessment process by collating the relevant background information required to complete the nomination form.

- Nominators should bookmark important links for quick access:
    - Atlas of Living Australia (ALA) – Spatial Portal
    - Queensland Globe
    - Australasian Virtual Herbarium (AVH)
    - WildNet
- Create a folder labelled with the species name to save all relevant data and materials. This folder can then be easily shared with experts when reviewing the nomination, or other colleagues who may be assessing similar taxa. A suggested folder structure includes the following subfolders:
    - Nomination form
    - Data and maps
    - Correspondence
    - Photos
    - Supporting information (references and previous listing assessments)
    - Superseded files
- Download the nomination form and save it into the species folder.

2.1 Taxonomic information

- Check the current name of the species. Species names can change with taxonomic revisions and may differ between jurisdictions depending on the accepted taxonomy.
- For CAM-compliant listings, current names should be obtained from the Australian National Species List (which has multiple indices):
    - For flora, the accepted taxonomic authority is the Council of Heads of Australasian Herbaria, which is available via the Australian Plant Name Index (APNI). The name currently accepted in the Australian Plant Census (APC) will be indicated by a 'red tick' (Figure 1). Nominators should cross check the taxonomy in the Census of Queensland Plants (Bean 2024) and any updated names in HERBRECS (DES internal database). Where the taxonomy differs, this should be documented in section 3.1.2, pg. 21.
    - For fauna, the accepted taxonomic authority is generally the Australian Faunal Directory. Nominators should cross check the currently accepted taxonomy in WildNet. (AFD; Figure 2). Where the taxonomy differs, this should be documented in section 3.1.2, pg. 21.
    - For bryophytes, lichens, algae and fungi, follow the Census of Queensland Plants (Bean 2024), and / or the relevant list within the Australian National Species List.
    - For varieties (flora only), the Queensland Plant Census (Bean 2024) should be followed.
- Note any synonyms that may be useful to include in the literature review (see Literature Review, pg. 19).
- Identify and save the taxonomic authority reference paper. This is the paper where the species has been described. For plants, the reference for this should be listed in your APNI search (Figure 1). Most taxonomic descriptions are published in the Queensland Herbarium journal *Austrobaileya,* which is freely available online (see Key Resources, p. 85).
- Where the original taxonomic paper is historic, it may be appropriate to refer to a contemporary description the species. For fauna, edited field guides / reference texts such as *Reptiles and Amphibians of Australia* (Cogger 2018) may be suitable. For flora, a contemporary description may be found in the *Flora of Australia.* Note that the botanical / scientific name will retain the authority of the original species author.

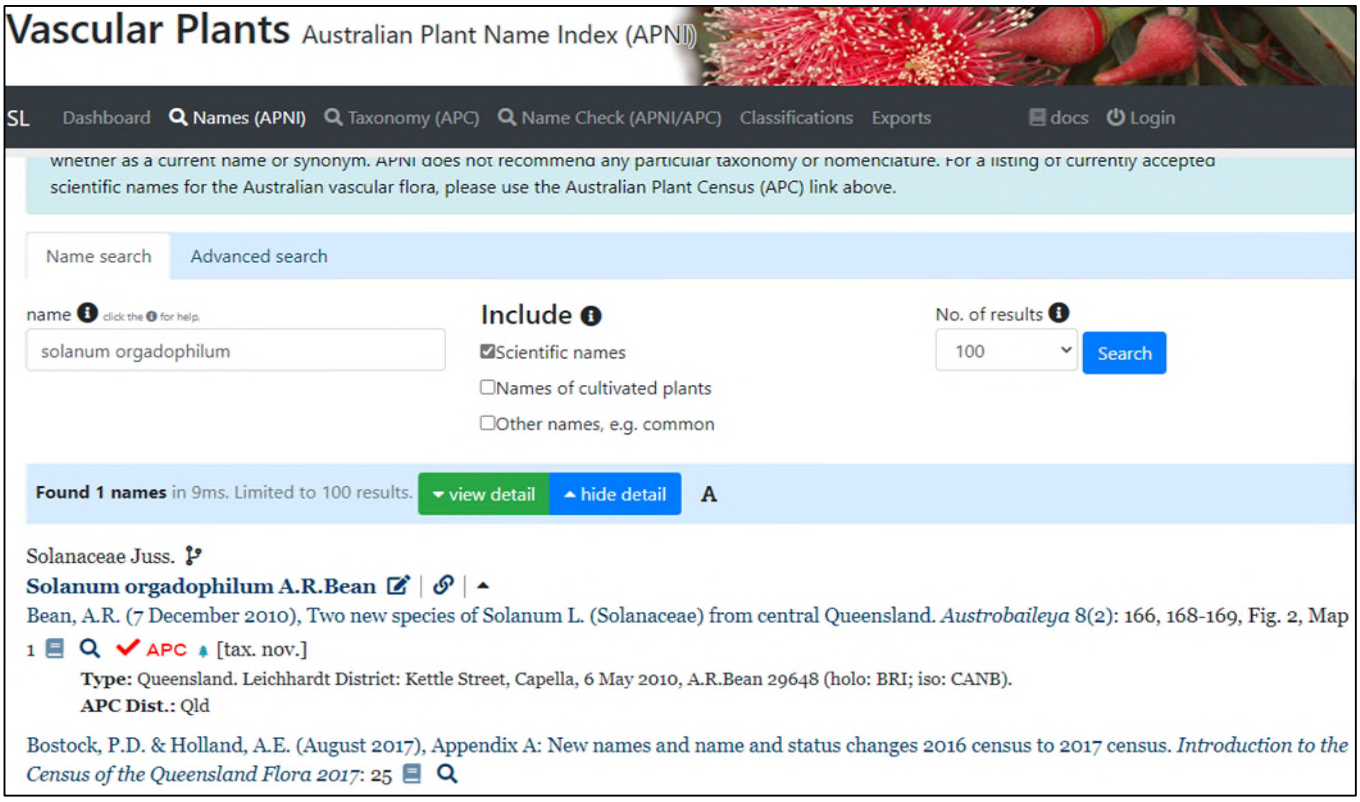

Figure 1. Screenshot of the Australian Plant Name Index, showing a search for *Solanum orgadophilum*. The red text indicates the currently accepted taxonomy.

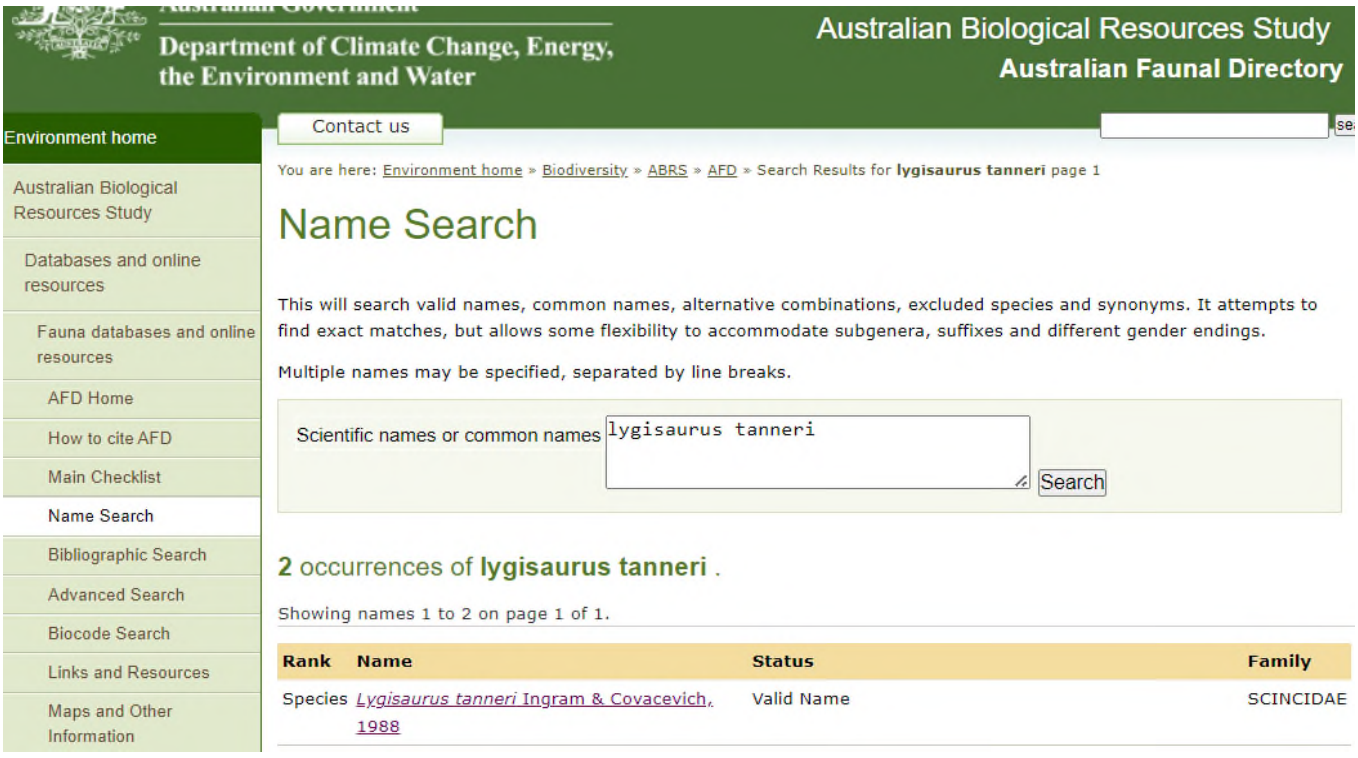

Figure 2. Screenshot of the Australian Faunal Directory, showing currently accepted taxonomy for *Lygisaurus tanneri.*

2.2 Distribution information

Information on where a species occurs is used to calculate key assessment parameters as part of the nomination. This data can come from a variety of different sources. The most reputable sources are “vouchered” specimen-backed records. Records associated with other surveys (i.e. field surveys) may also provide important information, as do personal communications.

Note that some taxa have confidential records. If you are preparing a nomination for a species that has confidential records, nominators will need to seek guidance from someone with appropriate authority or permission to use these. Publicly available records for these species will be obscured, and thus not in a form suitable for a nomination. A list of confidential (sensitive) records for Queensland species can be found here.

2.2.1 Flora occurrence records

There are two key sources of occurrence records used in Queensland flora nominations. These are the Queensland Herbarium (BRI) records and Australasian Virtual Herbarium (AVH), which contains records from other herbaria. The following section explains how to access these records.

2.2.1.1 BRI records

The most reliable source of collection records for Queensland endemic flora are the BRI records. These records are specimen-backed and stored at the Queensland Herbarium. These records are publicly available on AVH, but will have generalised coordinates for confidential species. These records should be reviewed and ‘cleaned’ by an expert prior to use. Cleaning should correct imprecise geo-referencing, remove duplicates, remove dubious records and review outliers to determine if they are correctly identified (see section 2.2.4).

2.2.1.2 AVH

Where access to BRI records is not available or you are completing a nomination for a species that occurs outside of Queensland, you can retrieve records from AVH. It can also be useful to download these records to supplement the BRI records, as in some cases other herbaria will hold collections of Queensland endemic taxa. For example, the Australian Tropical Herbarium (CNS / QRS) may hold additional specimen-backed records for taxa endemic to northern Queensland. Records for Queensland-endemic taxa held by other State herbaria (e.g. NSW) can also be used, however the identity of these specimens should be carefully reviewed.

To download records from AVH:

- In “simple search” type the species name and select “download” (Figure 3).
- Follow the prompts to “login” to the Atlas of Living Australia.
- Select “occurrence records”.
- Rename the “File name” with a date and the species name (i.e. YYYYMMDD_Genus-species-subspecies)
- Select “Full Darwin Core” for the download format.
- Select “.csv” as the output file format.
- In Step 2, select the relevant industry / application.
- A link to the folder will be provided via email.
- Download and “unzip” the folder by right clicking and selecting “extract all”. Save in the species’ folder.

2.2.1.3 Queensland Biodiversity and Ecology Information System (QBEIS)

For some Queensland flora, additional records will be available within state site monitoring datasets – QBEIS (formerly CORVEG). As these records are not backed by a specimen (but are field observations) it is extremely important they are spatially reviewed by an expert, with any outliers investigated prior to inclusion in a nomination. These non-specimen backed records *should only be included for taxa that are easy to identify in the field, and be used to calculate a maximum plausible bound for EOO and AOO (see section 3.4, pg. 51).* Additional data associated with these records (i.e. site disturbance, stems/ha) may be useful in other areas of the nomination.

- QBEIS records are available here.
- Add to cart and follow the prompts (Figure 4).
- Alternatively, ask your manager directly to provide this.

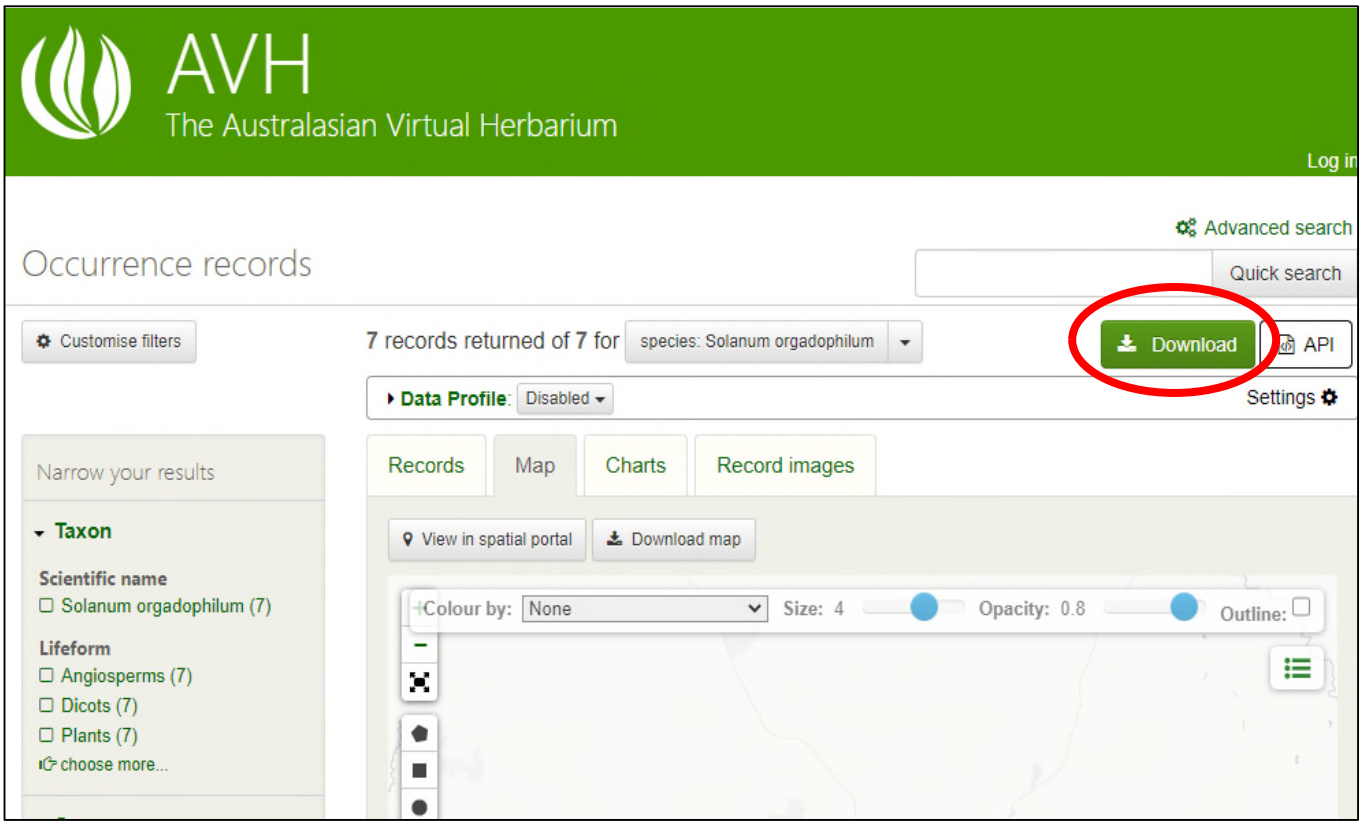

Figure 3. Screenshot of the AVH website interface, showing the 'download' button (red ellipse).

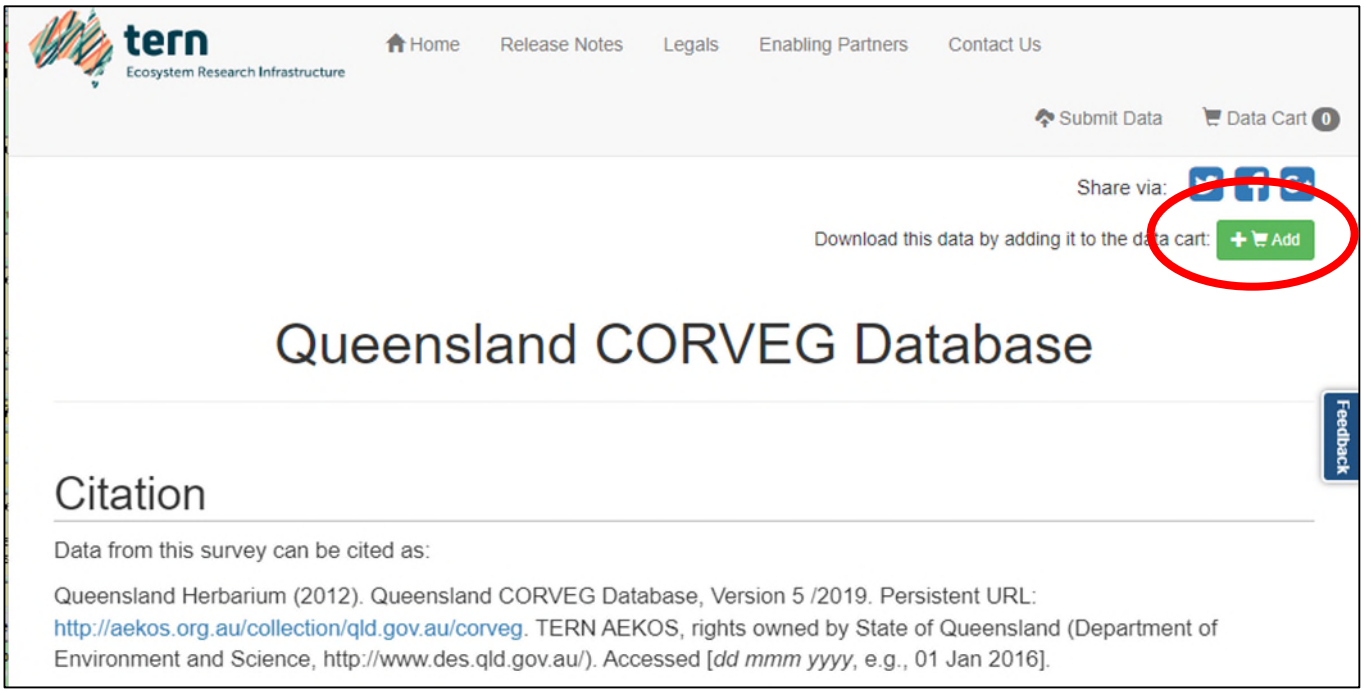

Figure 4. Screenshot of web page to download data from the Queensland CORVEG (now QBEIS) database. Nominators should 'add' the Queensland CORVEG Database to the data cart (red ellipse) and follow the prompts to download.

2.2.2 Fauna occurrence records

Fauna records are typically held over several dispersed databases including WildNet, QBERD, Queensland Museum and Australian Museum databases. Experts will also often have their own personal, unpublished data. Records within WildNet tend to have the highest precision and should be accessed first. Then, data from ALA that is not within the WildNet records should be downloaded and considered for inclusion based on the source. Typically, fauna nominations should include records from WildNet, and any additional records from Queensland Museum and Australian Museum (obtained directly or via ALA). Records from other institutions outside of Queensland will need careful vetting. It is crucial all records are 'cleaned' by an expert, particularly where they are historic. Cleaning should correct imprecise geo-referencing, remove duplicates, remove dubious records and review outliers to determine if they are correctly identified (see section 2.2.4).

2.2.2.1 WildNet records

For taxa endemic to Qld, fauna records can be obtained from the WildNet Database.

- Go to WildNet – Species Profile Search.
- Enter the species name and search, click the species profile from the search results.
- Check the taxonomy / name is current (Figure 5; Figure 6).
- Then, download the list of records as a .csv (Figure 5; Figure 6).

2.2.2.2 Atlas of Living Australia records

Check Atlas of Living Australia for records from Queensland Museum and Australian Museum that are not already included in the list of records from WildNet.

- Go to Atlas of Living Australia.
- Enter the species name and search, click the species profile from the search results.
- In the "Overview" tab, select "View and download occurrence records", located under the map showing occurrence records.
- On this page you can examine the information for each record individually by clicking on the record and/or download all records on the database for the species by clicking "Download".
- Create log in details or use alternative sign in options.
- Follow prompts for download – select occurrence records, select "Full Darwin Core" for download format. select "CSV" for output file format.
- Save data to species folder.
- In addition to cleaning data as per Section 2.2.4 below, check for and delete duplicates from WildNet Database and remove data from sources other than Queensland Museum and Australian Museum.

2.2.3 Other occurrence record sources

It can be useful to contact experts to obtain additional species records. If experts can provide additional records, it is important for nominators to check for significant outliers. Inclusion of records that are not specimen-backed should be clearly stated and justified in the distribution section. Inclusion could potentially be justified on the basis of a high-quality photograph of the species that clearly shows its distinguishing features. Additional records that are included from experts should have accurate latitude and longitude information, including any other field notes that the expert can provide.

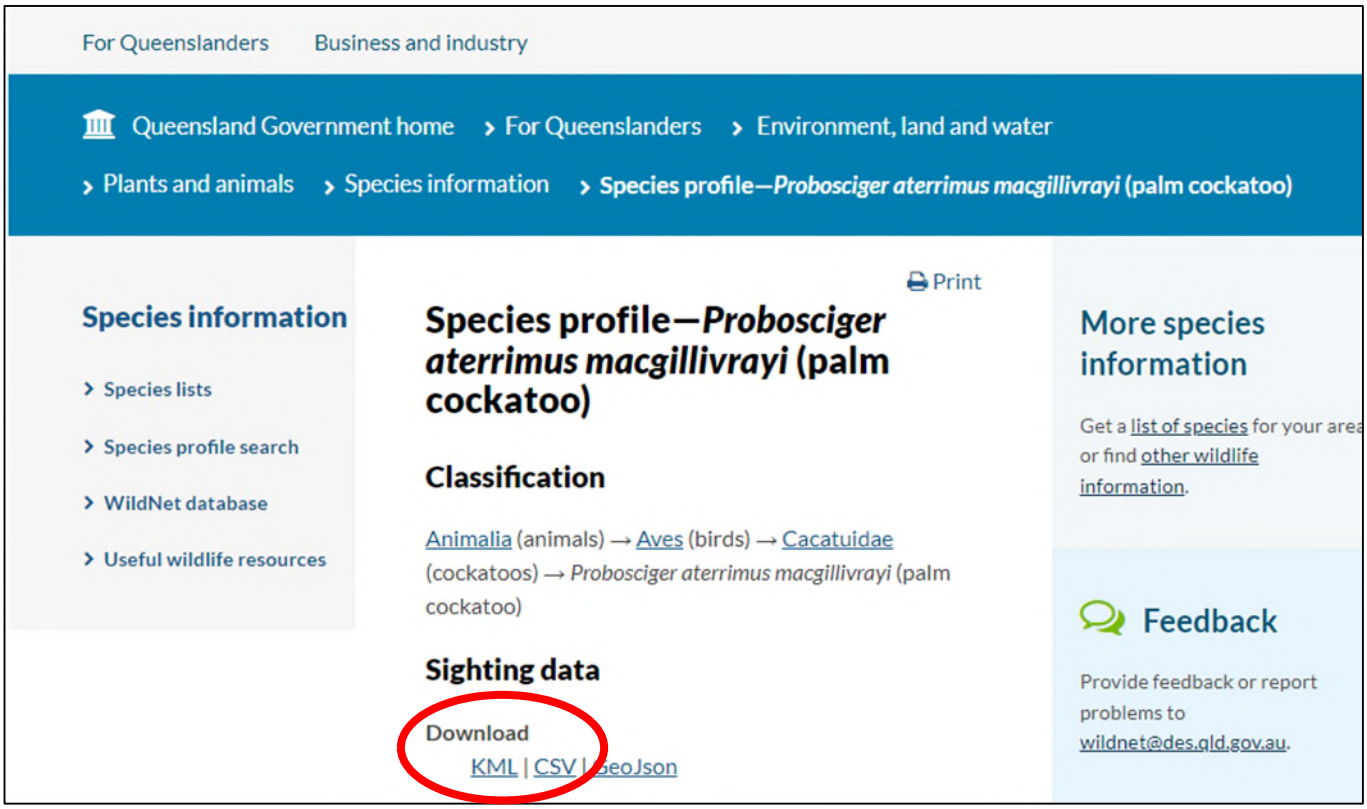

Figure 5. Screenshot of Species profile (WildNet) webpage, showing download button for WildNet records in red ellipse.

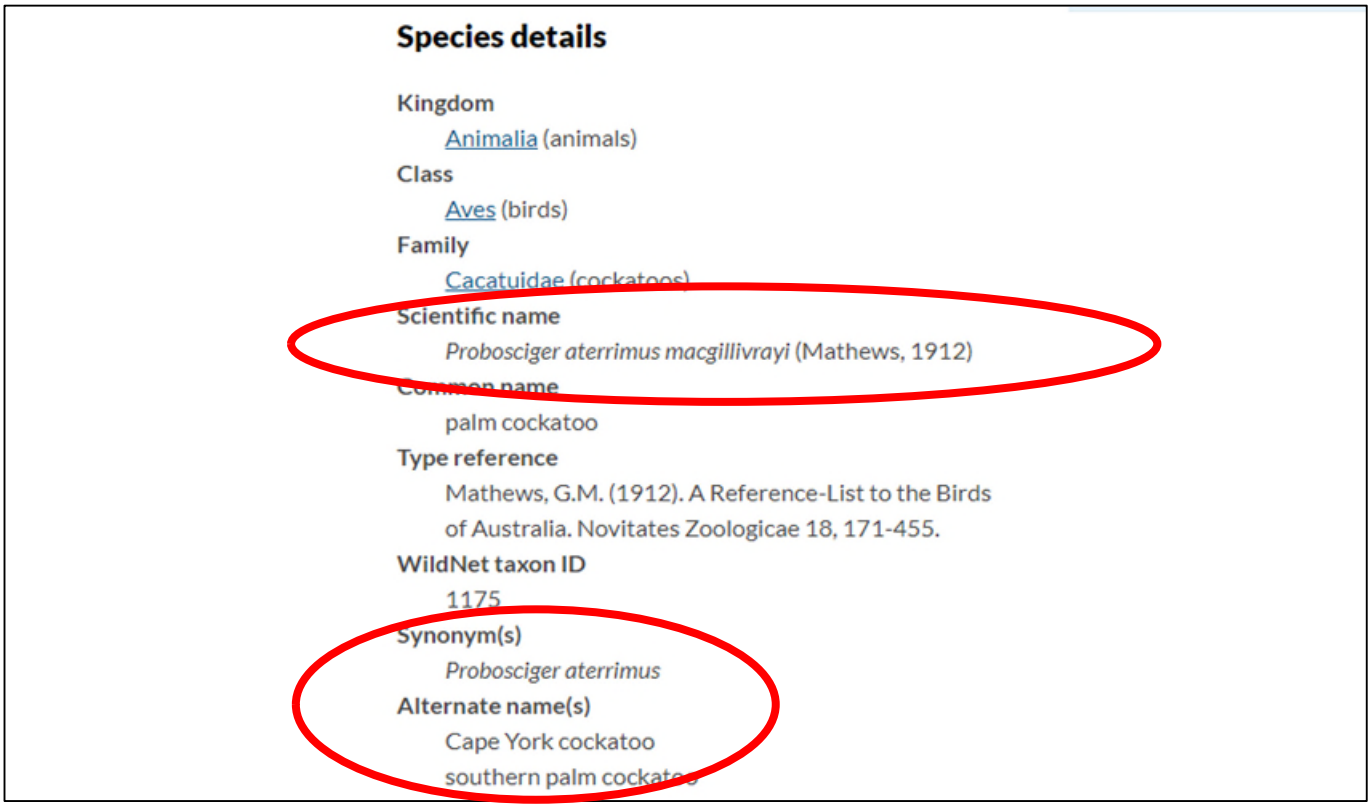

Figure 6. Screenshot of Species profile (WildNet) webpage, showing the accepted Scientific name and author, synonyms and alternate (common) names (red ellipses) for a fauna species.

2.2.4 Data cleaning

Occurrence data downloads will be in a spreadsheet format. To ensure this data is fit-for-purpose it will need to be 'cleaned'. Follow these steps to clean the occurrence data:

- Check the spreadsheet(s) refers to the correct species.
- Delete any unnecessary columns.
- Ensure the columns containing the latitude and longitude in decimal degrees are renamed as "Latitude" and "Longitude" so they can be imported into the ALA Spatial Portal and Queensland Globe.
- For AVH flora records, remove duplicate records by checking the "recordNumber" column for repeated values and prioritise the retention of BRI records.
- Check the precision of the occurrence records (in AVH this will be labelled "coordinateUncertainty"). Generally, any records with precision of >2000km should be reviewed for accuracy. Any records with poor precision, where the locality description does not match the actual GPS location should be moved in consultation with the relevant expert. Where records cannot be verified, consider deleting any that have a precision of >10,000km.
- If you can improve the precision of any records, provide this information to the relevant person / organisation (i.e., your manager), who can ensure the data curator is notified.
- Ensure the final file is saved in a .csv format for use in the ALA Spatial Portal and Queensland Globe.

Rename column headings to match Darwin Core terms and rearrange in the following order:

- **scientificName** to identify the organism.
- **institutionCode** to determine the herbaria.
- **catalogNumber** to distinguish each unique record.
- **recordNumber** to determine the collecting number and remove duplicates.
- **recordedBy** to determine the collector.
- **eventDate** to identify the date of the occurrence record.
- **decimalLatitude** to indicate the location of the occurrence record.
- **decimalLongitude** to indicate the location of the occurrence record.
- **maximumElevationInMeters** to indicate the elevation of the occurrence record.
- **coordinateUncertaintyInMeters** to determine the accuracy of the occurrence record.
- **Locality** to identify the broad area where the occurrence record was taken.
- **fieldNotes** provides information on habitat and sometimes abundance.
- **habitat** provides information on habitat.

For use in the ALA Spatial Portal, imported data needs to include the correctly named columns:

- **scientificName** to identify the organism.
- **catalogNumber** to distinguish each unique record.
- **eventDate** to identify the date of the occurrence record.
- **decimalLatitude** and **decimalLongitude** to indicate the location of the occurrence record.

The column headings will differ depending on the data source, so combination and homogenisation of fields is often required. An example of cleaned specimen records is provided in Appendix 1.

2.3 Literature review

Undertake a literature review for the species. Save any information you can find on the species into the species folder. Peer-reviewed publications on the species or its genus are especially valuable. If information is scarce, information on related taxa will be particularly useful. Remember to search for synonyms (previous names) of the species. Some sources of literature to consider:

- The original species nomination form (if the species is currently listed as threatened). This may be unpublished and need to be requested from the Queensland Herbarium.
- The taxonomic paper where the species was described.
- Peer-reviewed journal articles (Google Scholar or similar) related to the biology and ecology of the species or the genus more broadly.
- Textbooks
- Field guides
- Management Plans for conservation areas where the species occurs.
- The Species Profile and Threats Database (SPRAT) if the species is already listed at the Federal level.
- Grey literature sources from local governments / councils / NRM groups.

Familiarise yourself with the content of the literature you have found. Start to think about how it might relate to each of the nomination form sections.

Xanthostemon verticillatus occurs on the lands of the Eastern Kuku Yalanji Bama (People) and is restricted to the Wet Tropics bioregion in northern Queensland. It was reassessed using the Common Assessment Methodology as Vulnerable due to plausible future threats associated with infrastructure, invasive weeds and feral pigs.

Image © Andrew Ford.

3 Completing the nomination form

This section explains the level of detail required for each of the nomination form sections. Each heading below corresponds to a section in the nomination form. These are presented sequentially as per the nomination form.

3.1 Details of the nominated species

3.1.1 Name of species

The following section describes how to define the nominate species for the purposes of assessment.

If there is any contention about the species' name, or description whilst filling out this section of the form, it may indicate some taxonomic uncertainty. Taxonomy can influence the listing outcome for a species. If nominators find evidence to suggest the species may not be taxonomically sound, it is important to seek guidance from the Species Technical Committee and / or the relevant expert (i.e. curator) to determine whether to progress the species assessment. Check in with your manager or relevant expert for support.

3.1.1.1 Scientific name

Provide the scientific name including species author (Box 1).

3.1.1.2 Common name

Enter frequently used common names for the species (Box 1). Nominators may include any published Indigenous names, if they are from a reputable source, preferably connected to the Traditional Custodians. For example, a bush-tucker book authored by the relevant Traditional Custodians. If used, it may be helpful to provide the First Nations group in brackets after the relevant name.

Note that the style guidelines for the Queensland Herbarium do not capitalise common names unless they form part of a common noun. For example, 'Capella potato bush'.

Box 1. Example of text format for the 'Name of species' in the nomination form.

Scientific name

Magmellia luteilateralis Covacevich & McDonald 1980

Common name

orange-speckled forest skink

3.1.2 Taxonomy

3.1.2.1 Scale of categorisation

Select the relevant taxonomic categorisation for the nominate species. According to the CAM MOU, eligible species include all native organisms within the taxonomic units of species, subspecies and varieties. Populations and hybrids are also eligible if they meet specific criteria (see below).

Taxa should only be listed at one taxonomic level (i.e. species or subspecies, but not both). Nested listings, where taxa are listed at multiple levels are being resolved as part of CAM implementation. Where a taxon is listed at the species level, it includes relevant infra-specific taxa. Where a taxon is listed at the infra-specific level, other relevant infra-specific taxa require a separate assessment.

3.1.2.2 For a population

Populations can be nominated if they are:

- not part of a taxon that is eligible for listing as nationally threatened; and
- geographically isolated; and
- distinct; and
- able to be defined in a way that differentiates it from all other populations.

Geographic isolation should be justified with reference to the dispersal capacity of the taxon. Distinctiveness should

be justified using evidence of distinct genetics, phylogeny, morphology, ecology, physiology, behaviour, ecosystem role or other aspect of the population's biology. Justify the scale of categorisation for a population in the box provided (see Box 2. Example justification for nominating a population based on geographic isolation, genetic and morphological distinctness, and the species of which the population is a part not being eligible for a national threatened).

Nominators should contact the Species Technical Committee or relevant experts to seek prior endorsement for nominating a population.

3.1.2.3 For a hybrid

Hybrids can be nominated if they are:

- a distinct entity (the progeny are consistent within the agreed taxonomic limits for that taxon group);
- capable of self-perpetuating (not reliant on parent stock for replacement); and
- the product of a natural event (both parents are / were naturally occurring, and cross-fertilisation was by natural means.

Box 2. Example justification for nominating a population based on geographic isolation, genetic and morphological distinctness, and the species of which the population is a part not being eligible for a national threatened status*.

Details

Nepenthes mirabilis (Bramston Beach) is a distinguished population of the greater *N. mirabilis* taxon, of which the main population occurs in the Cape York Peninsula (CYP) from the Jardine River south to the Silver Plains on the east coast, and south of Aurukun on the west coast (Figure 1) (A. Field, pers. comm. 2023; A. Ford, pers. comm. 2023). *Nepenthes mirabilis* (Bramston Beach) is distinguished from the northern population by its homozygosity, whereas the northern population has been observed to hybridise with other *Nepenthes* spp., namely *N. tenax* and *N. rowanae*; which co-occur with *N. mirabilis* within the CYP *N. mirabilis* distribution (A. Field, pers. comm. 2023). While it is not impossible that *N. mirabilis* (Bramston Beach) may have the ability to obtain heterozygous genetics resulting from hybridisation, the fact that it has not hybridised thus far distinguishes the population from the CYP *N. mirabilis* population by being the most genetically isolated and highly homozygous population (A. Field, pers. comm. 2023).

A preliminary assessment of *N. mirabilis* indicates the species is not eligible for listing as threatened on a national scale. Therefore, *N. mirabilis* (Bramston Beach) is considered eligible for a population level assessment under the Common Assessment Method.

*Excerpt adapted from Riddell, K.B. (2023). Nomination to change conservation class of *Nepenthes mirabilis* (Bramston Beach) under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

3.1.2.4 For conventionally accepted species

Conventionally accepted species are those that are formally described and listed in the relevant taxonomic authority for flora and fauna, respectively. For flora, the accepted taxonomic authority is the Council of Heads of Australasian Herbaria, listed in APNI. However, nominators should also refer to the currently accepted taxonomy in the Queensland Plant Census (Bean 2024). If the nomenclature differs, nominators should contact the Species Technical Committee for advice on which nomenclature to use, and the decision should be documented in Section 3.1.2.6 below).

For fauna, the accepted taxonomic authority is either the Australian Faunal Directory, except where the State agrees on an updated taxonomy and nomenclature based on the latest scientific evidence. Nominators should also refer to the currently accepted taxonomy in WildNet. If the nomenclature differs, nominators should contact the Species Technical Committee for advice on which nomenclature to use.

For algae, bryophytes, lichens and fungi, the accepted taxonomic authority is listed in the corresponding Australian National Species List, but also follow Bean (2024).

This section should also be completed for 'populations' and 'hybrids' described in Section 3.1.2.2 and 3.1.2.3, using the taxonomy of the species.

3.1.2.5 For species that are not conventionally accepted

Species that are not considered conventionally accepted are those without a formal (published) description, that are also not included in the relevant taxonomic authority for flora and fauna, respectively. This includes species with phrase or hispid names (e.g., *Stackhousia sp.* (McIvor River J.R.Clarkson 5201)). If the species is not conventionally accepted nominators will need to provide either:

- a taxonomic description of the species in a form suitable for publication in conventional scientific literature, OR
- evidence that a scientific institution has a specimen of the species, and a written statement signed by a person who is a taxonomist and has relevant expertise (has worked with or is a published author on the group of species nominated) that the species is a new entity.

3.1.2.6 Taxonomic authority details

Include the full reference for the taxonomic description for the scientific name of the species (Box 3). Include details of hybridisation. These may be included in the species description, or in other literature. Nominators may need to return to this section after completing the 'Biology and ecology' section, which involves a broader review of literature for the species.

Ensure the relevant details of any taxonomic uncertainty or confusion are presented here, alongside explanations of alternate taxonomic opinions (if taxonomy is in doubt).

3.1.2.7 Order / family

Write the order and family for all species (Box 3). For fauna, consult WildNet; for flora, consult the Queensland Plant Census (Bean 2024).

3.1.2.8 Synonyms

List any synonyms, and preferably include the authors. These may be in the taxonomic description or in the relevant Australian National Species List index (i.e., APNI or AFD), identified by the label *'syn'* (Box 3).

Box 3. Example of text format for the Taxonomy section in the nomination form*.

Taxonomic authority details Covacevich, J and McDonald, KR 1980, 'Two new species of skinks from mid-eastern Queensland rainforest', *Memoirs of the Queensland Museum*, vol. 20, pp. 95-101.
Order/family Squamata: Scincidae
Synonyms *Sphenomorphus luteilateralis, Eulamprus luteilateralis, Tumbunascincus luteilateralis, Concinnia luteilateralis*

*Excerpt adapted from Parisi, MA. (2023). DRAFT nomination to change conservation class of *Magmellia luteilateralis* under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

3.1.3 Description

Present the description in two paragraphs as set out in the example below (Box 4).

- First, provide a full description, as a direct excerpt from your taxonomic description. Ensure it is in inverted commas, italicised and referenced.
- Second, describe the distinguishing features of the species, including closely related taxa, and how the species being assessed is differentiated from these taxa. This is often stated in the taxonomic description or dichotomous key of the genus. If it was described some time ago, check for updated information by reviewing descriptions from closely related taxa.

Box 4. Example text for the Description section of the nomination form*. There should be two key paragraphs: the full description and an overview of distinguishing features.

Full description (as in Bean 2010): "*Erect herbaceous resprouter, 0.2-0.4 m high. Adult branchlets white, grey or brown; prickles 1-5 per decimeter, straight, acicular, 1-3.5 mm long, 5-8 times longer than wide, glabrous or with scattered stellate hairs on lower half; stellate hairs dense or very dense, 0.4-0.7 mm diameter, stalks 0-0.15 mm long; lateral rays 7-8, porrect, central ray 0.3-1.3 times as long as laterals, not gland-tipped; type 2 hairs absent. Adult leaves ovate or broadly ovate, margins entire but often undulate; ...*"

Distinguishing features

This species belongs to the *S. macoorai* group but is easily distinguished from other species. It is most similar to *S. jucundum*, but differs in plant height, prickle length, leaf shape, corolla indumentum and habitat (Bean 2010).

*Excerpt adapted from Collingwood T.D. (2021). Nomination to change the conservation class of *Solanum orgadophilum* under the Queensland Nature Conservation Act 1992. Queensland Department of Environment and Science.

Summary of documentation requirements for Taxon details

- The species' name, including accepted scientific name and author abbreviations (or voucher specimen reference for undescribed species); order / family, synonyms (where relevant); common name(s); and Indigenous names (where known).
- Taxonomic authority reference, current taxonomic status and areas of uncertainty / confusion.
- The taxonomic level being assessed (e.g. species, subspecies, variety, population), noting that a taxon should only be represented (listed) at <u>one</u> taxonomic level.
- If the taxon is a population or hybrid, a clear statement on how the population meets the requirements above.
- Confirmation that the entity is conventionally accepted; or, if *not* conventionally accepted:
    - a taxonomic diagnosis and description of the species/subspecies in forms suitable for publication in conventional scientific literature; or
    - evidence that a scientific institution (such as state/territory museum or herbarium) has a voucher specimen of the species/subspecies; and
    - a written statement signed by a taxonomist or other person who has relevant expertise, confirming the validity of the new species/subspecies.

3.1.4 Distribution

In this section, several important metrics will be defined that are used to assess the species against the criteria. Nominators will also start to build a picture of potential threats that may be relevant to the species. There are five key steps:

- Confirm the scale of assessment.
- Estimate the EOO and AOO.
- Present information on the subpopulations and population size for the species.
- Make a series of maps that display the spatial context of the species.
- Describe and interpret these maps in a succinct series of paragraphs (see Section 3.1.5.3).

Minimum software requirements include an internet browser to access the ALA Spatial Portal and Queensland Globe (see Key resources, pg. 85). The calculate AOO and EOO tool within the ALA Spatial Portal can be used to assess the species' distribution metrics and Queensland Globe is used to assess the landscape context of the species. Nominators experienced in using GIS packages (i.e., QGIS, ArcPro or ArcGIS) can use these in place of Queensland Globe. However, this will require experience in downloading and manipulating spatial layers from Queensland Spatial Catalogue.

3.1.4.1 Scale of assessment

Under CAM, species must be assessed at the national scale. This means that their entire distribution within Australia, regardless of State jurisdictions, must be included in the assessment. Usually, Queensland-led assessments focus on Queensland-endemic species, for which records only occur within Queensland.

In some instances, however, species that only occur within Queensland within Australia, will also have an international distribution. For flora, this typically includes species that are also distributed throughout Papua New Guinea and Indonesia. For fauna, this may also include cases where species are visiting / migratory. The following rules of scale apply to nominations under CAM:

- Species are assessed at the national scale (all occurrences within Australia, but no occurrences outside of Australia)
- Where a species is vagrant (only occur in Australia on a random or occasional basis, without reliable breeding in Australia), they are not typically eligible for assessment.
- Where a species is visiting or migratory (that use part of Australia for their life cycle or migration route), they should be assessed on factors critical to their life cycle within Australia (breeding sites, feeding grounds or other significant habitat), and their relative risk within and outside Australia.
- Where a species has a contiguous global population (e.g. pelagic fish and marine organisms), they are assessed per their national distribution, however global threats that may impact the national assessment can be considered.
- Where a species has a discrete Australian population, they are assessed at the national scale with no adjustment for global distribution or threats.

Nominators should confirm the scale of assessment and seek clarification from the STC for any issues / questions.

3.1.4.2 Estimating the Extent of Occurrence and Area of Occupancy

The Extent of Occurrence (EOO) and Area of Occupancy (AOO) are the primary metrics used to measure the spatial spread of risk to a species being assessed. The Extent of Occurrence is defined as *"the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a species, excluding cases of vagrancy"* (IUCN 2012, pg. 11). This is measured using a minimum convex hull (IUCN SPC 2022). The Area of Occupancy is defined as *"the area within its EOO which is occupied by the species, excluding cases of vagrancy"* (IUCN 2012, pg. 11). This is measured using 2 x 2km grid cells (IUCN SPC 2022). Refer to Criterion B (pg. 62), or the relevant section in the IUCN Guidelines (IUCN SPC 2022) for further explanation of these terms.

Follow these steps to estimate the EOO and AOO in the ALA Spatial Portal:

- Save the final 'cleaned' version of occurrence records in .csv format using the column headers outlined in section 2.2.4.

- Ensure the scientificName, eventDate, decimalLatitude and decimalLongitude column names are correct prior to importing cleaned records, or alternatively change them when processing data in the ALA Spatial Portal (see Figure 8).
- Select “Import” > “Points”. Then, for step 1. Load data here - select “Load File” > “Select File” (Figure 7; Figure 8).
- For step 2. Check our initial interpretation, ensure your column headers are readable, select “Column headers” for your first line, and conduct a final check of your data before proceeding to step 3. Process sample and upload to sandbox. Input your species and select “Upload your data” (Figure 9).
- In the toolbar, select the first icon (magnifying glass) for your newly added species data layer to zoom to the extent of records. Select the colour red for these points.
- To calculate EOO and AOO, select the Tools dropdown tab > “Calculate AOO and EOO”. The default settings will be 1. Apply to area = “World” > 2. Select species = “your species occurrence points” > 3. AOO grid resolution “0.02” > 4. Alpha value =”2”. Do not change these settings, and then select “Next”. This will start a process and zip download containing all metrics and relevant spatial files.
- Deselect “Points Radius” and “Alpha Hull” layer in left toolbar and change EOO colour to white and AOO colour to black. EOO and AOO metrics can be viewed by selecting the information icon for each respective layer. Select map options and change base map to “Hybrid” before selecting “Download map” (Figure 10).
- Insert this map into the Distribution section of the nomination form labelled as **Figure 1** (see Box 5 for a comparable map generated with GIS software).

If the EOO is less than the AOO, the EOO should be changed to make it equal to the AOO to ensure it is consistent with the definition of the AOO as an area within the EOO (IUCN SPC 2022, pg. 50).

EOO cannot be calculated with less than three data points as it will typically be less than 0. In this case, the AOO is used as the EOO, as EOO cannot be smaller than the AOO.

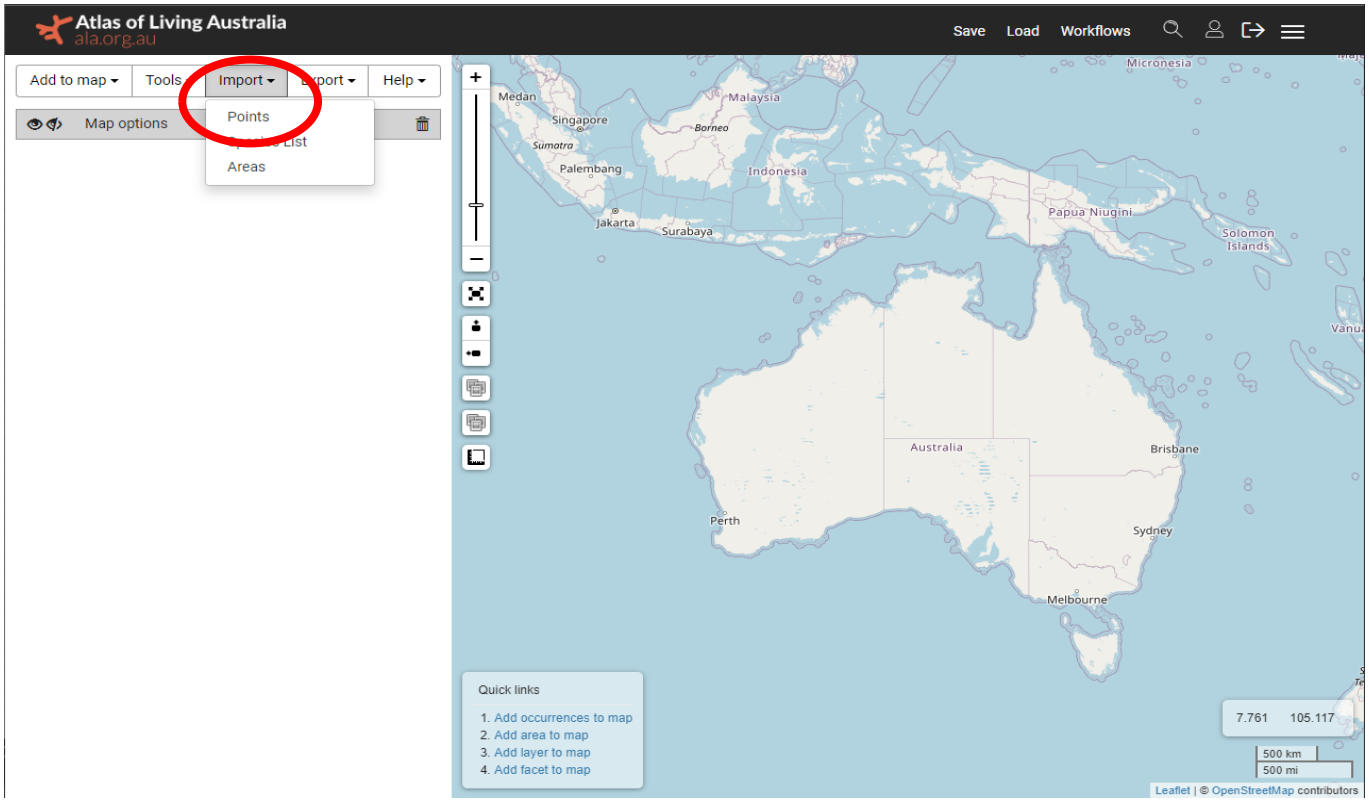

Figure 7. Screenshot of the ALA Spatial Portal. Nominators must import points by loading cleaned records saved as a .csv to calculate EOO and AOO (red ellipse).

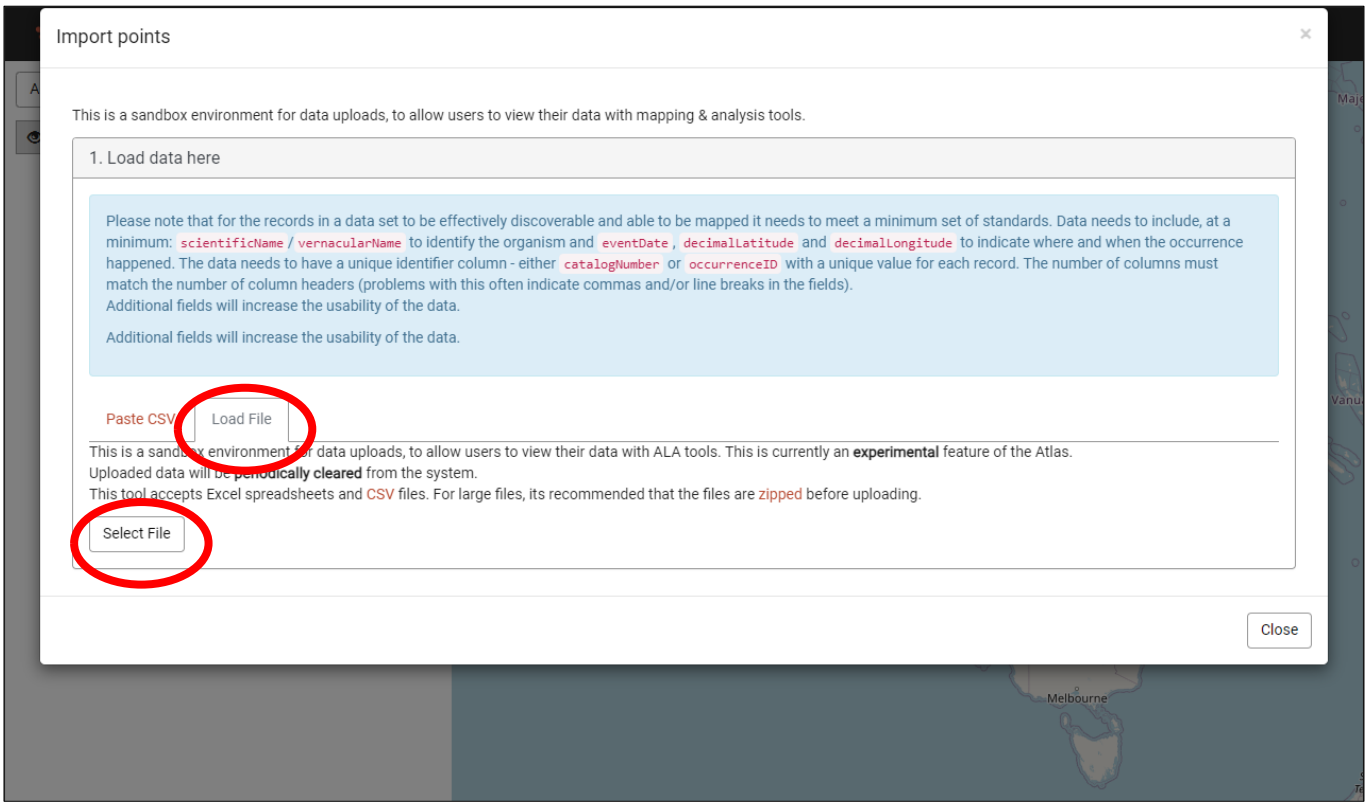

Figure 8. Screenshot of the ALA Spatial Portal. Nominators must import points by loading cleaned records saved as a .csv to calculate EOO and AOO (red ellipses).

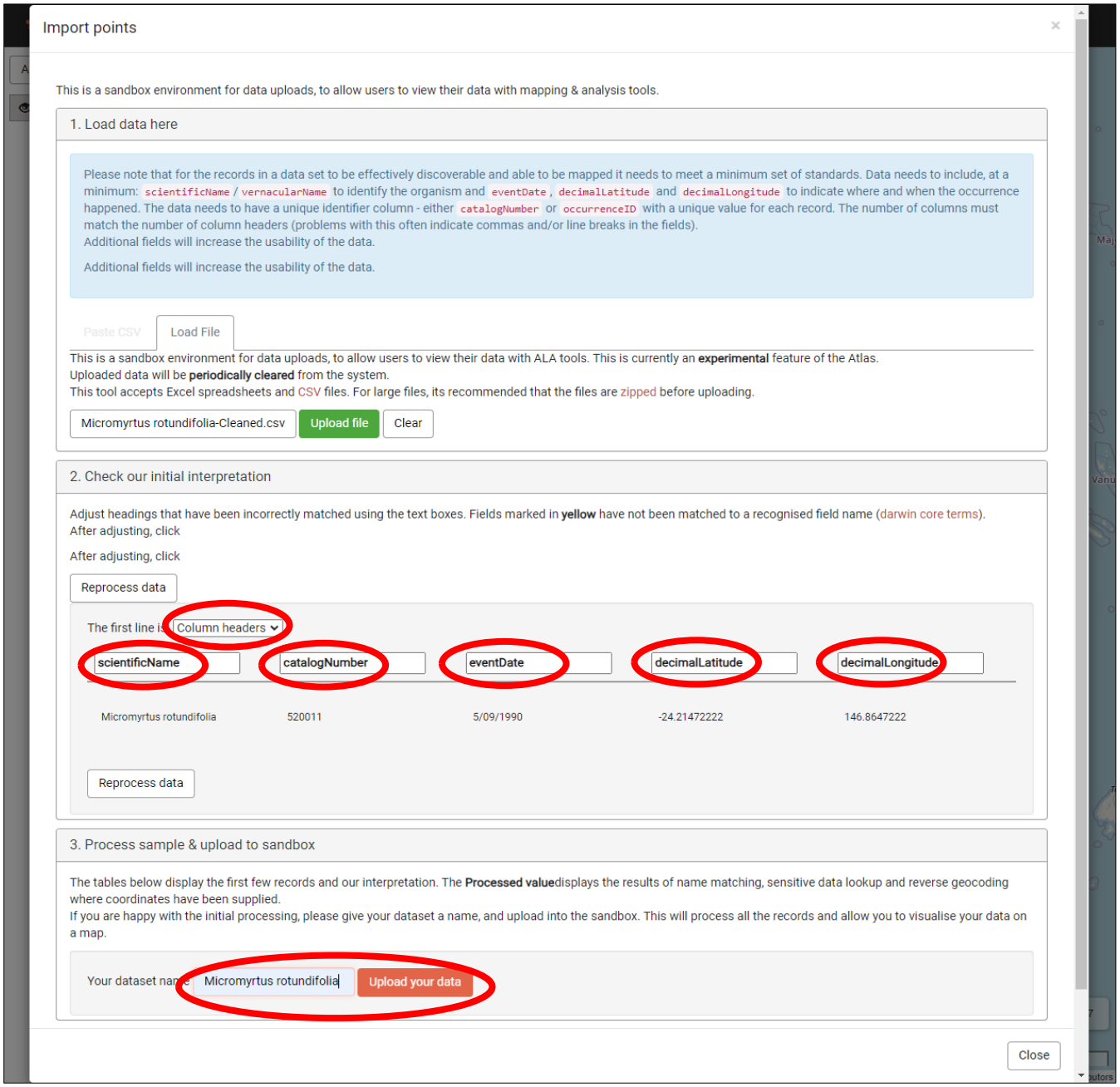

Figure 9. Screenshot of ALA Spatial Portal showing how to import cleaned occurrence data (red ellipse – bottom). Ensure data spreadsheet is in .csv format, required column headers are included and select first line is 'column headers'. Insert your species and upload your data.

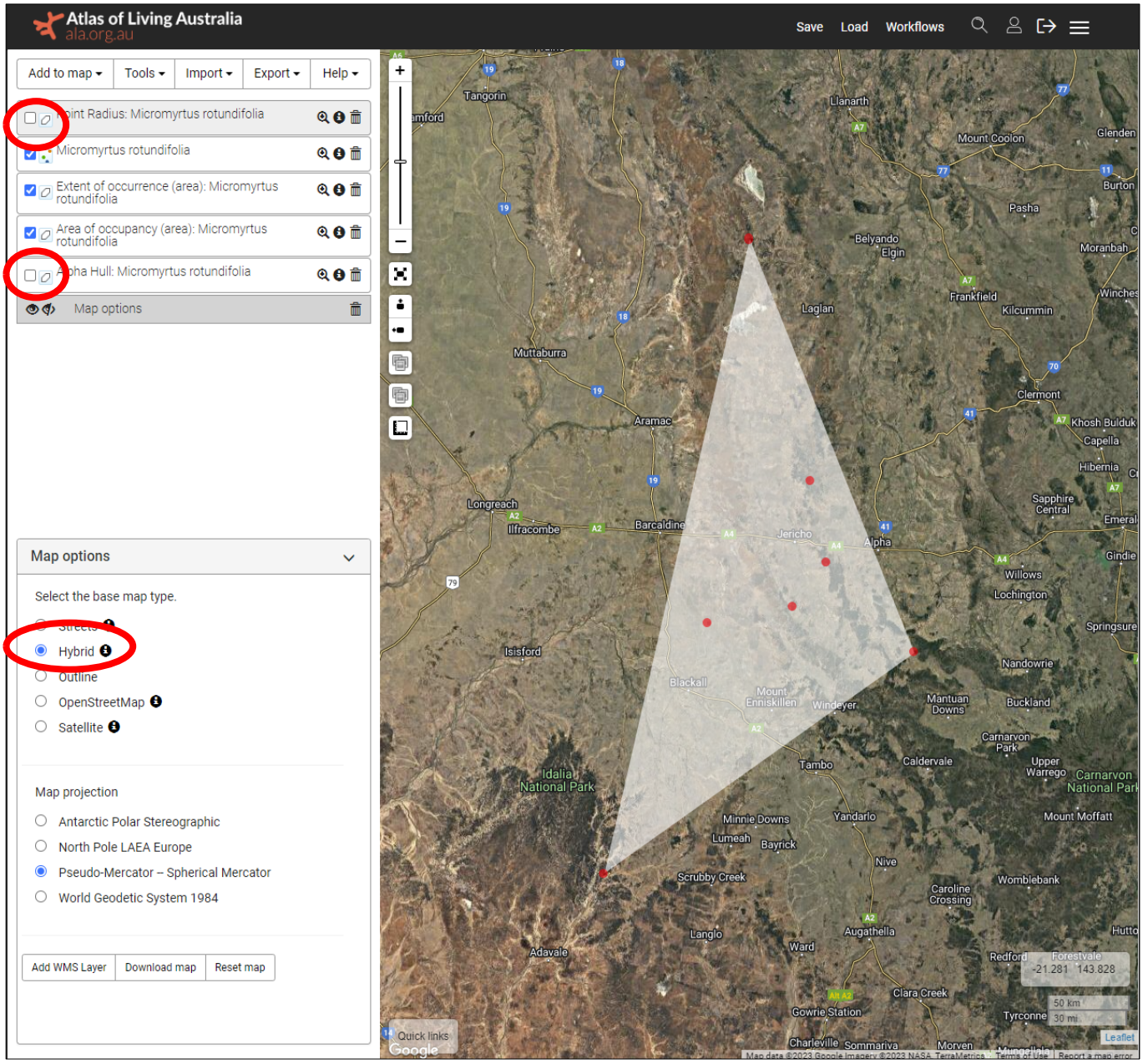

Figure 10. Screenshot of distribution map in ALA Spatial Portal, with red points overlayed on white minimum convex hull EOO and black AOO 2 x 2km grid cells for transfer into the nomination form. Deselect points radius and alpha hull and select 'hybrid' in map options, as shown in the red ellipses. Download map and metrics for inclusion in nomination form.

3.1.4.3 Reviewing land use and management characteristics

Next, use Queensland Globe to create relevant maps that display the geographical context of the species.

- *Important: Rename the decimalLatitude and decimalLongitude columns as 'latitude' and 'longitude', respectively. Ensure there are no blank columns or rows in the datasheet.*
- Import species records (LAYERS → ADD MY DATA → EACH ROW AS POINT → IMPORT) (Figure 11).
- Change colour so they are visible – orange with black outline and 100% fill opacity is recommended (Figure 12).
- Explore relevant layers that can be used to describe the spatial context of the species' distribution.
- LAYERS → ADD LAYERS (Figure 11).
    - Boundaries > Cultural Heritage party boundary
    - Biota > Regional Ecosystem Mapping > Biodiversity Status – pre-clear
    - Biota > Regional Ecosystem Mapping > Biodiversity Status – remnant
    - Economy > Production Permits > select all
    - Environment > Nature Refuge + Parks
    - Environment > Parks > Protected areas and forests
    - Planning Cadastre > Land Use
    - Planning Cadastre > Land parcels
    - Society > National native title tribunal > Indigenous land use agreements
- Change the base map as required to enhance the visibility of some layers (e.g., change the base map layer to 'base map grey' or 'base map topographic' to display mining lease tenure more clearly.
- Take screenshots of relevant maps. Before you take a screenshot, reduce the size and shape of your web-browsing window to be similar to the size of the nomination form box. This will ensure the map labels are displayed at a size that can be read.
- Be sure to capture scale bar + legend in screenshot.

Important considerations

- Most of Queensland is covered in exploration permits for resource extraction. It is appropriate to consider 'exploration permits' as a future potential threat, and 'mining leases' as a current/future-actual threat.
- Layer descriptions and metadata are available within the Queensland Spatial Catalogue.
- GeoRes Globe can provide a useful alternative to Queensland Globe for reviewing mining context.
- If the 'Cultural Heritage Boundary' layer does not provide adequate information to determine the Traditional Owners, please refer to the map provided by the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) or refer to any relevant National Park management plans that may contain information about Traditional Owners.

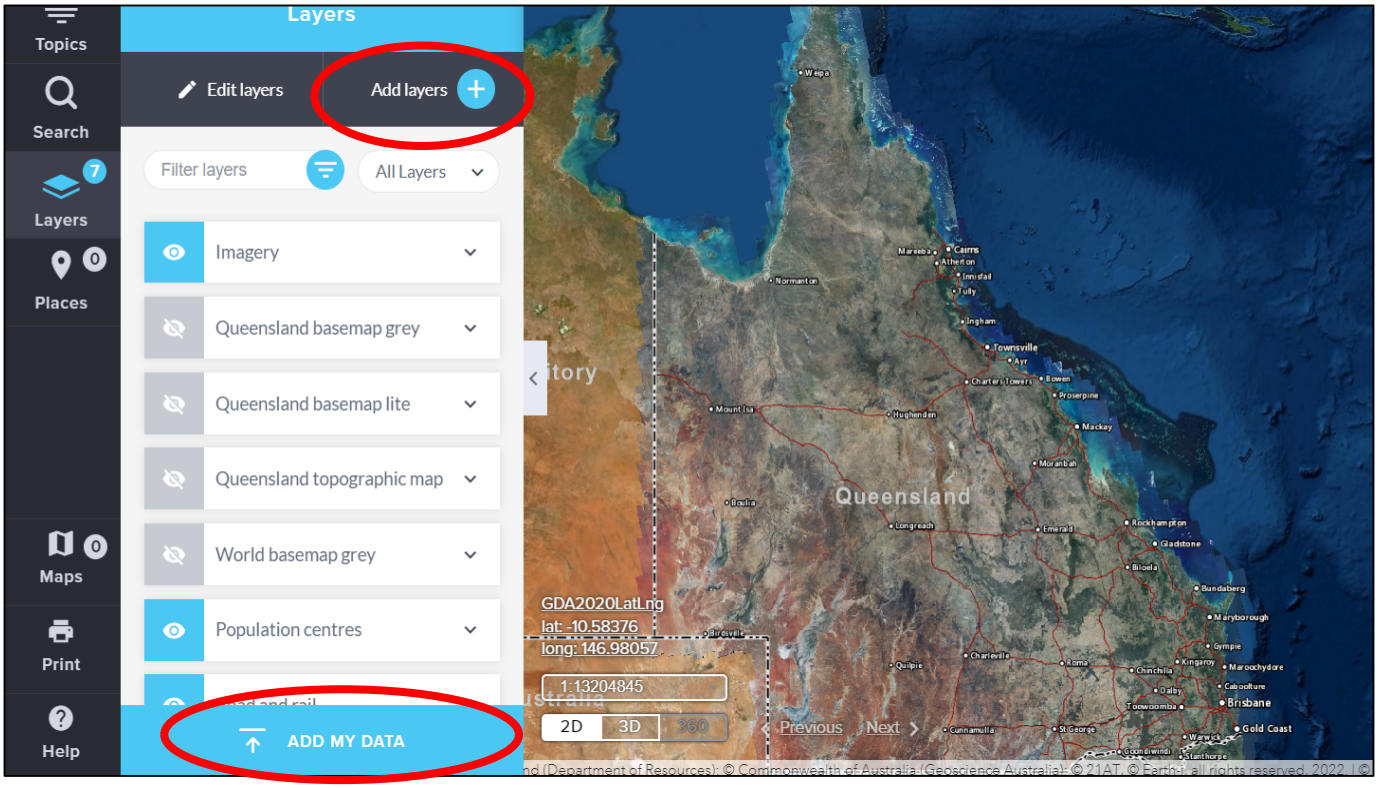

Figure 11. Screenshot demonstrating how to add data and layers in Queensland Globe (red ellipses).

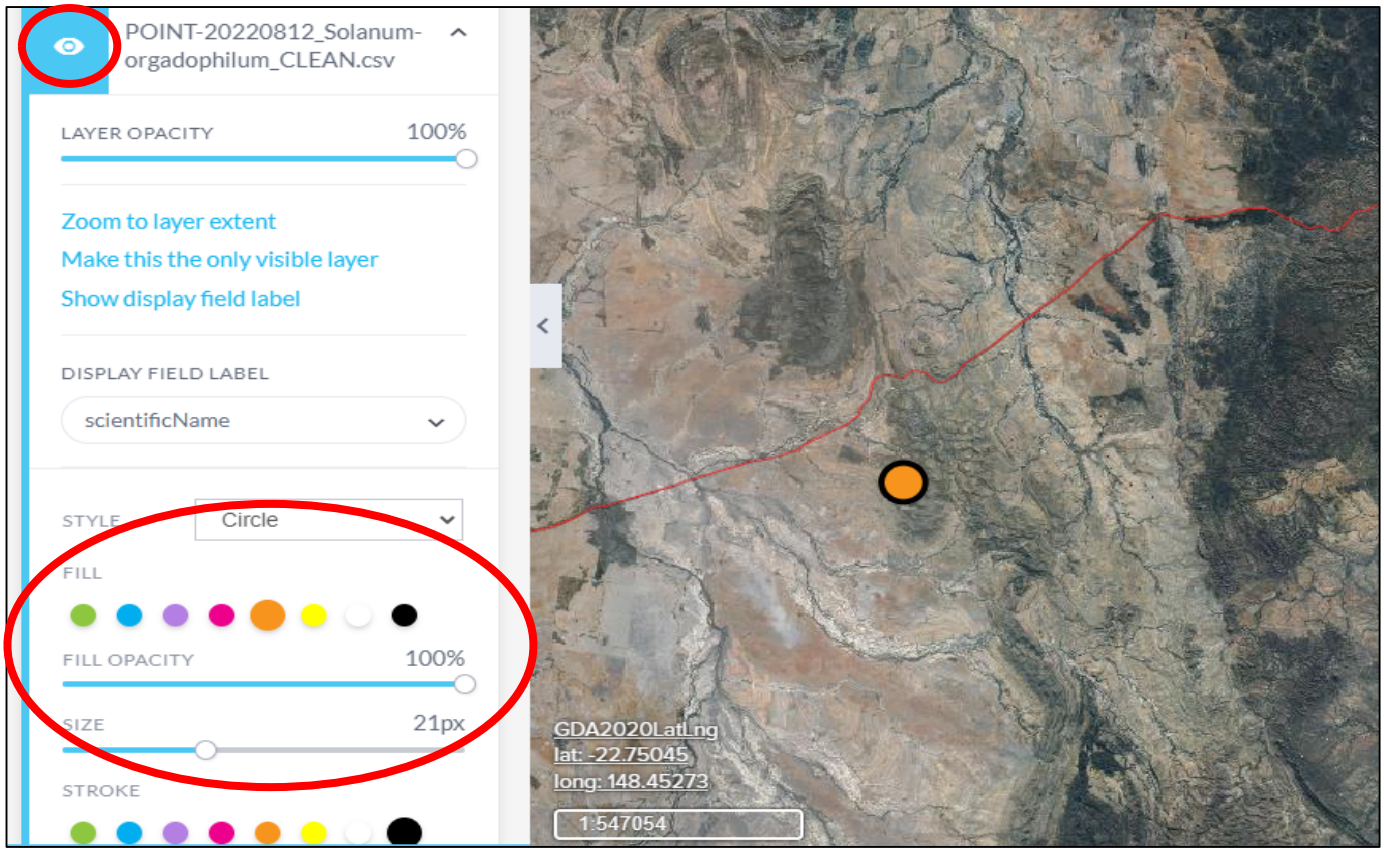

Figure 12. Screenshot demonstrating how to change the colour and size of occurrence records in Queensland Globe (red ellipse).

Example maps are provided in Section **Error! Reference source not found.**.

3.1.4.4 Response structure for Distribution

Nominators should then construct a succinct and concise series of paragraphs summarising the abovementioned information. A suggested format is provided below. It is appropriate to model the paragraph text from the example provided in Box 5.

Paragraph 1 – Geographic distribution context

- Describe whether the species has a narrow, disjunct, widespread or fragmented range based on a visual assessment of the ALA map of EOO and AOO.
- For species that also occur outside of Australia, state the scale of assessment (i.e. the assessment only includes the Australian distribution) and any relevant details (i.e. if threats that occur overseas will be considered for visiting species, per Section 3.1.2.1).
- State the general geographic details, including the nearest population centre and the bioregion; this can be for each subpopulation (widespread) or for the entire population (narrow).
- State the Traditional Custodians of the Country that overlap the distribution of the species.
- For fauna, describe species home range and movement patterns, particularly where these change seasonally.

Paragraph 2 – EOO and AOO

- State the EOO and AOO, and how this was calculated. Typically, the EOO and AOO are calculated using expert verified records, a minimum convex hull (EOO) and 2 x 2km grid (AOO). Reference the IUCN guidelines (IUCN SPC 2022).
- Be sure to only include 'wild' records in your distribution calculations, i.e., for flora, exclude any cultivated records that are flagged as "C" in the BRI records. Nominators should clearly explain if any records have been excluded and why.
- Comment on temporality of collection records. Specifically, if there are any parts of distribution where recent records have not been collected. If this is the case, note follow up surveys in these areas as a high priority conservation action in section 3.3, pg. 48..
- Include the year the species was first collected and the most recent collection year.
- Optional: Potential Habitat Modelling can be used to project a maximum EOO and AOO for some species. That is, calculating the area of a convex hull around the PHM polygon for EOO, and the area of 2 x 2km grid cells intersecting the polygon for the AOO. Often such modelling will result in large projections, particularly where a species' environmental associations are not well-understood due to a paucity of collecting records. This uncertainty should be stated in the assessment as required.

Paragraph 3 – Define subpopulations and population size

- Spatially define the subpopulations, including the number of subpopulations for the purposes of the assessment. Subpopulations are defined as *"geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less)"* (IUCN 2012, pg. 10). To define subpopulations, nominators should consider the relative geographic isolation and dispersal capacity of the species. For further information on how to define subpopulations see Section 3.5.5.4, Subpopulations (pg. 70).
- Where there are only a few subpopulations, nominators should attempt to name each one and refer to these throughout the nomination form. For example, the eastern, western, and northern subpopulations. Consider whether all suitable habitat has been searched. Make a statement about survey adequacy and confidence regarding the likelihood of finding additional subpopulations/occurrences with further survey in suitable habitat.

Paragraph 4 – Population size

- Comment on the size of the subpopulations, and the total population size. Population metrics should be discussed in terms of 'number of mature individuals'.
- Often, there are not enough data to provide population estimates for use in assessments. In this case, nominators should use 'plausible bounds' to account for this uncertainty. It is useful to construct a minimum and maximum plausible bound in relation to key quantitative thresholds that are used in the criteria assessment.
- Nominators should make every effort to describe the minimum and maximum plausible bounds for the population size. The key quantitative thresholds for number of mature individuals that will determine eligibility for a category are:
    - <50 (CR under D)
    - 50-250 (CR under C; EN under D)
    - 250-1,000 (EN under C; VU under D1)
    - 1,000-2,500 (EN under C; NT under D1)
    - 2,500-10,000 (VU under C)
    - 10,000-20,000 (NT under C).
- Therefore, nominators could seek expert advice on whether the population size could be placed within the abovementioned bounds to support a listing outcome under Criterion C and D. Note that the threshold of 3000 mature individuals (relevant for NT under D1) has been omitted from these ranges for simplicity. It is unlikely that an expert would be able to differentiate between 2,500 and 3,000 if making a 'best guess'.
- Then, if the population estimate is less than 10,000 mature individuals, and there is evidence of continuing decline, it is also appropriate to ask about the number of mature individuals in the largest subpopulation for use under Criterion C2:
    - <50 (CR)
    - 50-250 (EN)
    - 250-1,000 (VU).
- The lower plausible bounds may be used in the assessment if a precautionary approach is warranted given reasonable survey effort and a high level of threats. Conversely, the maximum plausible bounds may be used where survey effort has been very poor and threats are low.
- State the appropriate data qualifier (see Section **Error! Reference source not found.**, pg. **Error! Bookmark not defined.**) for the population size value used.
- Where there are population counts for multiple years, and across multiple subpopulations, it can be useful to tabulate this information to help discern trends. The table can also include information on land tenure to help explore threatening processes at each subpopulation. An example format is provided below.

Table 1. Population parameters for each subpopulation, including land tenure / threats and trends.

Subpopulation	Count of mature individuals (juveniles)	Land tenure / threats	Trend
1a (name)	YYYY: 12 (6) YYYY: 'uncommon' YYYY: 14 (6) + 17T	Freehold / national park	Increasing / decreasing / static / unknown
1b (name)			
2 (name)			
3T (name)			

*(T) = Translocated subpopulations/individuals.

Paragraph 5 – Land use and management context

- Describe the current land tenure (freehold, national park) and land use (grazing, nature conservation) for each subpopulation. If the species occurs in protected areas, list these areas.
- List and relevant Native Title bodies / Aboriginal corporations that may be responsible for land management in the species' distribution. List any relevant Indigenous Land Use Agreements.
- Finally, describe whether the species occurs within remnant habitat (i.e., Category B under the *Vegetation Management Act 1999*), or cleared land (Category X under the VMA).

Note: Although it is normal convention to display figures immediately after relevant text, in nomination forms, it aids comprehension to group figures together at the end of the text box. So, the Distribution text box should include paragraphs of text grouped together, followed by a series of maps.

Box 5. Example of text format and paragraph structure for the Distribution section of the nomination form*.

Dioclea hexandra is known from a narrow distribution between Tully Heads to Thornton Beach in the Wet Tropics bioregion. The species occurs on the lands of the Kuku-Yalanji, Djabuganjdji, Mamu, Djiru, Gulngay, Yidinjdji, Mbabaram and Djirbalngan People (Figure 1). Outside of Australia, the species is widespread, occurring throughout tropical Africa, India, tropical Asia, tropical Oceania and tropical America (Adema 1998; GRIN 2009). However, this assessment considers localities restricted to mainland Australia (Figure 1).

Extent of Occurrence and Area of Occupancy

The species has an Extent of Occurrence (EOO) of 5446.8km^2 and Area of Occupancy (AOO) of 60km^2, calculated using a 2 x 2km grid cell (AOO), a minimum convex polygon (EOO), and 24 expert verified herbarium specimen records (Figure 2; IUCN SPC 2022; BRI 2023). The species was first collected in 1912 and most recently collected in 2020.

Subpopulations

For the purposes of this assessment, *D. hexandra* is considered to occur within four subpopulations; the two northern subpopulations (Daintree catchment and Mossman), the central subpopulation (Innisfail) and the southern subpopulation (Tully). These subpopulations were delineated according to the distance of separation between clusters of records, the likelihood of suitable habitat between the clusters, surrounding topography and the likely dispersal capacity of the species. The species is passively dispersed through the water and ocean, drifting across large areas whilst remaining viable (Green 2001; Gunn and Dennis 1976). Although gene flow may occur across subpopulations, it is unlikely to occur regularly due to the distance between subpopulations and the barriers between. The northern cluster of records were considered two separate subpopulations as they occur in different drainage basins (Daintree and Mossman), which are likely to limit seed dispersal.

The species is distinctive and unlikely to be overlooked during surveys when in flower, as the large purple flowers or seed fall to the ground beneath plants. However, given the species is a canopy vine, it is possible it may be overlooked during surveys when flowers or seed are not present under mature plants, or within intact rainforest where visibility to the top of the canopy is difficult. This trend is evident in the collection records (Queensland Herbarium 2023), which almost exclusively occur on rainforest edges where it is easy to see and reach hanging branches (A. Ford, pers. comm. 2023). It is likely that additional occurrences exist in close proximity to current subpopulations.

Population size

The population size of the species is not precisely known. The species has not been adequately surveyed to make accurate or definitive estimates of the number of mature individuals, and additional surveys are required especially in adjacent and similar habitats.

Land use and presence in conservation estate

The species occurs across a variety of land uses across its distribution. In the north, the species is known to occur on land designated as cropping, other minimal use, utilities, intensive horticulture, grazing native vegetation, managed resource protection and nature conservation. The central subpopulation occurs on land classified as minimal use, managed resource protection and marsh/wetland. The southern occurrences for the species are on land classified as minimal use and cropping. Similar to the variety of land use that the species is known to occur on, the remnant and cleared land categories vary considerably across the distribution.

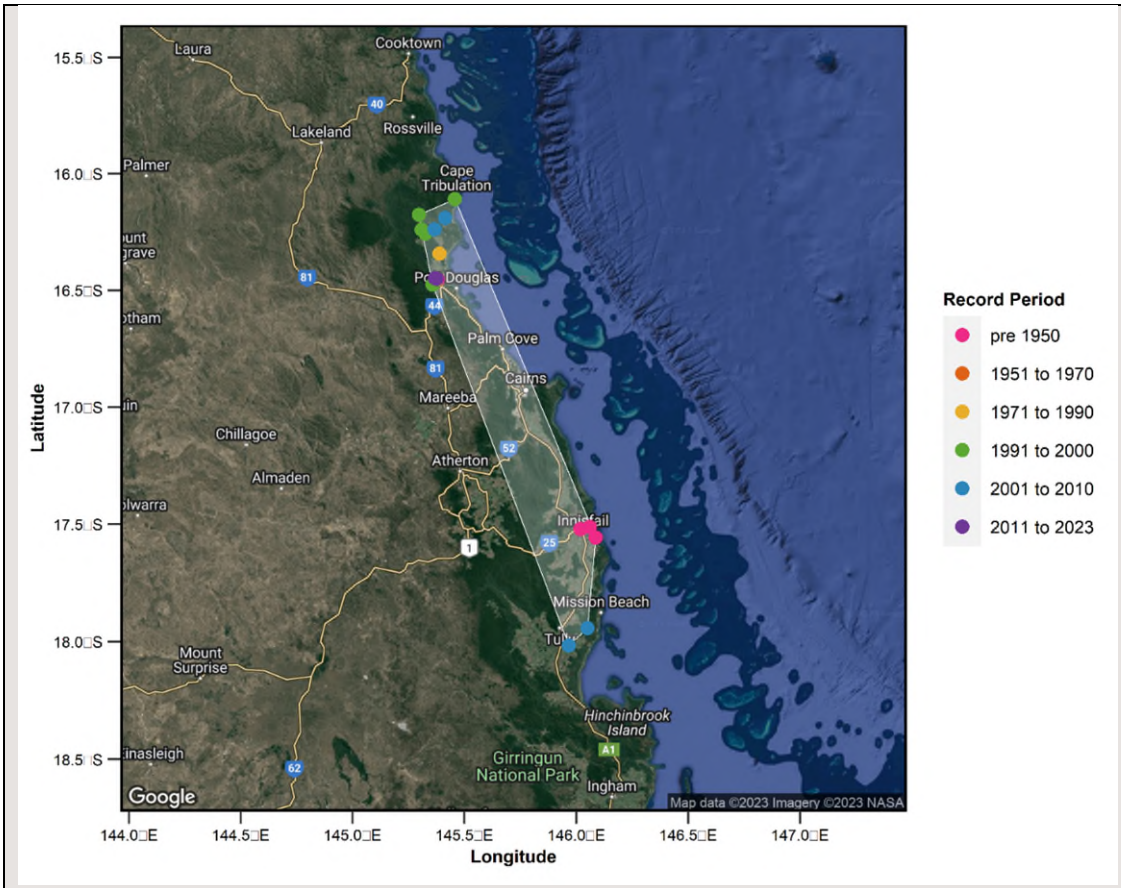

Figure 1. *Dioclea hexandra* is known from a narrow distribution between Tully Heads to Thornton Beach in the Wet Tropics bioregion. The species occurs on the lands of the Kuku-Yalanji, Djabuganjdji, Mamu, Djiru, Gulngay, Yidinjdji, Mbabaram and Djirbalngan People. The species has an Extent of Occurrence (EOO) of 5446.79km^2 and Area of Occupancy (AOO) of 60km^2, calculated using a 2 x 2km grid cell (AOO), a minimum convex polygon (EOO), and 24 expert verified herbarium specimen records (Figure 2; IUCN SPC 2022; BRI 2023).

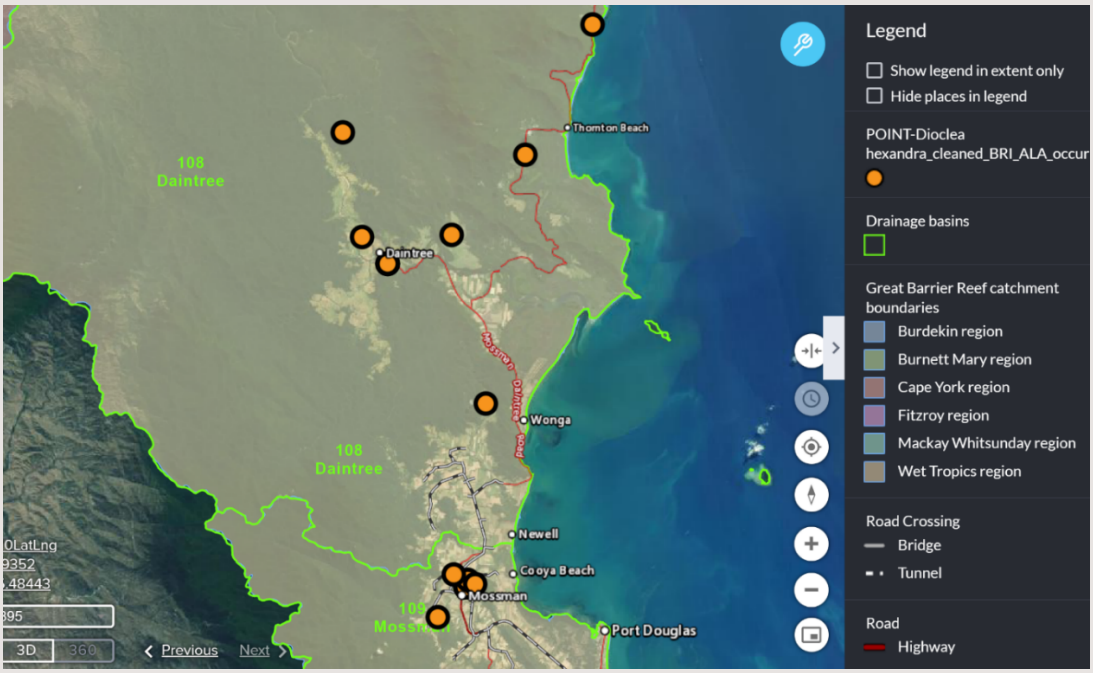

Figure 2. *Dioclea hexandra* occurrence points for the northern subpopulations in relation to drainage basins. The occurrences are split across two drainage basins; Daintree and Mossman, which are considered separate subpopulations in this assessment as the species is water dispersed. Map generated on Q Globe.

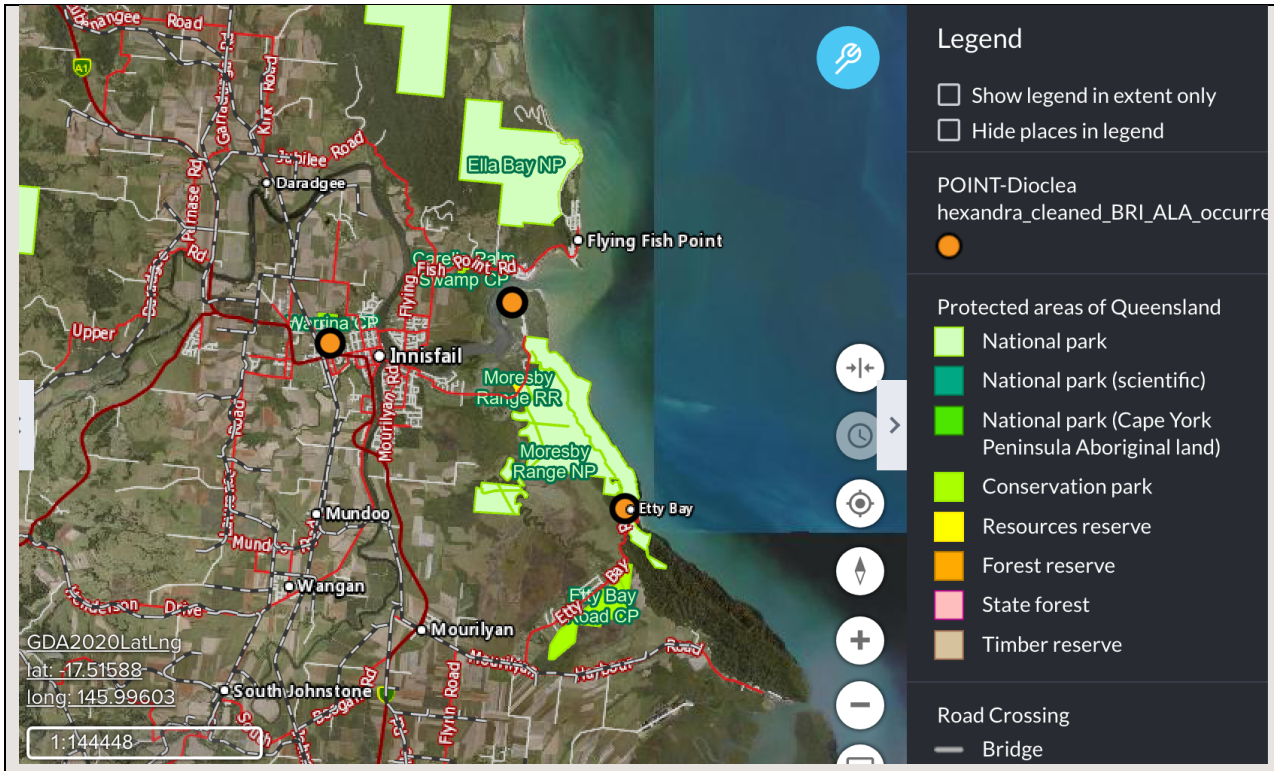

Figure 3. *Dioclea hexandra* occurrence points for the central subpopulation and the overlap of protected areas of Queensland. Some occurrences are within the Moresby Range National Park. Map generated on Q Globe.

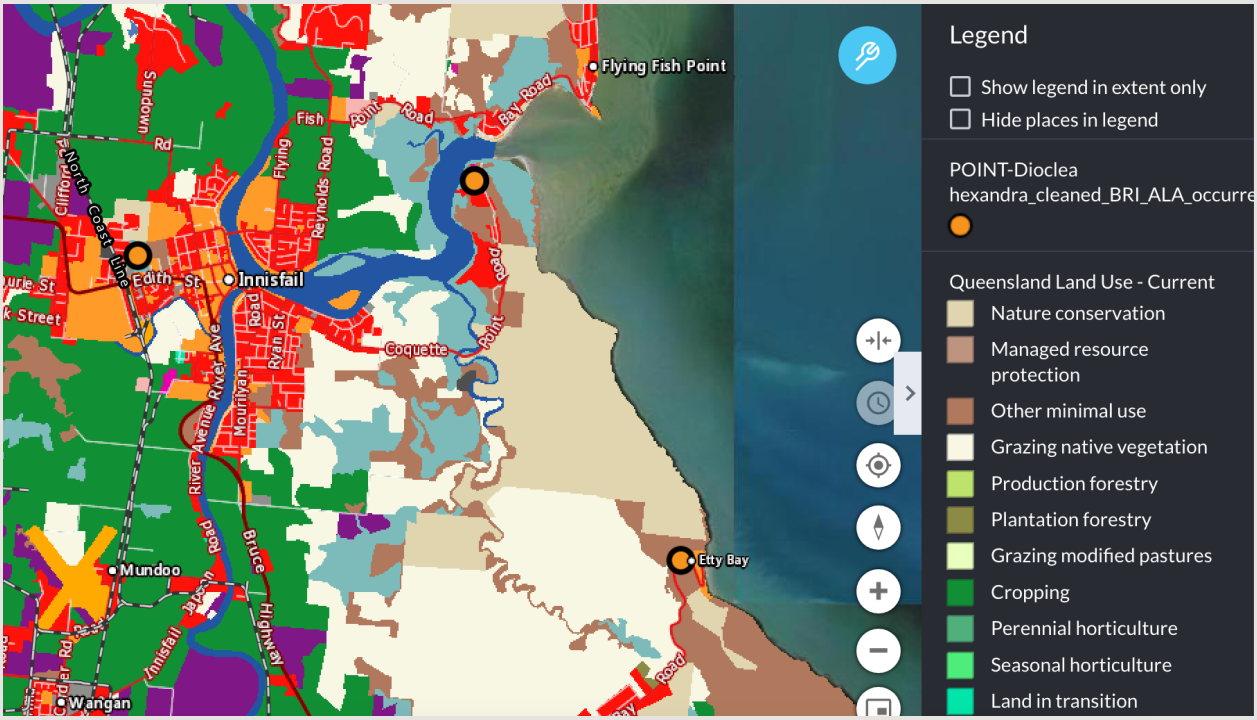

Figure 4. *Dioclea hexandra* occurrence points for the central subpopulation in relation to the land use of the region (Q Globe 2023). The central subpopulation occurs on land classified as minimal use, managed resource protection and marsh/wetland. Map generated on Q Globe.

*Excerpt adapted from Noble, E.A. (2023). Nomination to change the conservation class of *Dioclea hexandra* under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

Summary of documentation requirements for Distribution

- The species' distribution, including known / estimated current and past national distribution (including international distribution if relevant).
- For species with an extra-limital distribution, confirmation that the taxon has been assessed at the national scale; OR for visiting species, how extra-limital populations / threats were considered in the assessment.
- The species' EOO and AOO, plus calculation method.
- Data used to calculate EOO and AOO (e.g. point data, expert advice, habitat maps), along with a justification for any excluded data. Include upper and lower bounds (plausible range), if calculated.
- Any gaps in our understanding of the species' distribution.
- The number of mature individuals, including upper and lower plausible bounds.
- The number of subpopulations of the species including justification for delineation.
- For fauna, any daily or seasonal distribution patterns, e.g. breeding and non-breeding ranges.
- Desired but not essential:
    - information on land tenure and land use for each subpopulation
    - instances where the species' distribution intersects with protected areas, Ramsar wetlands, listed heritage sites, listed ecological communities, Indigenous Protected Areas, Indigenous Land Use Agreements etc.
    - map(s) at the appropriate scale and level of detail to support the assessment.

3.1.5 Biology and ecology

Nominators should then describe the biology and ecology for the species. The IUCN criteria rely on an understanding of how threatening processes interact with a species' biology and ecology. Therefore, this section provides important context when applying the criteria in later sections of the nomination form. Importantly, the summary of biology and ecology must be concise, and limited to information relevant to the assessment against the criteria and conservation actions.

3.1.5.1 Response structure for Biology and ecology

While each species will be different, responses can be structured following the below format (see Box 6).

Paragraph 1 – Habitat requirements

- Define the key characteristics of the habitat occupied by the species. This should include the vegetation type and underlying soil/substrate as well as vegetation structure, elevational range, aspect, and climate.
- For restricted taxa, habitat information recorded within the specimen collections or taxonomic paper are the authority, rather than regional ecosystem (RE) descriptions. Note that habitat of the species does not necessarily equate to the RE that intersect the occurrence records. Regional ecosystem mapping can be coarse or comprise multiple ecosystems within a polygon. Therefore, RE mapping information (i.e., what REs the species occurs in) should only be stated after a more specific review of habitat requirements (see final dot point for RE information).
- If the species occurs in different habitats depending on the subpopulation, nominators should note this by referring to the specimen record information.
- For fauna, explain how habitats are used, for example describe seasonal/breeding changes in habitat, if applicable. Provide detail on refugial habitat (i.e., does the species use different habitat in times of fire, drought, reproduction or flood)?
- Describe associated taxa. These can be found in the occurrence records or taxonomic description.
- List the RE that the species' occurrence records are associated with, and reference back to the figure provided in the Distribution section. Details on REs can be found in the Regional Ecosystem Description

Database search tool (see section 5, pg. 85).

Paragraph 2a – Reproduction, life cycle and generation length (flora)

- Does the species produce sexually or asexually (vegetatively)? If the species reproduces vegetatively, describe when, how and what conditions are needed.
- Provide detail on the age at sexual maturity, average life expectancy, natural mortality rates and then use these metrics to calculate generation length.

Generation length is defined as *"the average age of parents of the current cohort (i.e., newborn individuals in the population) [and] reflects the turnover rate of breeding individuals in a population. Generation length is greater than the age at first breeding and less than the age of the oldest breeding individual, except in taxa that breed only once"* (IUCN SPC 2022, pg. 29). Where generation length varies under threat, use the more natural pre-disturbance generation length (IUCN SPC 2022). It is often calculated as:

*Age of first reproduction + (0.5 * length of reproductive period)*

Provide full details of the method(s) used to calculate the generation length. For further detail see Section 3.5.3.3 Generation length (pg. 60).

Paragraph 2b – Reproduction (fauna)

- When does the species breed?
- What conditions are needed for breeding?
- Are there any breeding behaviours that make it susceptible to threats?
- Are there specific breeding sites, e.g., colonies for seabirds?

Paragraph 3 – Disturbance ecology

- Provide detail on how the species responds to **relevant** disturbance events (such as fire, flooding, cyclones).
- Outline whether the species is an obligate seeder or resprouting species and how this may impact the response to disturbances.
- Does the species require a disturbance regime (e.g., fire, cleared ground) to reproduce? Given the prevalence of fire in the Australian vegetation, it is almost always relevant to discuss the species' susceptibility to fire.

Paragraph 4a – Flowering, pollination and dispersal (flora)

- When does the species flower and set fruit? Review the herbarium records and taxonomic description. What conditions are needed for this?
- What is the pollination mechanism for the species?
- What are the dispersal mechanisms?

Paragraph 4b – Feeding and movement (fauna)

- Summarise the feeding behaviours, diet, and the timing/seasonality associated with these. Include any behaviour that may make the species vulnerable to a threatening process.
- Provide information on daily and seasonal movement patterns.

Some additional tips

- Often, it is not possible to include all this information, because there are few published studies. Ensure you state if this is the case. For example, '*There is no literature available that describes the fire ecology of the species'*.
- If there is no published literature on the species, check at the genus level. Often, it is appropriate to comment on the biology and ecology of other, closely related taxa. For example, '*However, other species in the genus are known to re-sprout after fire from a lignotuber'.*
- Review the species' occurrence records to get information about habitat types. The habitat type is often listed in the original species description, but this can be outdated. Often, new information in available in the species' records under the habitat column. Sometimes records can indicate if the area was recently

disturbed or other potential threats that may be relevant.

- State the REs in which the species occurs (for plants, and animals if restricted to a small number of REs). The utility of RE mapping as a surrogate for habitat extent may depend on how consistently the species of concern is found in the RE.
- You can also use the species' occurrence records to check when it flowers and fruits. Relate the date of the record to the reproductive status column.
- For both flora and fauna, try and provide information about dispersal. This will help you define subpopulations and some subcriteria (i.e., severe fragmentation). Return to the Distribution section and check your assessment of subpopulations is consistent with the dispersal/movement ecology of the species.
- For flora, try and investigate the fire response if it occurs in areas that are susceptible to fires.
- Use this review to think about how the species' ecology may make it susceptible to threatening processes.

An example is provided in Box 6.

Box 6. Example format and structure for the Biology / ecology section of the nomination form*.

Eucalyptus kabiana occurs on skeletal soils and rock crevices on steep trachyte slopes (QH 2020a). At Mt Beerwah, it occurs with *Corymbia trachyphloia, Calytrix tetragona, Leptospermum* spp.*, Triplarina volcanica, Commersonia fraseri, Hibiscus heterophyllus*, *Allocasuarina filidens, Lomandra confertifolia, Melaleuca groveana* and *Acacia hubbardiana* (QH 2020a). At Mt Coochin, *E. kabiana* grows on a steep slope in montane heath alongside *Corymbia trachyphloia, E. curtisii, Leptospermum luehmannii, L. microcarpum* and *Triplarina volcanica* (QH 2020a). Flowers and fruits have been recorded throughout the year, but flowers mostly occur in spring and fruit in summer (QH 2020a).

Eucalyptus kabiana has a lignotuber and can resprout vegetatively after disturbance such as fire (Nicolle 2008). Because this resprouting capacity is apparently unlimited, eucalypts with lignotubers can be extremely long-lived, i.e., hundreds of years (Nicolle 2008). Generation length for eucalypts has been estimated as 70 years (Fensham et al. 2020) but is probably longer for *E. kabiana* given its resprouting capacity.

Eucalypts generally rely on mobile pollinators (e.g., insects, birds, bats) to mediate and maintain genetic diversity, as seed dispersal is typically passive (Byrne et al. 2008; Booth 2017; Low 2011). As *Eucalyptus* spp. lack dispersal structures on their seeds, seed typically falls <100m from parent plants, apart from species that occur near watercourses that can further aide seed movement (Booth 2017; Low 2011; Reid and Potts 1998).

Eucalyptus kabiana can reproduce sexually from seed, although data on germination rates is not available (Trueman et al. 2017). Recruitment has not been observed in the wild subpopulations, although this is not unusual for long-lived mallees (Fensham et al. 2020). The species can also be readily propagated from cuttings, which mature to trees 3-5 m in height after six years in ex situ conditions (Trueman et al. 2017). The time to reproductive maturity in situ may be longer due to ecological processes such as competition, nutrient availability and prevailing climatic conditions that affect growth and vigour.

Eucalyptus kabiana is a very long-lived perennial that can survive disturbance such as fire, and therefore extreme fluctuations are not likely (IUCN 2019).

*Excerpt adapted from Collingwood T.D. (2022). Nomination to change the conservation class of *Eucalyptus kabiana* under the *Queensland Nature Conservation Act 1992*. Queensland Department of Environment and Science.

Summary of documentation requirements for Biology / ecology

- Habitat
- Feeding and movement (fauna)
- Life cycle and reproduction (including generation length calculation, plausible bounds and justification for formula used)
- Any gaps in our understanding of the species' biology/ecology, and/or a statement that little is known of the species' biology/ecology.

Gossia bamagensis is one of a suite of Myrtaceae species that require reassessment using the Common Assessment Methodology to document the rapidly emerging threat of *Austropuccinia psidii* (myrtle rust disease).

Image © Andrew Ford.

3.2 Threats

3.2.1 Identification of known threats and impact of the threats

Nominators should then describe the threats to the species. By this stage, nominators should have a good understanding of the threats relevant to the species. Nominators should first review the information they have collated and identify a list of possible threats. Nominators should then contact the appropriate expert/s for the species to refine this list of threats.

3.2.1.1 Review potential threats

Nominators should review possible threats by doing the following:

Check the land use map and remnant RE map from the distribution section:

- Does the species occur in areas that have been cleared? Review the proportion of relevant RE that have been cleared by referring to the clearing statistics in the RE Description Database search tool (see Key resources, pg. 85).
- Does the species occur in isolated subpopulations that are surrounded by land use change?
- Does the species occur on freehold land near urban areas?

Review the ecology section:

- Is the species susceptible to climate change impacts (e.g., is it restricted to refugial habitat)?
- Is the species susceptible to decline from changes to fire regimes (i.e., an obligate seeder that now occurs in an area with more frequent fire regimes; or a fauna species that relies on long-unburnt habitat)?
- Does the species cooccur with any invasive weeds?
- Is the species a known dietary component of vertebrate pests? (i.e., in the critical weight range for feral cat/fox predation)?
- Are there any geographical or land use boundaries that are inhibiting dispersal (i.e., highways or infrastructure between mammal subpopulations)

3.2.1.2 Consult experts to determine threats

After reviewing the possible threats to the species, nominators should consult with the relevant expert to refine this list. Relevant experts may include the collectors of the species (noted in the occurrence records for the species), the species' curator, land managers that work in the region where the species occurs (i.e., Queensland Parks and Wildlife Rangers), or researchers who have published peer-reviewed or grey literature on the species. Efforts should be made to contact a representative list of experts, aiming to capture insight on the status of the species across its distribution. For example, if the species has a scattered distribution, nominators should attempt to contact an expert that knows the species in the north and south of its range. Guidance on questions to ask experts for the purposes of completing a nomination is provided in Appendix 2. Once the list of possible threats has been refined to include only those threats that are **relevant** to the species, the threats should be classified.

3.2.1.3 Threat classification

Threats should be classified according to the IUCN – CMP Unified Classification of Direct Threats, which is summarised in Table 3 (IUCN 2022). Under this classification, each threat has up to three levels of classification, starting broad and becoming more specific. This system classifies threats according to the source of the threat. Therefore, land clearing attributed to agriculture should be classified separately to land clearing due to urbanisation.

Nominators should attempt to assign a threat class that is as specific as possible (for example, IUCN threat 7.1.1 rather than IUCN threat 7.1). Where further detail is required to explain the threat, place it in brackets after the threat class. Take care to distinguish between 'threats' and 'symptoms'. A threat is the *process* that is causing a decline/impact, while a symptom is an outcome of the threat. For example, lack of recruitment may be symptomatic of inappropriate fire regimes. The Federal list of Key Threatening Processes provides useful additional guidance when describing threats.

Table 2. Example text for the threats table on the nomination form*.

Threat 1. IUCN threat 5.4.1 Biological resource use – fishing and harvesting aquatic: intentional use (illegal fishing)	
Status	**Evidence**
Timing: current, future Confidence: inferred Likelihood: almost certain Consequence: moderate Trend: increasing Extent: entire range Risk: very high	Illegal take of fish from no take zones removes mature individuals in areas where they are protected. A significant increase in targeting of Mary River cod by fishermen is evident through social media (tagging on Facebook) and an increase in the number of tagged Mary River cod on the Infofish database (Brooks et al. 2019). Tagged Mary River cod on Infofish increased from 28 in 2011 to 171 in 2013, demonstrating increased targeting including during the breeding season (Brooks et al. 2019). Removing fish from wild subpopulations jeopardises recovery efforts by directly depleting the population size. Illegal take of fish is likely to occur across the entire range of the species, particularly in the known strongholds.

*Parisi, M.A. (2023). Nomination to change the conservation class of species *Maccullochella mariensis* under the *Queensland Nature Conservation Act 1992*. Queensland Department of Environment and Science.

Climate change as a threat

Nominators can review the risk of climate change for a species by relating its ecology or currently occupied climatic envelope to projected climate changes. Key resources to identify projected climate changes include:

- CSIRO Climate Change Cluster Reports
    - Nominators should identify the NRM region relevant to the species based on the map here. There are shapefiles available to help identify the region your species occurs in if it is difficult to determine from the map alone. Nominators should then read the appropriate cluster report here.
    - A summary of the key climatic changes, along with the confidence with which they are projected to occur should be summarised into the threats table. Using this approach, the threat of climate change is only likely to be 'suspected' (see Data Quality, pg. **Error! Bookmark not defined.**).
- Queensland Future Climate Dashboard
    - Nominators can use this tool to explore how key climate variables are likely to change in the future (2030, 2050, 2070, 2090) depending on different climate scenarios (RCP 4.5, RCP 8.5).
- Peer-reviewed research.

Table 3. Summary of IUCN threat categories with descriptions (IUCN SPC 2022; Kearney et al. 2019). Detailed guidance on the IUCN threat typology should be used in assessments and is available here: IUCN – CMP Unified Classification of Direct Threats.

Threat class	Threat	Description	Examples
1	Residential and commercial development	Threats from human settlements or other non-agricultural land uses with a substantial footprint.	Land clearing for urban settlements.
2	Agriculture and aquaculture	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture and aquaculture.	Land clearing for agriculture.
3	Energy production and mining	Threats from production of non-biological resources.	Land use change associated with open-cut mining, construction of associated infrastructure.
4	Transportation and service corridors	Threats from long narrow transport corridors and the vehicles that use them.	Clearing for major roads and railways.
5	Biological resource use	Threats from consumptive use of 'wild' biological resources, including both deliberate and unintentional harvesting effects; also persecution or control of specific species.	Illegal collection of orchids/ reptiles.
6	Human intrusion and disturbance	Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive use of biological resources	Trampling and erosion on recreational tracks, 4wd disturbance.
7	Natural systems modifications	Threats from actions that convert or degrade habitat in service of 'managing' natural or semi-natural systems, often to improve human welfare. For example, fire and fire suppression, dams and water use.	Construction of dams, inappropriate fire regimes.
8	Invasive and other problematic species, genes and diseases	Threats from non-native and native plants, animals, pathogens/microbes, or genetic material that have, or are predicted to have harmful effects on biodiversity following their introduction, spread, and/or an increase in their abundance.	Hybridisation with cultivated plants. Vertebrate pests.
9	Pollution	Threats from introduction of exotic and/or excess materials or energy from point and non-point sources.	Nutrient excess near urban settlements causing proliferation of weeds.
10	Geological events	Threats from catastrophic geological events.	Volcano eruption; tsunami
11	Climate change and severe weather	Threats from long-term climate changes that may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation or potentially can wipe out susceptible species habitat.	Periods of prolonged drought combined with very hot days leading to an increase in extreme fire weather.

3.2.1.4 Threat attributes and evidence

- Nominators should then assign parameters to each threat. These parameters describe the mechanism, timing, confidence / data quality, likelihood, consequence trend and extent for each threat and the effect on the species (Table 4).
- A summary of key attributes should be provided in Column 2 of the threats table on the nomination form.
- Nominators should take care to understand the definitions related to the 'data quality' threat attributes (observed, estimated, projected, inferred and suspected). These are detailed in the IUCN Guidelines and in section 3.5.1 (pg. 55) of this document.
- Nominators should then detail the evidence that links to the key parameters in the 'Evidence' column of the threats table. The key attributes do not have to be discussed in order within the evidence column. Ensure this section is fully referenced and concise (e.g. 250 words per threat as a guide).
- This section will directly feed into your criteria assessment. Ensure you have a good understanding of the threats, and that any declines / reductions are clearly set out and well justified.
- For past threats, the likelihood, consequence, and extent attributes can be applied retrospectively (**Error! Reference source not found.**).
- For future threats, the likelihood, consequence, and extent attributes should consider the plausible future scenario, if the threat is to eventuate. Nominators should be reasonably certain of the attribute level applied and avoid unrealistic scenarios.

Table 4. List of threat attributes, descriptions and relevant parameter definitions to be entered into column two of the Threat attribute table in the nomination form.

Attribute	Description	Threat attribute parameter
Mechanism	The way the threat causes a decline in the population.	• Direct: via disruption of survival and reproduction • In-direct: via interactions with other threatening processes
Timing	The temporal nature of the threat; can be more than one.	• Past • Current • Future
Confidence/ data quality	The nature of the evidence about the impact of the threat on the species.	• Observed: based on census data (i.e., all individuals in population counted) • Estimated: based on statistical assumptions (i.e., sample of population) • Projected: based on statistical assumptions and extrapolated into time) • Inferred: based on indirect evidence on variables of a same type • Suspected: based on indirect evidence on variables of a different type
Likelihood	The likelihood of the threat impacting on the whole population or extent of the species or a part thereof (where the threat impacts).	*Note: this can be applied retrospectively* • Almost certain: occurred, or is expected to occur every year • Likely: occurred, or is expected to occur at least once every 5 years • Possible: occurred, or might occur at some time • Unlikely: occurred, or is known to have occurred only a few times • Unknown: currently unknown how often the threat will/ or did occur

Consequence	The severity of the threat, should it be realised.	*Note: this can be applied retrospectively* • Not significant: had, or has no long-term effect on individuals or population • Minor: individuals were/are adversely affected but no effect at population level • Moderate: population was/is stable or beginning to decline • Major: population decline was/is ongoing • Catastrophic: population trajectory was/is close to extinction
Trend	The extent to which the threat will continue to operate on the species.	*Note: apply to the current situation (i.e., not retrospectively)* • Decreasing • Static • Increasing • Unknown
Extent	The spatial context of the threat in terms of the range of the species.	*Note: this can be applied retrospectively* • Entire range • Part of range • Unknown
Risk	Risk matrix rating	• E.g., low, moderate, high or very high risk.

3.2.1.5 Threat risk

Nominators should then use the Risk Matrix to rank the threats according to the risk (Table 5).

- Threats should be placed into the relevant cell in the Risk Matrix by using the 'consequence' and 'likelihood' threat attributes.
- Nominators should then determine the Risk Rating for each threat (low, moderate, high, very high).
- Threats listed in the threats table should then be re-ordered so they are presented in order from highest to lowest risk.
- Note that a future or past threat can be listed higher on the threat Risk Matrix (and in the threat table) than a current threat.
- Nominators should carefully consider the relevance of including threats that have a risk of 'not significant'. In some circumstances, it is appropriate to include threats that are 'not significant'. For example, it would be informative to include the threat of myrtle rust for a species' of Myrtaceae, even if the threat was 'not significant', as it would demonstrate that this very topical threat has been considered in the nomination. By contrast, it would be unnecessary to include the threat of feral pigs for a species that occurs in an area that is never likely to be impacted by feral pigs.
- Nominators should annotate past threats with an asterisk (*). This is to ensure that high risk threats that are not likely to be operating on the species anymore can be differentiated from current threats with the same risk level.

Table 5. Completed risk matrix for the Mary River cod (*Maccullochella mariensis*). List threats in cells according to the consequence and likelihood identified in the threats table.**

Likelihood	Consequence				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain			**IUCN Threat 8.1.2. Invasive and other problematic species, genes and diseases** Invasive non-native/alien species/diseases: named species (introduction of carp and tilapia) **IUCN Threat 7.2. Natural system modifications** Dams and water management use (construction of dams, weirs, barrages, culverts and road crossings)		***IUCN Threat 5.4.1. Biological resource use** Fishing and harvesting aquatic resources: intentional use: subsistence/ small scale (overfishing)
Likely			**IUCN Threat 11.4. Climate change and severe weather** Storms and flooding **IUCN Threat 9.2.2 Pollution** Industrial and military effluents: seepage from mining		
Possible					
Unlikely					
Unknown					
Risk matrix legend/Risk rating:					
LOW RISK		**MODERATE RISK**	**HIGH RISK**		**VERY HIGH RISK**

**Abbreviated risk matrix from Parisi, M.A. (2023). Nomination to change the conservation class of species *Maccullochella mariensis* under the *Queensland Nature Conservation Act 1992*. Queensland Department of Environment and Science.

Rhodamnia longisepala is known from a very restricted distribution in the Wet Tropics bioregion of Queensland. The species was reassessed using the Common Assessment Methodology and found to be eligible for listing as Critically Endangered due to having less than 50 mature individuals, and the threat of myrtle rust.

Image © Andrew Ford.

3.3 Conservation advice: threat abatement and recovery actions

Give an overview of recovery and threat abatement/mitigation actions that are underway, have been formally proposed or that you would like to recommend. Address all threats listed (including future threats) or state threats that lack conservation advice.

- Nominators should first review any existing recovery plans, Federal conservation advice or relevant threat abatement plans for relevant recovery actions to the threats for the species.
- Identify who is undertaking these activities and how successful the activities have been to date.
- Describe any mitigation measures or approaches that have been developed specifically for the species at identified locations. Identify who is undertaking these activities and how successful the activities have been to date.
- For taxa nominated as Extinct in the Wild, provide details for any naturalised or captive subpopulations and the level of human intervention required to sustain the species.
- Past threats that are static (have ceased) may not require threat abatement and recovery actions if they are not continuing to impact the population.

Present your overview following the format in Table 6 and Table 7. Note that threats should be presented in the order as listed in the previous threats table. Additional examples of recovery actions are provided in Appendix 3 but follow the format of Table 6 and Table 7.

For each threat, ensure you consider actions that encompass:

- Partnership with traditional custodians in co-design and delivery of management actions, to ensure management approaches align with or consider cultural aspirations for relevant First Nations groups.
- Further targeted field survey requirements, particularly where the species' habitat has been poorly surveyed.
- Re-survey of historical collection sites, particularly where these have not been visited in >10 years.
- Time-series monitoring to determine population trends in relation to key threats.
- Research to better understand the biology and ecology of the species.
- Extension and awareness with relevant stakeholders (i.e., landholder where it occurs on private land) or specific recreational communities.
- Land management strategies, including developing plans and implementing plans.
- *Ex situ* conservation for species with very limited distributions.

Table 6. Format for presenting threat abatement and recovery action advice. Ensure threats are presented in the same order as the threats table.

Threat	**Abatement or recovery action underway**
[Threat 1 description]	*Threat 1 current action 1* *Threat 1 current action 2* *Threat 1 current action 3*
[Threat 2 description]	*Threat 2 current action 1* *Threat 2 current action 2* *Threat 2 current action 3*
[Threat 3 description]	*Threat 3 current action 1* *Threat 3 current action 2* *Threat 3 current action 3*
Threat	**Abatement or recovery action proposed**
[Threat 1 description]	*Threat 1 proposed action 1* *Threat 1 proposed action 2* *Threat 1 proposed action 3*
[Threat 2 description]	*Threat 2 proposed action 1* *Threat 2 proposed action 2* *Threat 2 proposed action 3*
[Threat 3 description]	*Threat 3 proposed action 1* *Threat 3 proposed action 2* *Threat 3 proposed action 3*

Some tips

- Ensure your recovery actions are communicated in concise, clear sentences.
- For each threat, ensure you list your actions in order of importance.
- Many key threatening processes also have targeted actions detailed in a Threat Abatement Plan – review these and see if they can be adapted to the species.
- Review management plans for areas where the species occurs such as within National Parks to see what is happening in that area generally. Is the species specifically referred to?
- Check the Action Plans for Birds 2020 (Garnett and Baker 2021), Action Plan for Australia's Most Imperilled Plants 2021 (Silcock et al. 2021), Action Plan for Australian Mammals 2012 (Woinarski et al. 2014) and Action Plan for Australian Lizards and Snakes 2017 (Chapple et al. 2019) for guidance on appropriate threat abatement actions.
- Many threats will have similar required actions, in this case repetition is completely acceptable.

Table 7. Excerpt of conservation advice: threat abatement and recovery table from nomination form for *Crudia papuana.**

Threat	Abatement or recovery action underway
IUCN threat 11. Climate change and severe weather 11.1 Habitat shifting and alteration	Climate projections (modelling) have been undertaken for the NRM region (Moise et al. 2015) but provide no species-specific recommendations / projections.
IUCN threat 8. Invasive and other problematic species, genes and diseases 8.1 Invasive non-native/alien species/diseases 8.1.2 Named species (feral pigs *Sus scrofa*)	No recovery actions currently address this threat. It is likely that wild feral pigs are hunted by local communities, which may reduce the pressure of this threat.
Threat	**Abatement or recovery action proposed**
IUCN threat 11. Climate change and severe weather 11.1 Habitat shifting and alteration	Consult or partner with the Traditional Custodians to ensure recovery actions align with cultural aspirations for the species. Undertake time-series monitoring to quantify the population demographics of the species (number of mature individuals at each subpopulation) and trends. Undertake research to better understand how the habitat for the species may shift with rising sea levels and whether assisted migration or other techniques may be required to ensure the species can persist. Investigate strategies for assisted migration into adjacent habitat, accounting for potential impacts of feral pigs and competition with mangroves. If feasible and necessary, establish ex situ populations at appropriate institutions via seed banking or propagation for conservation and research, ensuring the maximum range of genetic diversity possible is represented.
IUCN threat 8. Invasive and other problematic species, genes and diseases 8.1 Invasive non-native/alien species/diseases 8.1.2 Named species (feral pigs *Sus scrofa*)	Consult or partner with the Traditional Custodians to ensure recovery actions align with cultural aspirations for the species. Co-design a management program for feral pigs to reduce the impact on critical habitat for *C. papuana.* Given the species has not been collected since 1980, re-survey of collection sites to determine whether the species is still extant and identify any threats is the highest conservation action required. Undertake further survey to identify additional occurrences of the species in poorly surveyed areas. Undertake research to better understand the conservation biology (genetic diversity) and ecology (fire ecology, pollination, habitat requirements, germination requirements, recruitment rates) of the species to inform targeted conservation actions. Undertake time-series monitoring to quantify the population demographics of the species (number of mature individuals at each subpopulation) and trends. If feasible and necessary, establish ex situ populations at appropriate institutions via seed banking or propagation for conservation and research, ensuring the maximum range of genetic diversity possible is represented.

*Excerpt adapted from Noble E.A. (2023). Nomination to change the conservation class of *Crudia papuana* under the *Queensland Nature Conservation Act 1992*. Queensland Department of Environment and Science.

3.4 Summary of key assessment parameters

Prior to assessing the species against the Criteria, nominators should collate the key assessment parameters into the table provided from the body of the nomination form. Definitions of these key terms follow the 'Guidelines for Using the IUCN Red List Categories and Criteria'. The table encourages nominators to specify 'plausible bounds' for each parameter. Plausible bounds are used to represent and manage uncertainty during the assessment process.

- Nominators should state the minimum and maximum plausible values for each parameter, along with the value used in the assessment.
- The value used in the assessment is likely to reflect the 'best guess'. However, it may also reflect the lower plausible value where a precautionary approach is warranted. For example, using the lowest plausible number of mature individuals when assessing a species that is known to be declining, but recent population estimates are not available.
- The estimate used in the assessment can be a range, but in any case, the best estimate should always be included in the range of plausible values.
- The plausible range may be established using various methods, for example based on confidence or probability intervals, expert opinion, or the consensus view of a group of experts. Justify the method used and to represent uncertainty, along with the estimate used in the assessment in the table below.
- Trend may be decreasing, increasing, static or unknown, as per the Threats table (Table 2). However, where possible 'unknown' should be avoided and the data qualifiers (section 3.5.1, pg. 55) should be used to make a best guess (i.e., decreasing – suspected).
- For continuing decline, severe fragmentation and extreme fluctuations, the table cell should contain a statement indicating whether the condition has been met for the species being assessed, alongside a justification against the definition of the term.

Cophixalus exiguus (dainty nursery frog, male pictured here) was reassessed using the Common Assessment Method as Vulnerable due to plausible future threats associated with climate change.

Image © Dr. Conrad Hoskin.

Table 8. Example of a key parameters table using plausible bounds, data qualifiers and justification for *Citrus inodora*.*

Metric	Value used	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	2,500	1,000	2,500	There are no precise population parameters available for the species. However, the population is estimated to comprise between 1,000-2,500 mature individuals (A. Ford pers. comm. 2023). The upper plausible bound was used in this assessment due to low survey effort.
Trend	Decreasing (inferred)			Although there are inferred threats to the species from urbanisation and invasive species, the impacts have not been adequately assessed or quantified with surveys. However, the number of mature individuals is inferred to be decreasing.
Generation length (years)	57.5-72.5	57.5	72.5	Generation length calculations were estimated using the formula: age at first reproduction + (0.5 * reproductive length) (IUCN SPC 2022). This species reaches maturity in 15 to 20 years and can live at least 100-125 years (A. Ford pers. comm. 2023). Therefore, the minimum estimate used within the assessment assumes the species matures at 15 years old and lifespan of 100 years, providing an estimate of 15 + (0.5 * 85) = 57.5 years. The maximum estimate used in the assessment is based on maturity at 20 years and lifespan of 105 years, providing an assessment of 20 + (0.5 * 105) = 72.5 years. Therefore, the generation length can be estimated as 57.5 to 72.5 years.
Extent of occurrence (km^2)	1,585.8	1,585.8	Not assessed	The EOO was estimated using a minimum convex polygon generated from 18 expert verified specimen records from 1899 to 2011 (IUCN SPC 2022; AVH 2023; Queensland Herbarium 2023). The species is suspected to be currently extant at all recorded sites. It is unlikely that the EOO is more extensive given the surrounding areas of similar habitat across this species distribution are relatively well surveyed. Potential habitat modelling is not available for this species and any additional occurrences are likely to be highly localised given the species has strong habitat preferences for lowland rainforests and adjacent suitable habitat has been extensively cleared (Australian Government 2021). Thus, the EOO used in this assessment is 1585.8km^2.
Trend	Decreasing (inferred)			Although there are inferred threats to the species from clearing for developments and associated habitat degradation by invasive species, the associated impacts on the species have not been adequately assessed or quantified with surveys. However, the extent of occurrence is inferred to be decreasing.

Metric	Value used	Minimum plausible value	Maximum plausible value	Justification
Area of occupancy (km^2)	24	24	Not assessed	The AOO was estimated using 2 x 2km grid cells and 18 expert verified herbarium collections from 1899 to 2011 (IUCN SPC 2022; AVH 2023; Queensland Herbarium 2023). The species is suspected to be currently extant at all recorded sites. It is unlikely that the AOO is more extensive given the surrounding areas of similar habitat across this species distribution are relatively well surveyed. Potential habitat modelling is not available for this species and any additional occurrences are likely to be highly localised given the species has strong habitat preferences for lowland rainforests and adjacent suitable habitat has been extensively cleared (Australian Government 2021). Thus, the AOO used in this assessment is 24km^2.
Trend	Decreasing (inferred)			Although there are inferred threats to the species from clearing for developments and associated habitat degradation by invasive species, the associated impacts on the species have not been adequately assessed or quantified with surveys. However, the area of occupancy is inferred to be decreasing.
Number of sub-populations	4	3	6	The number of subpopulations were delineated according to the distance of separation between clusters of records, the likelihood of suitable habitat between the clusters, surrounding topography and the likely dispersal capacity of the species. Clusters of records are separated by more than >12km with areas in between of different habitat and topography as well as suitable habitat being fragmented by non-remnant vegetation and infrastructure. This species was determined to have four subpopulations: the Bellenden Ker subpopulation, the Behana Gorge subpopulation, the Mossman Gorge subpopulation, and the Cow Bay subpopulation. Given there have been recent residential developments on freehold land in proximity to the Cow Bay subpopulation (Figure 7), the minimum estimate accounts the unlikely possibility that this subpopulation is no longer extant. The maximum estimate reflects the likely possibility that all four subpopulations are extant but splits the Bellenden Ker subpopulation into three separate subpopulations due to the fragmentation of habitat.
Trend	Static (suspected)			Although there are inferred threats to the species from clearing for developments and associated habitat degradation by invasive species, the associated impacts on the species have not been adequately assessed or quantified with surveys. However, the number of subpopulations is suspected to be static as there is no available information to determine subpopulation trends.

Metric	Value used	Minimum plausible value	Maximum plausible value	Justification
Number of locations	3	2	4	The number of locations is based on the most serious plausible threat of clearing for developments on freehold land, and in areas not impacted by this threat, the next most plausible serious threat of invasive species. For this assessment, this species is considered to occur at three locations due it's disjunct distribution, landscape mosaic of remnant and cleared vegetation, varying land management strategies and tenures. Where the species occurs in national parks, habitat clearing is not considered a threat but there may be habitat degradation from invasive species, especially for the Bellenden Ker subpopulation (A. Ford pers. comm. 2023). Furthermore, part of the Bellenden Ker subpopulation occurs on freehold land in proximity to residential and agricultural areas while the Cow Bay subpopulation occurs on freehold land in proximity to residential areas. The minimum estimate reflects the possibility that the threat of clearing and associated degradation is the same across all freehold land. Alternatively, the maximum estimate accounts for the possibility of varying impacts across the Bellenden Ker subpopulation that occurs on multiple freehold land parcels.
Continuing decline	A continuing decline is inferred for the species based on the threat of clearing and associated habitat degradation as well as subsequent interactions with invasive species. Clearing for residential, commercial, tourism and small-scale agriculture is applicable for the Cow Bay subpopulation as well as part of the Bellenden Ker subpopulation that occurs on freehold land. There is evidence of recent clearing of vegetation that is likely associated with residential developments (Figure 7), as well as the widespread and multifaceted impacts from feral pigs and invasive plants across lowland rainforests of the bioregion (Australian Government 2021). Therefore, the impacts and interactions between clearing and associated habitat degradation are inferred to cause a continuing decline in the area, extent and quality of habitat as well as the number of mature individuals			
Severe fragmentation	Although the species is naturally fragmented as it occurs in small, isolated habitat patches of lowland rainforest separated by >12km of varying habitat and topography, there is no evidence that >50% of the subpopulations occur in habitat patches that are too small to support a minimum viable population. Therefore, the species is not considered severely fragmented in this assessment.			
Extreme fluctuations	There are no known extreme fluctuations in EOO, AOO, number of subpopulations or locations for this species, but further evidence is required to understand the threat of clearing and associated habitat degradation on seed viability and extreme fluctuations. As a long-lived perennial tree, it is unlikely to drastically fluctuate in the number of mature individuals between years. Therefore, there is insufficient evidence to conclude this species undergoes extreme fluctuations.			

*Excerpt adapted from Verrall, B. (2023). Nomination to change the conservation class of *Citrus inodora* under the *Queensland Nature Conservation Act 1992.* Queensland Department of Environment and Science.

3.5 Eligibility against the criteria

Some general rules and tips

- The IUCN Red List Guidelines are the authority for applying the criteria and include detailed text and examples on their application. Additional guidance developed by the Interjurisdictional CAM Working Group is currently in preparation.
- Every section must be addressed. Under every criterion, address every sub-criterion sequentially, as per the examples. If nominators cannot make an assessment for a specific criterion due to lack of information, this should be stated. This is often the case.
- Sometimes, it is easy to start with the most familiar criterion rather than working through them sequentially. It can also be helpful to start by making notes in each box.
- Make sure any references to key parameters are also presented and justified in the previous sections of the nomination form. That is, there should be no new information presented here, just a synthesis of what has already been outlined.
- Explanations should be kept concise and limited to key details required for the STC to make a decision. It is appropriate to cross-reference the Key Parameters Table for more information or other parts of the assessment. Duplication of justification between Criteria can be avoided by cross-referencing (see Criterion B).
- Nominators should ensure they justify how / why the species meets the key definitions.
- To be eligible for listing under a particular subcriteria (i.e., B1, B2, C2 etc.), a species must meet every threshold to be listed as a particular category. For example:
    - If a species meets EN under B1 (EOO <5,000km^2), and EN under (a) (<5 locations) but has no continuing decline in any of b(i-v), then it is not eligible under Criterion B1.
    - If a species meets EN under B1 and has a continuing decline in b(i-v), but only meets VU under (a) due to having 7 locations, it can only be listed as VU as it does not meet every threshold for EN under B1.
    - If a species meets the number of mature individuals for EN under C (<2,500), but only meets VU under C2a(i), as it has 500 mature individuals in each subpopulation, it can only be listed as VU under C2. This is because it does not meet every threshold for EN.
- The overall eligible status for a set of criteria (i.e., A, B, C, D or E) is the highest category for which the species qualifies under any subcriteria. For example, if a species meets VU under C1, but EN under C2, the species is assessed overall as EN under Criterion C.
- The overall eligible status for the species is the highest category for which it is eligible under any criteria. This can be more than one criteria.
    - If the species meets VU under A2, and EN under B1, then overall it is eligible for nomination as EN under B1.
    - If the species meets VU under A2 and VU under C2, then overall, it is eligible for nomination as VU under A2; C2.

3.5.1 Dealing with uncertainty

Although the IUCN Criteria are quantitative, quantitative data are not always available for species that require assessment. This can create uncertainty when applying the quantitative thresholds of the IUCN categories and Criteria. There are two primary ways of dealing with this uncertainty when undertaking assessments:

- Using data qualifiers to describe the quality of the data being used; and
- Adopting a precautionary approach when making decisions about how data meet relevant thresholds.

3.5.1.1 Data quality

Although the IUCN Criteria are quantitative, detailed and relevant data are not always available for species that require assessment. This can create uncertainty when applying the quantitative thresholds of the IUCN categories and Criteria.

To account for this, the IUCN Red List criteria incorporate several levels of data quality, so that taxa without comprehensive data can be assessed. Data qualifiers are used in three key sections of the nomination form:

- When describing key parameters through the nomination (population size, EOO and AOO, number of subpopulations, etc.)
- In the threats section to describe the data quality relating to a threat.
- In the Criteria assessment section to support an assessment outcome.

The relative order of data quality is observed > estimated (past) > projected (future) > inferred > suspected. Applying data qualifiers in practice can be somewhat subjective at times, as adequate guidance and examples are still being made available. However, the general rule that all nominators should be aware of is that data of higher quality (observed, estimated, projected) involves far fewer assumptions that data of lower quality (inferred and suspected). While observed data has the fewest assumptions, suspected data has the most assumptions. For comprehensive examples of how to apply data qualifiers to key metrics, and common threats, refer to Appendix 4 and 5.

3.5.1.2 Observed data

Data that has been *observed* refers to information that is based on well-documented observations (IUCN SPC 2022). Observed data is always quantitative. For example:

- Population size based on a census.
- Population reduction from two census periods (3 generations ago and current).
- Continuing decline of habitat derived from a survey of all known habitat, or aerial photography of all known habitat.
- Continuing decline based on multiple census periods.

3.5.1.3 Estimated data

Data that has been *estimated* refers to information based on calculations that may include statistical assumptions about sampling or biological assumptions about the relationship between an observed variable and the variable of interest (IUCN SPC 2022). Estimated data is always quantitative. For example:

- Transect counts of singing male birds combined with assumptions about sex ratios to calculate the number of mature individuals.
- Population reduction or continuing decline in number of mature individuals derived from the estimated number at two different time points.
- EOO or AOO calculations based on ‘inferred sites of occurrence’ (e.g., sites inferred from presence of known habitat).

3.5.1.4 Projected data

As with estimated data, *projected* data refers to information based on calculations that may include statistical assumptions about sampling or biological assumptions about the relationship between an observed variable and the variable of interest (IUCN SPC 2022). However, projected data is extrapolated towards the future or in space. Projected data is always quantitative. For example:

- Population reduction from census data extrapolated into the future using statistical methods or models.
- Continuing decline in the area or extent of habitat predicted by a statistical model of land cover change, which is based on analysis of past land cover change from remote-sensed data.

3.5.1.5 Inferred data

Data that has been *inferred* refers to information in the same type of units but not a direct measure (IUCN SPC 2022). Inferred data can be involve a combination of quantitative and qualitative data. For example:

- Population reduction inferred from a change in catch statistics.
- Continuing decline in mature individuals inferred from trade estimates.
- Continuing decline in AOO inferred from rate of habitat loss.

3.5.1.6 Suspected data

Data that is *suspected* refers to information that is based on variables in different types of units (IUCN SPC 2022). Any reasonably supported suspicion, based on circumstantial evidence can be considered suspected data. Suspected data is always qualitative. For example:

- Percentage (%) population reduction based on decline in habitat quality or on incidence of a disease or circumstantial evidence.
- Population reduction based on information on trends in harvest, habitat quality, sightings (e.g., from structured expert elicitation).
- Anecdotal information about a population trend.

3.5.1.7 Minimum data quality requirements

Consequential differences occur when selecting observed / estimated / projected OR inferred OR suspected, as the latter two are not permissible with some criteria (Table 9).

Table 9. Minimum data quality requirements for criteria A-E. If the data qualifier for the listed parameter is of lower quality than required, it cannot meet the criterion, even if the numerical value meets the threshold for that criterion (excerpt from IUCN SPC 2022, pg. 19).

Criterion	Parameter	Minimum data quality
A	Population reduction	Suspected
B	AOO	Estimated
B	EOO	Estimated
B1b, B2b	Continuing decline in EOO; AOO; area, extent and/or quality of habitat; number of locations or subpopulations; number of mature individuals	Inferred
C, D	Number of mature individuals	Estimated
C1	Estimated continuing decline	Estimated
C2	Continuing decline in number of mature individuals	Inferred
C2a(i)	Size of largest subpopulation	Estimated
E	Extinction probability	Estimated

3.5.2 The precautionary principle

In preparing a nomination, nominators should reflect on, and have a good understanding of their personal risk tolerance.

A precautionary approach will classify a species as threatened unless there is strong indication that it is not threatened. Conversely, an evidentiary approach will classify a species as not threatened, unless there is strong indication that it is threatened. A spectrum of approaches exists between these extremes.

The IUCN guidelines recommend a precautionary, but realistic attitude is applied, while resisting an evidentiary attitude when applying the criteria. Despite this, uncertainty will remain in how much precaution should be applied. The general rule is to document decisions, and support these by stating whether a precautionary attitude has been considered. Thus, uncertainty should be actively considered throughout the criteria assessment section. Some examples of applying a precautionary, but realistic attitude include

- Using the lower plausible bounds for a population size under criterion C and D given the species has been relatively well surveyed, despite some areas of unsurveyed potential habitat.
- Using the upper plausible bounds for the number of mature individuals, given the species has been very poorly surveyed, and there are substantial areas of potential habitat to be surveyed.
- Using the upper plausible bounds for generation length (and thus to define a ‘very short time’ under Criterion D) given the species is a long-lived perennial, and faces imminent threats of climate change.
- Using the lower plausible bounds for population size, EOO and AOO, given the species is experiencing continuing decline due to a range of serious, inferred threats.

Corymbia rhodops is currently assessed as Vulnerable under the Nature Conservation Act but requires reassessment under the Common Assessment Methodology.

Image © Andrew Ford.

3.5.3 Criterion A

Criterion A is used to assess taxa in the context of a population reduction based on a variety of data sources including a direct observation, abundance indices, a decline in EOO/AOO and/or habitat quality, exploitation, and/or impacts of introduced or competing taxa. Species with a population reduction due to any of these factors may meet the category thresholds if the reduction occurs within a given timeframe (Table 10). Nominators should attempt to apply this criterion where there is sufficient evidence (suspected to observed) of a population reduction and the generation length of the species.

Table 10. Category thresholds for Criterion A (adapted from IUCN SPC 2022).

Population size reduction (reduction in total numbers) measured over the longer of 10 years or 3 generations based on any of A1 to A4				
	Critically Endangered (CR)	**Endangered (EN)**	**Vulnerable (VU)**	**Near Threatened (NT)**
A1	**≥ 90%**	**≥ 70%**	**≥ 50%**	**≥ 20%**
A2, A3, A4	**≥ 80%**	**≥ 50%**	**≥ 30%**	**≥ 20%**

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(*a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of (a) to (e)

(a) direct observation [*except A3*]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites

3.5.3.1 Population reduction

A population reduction is defined as a decline in the number of mature individuals, which does not need to be continuing (although it may be). This can be based on several data sources including:

(a) a direct observation,

(b) abundance index,

(c) decline in AOO, EOO or habitat,

(d) exploitation, and/or

(e) pathogen impacts.

3.5.3.2 Data qualifiers under Criterion A

It is important to note that only some data qualifiers can be used for each data source (a-e) under Criterion A (Table 11). For example, only data from a direct observation can meet the data quality for 'observed' as it is directly measuring population size. Metrics that use data that relates directly to population size (i.e., field surveys of individuals) can be used with a data qualifier of observed, estimated, or projected.

If the data source is based on a decline in AOO or EOO, the data qualifier under Criterion A can only be suspected, even if the decline in EOO or AOO was estimated. This is because the data source (i.e., the EOO and AOO) represent a variable of a different type, and thus assumptions must be made about the correlation between this data source and the population size (i.e., how many mature individuals were present in the part of the EOO or AOO that has declined). That is, if a reduction in EOO has been estimated, assessors can only suspect this corresponds to a reduction in population numbers, as they do not have data for the proportion of individuals present within the reduction area.

Table 11. Data qualifiers that can be used with each data source under Criterion A (adapted from IUCN SPC 2022).

Data qualifier	Data qualifier	Relevant criteria
(a) direct observation	observed, estimated	A1, A2, A4
(b) index of abundance	estimated	A1, A2, A4
	projected	A3, A4
	inferred	A1-4
(c) AOO, EOO, habitat quality	suspected	A1-4
(d) actual or potential exploitation	inferred, suspected	A1-4
(e) introduced taxa, hybridisation, pathogens, pollutants, competitors, parasites	inferred, suspected	A1-4

3.5.3.3 Generation length

Generation length is defined as the average age of parents of the current cohort (i.e., newborn individuals). This is used to scale time-based measures in the criteria against the reproductive rates (capacity for a species to replace itself) of a species. There are several ways to estimate this. A commonly used formula is:

*Age of first reproduction + (0.5 * length of reproductive period)*

For this formula, nominators will need to know (i) when the species becomes sexually mature, and (ii) when the species stops reproducing/senesces.

For plants with seed banks:

Juvenile period + ½ life of seeds in seed bank, OR median time to germination

Seed bank half-lives commonly range from <1-10 years.

Challenges

- Often there is not enough information to estimate generation length. However, an attempt should be made to address this. Review similar species in the genus with similar reproductive strategies to obtain more information if required. Ensure the level of uncertainty around the estimate is clearly stated.
- For plants that are strongly associated with a RE or threatened ecological community, the level of decline in this ecosystem can often be used as a proxy for population reduction.

3.5.3.4 Response structure for Criterion A

- Summary sentence
    - In the format provided in Box 7.
- Generation length
    - Describe the generation length for the species.
    - State the period over which a reduction is assessed (i.e., 10 years or 3 generations).
- Population reduction timing
    - State whether a reduction has occurred.
    - State the timing of the reduction and relevant subcriteria (A1-4).
- Population reduction basis
    - State what the population reduction is based on (a-e).
    - Describe the cause of the reduction (i.e., the relevant threat(s)). Note different threats may be relevant to different subcriteria (i.e., a future reduction due to mining under A3, but a past reduction due to land clearing under A1 or A2).
    - Check that the data qualifier is suitable (see section 3.5.3.2, pg. 60).
    - State the thresholds that are met and the consequent category the species is eligible under.

An example is provided in Box 7.

Box 7. Example response to Criterion A for *Leichhardtia coronata (a plant), *Acacia forsteri*** (a plant) and *Adclarkia dawsonensis* (a land snail)***.**

***Leichhardtia coronata* is assessed as <u>Vulnerable</u> under Criterion A4c.**

Generation length

The age of maturity, and therefore, the generation length and population trends for this species is unknown. Based on rudimentary estimates of age to maturity and longevity, the species is suspected to have a generation length of ~51-76.5 years. Therefore, a reduction is assessed over ~153-230 years (three generations) except for when the species is assessed under subcriterion A4 that permits a maximum period of 100 years into the future.

(A1-4) Population reduction within 10 years or three generations

Widespread clearing and degradation of lowland and hillside eucalypt forests in Southeast Queensland during the 19th and 20th centuries for residential, commercial, mining and agricultural purposes is inferred to have caused a population reduction in the past for the species (Field et al. 2012). However, widespread habitat clearing, and degradation was curtailed by the establishment of the national parks, state forests and other nature conservation areas as well as the protections afforded to remnant vegetation under the *Nature Conservation Act 1992* and the *Vegetation Management Act 1999.* However, the reduction in population size may not have ceased due to ongoing clearing and development (Moonie et al. 2023), as well as the potential for future population reductions for residential and commercial land supply over coming decades (Figure 7-9). While the impact of future development on freehold land on population size is difficult to predict, a reduction in the area of occupancy is suspected when accounting for that rapid and continuing growth of human population and subsequent urban sprawl across this species distribution (Field et al. 2012).

A suspected population reduction based on a decline in area of occupancy (c) can be calculated by assessing all collections since 1985 on freehold land that are in close proximity to residential and commercial developments or overlapping with mining exploration areas. Thus, there are 67 collections where the threat of development may not have ceased and is suspected to cause a reduction from 1985 to 2120 (up to a maximum 100 years into the future under A4). These 67 collections have an AOO of 124km^2, which amounts to a suspected 47.69% reduction in AOO, thereby meeting the threshold for subcriterion A4c.

***Acacia forsteri* is <u>Data Deficient</u> under Criterion A.**

Generation length

Generation length for the species is not precisely known (see Biology and Ecology).

(A1-4) Population reduction within 10 years or three generations

There are no data available to quantify past, current or future population reductions. However, the species is likely to have undergone a range reduction associated with land clearing in the east of its distribution (see Threats). There are insufficient data available to assess population reductions relative to generation length.

***Adclarkia dawsonensis* is assessed as <u>Data Deficient</u> under Criterion A.**

Generation length

The exact life span and generation length for the species is unknown. Other camaenids in Australia are estimated to have life spans of 10-20 years and it is reasonable to suspect *A. dawsonensis* has a similar life span (Queensland Department of Environment and Heritage Protection 2017). Based on similar species in the genus and field observations, it is likely that the species reaches sexual maturity after two years in ideal conditions (BAAM 2009; SKM 2009; JKR 2010; Stanisic et al. 2022). The length of reproductive period for the species in unknown, therefore there are insufficient data to estimate generation length for this species.

(A1-4) Population reduction within 10 years or three generations

A population reduction has been inferred in the past (A2) due to a (c) decline in quality of habitat from the threats of flooding and land clearing (see Threats). The threats of flooding and land clearing have not ceased, but are understood and reversible. However, there is insufficient data to quantify the magnitude and timing of the reduction. Additional monitoring data is required to determine the population trends within a given time.

A population reduction was inferred for the past and the future (A4) due to a (c) decline in quality of habitat from the threats of flooding and land clearing (see Threats). The threats of flooding and land clearing have not ceased, but are understood and reversible. However, there is insufficient data to quantify the magnitude and timing of the reduction. Additional monitoring data is required to determine the population trends within a given time for the species. Therefore, there are insufficient data to determine a population reduction relative to generation length for this species.

* Excerpt adapted from Verrall, B. (2023). Nomination to change the conservation class of *Leichhardtia coronata* under the *Queensland Nature Conservation Act 1992*. Queensland Department of Environment and Science.

** Excerpt adapted from Collingwood T.D. (2022). Nomination to change the conservation class of *Acacia forsteri* under the *Queensland Nature Conservation Act 1992*. Queensland Department of Environment and Science; and

*** Excerpt adapted from Parisi, MA. (2023). Nomination to change the conservation class of *Adclarkia dawsonensis* under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

Summary of documentation requirements for Criterion A

- The rate of population size reduction (%) and the method of calculation (e.g. statistical method, population model).
- Appropriate justification, for example:
    - the assumed pattern of decline (e.g. exponential, linear, accelerated, more complex)
    - how decline is extrapolated
    - how information has been combined from widely distributed or multiple subpopulations
    - assumptions of the model used (if fitted), justified by life history, habitat biology, threats, pattern of exploitation etc.
    - what data have been included/excluded, and why.
- When using a model to *project* reduction under A3, the best estimate should be used, otherwise a clear rationale for using the lower or upper bound.
- Whether the reduction is past and/or future.
- The timeframe for the reduction (i.e. the longer of 10 years or 3 generations), with appropriate justification (e.g. statement of generation length and how this was measured (see above)).
- The data qualifier for the reduction, i.e. observed, estimated, projected, inferred or suspected.
- The basis for quantifying/calculating the reduction, based on any of (a) - (e), noting that (a) cannot be used for A3.
- The causes of the reduction (i.e. threatening factors), including the scale and mechanism of their action, and whether or not these are reversible; understood; and ceased.

Solanum orgadophilum (Capella potato bush) is restricted to the Brigalow Belt and is listed as Critically Endangered due to land clearing.

Image © Teghan Collingwood.

3.5.4 Criterion B

Criterion B is used to assess species in the context of spatial distribution, an ongoing decline and/or an inherent susceptibility to decline. A species with a *restricted geographic range that is declining or has an inherent susceptibility to decline* due to a fragmented or fluctuating distribution, may meet the category thresholds (Table 12). Nominators should attempt to apply this criterion where high-quality spatial records for the species are available, along with evidence of continuing decline or extreme fluctuations.

Important: Criterion B is the most commonly mis-applied criterion. Care should be undertaken to understand all definitions, and that B1 and B2 are coupled with at least two of (a), (b) and/or (c).

Table 12. Category thresholds for Criterion B (adapted from IUCN SPC 2022).

Geographic distribution is precarious for either extent of occurrence AND/OR area of occupancy				
	Critically Endangered (CR)	**Endangered (EN)**	**Vulnerable (VU)**	**Near Threatened (NT)**
B1. Extent of occurrence (EOO)	**< 100km²**	**< 5,000km²**	**< 20,000km²**	**< 40,000km²**
B2. Area of occupancy (AOO)	**< 10km²**	**< 500km²**	**< 2,000km²**	**< 4,000km²**
AND at least 2 of the following 3 conditions for CR, EN or VU:				AND (b) for NT
(a) Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**	**Not applicable**
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals				**≥ 10% within the longer of 10 years or 3 generations**
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals				**Not applicable**

3.5.4.1 Extent of occurrence

Refers to "*the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy*" (IUCN SPC 2022).

- This is calculated as the minimum convex polygon or convex hull that includes all the occurrences for a species.
- Measures spatial spread of risk and the overall geographic spread of the localities at which the species occurs.
- If EOO is less than AOO, EOO should be increased to equal AOO to ensure consistency with the definition of AOO as an area within EOO.

3.5.4.2 Area of occupancy

The AOO is a scaled metric that represents the area of suitable habitat known, inferred, or projected to be currently occupied by the species (IUCN SPC 2022). It is generally estimated by with a 2 x 2km grid to enable comparison with the criteria thresholds. AOO is not designed to be a fine scale estimate of the actual area occupied by the species. The AOO is calculated by summing the area contained within the total number of 2 x 2km grid cells occupied by the species.

- Measures 'insurance effect' (spatial spread of risk).
- Often correlates to population size.

3.5.4.3 Severely fragmented

Refers to the situation in *which "increased extinction risk to the taxon results from the fact that most of its individuals are found in small and relatively isolated subpopulations (in certain circumstances this may be inferred from habitat information). These small subpopulations may go extinct, with a reduced probability of recolonisation"* (IUCN SPC 2022, pg. 48). A species' subpopulations must be both *small and isolated.* Population fragmentation is not the same as, but can be inferred from, habitat fragmentation. It must be assessed at scale appropriate to

biological isolation.

Information required to assess if a species is severely fragmented includes:

- The distribution of area of occupancy (i.e., detailed maps of occupied habitat),
- Some aspect of the dispersal ability of the species (e.g., average dispersal distance), and
- Average population density in occupied habitat (e.g., information on territory size, home range size, etc.)

Then, a species can be considered severely fragmented if most (>50%) of its total AOO is in habitat patches that are:

- Smaller than would be required to support a viable population, and
- Separated from other habitat patches by a large distance relative to dispersal capacity of the species (see below).

Summary of documentation requirements for 'severely fragmented'

- What percentage, if >50%, of the species' total AOO consists of habitat patches that are too small to support a viable population and are separated from other habitat patches by a large distance relative to the dispersal capacity of the species.
- The habitat area estimated to be required to support a viable population.
- The threshold used to define 'small' subpopulations that are not considered to be viable and how it was estimated.
- The degree of isolation of patches.
- The dispersal distance of the species.
- The history of subpopulation sizes or persistence, as it is likely that subpopulations that have persisted for multiple generations at small sizes are viable.

3.5.4.4 Locations

Locations refer to a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present. The standard rules for delineating locations are:

- All areas within the species' distribution must be considered.
- It is defined by the most serious plausible threat (i.e., the highest in the risk matrix).
- The timeframe for the threat impact must be short (i.e., 1-2 generations or 3 years, whichever is longer).

To assess locations, nominators will need to

- Define the time scale (the longer of 2 generations or 3 years)
- Reframe the definition of locations as a question: '*what is the area over which the threat could impact the species within 2 generations?'*

Some examples

- Feral cats occur throughout the distribution of the species and are known to heavily target it. Therefore, it could impact the species in all areas within 2 generations (20 years). Therefore, the species occurs in one location.
- Feral cats occur throughout the distribution of the species but are intensively managed in Frog National Park. Therefore, it is unlikely feral cats would have a substantial impact in the NP area over 2 generations (20-years). Therefore, the species occurs in two locations.
- Feral cats have much lower hunting success in the rainforest habitat where the species occurs compared with the open woodland streams. The impacts are likely to be substantially different between these sites over 2 generations (20 years). Therefore, the species occurs in 2 locations.

Challenging applications of locations

There are a number of scenarios when locations need to be defined using additional rules. These are described in detail in IUCN SPC (2022) and summarised here.

- **Multiple threats:** when there are 2+ serious threats, nominators should apply the one that results in the smallest number of locations (Appendix 4).
- **Distinct threats over range:** Where the most serious plausible threat is different across the species' range, nominators should use separate threats for each area (Appendix 5).
- **Cumulative impacts:** where the most serious plausible threat is habitat loss that occurs gradually and cumulatively via many small-scale events, locations should be defined by the area over which the population will be severely reduced within a single generation or 3 years, whichever is longer (Appendix 6).
- **Part population unaffected:** where part of the population is not impacted by a threat, nominators should:
    - Base the number of locations on the most likely threat that may affect the currently unaffected areas in the future; or
    - Consider not using locations if area impacted is <50%; or
    - Use subpopulations as a surrogate for locations in the unimpacted areas; or
    - Transpose the smallest location from the impact areas to the non-impacted areas (Appendix 7).

Some examples of application from Silcock et al. (2020):

Where the main threatening process operates at a landscape scale, the number of locations is defined as the number of discrete management units applicable to the threatening process. The delineation of management units may relate to the ability of the species to disperse between areas affected by the threat, the capacity for the threat to transition between units, or areas where different management practices are utilised to mitigate the threat.

- Taxa threatened by the airborne pathogen myrtle rust, where all subpopulations occur within the climatic range of the pathogen, are assessed as a single location.
- Often, where climate change is considered the major threat, all subpopulations are affected and considered a single location.
- Phytophthora (*Phytophthora* spp.) dieback is soil-borne, and fronts may move gradually through an area of contiguous, susceptible vegetation. However, spread to an uninfected area separated by an ecological barrier (e.g., farmland or urbanisation) would require a specific transport vector. Such geographically separated subpopulations would be considered multiple locations in relation to the threat of phytophthora.

Important: Nominators should only use the term 'location' in assessments with specific reference to the definition. Choose terms such as 'occurrence', 'sites' or 'subpopulations' as alternatives.

Summary of documentation requirements for 'locations'

- The most serious plausible threat from the risk matrix (or the relevant threats used to count locations).
- The proportion of the distribution/population affected by the threat(s).
- The nature of the effects (i.e., will it rapidly affect all individuals of the species present?).
- The timeframe over which the threat(s) occur(s) and how that could be considered 'rapid' in the context of the life history of the species.

3.5.4.5 Continuing decline

Continuing decline refers to a *recent, current or projected future* decline that is liable to continue in the absence of threat management. This may be *observed, estimated, inferred or projected*, depending on the criteria/subcriteria.

- For projected declines (i.e., into the future), there must be a high degree of certainty that they will take place; that is, merely plausible future declines are not eligible under Criterion B or C.
- Continuing declines differ from reductions, as they are liable to continue in the absence of remedial action.

Summary of documentation requirements for 'continuing decline'

- Whether the decline is recent, current or projected (future).
- A statement that the decline is likely to continue, without remedial action, with reference to the cause(s) of the decline.
- For B1b or B2b, the element(s) met under condition (b), i.e. any of (i) - (v), including explanation of how relevant terms were defined/applied (e.g. habitat, locations, subpopulations, mature individuals).
- For C1, the rate of decline (%) and timeframe (i.e. the longer of 10 years or 3 generations), including appropriate justification with reference to generation length.
- What data / information has been included / excluded, and why.
- Whether the decline is observed, estimated, inferred or projected, as appropriate.

3.5.4.6 Extreme fluctuations

Extreme fluctuations occur when the population size or distribution varies widely or rapidly, typically by a 10-fold increase/decrease. A fluctuation must represent a true change in the population, not just a flux between life stages (such as obligate seeding species following fire). Extreme fluctuations occur when:

- Population trajectories show a repeated pattern of increases and decreases.
- Taxa have life histories prone to boom-bust dynamics (e.g., granivorous mammals of arid climates, plants that respond to stand replacing disturbances).

Summary of documentation requirements for 'extreme fluctuations'

- How the extreme fluctuations are demonstrated/measured, with reference to population trajectories and/or life history traits (and where appropriate, the degree isolation and synchronicity across subpopulations).
- What data have been included/excluded, and why.
- Magnitude of the fluctuations (noting it must be ≥ 10-fold) and timeframe over which they are measured.
- The pattern or nature of the fluctuations (regular/sporadic).
- Clear justification that the ≥ 10-fold fluctuation demonstrates change in the total population (rather than a flux between different life stages).

3.5.4.7 Response structure for Criterion B

- Summary sentence
    - In the format provided in Box 8.
- EOO and AOO
    - State the EOO and AOO. State which threshold they meet.
    - State whether the calculated EOO and AOO are close to the threshold, and if so, whether a different threshold would be more appropriate. For example, if the species has been under-surveyed and qualifies for the CR AOO threshold, but is close to the EN AOO threshold, Nominators may reasonably recommend that the EN threshold is used.
- Severely fragmented
    - State whether the species meets the definition of severely fragmented. If it does, provide a clear justification.
- Number of locations
    - State the number of locations
    - State and justify the method used to delineate locations. Appropriate methods include using the most serious plausible threat, using the threat that results in the smallest number of locations, or using multiple threats where the species has different threats across its range.
    - Where the number of locations is uncertain, a range of values can be presented using plausible bounds. If the values do not fit within a category threshold, a decision of the appropriate category should be justified.
- Continuing decline
    - State whether there is a continuing decline for the species and the associated data qualifier (suspected, inferred, estimated, projected, observed). Justify the cause of the continuing decline by briefly describing the threats.
    - State the subcriteria (i-v) that are subject to a continuing decline.
- Extreme fluctuations
    - State whether the species is subject to extreme fluctuations. If extreme fluctuations are present, justify these against the definition provided in IUCN SPC (2022).

An example is provided in Box 8.

Box 8. Example application of Criterion B for *Parsonsia sankowskyana* (a perennial vine)* and *Adclarkia dawsonensis* (a land snail).**

***Parsonsia sankowskyana* is assessed as <u>Critically Endangered</u> under Criterion B1ab(i-v).**

(B1+2) EOO and AOO

The species has an EOO of 32.8 km^2 and AOO of 12 km^2 (see Distribution). Therefore, the species meets the threshold for CR for B1 and EN for B2. It is unlikely that the species is more widespread, and it is well within the threshold for CR under B1. Therefore, the threshold for CR has been used in this assessment.

(a) Severely fragmented

There are two subpopulations of the species, comprising three sites. All (100%) of these sites occur in small habitat patches or cleared vegetation amongst a heavily cleared landscape. The two subpopulations are separated by >50km, indicating that gene flow between sites is limited. Further, the total population size is estimated to be <50, indicating that the subpopulations are too small to be viable. As the species occurs in small, isolated habitat patches separated by large distances, with evidence that >50% of the subpopulations occur in habitat patches that are too small to support a minimum viable population, the species is considered severely fragmented in this assessment.

(a) Number of locations

The number of locations is based on the most plausible serious threat (residential and commercial development). All subpopulations are considered to be simultaneously impacted by residential and commercial development and thus constitute one location for the purpose of this assessment.

(b) Continuing decline

Almost all of the known occurrences for the species are on private property undergoing significant residential and commercial developments within recent years. These residential developments have left the potential habitat available for the species fragmented, occurring in small pockets that are likely to small to support a viable population. Further, surveys for the species in the last 15 years were unable to detect the species along any roads within the area, in areas that the species was known to occur previously (G. Sankowsky, pers.comm. 2023). A king tide event in 2020 led to the inundation of private properties across the Hervey Bay and Craignish region, encompassing the area in which *P. sankowskyana* occurs (Fraser Coast Regional Council 2021). These threats are likely to be causing decline in the habitat that the species can inhabit. These conditions indicate that there is continuing decline inferred in the species' extent of occurrence, area of occupancy, habitat quality, number of subpopulations and the number of mature individuals due to ongoing threats, thereby meeting sub-criterion (b)(i-v).

(c) Extreme fluctuations

It is unknown whether *P. sankowskyana* experiences extreme fluctuations. Given the species is a perennial vine with a persistent seedbank, extreme fluctuations in EOO, AOO, number of subpopulations or locations are unlikely and not accepted in this assessment.

***Adclarkia dawsonensis* meets the thresholds for listing as <u>Endangered</u> under Criterion B1+2ab(iii, v).**

(B1+2) EOO and AOO

The species has an EOO of 2,782.8km^2 and AOO of 100km^2 (see Distribution). Therefore, the species meets the thresholds for EN for B1 and EN for B2. The species is well within the thresholds for EN under B1/B2. Therefore, the threshold for EN has been used in this assessment.

(a) Severely fragmented

Although the species occurs in small habitat patches separated by large distances, there is no evidence that >50% of the subpopulations persist in habitat patches that are too small to be viable. Therefore, the species is not considered severely fragmented in this assessment.

(a) Number of locations

When assessed against the most serious plausible threat, flooding, *A. dawsonensis* is considered to occur at one location. Locations have been delineated due to the species occurring along the Dawson River, where flooding impacts the whole distribution.

(b) Continuing decline

A continuing decline has been inferred for the species based on the cumulative threats of flooding, land clearing, feral pigs and domestic livestock. These threats directly impact the species by removal of critical habitat and mortality by crushing. The threats are inferred to cause a continuing decline in habitat quality and the number of mature individuals, thereby meeting sub-criterion (b)(iii, v).

(c) Extreme fluctuations

It is unknown whether *A. dawsonensis* experiences extreme fluctuations. There is no evidence of extreme fluctuations in the distribution area or the number of mature individuals that represent a tenfold increase or decrease in the total population for this species (IUCN SPC, 2022).

*Excerpt adapted from Noble, E.A. (2023). Nomination to change the conservation class of *Parsonsia sankowskyana* under the Queensland Nature Conservation Act 1992. Queensland Department of Environment and Science.

**Excerpt adapted form Parisi, MA. (2023). Nomination to change the conservation class of *Adclarkia dawsonensis* under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

3.5.5 Criterion C

Criterion C is used to assess taxa in the context of population size and decline. Taxa with a *small population size and continuing decline* in the 'number of mature individuals' may meet the thresholds for listing under this criterion (Table 13). Nominators should attempt to apply Criterion C when there is sufficient information about the population size and evidence of decline in the number of mature individuals.

Important: Only continuing decline in 'the number of mature individuals' is permissible under Criterion C, rather than also AOO, EOO, locations/subpopulations and area, extent and/or quality of habitat as in Criterion B. For projected declines (i.e., into the future), there must be a high degree of certainty that they will take place; that is, merely plausible future declines are not eligible under Criterion B or C.

Table 13. Category thresholds for Criterion C (adapted from IUCN SPC 2022).

Small population size and decline					
		Critically Endangered (CR)	**Endangered (EN)**	**Vulnerable (VU)**	**Near Threatened (NT)**
Estimated number of mature individuals		**< 250**	**< 2,500**	**< 10,000**	**< 20,000**
AND either (C1) or (C2) is true					AND (C1) is true
C1 An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in the future		**25% in 3 years or 1 generation (whichever is longer)**	**20% in 5 years or 2 generations (whichever is longer)**	**10% in 10 years or 3 generations (whichever is longer)**	**10% in 10 years or 3 generations (whichever is longer)**
C2 An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of (a) or (b):					
(a)	(i) Number of mature individuals in each subpopulation	**≤ 50**	**≤ 250**	**≤ 1,000**	**Not applicable**
	OR				
	(ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**	**Not applicable**
(b) Extreme fluctuations in the number of mature individuals		**Applicable**	**Applicable**	**Applicable**	**Not applicable**

3.5.5.1 Number of mature individuals

Refers to the number of individuals known, estimated or inferred to be capable of reproduction.

- Individuals that will never be capable of reproducing should be excluded (i.e., densities too low).
- Use lower plausible bounds where fluctuations occur.
- For clonal taxa, use reproductive units (i.e., ramets) that can survive alone.
- Re-introduced taxa must be self-sustaining (produced viable offspring).

3.5.5.2 Continuing decline

See definition under Criterion B, pg. 66.

3.5.5.3 Generation length

See definition under Criterion A, pg. 70.

3.5.5.4 Subpopulations

Refers to geographically distinct groups in the population between which there is limited demographic or genetic exchange (typically one successful migrant individual or gamete per year or less). The method used to delineate subpopulations will vary between species. It is important to have an understanding of the species' dispersal

capacity and reproductive mechanisms (e.g., water dispersed seeds). As an example:

- For a species of tree, a subpopulation can be defined as a spatially distinct segment of the population that experiences insignificant or reproductively unsuccessful migration of seed or pollen from other subpopulations. For example, species inhabiting separate mountain tops would likely be classified as separate subpopulations. If the mountains were close enough together and the species was dispersed (either pollen or fruit) by highly mobile species (such as bats or birds), they could reasonably considered a single subpopulation.
- For a species of shrub that has water dispersed seed, catchments or drainage basins may be a useful scale to delineate subpopulations.
- For a freshwater fish, subpopulations may be defined by catchments, between which would be low rates of gene transfer.
- For freshwater fish or plants that occur in very isolated habitat such as springs, subpopulations may be defined by each distinct spring, unless overland flow facilitates dispersal between the springs each year.
- For terrestrial taxa that inhabit islands, subpopulations may be defined by each discrete island, as migration between these islands is likely to be limited by the ocean. This delineation is not likely to be applicable to birds, which may regularly travel between islands. Similarly, plants with buoyant, desiccation-resistant seed may be able to regularly exchange gametes between the islands.

3.5.5.5 Extreme fluctuations

See definition under Criterion B, pg. 67.

3.5.5.6 Response structure for Criterion C

- Summary sentence
    - In the format provided in Box 12.
- Number of mature individuals
    - State the number of mature individuals. Where plausible bounds are used, comment on whether the lower or upper bounds should be used in the assessment. Lower bounds are typically used where a precautionary approach is warranted given the presence of threatening processes. Upper plausible bounds are typically used if further survey is required and threats are minimal.
- Continuing decline
    - State whether there is a continuing decline for the species and the associated data qualifier (suspected, inferred, estimated, projected, observed). Justify the cause of the continuing decline by briefly describing the threats.
- Subpopulation size and proportion
    - State the number of mature individuals in each subpopulation.
    - State the proportion (%) of mature individuals in each subpopulation.
- Extreme fluctuations
    - State whether the species is subject to extreme fluctuations. If extreme fluctuations are present, justify these against the definition provided in IUCN SPC (2022).

An example of how to justify assessment under Criterion C is provided in Box 9.

Box 9. Example application of Criterion C. *Parsonsia sankowskyana (a perennial vine) can be assessed under Criterion C as there are sufficient data available on population size and continuing decline is evident. While *Adclarkia dawsonensis*** (a land snail) meets the requirements under Criterion C for continuing decline, the population size is unknown so it cannot be assessed.**

***Parsonsia sankowskyana* is assessed as Critically Endangered under Criterion C2a(i).**

(C) Number of mature individuals

The total number of mature individuals is estimated to be less than 50, with a high probability that there are less than 10 (P. Forster 2023. pers. comm., 2023).

C1+2 Continuing decline in mature individuals (% AND/OR at any rate)

A continuing decline in the number of mature individuals is inferred for the species.

(a) Number and proportion of mature individuals in each subpopulation

The total number of mature individuals across the two subpopulations is <50, therefore meeting the thresholds for listing as CR. The proportion of mature individuals in one subpopulation is unknown.

(b) Extreme fluctuations

It is unknown whether *P. sankowskyana* experiences extreme fluctuations. Therefore, there are no known extreme fluctuations in the number of mature individuals.

***Adclarkia dawsonensis* is assessed as Data Deficient under Criterion C.**

(C) Number of mature individuals

Current population data is not sufficient to estimate population size for *A. dawsonensis*.

(C1+2) Continuing decline in mature individuals (% AND/OR at any rate)

A continuing decline has been inferred for the species based on the threats of flooding, land clearing, feral pigs and domestic livestock. These threats directly impact the species by removal of critical habitat and mortality by crushing. The sheer number of threats occurring across the entire range of the population are likely to have an ongoing impact on the species.

(a) Number and proportion of mature individuals in each subpopulation

The number and proportion of mature individuals in each subpopulation is unknown.

(b) Extreme fluctuations

It is unknown whether *A. dawsonensis* experiences extreme fluctuations. There is no evidence of extreme fluctuations in the distribution area or the number of mature individuals that represent a tenfold increase or decrease in the total population for this species (IUCN SPC 2022).

*Excerpt adapted from Noble, E.A. (2023). Nomination to change the conservation class of *Parsonsia sankowskyana* under the Queensland Nature Conservation Act 1992. Queensland Department of Environment and Science.

**Excerpt adapted form Parisi, MA. (2023). Nomination to change the conservation class of *Adclarkia dawsonensis* under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

3.5.6 Criterion D

Criterion D is used to assess species in the context of population size or extent. Those species with very *small population sizes*, or populations that are *restricted* in the context of potential threatening processes may meet the category thresholds for subcriteria D1 or D2, respectively (Table 14).

A species qualifies for listing under D1 if the population size is estimated to number fewer than 3000 mature individuals. This subcriterion is intended to capture those taxa with acute restriction in their population size, even if they are not declining.

A species qualifies for listing under D2 if the population is sufficiently restricted (in either AOO or locations) AND has a plausible future threat that could drive the species to become threatened (Vulnerable, Endangered or Critically Endangered) or Extinct in a short time. The subcriterion is intended to capture taxa with restricted distributions such that the population is prone to the effects of human activities or stochastic events in an uncertain future. The focus of subcriterion D2 is *the risk that the species could rapidly become CR or EX.*

Taxa with very restricted ranges or small populations that do not meet the data quality requirements under Criteria A-C may often meet the threshold for Vulnerable under Criterion D2. Rather than having a clear line of evidence for continuing decline, a 'plausible future threat' can be used to assess the species. For a listing of Vulnerable, the plausible future threat must have the potential to drive the species to CR or EX in a 'very short time'. For a listing of Near Threatened, the plausible future threat must have the potential to drive the species to EN or VU in a 'very short time'.

Important: The spatial thresholds (AOO and number of locations) are provided as indicators only, NOT as literal thresholds. The emphasis of criterion D is the possibility the species could be rapidly driven to a higher threat category, rather than the spatial thresholds alone. Thus, if a species occurs close to a threshold, an argument can be made as to why it is eligible for that category on the basis that it could become rapidly threatened in the future.

Table 14. Category thresholds for Criterion D (adapted from IUCN SPC 2022).

Very small population				
	Critically Endangered (CR)	**Endangered (EN)**	**Vulnerable (VU)**	**Near Threatened (NT)**
D1. Number of mature individuals	**< 50**	**< 250**	**D1. < 1,000**	**D1. < 3,000**
OR				
D2. [Only applies to the VU and NT categories] Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time (for VU), or EN or VU in a very short time (for NT).	**Not applicable**	**Not applicable**	**D2. Typically: AOO < 20km^2 or number of locations ≤ 5**	**D2. Typically: AOO < 40km^2 or number of locations ≤ 10**

3.5.6.1 Number of mature individuals

Refer to definition under Criterion C, pg. 70.

3.5.6.2 Area of occupancy

Refer to definition under Criterion B, pg. 64.

3.5.6.3 Locations

Refer to definition under Criterion B, pg. 65.

3.5.6.4 Plausible future threat(s)

A plausible threat is defined as the effects of human activities or stochastic events in an uncertain future. Plausible

threats include *both natural and anthropogenic events*. There must be a substantial possibility of these activities or events occurring. The following examples would *not* suffice as plausible future threats:

- Unlikely events, such as the eruption of an inactive volcano
- Non-specific events that were not observed in similar species (e.g., an unspecified disease epidemic)
- Events unlikely to cause extinction (e.g., because the species has survived many cyclones, or is likely to adapt to climate change, or fire regimes that have not deviated from historical norms)
- Events unlikely to occur rapidly enough to result in a CR or EX listing in a very short time *after the event occurs* (or VU or EN for NT).

3.5.6.5 Very short time

A 'very short time' is defined as the longer of 1-2 generations or 3-5 years after the threatening event occurs. That is, the species would deteriorate to meet the listing thresholds for CR or EX *under any criteria*, after the potential threat occurred within the longer of 1-2 generations or 3-5 years.

An example of how to justify assessment under Criterion D is provided in Box 10.

3.5.6.6 Response structure for Criterion D

- Summary sentence
    - In the format provided in Box 10.
- Number of mature individuals
    - State the number of mature individuals. Where plausible bounds are used, comment on whether the lower or upper bounds should be used in the assessment. Lower bounds are typically used where a precautionary approach is warranted given the presence of threatening processes. Upper plausible bounds are typically used if further survey is required and threats are minimal.
- AOO
    - State the AOO. State which threshold is met.
- Number of locations
    - State the number of locations.
    - State and justify the method used to delineate locations. Appropriate methods include using the most serious plausible threat, using the threat that results in the smallest number of locations, or using multiple threats where the species has different threats across its range.
    - Where the number of locations is uncertain, a range of values can be presented using plausible bounds. If the values do not fit within a category threshold, a decision of the appropriate category should be justified.
- Plausible future threat that could drive the taxon to CR or EX (for VU), or EN or VU (for NT) in a very short time
    - State if there is a plausible future threat to the species
    - Define a 'very short time' (the longer of 1-2 generations or 3 years)
    - Justify how the species could become eligible for any category after this plausible threatening event occurred.

An example is provided in Box 10.

Box 10. Example application of subcriteria D1 and D2. *Parsonsia sankowskyana (a perennial vine) has population size information and can be assessed under Criterion D1. *Dioclea hexandra*** (a perennial vine) meets different thresholds under Criterion D1 and D2. *Adclarkia dawsonensis**** (a land snail) can only be assessed under Criterion D2 as it lacks population estimates.**

***Gymnostoma australianum* meets the thresholds for listing as Vulnerable under Criterion D2.**

(D+D1) Number of mature individuals

With recent observations across the subpopulations and the likelihood of additional records at Thornton Peak, 2,800 mature individuals are used as the estimate within the assessment.

(D2) AOO and number of locations

The species has an AOO of 20km^2.

The number of locations is based on the most plausible serious threats (increased flooding frequency and severe cyclone events). For the upland subpopulations, montane drying or cyclones are likely to be the most serious threat, simultaneously impacting all sites and resulting in one location. For the two lowland subpopulations (Noah Creek and Roaring Meg Creek), the most serious threat is an increase in severity and frequency of high impact floods. This threat is likely to operate at the scale of a creek system, with potentially different impacts at each site resulting in two locations. Therefore, the number of locations is considered three on the basis of increased flooding frequency and severe cyclone events.

(D2) Serious plausible threat that could rapidly drive the taxon to CR/EX (for VU) or VU/EN (for NT)

There are several plausible threats that could drive the species to CR in a very short time. The species is currently near the threshold for CR under B1, with a continuing decline potentially reducing this further if additional surveys are undertaken. A continuing decline has been suspected for the species based on the threat of climate change in combination with feral pig impacts. It is highly plausible that these threats could cause a continuing decline such that it would become eligible as CR under Criterion B1ab(1-v).

***Dioclea hexandra* meets the thresholds for listing as Near Threatened under Criterion D2.**

(D+D1) Number of mature individuals

There are no historic or current data on the population parameters for the species. Although several records exist for the species, no quantitative surveys have been undertaken to record the number of individuals. Therefore, no estimate can be made for the number of mature individuals for the species.

(D2) AOO and number of locations

The species has an AOO of 60km^2 with the species occurring at four locations based on the most plausible serious threat (feral pigs).

(D2) Serious plausible threat that could rapidly drive the taxon to CR/EX (for VU) or VU/EN (for NT)

The species has multiple threats that could drive it to EN in a short time. A short time for this species is likely to be >20 years. Although the generation length is unknown, a similar species (*D. megacarpa)* matures after 20 years (Janzen 1971), indicating *D. hexandra* is likely to be long-lived. The species is already eligible for listing as EN under B2ab(i-v), and with additional surveys the species may become eligible for listing as EN under C2a(i) as the species is known from few individuals across a large distribution. However, it is not considered plausible the species would be driven to CR in this time, and therefore the species is only eligible for NT under D2.

***Adclarkia dawsonensis* meets the threshold for listing as Vulnerable under Criterion D2.**

(D+D1) Number of mature individuals

Current population data is not sufficient to estimate population size for *A. dawsonensis*.

(D2) AOO and number of locations

The species has an AOO of 100km^2. When assessed against the most serious plausible threat, flooding, *A. dawsonensis* is considered to occur at one location. Locations have been delineated due to the species occurring along the Dawson River, where flooding impacts the whole distribution.

(D2) Serious plausible threat that could rapidly drive the taxon to CR/EX (for VU) or VU/EN (for NT)

There are several threats that could drive the species to CR or EX in a very short time. Generation time was suspected to be 4-9 years if sexual maturity was reached after two years, life span was 10-20 years and length of reproductive period was 4-14 years. A short time for this species is suspected to be 8-18 years (i.e., the longer of 3 years or 1-2 generations), based on the suspected generation length. The species has several inferred threats including flooding, land clearing, feral pigs and domestic livestock. Particularly when combined with other threatening processes, it is highly plausible that the threat of flooding could drive the taxon to CR or EX in a very short time, due to localised losses resulting in a severely reduced EOO and AOO.

*Excerpt adapted from Noble, E.A. (2023). Nomination to change conservation class of *Gymnostoma australianum* under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

**Excerpt adapted form Noble, E.A. (2023). Nomination to change conservation class of *Dioclea hexandra* under the Queensland Nature Conservation Act 1992. Queensland Department of Environment and Science.

***Excerpt adapted form Parisi, MA. (2023). Nomination to change the conservation class of *Adclarkia dawsonensis* under the Queensland *Nature Conservation Act 1992*. Queensland Department of Environment and Science.

3.5.7 Criterion E

Criterion E is used to assess taxa using a *quantitative analysis* related to the probability of extinction in the wild. Those taxa with a high probability of extinction, measured as a loss within a given timeframe, may meet the category thresholds (Table 15). The process is typically quite involved, usually related to a peer-reviewed publication. There are few examples of Criterion E application in Queensland, but it has been applied for *Grevillea caleyi* in New South Wales (Regan et al. 2003). Criterion E requires nominators to calculate extinction risk for up to three time periods:

- 100 years (for NT and VU)
- The longer of 20 years or five generations (up to 100 years)
- The longer of 10 years or three generations (up to 100 years).

An example of how to justify assessment under Criterion E is provided in

Box 11.

Table 15. Category thresholds for Criterion E (adapted from IUCN SPC 2022).

Quantitative Analysis				
	Critically Endangered (CR)	**Endangered (EN)**	**Vulnerable (VU)**	**Near Threatened (NT)**
Indicating the probability of extinction in the wild to be:	**≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)**	**≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)**	**≥ 10% within 100 years**	**≥ 5% within 100 years**

Box 11. Example application of Criterion E (example extracted from TSSC 2018).

***Grevillea caleyi* meets the thresholds for listing as Critically Endangered under Criterion E.**

Probability of extinction (**E**)

"Regan and Auld (2004) suggest that extinction risk currently varies from 60% (low fire frequency 15-30 years between fires) to 96% (high fire frequency – five years between fires) in 50 years due to the risk of wildfire burning over any planned fires. Most decline is predicted to occur in the first 25-30 years of the models developed by Regan and Auld (2004). A generation in G. caleyi *is thought to between 8-15 years (and 3 generations 24-45 years). However, given that generations are triggered by fire events (and do not occur independently of fire) and that the average fire return interval in the habitat is approximately 7-17 years (Bradstock and Kenny 2003), 3 generations is most likely to be 21-60 years. Although uncertain, this suggests that the probability of extinction is likely to be ≥ 50% in 3 generations. Consequently,* Grevillea caleyi *would meet Criterion E as Critically Endangered".*

Summary of documentation requirements for Criterion E

- Probability of extinction (%) over the relevant time period(s).
- The time period(s) over which extinction probability is assessed, with reference to the criterion thresholds and the generation length of the species, up to 100 years.
- The quantitative analysis technique used (e.g. PVA), with supporting documentation and explanation of the data used, assumptions and uncertainties.

3.6 Summary of criteria under which the species is eligible

To complete this section, nominators should

- Write the category (CR, EN, VU) and the subcriteria for which the species qualifies next to the relevant criteria headings as in Box 12.
- Then, write the highest category and criteria for which the species qualifies (this can be more than one) as the overall eligible listing class, as in Box 13.

Box 12. Nominators should write the eligible category and subcriteria next to each category.

Summary of wildlife class/category and criteria under which the species is eligible for listing as CR / EN / VU / NT

Criterion A: VU A2bd

Criterion B: CR B1ab(v)

Criterion C: CR C1

Criterion D: EN D

Criterion E: DD

Box 13. Nominators should write the overall category and criteria that the species' is eligible for listing as. The eligible category/criteria is the highest, and can be more than one.

Overall eligible listing wildlife class / category and criteria

CR B1ab(v); C1

3.7 Nomination listing details

3.7.1 Current listing class / category

Select the appropriate category for the *NC Act* and the *EPBC Act.*

- The status under the *NC Act* will be listed on WildNet.
- The status under the *EPBC Act* will be listed on the SPRAT database.
- Include details, where available, of any non-statutory listing class /categories.

Review all previous listings for the species (historic and current) and follow the text format displayed in Box 14.

Box 14. Example text format for the Initial listing section of the nomination form.

[*Species name*] was listed as [Category] under Criterion [xxxx] on [DATE] due to [reasons].

The species was then de-listed in [DATE] due to a significant expansion in range and population size, resulting in the number of mature individuals, EOO and AOO exceeding the thresholds for Vulnerable.

OR

The initial listing information is not available for this species.

The species is listed as VU under Criterion D2 on the IUCN Red List.

3.7.2 Nominated listing class

Nominators should state the proposed category and criteria for listing under the *NC Act*, along with a brief justification for why the species meets the thresholds for this category (Box 15).

Box 15. Example text format for the nomination transfer section of the nomination form.

> [Species name] has been assessed under the CAM-compliant methodology and meets the thresholds for listing as [Category] under Criterion [XX], because [reason X, Y, Z].

3.7.3 Reason and eligibility for transfer to another class

Nominators should review the historic, current and nominated listing class to determine whether there is a change in class, and the reason for the change / no change (Box 16). Note this section applies to the 'wildlife class' (status under the *NC Act* in Queensland), rather than to changes to the 'listing category' (status under the *EPBC Act* C'wlth). Nominators should detail the following:

- State whether the species is eligible for a transfer based on the current 'wildlife class' and the overall 'wildlife class' in Section 3.6, pg. 78.
- If there is a change, state whether this change is 'genuine' or 'non-genuine' and provide justification.
    - Genuine change refers to an actual change in the status of the species due to threats or management actions.
    - Non-genuine change typically refers an erroneous prior listing or species change.
- If there is no change, state why this is so (i.e. the threats remain stable).

The following rules apply to category transfers:

- For genuine changes to a lower threat category, at least five years must have passed since the data show the species no longer meet the criteria for the category in which it is currently listed (this is not necessarily the date of previous assessment).
- If the original classification was erroneous or based on a nongenuine change, the species may be transferred immediately to the category it is currently eligible for listing under.

Nominators will need to justify any category transfers against the abovementioned rules.

Box 16. Example text format for the reason and eligibility for transfer section of the nomination form.

> *Species* is eligible for transfer to a higher wildlife class. *Species* was listed as VU under Criterion D2 in 2009 due to a restricted range and future plausible threat of climate change. The species is now eligible for CR under Criterion B due to the emerging threat of montane drying (climate change), with the species experiencing a continuing decline, alongside very restricted range (EOO and AOO = 4km^2) and small number of locations (1). This represents a genuine (recent) change in wildlife class.

3.7.4 Reason and eligibility for transfer to EX / EW

If a species is eligible for a category transfer to EX or EW, nominators should select the relevant check box.

- For transfer to EX, there must be evidence of exhaustive surveys undertaken in all known or likely habitat throughout its historical range, at appropriate times (diurnal, seasonal, annual), and over a timeframe appropriate to its life cycle or form.
- For transfer to EW, the abovementioned rule must be met, along with either:
    - Evidence that the species exists in cultivation, in captivity or as a naturalised population(s) well outside the past range; AND/OR
    - Evidence that remaining subpopulations are not 'wild'.

Nominators should provide a justification for how these rules have been met in the 'Details' section.

3.7.5 Impact of transferring a threatened species to NT / LC

Only complete this section if the nomination is for transfer of a species to Near Threatened or Least Concern from a class of nationally threatened wildlife (Extinct, Extinct in the Wild, Critically Endangered, Endangered or Vulnerable). Provide details of the expected impact on the species if conservation actions were ceased following its transfer from a threatened wildlife class.

3.8 Other considerations

3.8.1 Standard of scientific evidence and adequacy of survey

Nominators should consider the information compiled in the assessment up to this point. There should be sufficient evidence to support the assessment (i.e. demonstrate that one criterion is met). If the information is sufficient to warrant a listing, insert the standard text from Box 17.

If there is insufficient information, the species would be classified as Data Deficient. As this category is not present within the *NC Act,* nor the *EPBC Act,* this translates to a status of Least Concern. Thus, it is preferrable to state that the survey has been adequate to support a listing assessment, particularly in following the 'precautionary attitude' recommended in the IUCN guidelines (IUCN 2022). Therefore, the standard text presented in Box 17 becomes mandatory for assessments where the nominator is recommending a listing status of VU, EN, CR, EW or EX.

Additional text has been developed to recognise the species that would be classified as Data Deficient. This text should be included in addition to the standard text when the following requirements are met:

- not collected in more than 20 years or 3 generations, whichever is greatest; and
- with no current information on populations or potential threats.

Nominators should ensure that shortfalls in survey adequacy are incorporated into the nomination by using the relevant data qualifiers. Where substantial assumptions in key parameters are made, it is likely the data qualifier will be suspected at most.

Box 17. Standard statement on survey adequacy for the Standard of scientific evidence section on the nomination form.

For this assessment it is considered that the survey of the species has been adequate and there is sufficient scientific evidence to support the listing outcome.

AND (for data deficient species):

The data available for this taxon are very limited and it would qualify as Data Deficient under the IUCN guidelines (IUCN 2022). However, given this category is not available under the Nature Conservation Act 1992, and the IUCN guidelines recommend "*that assessors should adopt a precautionary but realistic attitude, and to resist an evidentiary attitude to uncertainty when applying the criteria (i.e., have low risk tolerance*)" (IUCN 2022, pg. 24, Section 3.2.4 Dealing with uncertainty), the Species Technical Committee has taken a precautionary approach and will classify a taxon on the basis of the known information and expert ecological knowledge. Further population and ecological surveys and monitoring of the taxon are recommended.

3.8.2 Indigenous cultural significance

Refer to the information gathered regarding the Traditional Custodians for the land on which the species occurs from the map created in the Distribution section (pg. 24). Alternatively, the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) website https://aiatsis.gov.au/explore/map-indigenous-australia can provide useful information on engaging with Traditional Custodians and link to maps of Indigenous Australia. Note that it is not appropriate to reproduce (screenshot) the AIATSIS map for use in the nomination. Rather, nominators should provide a link to the website within the text as appropriate.

With support from a suitably qualified or experienced leader, efforts should be made to contact the Indigenous representatives who are the custodians for the species. However, if this is not feasible, enter the statement in Box 18.

Box 18. Example text for the Indigenous cultural significance section of the nomination form.

> The cultural, customary and spiritual significance of species and the ecological communities they form are diverse and varied for Indigenous peoples and their stewardship of Country. This section describes some examples of this significance but is not intended to be comprehensive or applicable to, or speak for, Indigenous peoples. Such knowledge may be held by Indigenous peoples who are the custodians of this knowledge and have the rights to decide how this knowledge is shared and used.
>
> The distribution of this species overlaps with the country of the X and Y People. Despite this, the cultural and customary significance of the species is not publicly available. Further consultation with the Traditional Custodians of these lands will benefit the conservation of the species by providing awareness of traditional knowledge and management practices on Country.
>
> This statement of significance is not intended to be comprehensive, applicable to, or speak for, all Indigenous Australians. It is acknowledged that Indigenous peoples who are the custodians of this knowledge have the rights to decide how it is shared and used.

3.8.3 Additional information

Insert an abbreviated table of records used to calculate the EOO and AOO here. Ensure the source of the records is attributed. See Appendix 1 for an example. A separate table for records that have been excluded is also useful.

3.8.4 Images of the species

Often, species' experts will have personal photographs saved of the species. These can be very helpful for future science communication purposes. Ask the expert reviewers if they have any photographs they are willing to share for governmental use. Make sure they are attributed correctly.

3.9 Reference list

Ensure a comprehensive and reference list is included with consistent formatting.

3.10 Publication approval and citation

- Nominators should select the appropriate checkbox according to whether they approve their details to be published alongside the nomination on the Queensland Government website.
- Nominators should edit the suggested citation to include their name, the date and the species name as per Box 19.

Box 19. Required citation format.

> Surname, X.X. (YYYY) Nomination to change conservation class of *Genus species* under the Queensland Nature Conservation Act 1992. Queensland Department of Environment and Science.

3.11 Nominator and reviewer details

Enter the details of the reviewer and nominator. Note that these details are subject to the provisions of the *Privacy Act 1988* and will not be divulged to third parties, except for state and territory governments and scientific committees that have agreed to collaborate on national threatened species assessments using a CAM. If there are multiple nominators, please copy and paste the tables and fill out for each nominator.

3.11.1 Reviewer details

Throughout the process of compiling the nomination, nominators should have identified some experts for the species. These will be people who have collected the species, or whose names feature strongly in publications regarding the species. Reach out to them and ask if they would be willing to review the nomination. This is not always possible or feasible. In this case, ask for guidance.

3.11.2 Nominator details

Enter your details.

3.12 Consistency checklist

The following sections must be checked for consistency prior to submission.

- EOO is consistent between Distribution, Key Parameters Table (KPT), and Criterion B.
- AOO is consistent between Distribution, KPT, Criterion B, and Criterion D.
- Number of mature individuals is consistent between Distribution, KPT, Criterion C, and Criterion D.
- Number of subpopulations is consistent between Distribution, KPT, and Criterion C.
- Severe fragmentation text is consistent between KPT and Criterion B.
- Extreme fluctuations text is consistent between KPT, Criterion B, and Criterion D.
- Number of locations is consistent between KTP, Criterion B, and Criterion D.
- Most serious plausible threat used to define locations aligns with the highest risk threat in the threats table, unless a different serious threat results in the smallest number of locations. If the latter is the case, this is clearly stated in the justification of locations.
- The ‘consequence’ and ‘likelihood’ threat parameters are consistent between the threats table and the risk matrix.
- The ‘risk’ threat parameters are consistent with the risk matrix outcome.
- The threats are listed from highest to lowest risk based on the risk matrix. The threat abatement section lists threats in the same order.

Homoranthus porteri is known from a restricted distribution on the Country of the Bar-Barrum and Jirrbal People, on the boundary between the Wet Tropics and Einasleigh Uplands bioregions in northern Queensland. The species is currently listed as Vulnerable but requires reassessment using the Common Assessment Methodology to incorporate the emerging threat of wind farm construction.

Image © Andrew Ford.

4 References

If not explicitly referenced, all information in this assessment manual was based on IUCN SPC (2022).

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Woinarski J., Burbidge A. & Harrison P. (2014). *The action plan for Australian mammals 2012.* CSIRO Publishing.

5 Key resources

Resource	Web link
Action Plans with example recovery actions	Imperilled Plants 2021 https://www.nespthreatenedspecies.edu.au/publications-and-tools/action-plan-for-australia-s-imperilled-plants-2021 Lizards and snakes 2017 https://www.publish.csiro.au/book/7823/ Birds 2020 https://www.publish.csiro.au/book/7905/ Mammals 2012 https://www.publish.csiro.au/book/7010/
auNSL	https://biodiversity.org.au/nsl/
Australasian Virtual Herbarium	https://avh.ala.org.au/#tab_simpleSearch
Austrobaileya	https://www.jstor.org/journal/aust
Census of the Queensland Flora 2021	https://www.data.qld.gov.au/dataset/census-of-the-queensland-flora-2021
Climate change cluster reports	https://www.climatechangeinaustralia.gov.au/en/communication-resources/reports/ (scroll to bottom of page for cluster report links)
QBEIS database (formerly CORVEG)	http://aekos.org.au/index.html#/search-results/list/dataset-details-a?datasetId=au.org.aekos.transform.generated.subgraph.impl.entities.SURVEYSUBGRAPH:T1558058576915
CSIRO cluster report NRM regions – including shapefiles	https://www.climatechangeinaustralia.gov.au/en/overview/methodology/nrm-regions/
DCCEWW - Common Assessment Method	https://www.dcceew.gov.au/environment/biodiversity/threatened/cam#national-scale
GeoResGlobe	https://georesglobe.information.qld.gov.au/
IUCN threat classification scheme	https://www.iucnredlist.org/resources/classification-schemes
Key threatening processes	http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl
LongPaddock Climate Dashboard	https://longpaddock.qld.gov.au/qld-future-climate/dashboard/
Northern Australia Fire Information (NAFI)	https://www.firenorth.org.au/nafi3/
Queensland Globe	https://qldglobe.information.qld.gov.au/
Red List Criteria Summary Sheet	https://www.iucnredlist.org/resources/summary-sheet
Share library	Internal (DES)
The Australian Institute of Aboriginal	https://aiatsis.gov.au/explore/map-indigenous-australia

and Torres Strait Islander Studies (AIATSIS) website	
Threat Abatement Plans	https://www.dcceew.gov.au/environment/biodiversity/threatened/threat-abatement-plans/approved
WildNet	https://apps.des.qld.gov.au/species-search/
WildNet confidential species records	https://www.data.qld.gov.au/dataset/queensland-confidential-species
Nomination form	https://www.qld.gov.au/environment/plants-animals/conservation/threatened-wildlife/threatened-species/conservation-status/species-technical-committee
AusTraits	https://austraits.org/
Interactive World Forest Map	https://www.globalforestwatch.org/map/
Australian cyclone interactive GIS map	https://www.arcgis.com/home/webmap/viewer.html?url=https://gisservices.information.qld.gov.au/arcgis/rest/services/EventsIncidents/CycloneHistorical/MapServer&source=sd

6 Appendices

Appendix 1. Example of cleaned herbarium specimen records

Example of cleaned herbarium specimen records for *Acacia argentina* extracted from Australasian Virtual Herbarium. Duplicates are represented by red text and identified by comparing 'record numbers'. Removal of duplicates leaves four specimen records for *A. argentina*. Note that valuable information on population size is present in the 'Event Remarks' column. Information about habitat type should also be reviewed and detailed in the biology/ecology section of the nomination form.

Catalog Number	Record Number	Recorded By	Event Date	Latitude	Longitude	Precision	Reproductive Condition	locality	Occurrence Remarks	habitat	Event Remarks
BRI AQ0588589	PIF19673	Forster, P.I.	24/09/1996	-25.3261	150.0199	100	Flowers and fruit	Jarwood Station (GPS 25 19 40 150 01 08).	Blue-silver leaved shrub to 1.5m high, yellow flowers, young fruit.	Woodland of Eucalyptus melanophloia.	Very common in area. Type specimen-Austrobaileya 7:348(2006)
BRI AQ0588593	PIF19649	Forster, P.I.	23/09/1996	-25.2148	149.4574	100	Flowers and fruit	Gwambagwine, Ruined Castle Creek catchment (GPS 25 12 59 149 27 23).	Shrub to 3m high, silver-blue foliage, yellow flowers, young fruit.	Woodland of Corymbia bunites, Eucalyptus fibrosa and Angophora leiocarpa on sandstone.	Very common in area.
BRI AQ0639552	FC2	Carter, F.	1/07/1995	-25.2195	149.4513	100	Flowers	Ruined Castle Creek catchment, Murphy Range, Gwambagwine (GPS 25 13 16 149 27 01).	Shrub to 4m high, yellow flowers.	Open forest/woodland Eucalyptus watsoniana, Angophora leiocarpa, Lysicarpus angustifolius, Acacia spp., Triodia sp. and Xanthorrhoea sp.	Common in area.

BRI AQ0588599	PIF19740	Forster, P.I.	24/09/1996	-25.3239	150.0238	100	Flowers and fruit	Precipice National Park, catchment of Precipice Creek (GPS 25 19 32 150 01 22).	Shrub to 2m high, blue-silver foliage.	Woodland of Eucalyptus acmenoides, E. crebra and Angophora leiocarpa on sandstone cliff lines along seasonal watercourse.	
NSW 842940	19649	Forster, P.I.	23/09/1996	-25.2147	149.4575	100		Gwambagwine, Ruined Castle Creek catchment (GPS 25 12 59 149 27 23).	Shrub to 3 m high, silver-blue foliage, yellow flowers, young fruit. Very common in area.	Woodland of Corymbia bunites, Eucalyptus fibrosa and Angophora leiocarpa on sandstone.	
MEL 2327287A	19649	Forster, P.I.	23/09/1996	-25.2	149.45	10000	flowers | fruit	Gwambagwine, Ruined Castle Creek catchment. (GPS 25 12 59 149 27 23).	Very common in area.	Woodland of Corymbia bunites, Eucalyptus fibrosa and Angophora leiocarpa on sandstone.	
CANB 687998.1	19673	Forster, P.I.	24/09/1996	-25.327	150.0188	50	flowers|fruit| leaf	Jarwood Station.	Blue-silver leaved shrub to 1.5 m high, yellow flowers, young fruit. [Photographed for GPI 2013.]	Woodland of Eucalyptus melanophloia.	
NSW 842724	19673	Forster, P.I.	24/09/1996	-25.3261	150.02	100	buds|flowers | fruits	Jarwood Station.	Blue-silver leaved shrub to 1.5 m high, yellow flowers, young fruit. Very common in area. Isotype- Austrobaileya 7:348(2006).	Woodland of Eucalyptus melanophloia.	
AD 203216	19673	Forster, P.I.	24/09/1996	-25.3263	150.0197	15		Jarwood Station		Woodland of {Eucalyptus melanophloia}	

DNA D0186190	19673	Forster, I. Paul	24/09/1996	-25.3247	150.0207		fruit	Jarwood Station.	Woodland of Eucalyptus melanophloia. Blue-silver leaved shrub to 1.5m high; yellow flowers; young fruit. Very common in area. Isotype- Austrobaileya 7;348(2006). ISOTYPE		
MEL 2313184A	19673	Forster, P.I.	24/09/1996	-25.3278	150.0189	1000	flowers | fruit	Jarwood Station (GPS 25 19 40 150 01 08).	Very common in area.	Woodland of Eucalyptus melanophloia.	
MEL 2327281A	19740	Forster, P.I.	24/09/1996	-25.3167	150.0167	10000	flowers | fruit	Precipice National Park, catchment of Precipice Creek. (GPS 25 19 32 150 01 22)		Woodland of Eucalyptus acmenoides, E. crebra and Angophora leiocarpa on sandstone cliff lines along seasonal watercourse.	

Appendix 2. Example questions for expert consultation

Dear/Hi [NAME],

I have been preparing a threatened species listing nomination for [SPECIES] and it looks like you may have some information that could be useful in preparing the advice. I understand that you may be very busy, but I would be very grateful if you had time to provide insight into any of the below questions.

[List the questions relevant to your species here – refer to below for some generalised words]

[TIMEFRAME] We are working to a deadline of [DATE]. It would be ideal to have your feedback by then, but of course I/we understand that this may be unrealistic with your existing commitments so very happy for you to let me know another time that may be more suitable for you.

Thank you/Warm regards,

[YOUR NAME]

Questions

- **Distribution:** Has the species been well surveyed? Is it accurately represented by the distribution map provided? Is it likely to be overlooked in the field? If so, why? Is the species likely to still be present at all sites?
- **Population size:** Can you provide a population size estimate based on the number of mature individuals? These are the thresholds we use in the assessment: <50, 50-250, 250-1,000, 1,000-2,500, 2,500-10,000, 10,000-20,000.
- **Generation length:** Do you know when the species would become reproductively mature (under normal conditions), and how long it lives for? A range of values is useful if you are unsure.
- **Habitat:** My current understanding of the habitat is [insert habitat requirements here]. Would you agree with this?
- **Disturbance ecology:** Can you provide any information on how the species would respond to disturbances such as fire, cyclones and flooding? Would these events typically kill the species? Would it recover well thereafter?
- **Dispersal:** What are the likely pollinators and seed dispersal mechanisms? (flora only)
- **Reproduction:** What are the conditions needed for breeding? (fauna only)
- **Threats:** What are the key threats? Do they impact all subpopulations the same? Do you think the population is declining due to these threats? Do you know of any data to support this?
- **Recovery actions:** Are there current recovery actions or monitoring for the species? Can you recommend any additional actions?

Appendix 3. IUCN Unified Classification of Direct Threats Version 3.2

Direct threats are the proximate human activities or processes that have impacted, are impacting, or may impact the status of the taxon being assessed (e.g., unsustainable fishing or logging). Direct threats are synonymous with sources of stress and proximate pressures. Threats can be past (historical, unlikely to return or historical, likely to return), ongoing, and/or likely to occur in the future. Table adapted from IUCN (2022).

LEVEL OF CLASSIFICATION	DEFINITION AND APPLICATION
1. RESIDENTIAL AND COMMERCIAL DEVELOPMENT	Threats from human settlements or other non-agricultural land uses. These are threats tied to a defined and relatively compact area, which with a substantial footprint distinguishes them from those in **4. Transportation and service corridors** which have a long narrow footprint, and **6. Human intrusions and disturbance** that do not have an explicit footprint.
1.1 Housing and urban areas *(Urban areas, suburbs, villages, vacation homes, shopping areas, offices, schools, hospitals, birds flying into windows, land reclamation or expanding human habitation that causes habitat degradation in riverine, estuary and coastal areas, etc.)*	Human cities, towns, and settlements including non-housing development typically integrated with housing. This category obviously dovetails somewhat arbitrarily with **1.2 commercial and industrial areas**. Generally, if people live in the development, it should fall into this category.
1.2 Commercial and industrial areas *(Military bases, factories, stand-alone shopping centres, office parks, power plants, train yards, shipyards, airports, landfills, etc.)*	Factories and other commercial centres. Shipyards and airports fall into this category, whereas shipping lanes and flight paths fall under **4. Transportation and service corridors.** Dams are not included here, rather they are in **7.2 dams and water management/use.**
1.3 Tourism and recreation areas *(Ski areas, golf courses, resorts, cricket fields, parks, campgrounds, coastal and estuarine tourist resorts, etc.)*	Tourism and recreation sites with a substantial footprint. There is a fine line between housing and vacation housing/resorts. Be careful not to confuse this category, which focuses on the habitat effects of recreation areas, with those in **6.1 recreational activities**, which focuses on the disturbance effects posed by recreation.
2. AGRICULTURE AND AQUACULTURE	Threats from farming and ranching because of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture (includes the impacts of any fencing around farmed areas. Threats resulting from the use of agrochemicals, rather than the direct conversion of land to agricultural use, should be included under 9.3 agricultural and forestry effluents. Likewise in cases where conversion to agriculture causes increase run-off and hence sedimentation of rivers and lakes, that is also best treated under 9.3 agricultural and forestry effluents.
2.1 Annual and perennial non-timber crops	Crops planted for food, fodder, fibre, fuel, or other uses
2.1.1 Shifting agriculture **2.1.2 Small-holder farming** **2.1.3 Agro-industry farming** **2.1.4 Scale unknown/unrecorded**	Select the appropriate scale of the farming activity and list the specific crop(s).

(Wheat farms, sugar cane plantations, rice paddies, hillside rice production, household swidden plots, banana or pineapple plantations, mango or apple orchards, olive or date groves, vineyards, oil palm plantations, tea or coffee plantations, mixed agroforestry systems, coca plantations, etc.)	
2.2 Wood and pulp plantations	Stands of trees planted for timber or fibre outside of natural forests, often with non-native species. If it is one or a couple timber species that are planted on a rotation cycle, it belongs here. If it is multiple species or enrichment plantings in a quasi-natural system, it belongs in **5.3 logging and wood harvesting.**
2.2.1 Small-holder plantations **2.2.2 Agro-industry plantations** **2.2.3 Scale unknown/unrecorded** *(Teak or eucalyptus plantations, loblolly pine silviculture, Christmas tree farms, etc.)*	Select the appropriate scale for the plantation and list the specific trees.
2.3 Livestock farming and ranching	Domestic terrestrial animals raised in one location on farmed or non- local resources (farming); also, domestic, or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (ranching). In farming, animals are kept in captivity; in ranching they are allowed to roam in wild habitats. If a few animals are mixed in a subsistence cropping system, it belongs in **2.1 annual and perennial non-timber crops**. Forage of wild resources for stall-fed animals falls under **5.2 gathering terrestrial plants.** Domesticated livestock that has gone feral should be treated under **8.1 invasive non-native/alien species**, but other wild-roaming livestock may also require closer consideration to determine if they are best placed here or also under **8.1**.
2.3.1 Nomadic grazing *(Cattle feed lots, chicken farms, dairy farms, cattle ranching, goat, camel, or yak herding, etc.)*	Pastoralists who are normally only present for part of the year, usually after good rains have improved the grazing. Select the appropriate scale of the farming activity and list the specific animals and/or system.
2.3.2 Small-holder grazing, ranching or farming **2.3.3 Agro-industry grazing, ranching or farming** **2.3.4 Scale unknown/unrecorded**	Select the appropriate scale of the farming activity and list the specific animals and/or system.
2.4 Marine and freshwater aquaculture	Aquatic animals raised in one location on farmed or non-local resources; also, hatchery fish allowed to roam in the wild. Farmed animals are kept in captivity; hatchery fish are put into wild habitats and are the aquatic equivalent of terrestrial ranching.
2.4.1 Subsistence/artisanal aquaculture **2.4.2 Industrial aquaculture**	Select the appropriate scale of aquaculture and list the specific species and/or system.

2.4.3 Scale unknown/unrecorded *(Shrimp or fin fish aquaculture (especially those that cause destruction of mangrove habitats), fishponds on farms, hatchery salmon, seeded shellfish beds, artificial algal beds, etc.)*	
3. ENERGY PRODUCTION AND MINING	Threats from production of non-biological resources. Various forms of water use (for example, dams for hydro power) could also be put in this class, but these threats seemed more related to other threats that involve alterations to hydrologic regimes. As a result, they should go in **7.2 dams and water management/use.**
3.1 Oil and gas drilling *(Oil wells, deep sea natural gas drilling, hydraulic fracking, etc.)*	Exploring for, developing, and producing petroleum and other liquid hydrocarbons. Oil and gas pipelines go into **4.2 utility and service lines**. Oil spills that occur at the drill site should be placed here; those that come from oil tankers or pipelines should go in **4. Transportation and service corridors** or in **9.2 industrial and military effluents**, depending on your perspective.
3.2 Mining and quarrying *(Coal strip mines, alluvial gold panning, gold mines, rock quarries, sand/salt mines, coral mining, deep sea nodules, guano harvesting, dredging outside of shipping lanes, etc.)*	Exploring for, developing, and producing minerals and rocks. It is a judgement call whether deforestation caused by strip mining should be in this category or in **5.3 logging and wood harvesting** - it depends on whether the primary motivation for the deforestation is access to the trees or to the minerals. Sediment or toxic chemical runoff from mining should be placed in **9.2 industrial and military effluents** if it is the major threat from a mining operation.
3.3 Renewable energy *(Geothermal power production, solar farms, wind farms (including birds flying into windmills), tidal farms, etc.)*	Exploring, developing, and producing renewable energy. Hydropower should be put in **7.2 dams and water management/use.**
4. TRANSPORTATION AND SERVICE CORRIDORS	**Threats from long narrow transport corridors and the vehicles that use them including associated wildlife mortality.** **This class includes transportation corridors outside of human settlements and industrial developments. These corridors create specific stresses to biodiversity including especially fragmentation of habitats and lead to other threats including farms, invasive species, and poachers.**
4.1 Roads and railroads *(Highways, secondary roads, primitive roads, logging roads, bridges and causeways, roadkill, fencing associated with roads, freight/passenger/mining railroads, etc.)*	Surface transport on roadways and dedicated tracks. Off-road vehicles are treated in the appropriate category in **6. Human intrusions and disturbance**. If there are small roads associated with a major utility line, they belong in **4.2. Utility and service lines.**
4.2 Utility and service lines *(Electrical and phone wires, aqueducts, oil and gas pipelines, electrocution of wildlife, etc.)*	Transport of energy and resources. Cell phone and other communication towers connected by small access roads belong here. If there are small utility lines using a road right of way, they belong in **4.1 roads and railroads.** Oil spills from pipelines should go in **9.2 industrial and military effluents.**

4.3 Shipping lanes *(Dredging, canals, shipping lanes, ships running into whales, wakes from cargo ships, etc.)*	Transport on and in freshwater and ocean waterways. This category includes dredging and other activities that maintain shipping lanes. Anchor damage from dive boats belongs in **6.1 recreational activities**. Oil spills from ships should go in **9.2 industrial and military effluents.**
4.4 Flight paths *(Flight paths, jets impacting birds, etc.)*	Air and space transport. Airports fall into **1.2 commercial and industrial areas**.
5. BIOLOGICAL RESOURCE USE	Threats from consumptive use of "wild" biological resources including Consumptive use means that the resource is removed from the system or both deliberate and unintentional harvesting effects, also persecution or control of specific species. Consumptive use means that the resource is removed from the system or destroyed - multiple people cannot use the same resource, as they could under **6. Human intrusions and disturbance.** Threats in the class can affect both target species (harvest of desired trees or fish species) as well as "collateral damage" to non-target species (trees damaged by felling or fisheries bycatch) and habitats (coral reefs destroyed by trawling). Persecution/control involves harming or killing species because they are considered undesirable. For some of the use threats there is an additional question on whether international trade is a significant driver of decline **(5.1.1, 5.2.1, 5.3.1, 5.3.2, 5.4.1, 5.4.2).**
5.1 Hunting and collecting terrestrial animals	Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch. This category focuses on animals that primarily live in a terrestrial environment. There are obviously some species that live on the terrestrial/aquatic boundary. Hunting otters, beavers, amphibians, polar bears, penguins, waterfowl, and seabirds should (somewhat arbitrarily) go here. Hunting seals, whales and other marine mammals, and freshwater and marine turtles go in **5.4 fishing and harvesting aquatic resources.** Yes, most people "gather" honey, eggs, or insects or other slow-moving targets, rather than "hunt" them. But for consistency it was decided to keep all animal products as being hunted. This option does not distinguish between small and large scale (unlike others below) as generally most hunting and collecting of animals is small scale, but arguably some hunting in the past was very large "industrial" scale.
5.1.1 Intentional use (species being assessed is the target) *(Bushmeat hunting, trophy hunting, beaver trapping, butterfly collecting, honey or bird nest hunting, etc.)*	For species unintentionally impacted the stress is usually coded as mortality, however, in the case of species' losing their prey base the stress would be coded as **2.3.8 indirect species effects - other**.
5.1.2 Unintentional effects (species being assessed is not the target)	Pest control often impacts non-targeted species, hunter's dogs may chase after and kill other non-target species during a hunt, loss of a species' prey base due to over-harvesting by humans of their prey, etc.
5.1.3 Persecution/control *(Wolf control, pest control, persecution of snakes etc.)*	

5.1.4 Motivation unknown/unrecorded	It is not known if the hunting or collection is intentional, unintentional or if it is persecution/control.
5.2 Gathering terrestrial plants	Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons. This category focuses on plants, mushrooms, and other non-animal terrestrial species except trees which are treated in **5.3 logging and wood harvesting.**
5.2.1 Intentional use (species being assessed is the target) *(Wild mushroom collection, forage for stall fed animals, orchid collection, rattan harvesting, etc.)*	
5.2.2 Unintentional effects (species being assessed is not the target) *(Other plants accidentally removed/killed as a result of methods/approach used to harvest a target species, etc.)*	
5.2.3 Persecution/control *(Control of host plants to combat timber diseases, etc.)*	
5.2.4 Motivation unknown/unrecorded	It is not known if the use is intentional, unintentional or if it is persecution/control.
5.3 Logging and wood harvesting	Harvesting trees and other woody vegetation for timber, fiber, or fuel. Felling trees to clear agricultural land goes in the appropriate category in **2. Agriculture and aquaculture.** If it is a few timber species that are planted on a rotation cycle, it belongs in **2.2 wood and pulp plantations.** If it is multiple species or enrichment plantings in a quasi-natural system, it belongs here.
5.3.1 Intentional use: subsistence/small scale (species being assessed is the target) [harvest] **5.3.2 Intentional use: large scale (species being assessed is the target) [harvest]** **5.3.3 Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest]** **5.3.4 Unintentional effects: large scale (species being assessed is not the target) [harvest]** **5.3.5 Motivation unknown/unrecorded**	Select the appropriate scale and list the specific product(s) harvested and the method used e.g., clear cutting of hardwoods, selective commercial logging of ironwood, pulp or woodchip operations, fuel wood collection, mangrove charcoal production, etc. If the intention of the harvest is not known, then 5.3.5 should be used.
5.4 Fishing and harvesting aquatic resources	Harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for

	control/persecution reasons; includes accidental mortality/bycatch. This category focuses on all kinds of species that are primarily found in an aquatic environment. There are obviously some species that live on the terrestrial/aquatic boundary. Hunting otters, beavers, amphibians, polar bears, penguins, waterfowl, and sea birds should (somewhat arbitrarily) go in **5.1 hunting and collecting terrestrial animals.** Hunting seals, whales and other marine mammals, and freshwater and marine turtles go here. It is important to consider the distinction between intentional and an unintentional fishery – the former specifically targets a species or adjusts its fishing tactics to catch a particular species, whereas the unintentional option covers all other fisheries including bycatch and discards.
5.4.1 Intentional use: subsistence/small scale (species being assessed is the target) [harvest] *(Seaweed collection, shellfish collection, collection for aquarium trade, fish traps, artisanal trawling, handline fishing, spear fishing, turtle egg collection, whaling, seal hunting, blast fishing for grouper, etc.)*	
5.4.2 Intentional use: large scale (species being assessed is the target) [harvest] *(Commercial trawling, commercial long-line fisheries, whaling, seal hunting, turtle egg collection, live coral collection, seaweed collection, etc.)*	
5.4.3 Unintentional effects: subsistence/small scale (species being assessed is not the target) [harvest] *(Blast fishing, cyanide fishing, artisanal trawling, seaweed collection, shark nets trapping non-target species, loss of a species' prey base due to over-harvesting by humans of their prey, etc.)*	Note that the stresses can be both ecosystem degradation and species mortality. In the case of species' losing their prey base the stress would be coded as 2.3.8 indirect species effects – other.
5.4.4 Unintentional effects: large scale (species being assessed is not the target) [harvest] *(Blast fishing, cyanide fishing, commercial trawling, commercial long-line fisheries, seaweed collection, shark nets trapping non- target species, loss of a species' prey base due to over- harvesting by humans of their prey, etc.)*	Note that the stresses can be both ecosystem degradation and species mortality. In the case of species' losing their prey base the stress would be coded as **2.3.8 indirect species effects – other.**
5.4.5 Persecution/control *(Beach protection with shark nets, sharks and seals killed because they eat commercial fish species, etc.)*	

5.4.6 Motivation unknown/unrecorded	It is not known if the harvest is intentional, unintentional or if it is persecution/control.
6. HUMAN INTRUSIONS AND DISTURBANCE	Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources. Non-consumptive use means that the resource is not removed - multiple people can use the same resource (for example, birdwatching). These threats typically do not permanently destroy habitat except perhaps in extremely severe manifestations.
6.1 Recreational activities *(Off-road vehicles, motorboats, motorcycles, jet-skis, snowmobiles, ultralight planes, dive boats, whale watching, mountain bikes, hikers, cross-country skiers, hand gliders, birdwatchers, scuba divers, pets brought into recreation areas, temporary campsites, caving, rock-climbing, etc.)*	People spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons. This category does not include work involving consumptive use of biodiversity - for example disturbance impacts from loggers or hunters would be in the appropriate category in **5. Biological resource use.** Vehicles and boats in established transport corridors go in **4. Transportation and service corridors.** The development of permanent recreational or tourist facilities (such as hotels and resorts) should be included under section **1.3 tourism and recreation areas** rather than here.
6.2 War, civil unrest and military exercises *(Armed conflict, mine fields, tanks and other military vehicles, training exercises and ranges, defoliation, munitions testing, etc.)*	Actions by formal or paramilitary forces without a permanent footprint. This category focuses on military activities that have a large impact on natural habitats but are not permanently restricted to a single area. Permanent military bases should go under **1.2 commercial and industrial areas**. Other military activities might best be assigned to other categories. For example, hunting of specific animals by soldiers living off the land fits under **5.1 hunting and collecting terrestrial animals.**
6.3 Work and other activities *(Law enforcement, drug smugglers, illegal immigrants, species research, vandalism, etc.)*	People spending time in or traveling in natural environments for reasons other than recreation or military activities
7. NATURAL SYSTEM MODIFICATIONS	Threats from actions that convert or degrade habitat “managing” natural or semi-natural systems, often to improve human in service of welfare. This category deals primarily with changes to natural processes such as fire, hydrology, and sedimentation, rather than land use. Thus, it does not include threats relating to agriculture (which should be under **2. Agriculture and aquaculture**), or infrastructure (**1. Residential and commercial development** and **4. Transportation and service corridors).**
7.1 Fire and fire suppression	Suppression or increase in fire frequency and/or intensity outside of its natural range of variation. This category focuses on the human activities that lead to either not enough fire or too much fire in the ecosystem in question. If fire escapes from established agricultural lands, it belongs here, if fire is used to clear new agricultural lands, it belongs in the appropriate category in **2. Agriculture and aquaculture.** It also includes damaging "natural" fires in systems that have lost their natural resilience.

7.1.1 Increase in fire frequency/intensity *(Inappropriate fire management, escaped agricultural fires, arson, campfires, fires for hunting, etc.)*	List the specific source of fire.
7.1.2 Suppression in fire frequency/intensity *(Fire suppression to protect homes, inappropriate fire management, etc.)*	List the specific source of lack of fire.
7.1.3 Trend unknown/unrecorded	
7.2 Dams and water management/use	Changing water flow patterns from their natural range of variation either deliberately or as a result of other activities. This category focuses on the human activities that lead to either not enough water or too much water in the ecosystem in question. Note that homogenizing flows to a constant level may be outside the "natural range of variation." dredging belongs in **4.3 shipping lanes.**
7.2.1 Abstraction of surface water (domestic use) **7.2.2 Abstraction of surface water (commercial use)** **7.2.3 Abstraction of surface water (agricultural use)** **7.2.4 Abstraction of surface water (unknown use)** *(Change in salt regime, wetland filling for mosquito control, levees and dikes, surface water diversion, channelization, ditching, artificial lakes, etc.)*	List the specific source of the alteration.
7.2.5 Abstraction of ground water (domestic use) **7.2.6 Abstraction of ground water (commercial use)** **7.2.7 Abstraction of ground water (agricultural use)**	List the specific source of the alteration e.g., groundwater pumping, etc.
7.2.8 Abstraction of ground water (unknown use)	
7.2.9 Small dams **7.2.10 Large dams** **7.2.11 Dams (size unknown)** *(Dam construction, release of too little or cold water from dam operations, sediment control, etc.)*	List the specific source of the alteration. If dams are coded the following stresses may be appropriate: 1.1, 1.2, 1.3, 2.2.
7.3 Other ecosystem modifications *(Land reclamation projects, abandonment of managed lands, riprap along shoreline,*	Other actions that convert or degrade habitat in service of "managing" natural systems to improve human welfare. This option includes both too much management (over-

mowing grass, tree thinning in parks, beach construction, removal of snags from streams, etc.)	management) or too little (abandonment). The latter is particularly relevant when former agricultural lands are abandoned.
8. INVASIVE AND OTHER PROBLEMATIC SPECIES, GENES AND DISEASES	Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance. After much deliberation it was decided to restrict the use of "invasive species" to refer to non-native species to keep things simple for policy makers. The term "problematic native species" is used instead to refer to native species that have become superabundant or otherwise cause problems. If possible, also record the source of the invasive species and/or conditions that exacerbate their effect. This is the class of threats that covers diseases. Where the kingdom for a fungal disease is unknown, it should be coded under **8.1.1, 8.2.1** or **8.3.1** and the disease name should be noted in the text field.
8.1 Invasive non-native/alien species/diseases	Harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities. We are defining non-native/alien/exotic species and diseases as those brought in either intentionally or accidentally by humans in the last 10,000 years. Note that for diseases, it is the infective agent, which is considered to be the threat, with the disease being its manifestation in individuals. Domesticated livestock that has gone feral should be coded here, but there is a grey area concerning 'farmed' livestock which are allowed to roam wild; if these are rounded up periodically, they could be considered "farmed" and coded under **2.3 livestock farming and ranching**, but if there is little to no management they might be better placed here.
8.1.1 Unspecified species	Only to be used if it is known that there is a threat from an invasive, but the species involved have not been named or only named at a very general level - e.g., Invasive plants, invasive animals, etc. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the threat's narrative.
8.1.2 Named species *(List the specific plant, animal, or microbe e.g., feral domesticated cattle, household pets, zebra mussels, Dutch elm disease or chestnut blight, Miconia tree, introduction of species for biocontrol, chytrid fungus affecting amphibians, etc.)*	A list of named taxa (e.g., species or a group of species like rats if it is unclear which species in particular is involved) is available to select from in the sis database via the "quick add" function (this list has been compiled in collaboration with the IUCN SPC invasive species specialist group and links to the information held in the global invasive species database). In addition, any taxon already in the taxonomic hierarchy in the sis database (at whatever taxonomic level) can be added as a named invasive via the "quick add" function. Note, if the named disease is caused by viruses or prions, option **8.5** should be used instead and there is a separate list of those "organisms".
8.2 Problematic native species/diseases	Harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question but have become "out-of-balance" or "released" directly or indirectly due to human activities. It is a bit of a judgement call as to when a species becomes "problematic" (also referred to as species being "outside its natural

	range of variation"). Note that for diseases, it is the infective agent, which is considered to be the threat, with the disease being its manifestation in individuals.
8.2.1 Unspecified species	Only to be used if it is known that there is a threat from a native taxon, but the species involved have not been named or only named at a very general level - e.g., Plants, animals, etc. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the threat narrative.
8.2.2 Named species *(List the specific plant, animal, or microbe e.g., over-abundant native deer, over-abundant algae due to loss of native grazing fish, native plants that hybridize with other plants, plague affecting rodents, etc.)*	A list of named taxa (e.g., species or a group of species like rats if it is unclear which species is involved) is available to select from via the taxonomic hierarchy in the sis database using the quick add function. Additions to the hierarchy will be required for taxa which are not yet in the system.
8.3 Introduced genetic material Pesticide resistant crops, hatchery salmon, restoration projects using non-local seed stock, genetically modified insects for biocontrol, genetically modified trees, genetically modified salmon, etc.	Human altered or transported organisms or genes. Hatchery fish are not necessarily invasive species, but they can upset the gene pool of native fish.
8.4 Problematic species/diseases of unknown origin	Harmful plants, animals, or pathogens and other microbes of unknown origin. It is not known if they were deliberately or accidentally introduced (see **8.2**) or if they were originally found within the ecosystem(s) in question (see **8.3**). Efforts should be made to determine if the options under **8.2** or **8.3** could be used, but if the origin of the problematic taxon concerned is really unknown, then this option should be used. Note that for diseases, it is the infective agent, which is considered to be the threat, with the disease being its manifestation in individuals.
8.4.1 Unspecified species	Only to be used if it is known that there is a threat from a taxon of unknown origin and the taxon involved has not been named or only named at a very general level - e.g., Plants, animals, etc. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the threat's narrative.
8.4.2 Named species *(List the specific plant, animal, or microbe.)*	The named taxon can be selected from the taxonomic hierarchy in the sis database via the "quick add" function. Additions to the hierarchy will be required for taxa which are not yet in the system.
8.5 Viral/prion-induced diseases	Viruses are small infectious agents that replicate only inside the living cells of an organism. Although viruses occur universally, each cellular species has its own specific range that often infect only that species. Most viruses co-exist harmlessly in their host and cause no signs or symptoms of disease. However, a number are important pathogens which can result in diseases which significantly reduce reproduction or increase mortality. Prions are infectious agents composed of protein in a misfolded form. They do not contain nucleic acids. All known prion diseases affect the structure of the brain and other neural tissue, they are mainly found in mammals, are currently untreatable and are universally fatal.

	The intention here is not to record all know viruses or prions recorded for the species being assessed, but only those that are thought to be having a negative impact on the species concerned. Note that it is the infective agent, which is considered to be the threat, with the disease being its manifestation in individuals.
8.5.1 Unspecified "species" (disease)	Only to be used if it is known that there is a threat from what is probably a virus or a prion, but the organism involved have not been named or is only named at a very general level - e.g., Avian virus. There is a text box alongside the threat to provide further explanation/detail on this and some of the information might also be relevant for inclusion under the threat's narrative.
8.5.1 Named "species" (disease) *(List the specific virus (e.g., Foot and Mouth Disease Virus, West Nile Virus, Rabies Virus, Newcastle Disease Virus, etc.) Or prion (e.g., scrapie, Bovine spongiform encephalopathy (BSE) or mad cow disease, etc.)*	A list of the most commonly encountered viruses and prions that cause diseases in plants and animals is maintained in the sis database separate from the taxonomic hierarchy. These are available for selection from a drop-down list. The list will be added to as new problematic viruses and prions are identified.
8.6 Diseases of unknown cause	Occasionally plants and animals are impacted by diseases of unknown origin and often it may take many years to identify the pathogen responsible. For example, it is not known what causes white-band disease (WBD) in Acroporid corals, but the disease is having a huge impact in some parts of the world. This option will be used in cases where a disease has been described, but the pathogen responsible is not yet known. Once the pathogen is identified the records will need to be recoded accordingly.
9. POLLUTION	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources. This class deals with exotic or excess materials introduced to the environment. There is obviously a fine distinction when the pollution comes from another threat- for example, should an oil spill from a pipeline be classified as **4.2 utility and service lines** or **9.2 industrial and military effluents**? You will have to exercise some judgement here as to which represents the direct threat in your situation. In some cases, the source of the pollution may be either unknown or from a historical source (e.g., heavy metals buried in sediments). In these cases, you may have to make an educated guess as to which category to assign the pollutant.
9.1 Domestic and urban wastewater	Water-borne sewage and non-point runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments. This category does not include major industrial discharge, which falls under **9.2 industrial and military effluents**. It does include chemicals and next generation pollutants (caffeine or pharmaceuticals) in household waste streams. Technically, sewage from a pipe is "point-source" whereas a leaking septic system is "nonpoint-source." this category does not include agricultural runoff, which falls under **9.3 agricultural and forestry effluents**.
9.1.1 Sewage *(List the source, and if possible, the specific pollutants of concern e.g., discharge from municipal waste treatment plants, leaking septic*	

systems, untreated sewage, outhouses, etc.)	
9.1.2 Run-off *(List the source, and if possible, the specific pollutants of concern e.g., oil or sediment from roads, fertilizers and pesticides from lawns and golf-courses, road salt, etc.)*	
9.1.3 Type unknown/unrecorded	Water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments. The source of the pollution is often far from the system – an extreme example are the heavy metals that migrating eels bring to the Sargasso Sea. Often, the pollutants only become a problem when they bioconcentrate through the food chain. Oil spills from pipelines should generally go here.
9.2 Industrial and military effluents	
9.2.1 Oil spills *(List the source e.g., leakage from fuel tanks, oil spills from pipelines, PCBs in river sediments, etc.)*	
9.2.2 Seepage from mining *(List the specific pollutants, if possible, e.g., mine tailings, arsenic from gold mining, etc.)*	
9.2.3 Type unknown/unrecorded *(Toxic chemicals from factories, illegal dumping of chemicals, other industrial effluent, ship waste discharge, etc.)*	There are other known examples of industrial pollution, which are not specifically captured under the classification scheme. These should be coded here for now, and the type/cause of the pollution noted in the text box.
9.3 Agricultural and forestry effluents	Water-borne pollutants from agricultural, silvicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied. Wind erosion of agricultural sediments or smoke from forest fires goes in **9.5 Air-Borne Pollutants**.
9.3.1 Nutrient loads *(List the source and specific pollutant of concern: e.g., nutrient loading from fertilizer run-off, manure from feedlots, nutrients from aquaculture, etc.)*	
9.3.2 Soil erosion, sedimentation *(List the source and specific pollutant of concern: e.g., soil erosion from overgrazing, increased run-off and sedimentation due to conversion of forests to agricultural lands, etc.)*	

9.3.3 Herbicides and pesticides *(List the source and specific pollutant of concern: e.g., herbicide run-off from orchards, etc.)*	
9.3.4 Type unknown/unrecorded	
9.4 Garbage and solid waste *(List the type, source, and if possible, the specific pollutants of concern: municipal waste, litter from cars, flotsam and jetsam from recreational boats, waste that entangles wildlife, construction debris, etc.)*	Rubbish and other solid materials including those that entangle wildlife. This category generally is for solid waste outside of designated landfills - landfills themselves should go in **1.2 commercial and industrial areas.** Likewise, toxins leaching from solid waste - for example, mercury leaking out of a landfill into groundwater - should go in **9.2 industrial and military effluents**.
9.5 Air-borne pollutants	Atmospheric pollutants from point and nonpoint sources. It may be difficult to determine the sources of many atmospheric pollutants – and thus hard to take action to counter them.
9.5.1 Acid rain *(Acid rain, excess nitrogen deposition, radioactive fallout, wind dispersion of pollutants or sediments, smoke from forest fires or wood stoves, etc.)*	List the source, and if possible, the specific pollutants of concern.
9.5.2 Smog *(Smog from vehicle emissions, coal burning, wind dispersion of pollutants or sediments, smoke from forest fires or wood stoves, etc.)*	Smog is a type of air pollution derived from vehicular emission from internal combustion engines and industrial fumes that react in the atmosphere with sunlight to form secondary pollutants that also combine with the primary emissions to form photochemical smog. Smog is also caused by large amounts of coal burning in an area caused by a mixture of smoke, Sulphur dioxide and other components. List the source, and if possible, the specific pollutants of concern.
9.5.3 Ozone *(Vehicle emissions, factory smoke emissions, smoke from forest fires or wood stoves, wind dispersion of pollutants or sediments, etc.)*	Ozone is not emitted directly by car engines or by industrial operations, but formed by the reaction of sunlight on air containing hydrocarbons and nitrogen oxides that react to form ozone directly at the source of the pollution or many kilometers down wind. List the source, and if possible, the specific pollutants of concern.
9.5.4 Type unknown/unrecorded	
9.6 Excess energy	Inputs of heat, sound, or light that disturb wildlife or ecosystems. These inputs of energy can have strong effects on some species or ecosystems.
9.6.1 Light pollution *(Lamps attracting insects, beach lights disorienting turtles, etc.)*	List the source, and if possible, the specific pollutants of concern.
9.6.2 Thermal pollution *(Heated water from power plants, damaging atmospheric radiation resulting from ozone holes, etc.)*	List the source, and if possible, the specific pollutants of concern.
9.6.3 Noise pollution *(Noise from highways or airplanes,*	List the source, and if possible, the specific pollutants of concern.

sonar from submarines that disturbs whales, etc.)	
9.6.4 Type unknown/unrecorded	
10. GEOLOGICAL EVENTS	Threats from catastrophic geological events. Strictly speaking, geological events may be part of natural disturbance regimes in many ecosystems. But they need to be considered a threat if a species or habitat is damaged from other threats and has lost its resilience and is thus vulnerable to the disturbance.
10.1 Volcanoes *(Eruptions, emissions of volcanic gasses, etc.)*	Volcanic events
10.2 Earthquakes/tsunamis *(Earthquakes, tsunamis, etc.)*	Earthquakes and associated events
10.3 Avalanches/landslides *(Avalanches, landslides, mudslides, etc.)*	Avalanches or landslides
11. CLIMATE CHANGE AND SEVERE WEATHER	Threats from long-term climatic changes which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat. Strictly speaking climatic events may be part of natural disturbance regimes in many ecosystems. But they are a threat if a species or habitat is damaged from other threats and has lost its resilience and is thus vulnerable to the disturbance. Many climatic events may also be increasing in frequency or intensity outside their natural range of variation due to human causes.
11.1 Habitat shifting and alteration *(Sea-level rise, desertification, tundra thawing, coral bleaching, etc.)*	Major changes in habitat composition and location. This category focuses primarily on the habitat effects of climate change.
11.2 Droughts *(Severe lack of rain, loss of surface water sources, etc.)*	Periods in which rainfall falls below the normal range of variation. Drought degrades the ecosystem, and it is likely to cause species mortality, but **1.2 ecosystem degradation** should be coded under the stresses as the primary effect.
11.3 Temperature extremes *(Heat waves, cold spells, oceanic temperature changes, disappearance of glaciers/sea ice, etc.)*	Periods in which temperatures exceed or go below the normal range of variation
11.4 Storms and flooding *(Thunderstorms, tropical storms, hurricanes, cyclones, tornados, hailstorms, ice storms or blizzards, dust storms, erosion of beaches during sstorms, etc.)*	Extreme precipitation and/or wind events
11.5 Other impacts	Other impacts of climate change or severe weather events not covered above (list the specific type of impacts)

12. OTHER OPTIONS	The threats classification scheme is intended to be comprehensive, but as there are often new and emerging threats, this option allows for these new threats to be recorded
12.1 Other threat	State the specific problem/s. This should be captured in both the explanation text box and the threats narrative.

Appendix 3. Potential conservation / threat abatement actions

(Adapted in part from DAWE 2021).

Threat category	Example recovery actions
Residential and commercial development	• Ensure the species and its habitat are adequately represented in the protected area estate. Investigate options to protect additional habitat under appropriate conservation covenants. • Prior to any land clearing, ensure thorough targeted surveys are undertaken by a suitably qualified person to identify occurrences of the species so that adequate mitigation can be undertaken. • Raise awareness of the species with the local community to encourage stewardship activities, such as habitat improvement via weeding, erosion control etc. • If any individuals are likely to be directly impacted by residential/commercial development, ensure they are adequately represented in an *ex-situ* conservation collection.
Agriculture and aquaculture	• If livestock grazing occurs in the area, landowners/managers to use an appropriate management regime and density that does not detrimentally affect this species and manage total grazing pressure at important sites through exclusion fencing or other barriers. • Develop and implement a stock management plan for <SPECIES> for roadside verges and travelling stock route. Distribute this information to drovers and graziers in the area to increase awareness of the species requirement. • Does the species require a specific % of ground cover, i.e., some birds and reptiles? If so, add a conservation action to retain or enhance cover. • Undertaken extension/awareness activities to inform landholders of the presence (or potential presence) of the species, with the view to collaborate on protecting the species and its habitat.
Energy production and mining	• Ensure the species and its habitat are adequately represented in the protected area estate. Investigate options to protect additional habitat under appropriate conservation covenants. • Prior to any land clearing, ensure thorough targeted surveys are undertaken by a suitably qualified person to identify occurrences of the species so that adequate mitigation can be undertaken. • If any individuals are likely to be directly impacted by energy production/mining, ensure they are adequately represented in an *ex-situ* conservation collection.
Transportation and service corridors	• Ensure the species and its habitat are adequately represented in the protected area estate. Investigate options to protect additional habitat under appropriate conservation covenants. • Prior to any land clearing, ensure thorough targeted surveys are undertaken by a suitably qualified person to identify occurrences of the species so that adequate mitigation can be undertaken. • If any individuals are likely to be directly impacted by transportation corridors, ensure they are adequately represented in an *ex-situ* conservation collection.
Biological resource use	*Timber harvesting* • For target species – Investigate and establish sustainable take levels (if any) to ensure the species' population persists in the long term.

	• For non-target species – Ensure logging is excluded from areas where the species occurs in <STATE FOREST NAME>. Determine a suitable buffer around occurrences of the species to exclude logging activities to prevent direct and indirect damage to the species and its habitat. • Incorporate <SPECIES> into the management plan for <STATE FOREST NAME>. • Ensure all contractors are aware of the species' presence, and their obligations to protect it. • Precisely map the occurrences of the species throughout <STATE FOREST NAME> to guide management actions. *Illegal take (overfishing, illegal seed/plant/animal collection)* • Undertake education and awareness activities to communicate the detrimental impact that illegal take has for the species. • Investigate the suitability/feasibility of reinforcing the wild population with translocated individuals. Ensure disease and genetic implications are carefully managed. • Ensure genetic diversity from areas targeted by poachers is adequately represented in *ex situ* conservation collections.
Human intrusion and disturbance	• Prevent habitat disturbance. Control access routes by installing gates/fences to suitably constrain <STOCK/VEHICLE/PUBLIC> access to known sites on public land and manage access on private land and other land tenure. • Improve the management of stream flows, water quality and riparian environments throughout catchments of existing and potential sites by... • Protect and rehabilitate riparian vegetation <OR OTHER KEY HABITAT> by... • Ensure land managers are aware of the species' occurrence and implement protection measures against key and potential threats. Add to references: SERA (Society for Ecological Restoration Australia) (2017) National standards for the practice of ecological restoration in Australia. Standards reference group, Society for Ecological Restoration Australia. Viewed 11 April 2016. Available at: http://www.seraustralasia.com/standards/National%20Restoration%20Standards%202nd%20Edition.pdf
Natural system modifications – fire	• Fires must be managed to ensure that prevailing fire regimes do not disrupt the life cycle of <SPECIES>, degrade the habitat of the species, promote invasion of exotic species, or increase impacts of grazing/predation. • Physical damage to the habitat and individuals of the <SPECIES> must be avoided during and after fire operations. • Fire management authorities and land management agencies should use suitable maps and install field markers to avoid damage to <SPECIES>. • Undertake active weed control after fire management along urban roadsides. *For orchids and other geophytes* Ensure that prescribed fires occur only within the habitat during the dormant phase of the <SPECIES> life cycle. *For obligate seeding shrubs (Serotinous obligate seeding shrubs are a small subset of genera that release seed in response to fire rather than spontaneously at seed maturation and include some Eucalypts, Hakea, Banksia, Melaleuca etc.)* • Ensure that fires do not occur within populations before an accumulation of a seedbank large enough to replace the number of fire-killed standing plants. Replacement estimates should incorporate expected post-fire rates of seedling survival.

	• Ensure that intervals between successive fires account for the longevity of the standing plant population, noting that serotinous seedbanks are unlikely to persist longer than the standing plant population. • Ensure that fires are sufficiently intense to trigger complete seed release from the serotinous fruits (i.e., by ensuring canopy combustion) and to trigger optimal germination. *Woody resprouting plants* • Avoid successive fire intervals that are shorter than the period required for burnt individuals to resprout and adequately recover. *Fire-killed long-lived plant species, or species that occur in communities dominated by them (e.g., alpine, rainforest and subalpine plant communities)* • Ensure fuel reduction and other planned fires are not implemented at the site. • Where appropriate, employ fuel reduction activities and other protective measures at strategic locations nearby to reduce the potential adverse impacts of wildfire on the species' population, but ensure these are well planned and implemented and do not constitute an increased risk (e.g., through escape of planned fires), and are of low intensity. *Groundcover-dependent vertebrates* • Ensure that a high proportion of the habitat is maintained with a post-fire age sufficient to provide adequate cover (or habitat) to the threatened species. • Ensure immediate and ongoing post-fire predator control within the habitat when fires do occur. • Ensure grazing by introduced herbivores is minimised or excluded post-fire until adequate vegetation recovery has occurred. • Ensure that areas of dense ground cover/leaf litter are retained within the habitat when prescribed fires are implemented. Reduce the frequency of high intensity fires to retain hollow logs and large woody debris on the ground. *Arboreal mammals and hollow-dependent birds* • Reduce the frequency of high intensity fires to limit the loss of hollow-bearing trees, and/or minimise bottlenecks in the recruitment of young trees to larger size classes. • Reduce the intensity of fires so that the canopy (and associated nesting sites) is retained during/after fire events. • Investigate the option to install carefully designed (species-specific) nest boxes if there is a shortage of hollows in some areas. *Seed-eating animals* • Manage fire to produce a fine-scale mix of vegetation of different ages (time-since fire), including some relatively long-unburnt vegetation. *Nectivorous animals and other canopy feeders* Reduce the frequency of high intensity fires that affect the timing and volume of flower production, and the canopy foliage. *Habitats in which invasive grasses and forbs are a threat* • Minimise use of prescribed fire and follow up with appropriate weed control. • For tropical and arid-tropical areas, use prescribed fire after invasive grass seed has germinated and before seed set has occurred to control invasive annual grasses. *Habitats in which invasive (exotic or native) shrubs or trees are a threat* • Where appropriate, use prescribed fire to manage the density and/or abundance of

	invasive species that may reduce the suitability of habitat for the species. • Where appropriate, use manual or chemical control methods as an alternative to prescribed fire. This should consider the probability of invasive species germinating in response to physical disturbance of soils. *For species with few individuals or single populations* • Avoid any management or research activities that may negatively impact the persistence of the population.
Invasive and other problematic species, genes and diseases	*General* • Develop and implement strategies to control predation by the <INVASIVE SPECIES>, as detailed in the relevant Threat Abatement Plans or management strategies. • Manage sites by... to identify, control and reduce the spread of invasive species particularly <INVASIVE SPECIES>. • Implement suitable hygiene protocols including... to protect known subpopulations from outbreaks of <DISEASE/PARASITE – scientific/common name> • Ensure appropriate hygiene protocols are adhered to when entering or exiting sites for survey, monitoring or management such as those outlined in the Arrive Clean, Leave Clean Guidelines (Department of the Environment 2015). Add to references: Department of the Environment (2015) Arrive clean, leave clean: Guidelines to help prevent the spread of invasive plant diseases and weeds threatening our native plants, animals and ecosystems. Canberra. Available at: https://www.environment.gov.au/biodiversity/invasive-species/publications/arrive-clean-leave-clean Disease - phytophthora (*Phytophthora cinnamomi*) • Implement a *P. cinnamomi* management plan to ensure that the fungus is not introduced into uninfected areas where the species occurs, and that the spread in areas outside of, but adjacent to the population is mitigated (DoE 2014). • Ensure that appropriate hygiene protocols are adhered to when entering or exiting the known location of <SPECIES>, such as those outlined in Podger et al. (2001). • Implement a hygiene management plan and risk assessment to protect known populations from further outbreaks of *P. cinnamomi*. This may include but is not limited to ensuring contaminated water is not used for firefighting purposes; contaminated soil is not introduced into the area as part of restoration, translocation, infrastructure development or revegetation activities; all areas where <SPECIES> is known to occur that are free of *P. cinnamomi* are sign posted and hygiene stations are implemented and maintained. • Implement mitigation measures in areas that are known to be infected by *P. cinnamomi,* this may include but is not limited to application of phosphite (H3PO3), noting the potential deleterious effects as a fertiliser with prolonged usage. Add to references: Podger F.D., James S.H., & Mulcahy M.J. (2001). *Phytophthora cinnamomi* and disease caused by it- a protocol for identifying 'protectable areas' and their priority for management. *Draft report prepared for Department of Parks and Wildlife*. Available from www.dpaw.wa.gov.au/images/documents/conservation-management/pestsdiseases/disease-riskareas/Protecting_the_Protectable_and_Protocols_for_Defining_Protectable_Areas.pdf Commander L.E., Coates D., Broadhurst L., Offord C.A., Makinson R.O. & Matthes M. (2018) Guidelines for the translocation of threatened plants in Australia Third Edition. *Australian Network for Plant Conservation*, Canberra. Disease - chytrid fungus (*Batrachochytrium dendrobatidis*) *Nominators should refer to actions in the Threat abatement plan for infection of amphibians*

	with Chytrid fungus resulting in Chytridiomycosis. Add to references: Department of the Environment and Energy (2016). *Infection of amphibians with Chytrid fungus resulting in Chytridiomycosis (2016).* Commonwealth of Australia. Available at: https://www.dcceew.gov.au/sites/default/files/documents/tap-chytrid-fungus-2016.pdf Disease - myrtle rust (*Austropuccinia psidii*) *Nominators should refer to the recovery actions outlined in Myrtle rust in Australia: a national action plan (Makinson et al. 2020) when considering recovery actions for myrtle rust-impacted species.* • Follow the recommendations and actions outlined in Myrtle rust in Australia: a national action plan (Makinson et al. 2020). This should include…<INSERT RELEVANT ACTIONS HERE> • Engage with experts on the pathogen and species to ensure a coordinated response to the impact of myrtle rust on this species. Add to references: Makinson R.O., Pegg G.S., Carnegie A.J. (2020). *Myrtle rust in Australia – a national action plan.* Australian Plant Biosecurity Science Foundation. Canberra, Australia. Available at: http://www.apbsf.org.au/wp-content/uploads/2020/07/PBSF-Myrtle-Rust-National-Action-Plan-2020.pdf *Predators and feral herbivores* *Nominators should refer to relevant threat abatement plans for key predators and feral herbivores. If relevant add an action about the need to consider the impact of fox and cat control post any burn or large rain event.* • Ensure immediate and ongoing post-fire predator control within the species' habitat. • Protect vulnerable subpopulations from grazing/browsing pressure after fire events through targeting culling or enclosure fencing. *Invasive weeds* *Nominators should refer to relevant threat abatement plans for invasive weeds.* • Identify and remove new weeds or undertake weed control (identify which is relevant) in the local area that could become a threat to the species, using appropriate methods. Consider the possible disturbance/overspray threats associated with the control method.
Pollution	• Investigate options to limit or manage pollution to minimise the impact on the species. • Liaise with key stakeholders to develop a management strategy to address the negative impacts of pollution on the species. • Undertake extension and awareness activities to ensure key stakeholders are aware of the negative impacts of pollution on the species.
Geological events	• Develop a management strategy to guide recovery actions for the species after significant weather/geological events. • Establish an *ex-situ* subpopulation / seed bank / conservation collection that represents the maximum range of genetic diversity possible.
Climate change and severe weather	• Undertake research to better understand the conservation genetics of the species. Specifically, determine if the species demonstrates genetic sub structuring; the effective population size based on genetic variation; and whether some genetic variation is already infrequent or at threat of extinction. • Undertake research to better understand the biology and ecology of the species, and the implications that climate change may have for the species. • Establish an *ex-situ* population via seed banking or propagation for conservation and

	research, ensuring the maximum range of genetic diversity possible is represented
Recovery actions grouped by theme (i.e., these may apply to multiple threats and <u>should be repeated against all relevant threats</u> in the nomination form where applicable).	
Ex situ conservation (For plants)	*Ex-situ conservation collections/populations should be considered when there is a high extinction risk to the species in the wild. Translocations should always follow best-practice guidelines, and these should be referenced in the listed recovery actions accordingly.* • Establish plants in cultivation in appropriate institutions such as botanic gardens. • To manage the risk of losing genetic diversity, undertake appropriate seed and storage in long term custodial collections until no longer needed and determine viability of stored seed. Best practice seed storage guidelines and procedures should be adhered to, to maximise seed viability and germinability. Seeds from all natural populations to be collected and stored. • To manage risk of losing genetic diversity, undertake seed collections and store at appropriate institutions. Seeds from as many wild plants as possible across the majority of wild subpopulations should be collected and stored. • If deemed appropriate, undertake conservation translocations in suitable habitat with secure land tenure, to increase the number of subpopulations of <SPECIES>, in accordance with the *Guidelines for the translocation of threatened plants in Australia* (Commander et al. 2018) OR equivalent guidelines for fauna.
Stakeholder engagement/ community engagement (relevant to many threats)	*Stakeholder engagement/extension activities should be included where a species is not wholly protected in conservation estate. Prior to listing actions regarding stakeholder engagement, Nominators should identify the relevant stakeholders e.g., Traditional Custodians, landholders, public land managers, drovers (travelling stock routes), industry (e.g., mining, fishing), the general public (for high profile species), NGOs, and/or developers. Nominators should then determine the objectives for any public engagement, e.g., to improve management on private land, to avoid negative publicity, to ensure recent scientific knowledge is incorporated into public land management. Separate engagement processes (and thus recovery actions listed in the nomination form) will likely be required where there are different objectives.* • For small populations – prepare a <SPECIES / WEED / FERAL PEST / DISEASE> management strategy with input from local experts or <OTHER STAKEHOLDER(S)>. Work with <STAKEHOLDERS> to implement the management strategy. • Actions must be stated for each engagement process identified, e.g., Indigenous engagement/consultation, a specific community/ landholder consultation. • Engage and involve Traditional Custodians in conservation actions, including the implementation of Indigenous fire management and other survey, monitoring and management actions. • Ensure information on <SPECIES> and their habitat is shared between state forest managers and government scientists. New population data and research should be available to all stakeholders to continue to implement best-practice land management that minimises the impacts of potential threats on the species. • Where research identifies potential habitat for the species in areas that are privately-owned, liaise with landholders to provide information on the species and its habitat requirements, and encourage reporting of any sightings. • Increase the recognition and support for the species' recovery by disseminating information on the species and its conservation status to the public.
Survey and monitoring priorities	*Time-series monitoring* *Time-series monitoring is critical for detecting changes in population over time, and therefore discerning whether the population is responding positively or negatively to threats and threat abatement actions. Consider including a recovery action related to time-series monitoring*

	under any relevant threats where data is required to understand the threat or the species' response to the threat more comprehensively. • Design and implement a time-series monitoring program (or if appropriate, support and enhance existing programs) to determine population size and trends in population demographics in relation to threats and management actions. Use data to assess population size and the viability of and status of the (sub)population(s). • Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary. • Where the public is involved in citizen science type monitoring (e.g., many birds, frogs, flying foxes), determine whether these data can be used in monitoring populations, or whether the methods could be adapted to generate more useful data. • For fire impacted species – establish and maintain a monitoring program to document post-fire recovery, determine minimum tolerable fire intervals, determine trends in population size and distribution, determine threats and their impacts, and monitor the effectiveness of management actions and the need to adapt them if necessary. • For plants threatened by fire – monitor the size, structure, and reproductive status of populations at different stages in the fire cycle, taking opportunities to monitor after planned and unplanned fires (where they occur) and improve understanding of the fire response of the species. Precise fire history records must be kept for the habitat and extant populations (confirmed and suspected) of the species. • For animals threatened by fire – monitor the response of the population to fire, using an appropriate measure (occupancy, population abundance, individual mortality, ranging behaviour, breeding success, etc.) based on knowledge of the ecology of the species, and with a monitoring design that aims to improve understanding of the species' response to fire. Precise fire history records must be kept for the habitat and extant populations (confirmed and suspected) of the species. • Predation – monitor the abundance of introduced predators across the species range and responses of <SPECIES> to predator control programs. Evaluate the use and effectiveness of management interventions and modify if required. *Poorly known species – survey requirements* *For taxa where population size or distribution are not comprehensively known, further targeted survey is typically required to better understand the distribution, population size, threats and required threat abatement actions for the species. Consider listing this recovery action against any threats that would rely on a better understanding of population size, distribution, and threats for appropriate management to occur.* • Undertake targeted surveys in suitable habitat to locate any additional occurrences of the species to assess population size and distribution more precisely.
Information and research priorities	*General* *For taxa with poorly known biology and ecology, further research is often required to adequately inform recovery planning (i.e., weed management strategies, fire management strategies) and also the listing (i.e., generation length). Consider listing this recovery action against any threats where further research is required to inform effective threat management.* • For plants - investigate the ecological requirements of <SPECIES> that are relevant to persistence and recruitment, including seed storage conditions in ex situ seed banks; population genetic structure, levels of genetic diversity and minimum viable population size; reproductive status, longevity, fecundity, and frequency and size of recruitment events; soil seed bank dynamics, particularly the longevity of seed in the soil seed bank; pollinator identity, biology, and requirements; the effect of drought on mortality rates of the species. • For fire impacted species – Identify an optimal fire regime for the species by assessing population-level responses to a range of fire regimes and modelling population viability across all fire scenarios. Assess the efficacy of management

	options in reducing the incidence, extent, and intensity of fire. *Species Distribution Modelling for estimating extent of occurrence (EOO)* *Species distribution modelling (SDM) is appropriate when the geographical range of a species is poorly known and is often used when limited presence records are available and data is often of a broad spatial resolution. Note that this requires a reasonably sized dataset of species presence information plus the range of environmental variables that are known to influence the species distribution (Phillips et al. 2006). If this data is not available, then a research priority should be to collect and assimilate this information.* • Develop predictive models for the species' geographical distributions based on the environmental conditions of sites of known occurrences. Add to references: Phillips S.J., Anderson R.P., & Schapire R.E. (2006). Maximum entropy modelling of species geographic distributions. *Ecological Modelling*. 190,3-4, 231-259. *Habitat Suitability Modelling to assess Area of Occupancy (AOO)* *Habitat Suitability Modelling is used to identify the environmental variables a species prefers and requires finer scale data than the SDM but produces results of a much higher and more accurate resolution. Note that this requires a reasonably high number of presence records, plus the environmental variables located at this site and other sites chosen at random.* • Develop habitat suitability models to determine the ecological/environmental indices responsible for a species' distribution, and how it may change due to the impending threats (Guisan et al. 2000). Add to references: Guisan A. & Zimmermann N.E. (2000) Predictive habitat distribution models in ecology. *Ecological Modelling* 135, 147-186. *Connectivity analysis* *Connectivity analysis is used to identify and prioritize important areas for connectivity conservation between disconnected populations across a heterogeneous landscape. Note that this requires information on individual-based movement, or genetic diversity in the population. IF not available then collection of these data should be a research priority.* • Undertake connectivity analysis to prioritise important areas for conservation, the location of critical habitat linkages and barriers to the movement of individuals and gene flow (McRae et al. 2008). Add to references: McRae B.H., Dickson B.G., Keitt T.H., & Shah V.B. (2008) Using circuit theory to model connectivity in ecology and conservation. *Ecology* 10, 2712-2724.

Appendix 4. Data qualifier examples for key parameters

Extent of occurrence		
Observed	*EOO*	Comprehensive surveys of all known and potential habitat have been undertaken for the species and used to create a distribution map. The area of a minimum convex hull around this distribution provides an observed EOO.
	Continuing decline	A census has been undertaken for a species at three-year intervals for the past 20 years. Data from the last three census' indicate the species has become progressively absent at several formerly known sites. At each census year, the EOO has become smaller as the local extinctions occur on the edge of the species' range. Therefore, there is an observed continuing decline in the EOO for this species.
	Reduction	If the EOO retracted and stabilised, this would be considered an observed reduction in EOO (rather than continuing decline) and could be used to suspect a reduction under Criterion A1-4c.
Estimated	*EOO*	Surveys have been taken at representative sites across the species' distribution and specimen records from these sites have been lodged to relevant collection institutions. The area of a minimum convex hull around this distribution provides an estimated EOO. Estimated EOO can also include calculations that incorporate 'inferred sites of occurrence', (i.e., actual presence of known, suitable habitat). However, this should only be used as a maximum plausible bound and not the actual value used for assessment under B. *Minimum data quality requirement for nominations.*
	Continuing decline	Monitoring plots are established at 10 core habitat sites across the species range. Monitoring at 3 time periods indicates the species' range is retracting. Because the data includes representative sites and 2+ time periods, a continuing decline in EOO can be estimated.
	Reduction	If the EOO retracted but stabilised, this would represent an estimated reduction in EOO and could be used to suspect a reduction under Criterion A.
Projected	*EOO*	Surveys have been taken at representative sites across the species' distribution and specimen records from these sites have been lodged to relevant collection institutions. These have been used to create a suitable habitat model for the species. The area of a minimum convex hull around this distribution provides a projected EOO as it has been extrapolated in space.
	Reduction	Monitoring plots are established at 10 core habitat sites across the species range. A mine has been approved for development along the northern boundary of the species range which equates to 50% of its estimated EOO. Although production has not commenced, future reductions are highly likely to occur, and can be quantified. Therefore, a reduction in EOO can be projected for the species. Projected reductions in EOO can be used to suspect a reduction under Criterion A1-4c.
Inferred	*EOO*	The species is highly cryptic but is closely associated with another taxa. The EOO can be inferred using the EOO of the closely related taxa. *Not eligible under criteria B.*

	Continuing decline	A species within the same genus has an estimated continuing decline in EOO due to feral pig impacts. The study species has very similar ecology and habitat, and feral pigs are known to occur in high densities at the northern extent of the species' EOO. Therefore, a continuing decline in the EOO can be inferred for this species. Continuing decline in EOO based on an estimated continuing decline in habitat quality and AOO. The decline in habitat quality and AOO should be occurring in areas where it would cause the EOO to contract (i.e., the edge of the species' range).
Suspected	*EOO*	The EOO is derived from anecdotal information of suitable habitat for the species. *Not eligible under criteria B.*
	Continuing decline	The northern part of an *Acacia* sp. distribution is experiencing more frequent fire regimes. However, the species occurs in microhabitat with low biomass and the time between fires remains long enough to allow juvenile plants to become mature and produce seed. Therefore, a continuing decline in EOO can only be suspected in relation to this threat. A small, insectivorous mammal lives in rocky scarps and fire regimes are becoming more frequent in the landscape. However, the rocky scarps are thought to act as a pyric buffer and prevent direct impacts to the species. Although it's prey may be impacted in the broader landscape, a continuing decline in EOO can only be suspected for the species. *Not eligible under criteria B.*
Area of occupancy		
Observed	*AOO*	Comprehensive surveys of all known and potential habitat have been undertaken for the species and all known sites are georeferenced. The georeferenced sites are intersected with a 2 x 2km grid. The sum of the area of grid cells that include a record of the species provided an observed AOO.
	Continuing decline	A census has been undertaken for a species at three-year intervals for the past 20 years. Data from the last three census' indicate the species has become progressively absent at several formerly known sites. Research has demonstrated that the species is fire-sensitive, and the localised extinctions correspond to recent, high intensity fire scar mapping. At each census year, the AOO has become smaller. Therefore, there is an observed continuing decline in the AOO for this species.
	Reduction	If the AOO retracted and stabilised, this could only be considered an observed reduction in AOO (rather than continuing decline) and could be used to suspect a population reduction in mature individuals under Criterion A1-4c.
Estimated	*AOO*	Surveys have been taken at representative sites across the species' distribution and specimen records from these sites have been lodged to relevant collection institutions. The georeferenced sites are intersected with a 2 x 2km grid. The sum of the area of grid cells that include a record of the species provided an observed AOO. This is the standard usually applied in Queensland nominations. *Minimum data quality requirement for nominations.*

	Continuing decline	Monitoring plots are established at 10 representative sites across the species range. Monitoring at three time periods indicates the number of 2 x 2km grid cells occupied by the species' is declining due to localised extinctions. Threats are continuing and these declines are also liable to continue. Because the data includes representative sites and 2+ time periods, there is an estimated continuing decline in AOO.
Projected	*AOO*	Surveys have been taken at representative sites across the species' distribution and specimen records from these sites have been lodged to relevant collection institutions. These have been used to create a distribution model for the species. The sum of the area of grid cells that intersect the modelled habitat provide a projected AOO.
	Continuing decline	Monitoring plots are established at 10 core habitat sites across the species range. Invasive weeds are progressively outcompeting the species at several sites within the species' range. Impacts are likely to occur for the foreseeable future, resulting in a gradual decline in the number of 2 x 2km grid cells occupied by the species. Therefore, a continuing decline in AOO can be projected for the species as these impacts are extrapolated into the future.
Inferred	*AOO*	The species is highly cryptic but is closely associated with another taxa. The AOO can be inferred using the AOO of the closely associated taxa. *Not eligible under criteria B or D.*
	Continuing decline	Continuing decline in AOO based on an estimated continuing decline in habitat quality. The decline in habitat quality must be of a sufficient scale to indicate the AOO will decline. A continuing decline has been estimated based on sample sites within one subpopulation due to domestic stock. This threat is present across all sites, and therefore there is quantitative information on one subpopulation that there will be decline due to domestic stock. This can be projected to impact all subpopulations for the species and thus cause continuing decline in EOO, AOO and quality of habitat.
Suspected	*AOO*	The AOO is derived from anecdotal information of suitable habitat for the species. *Not eligible under criteria B or D.*
	Continuing decline	The species is thought to be negatively impacted by climate change. However, because there is no comprehensive information on the species biology or specific habitat requirements, the mechanism of decline cannot be identified. Therefore, the decline is only suspected and is not eligible under Criterion B or C. *Not eligible under criteria B or C.*
Area, extent and quality of habitat		
Observed	*Area and extent of habitat*	Comprehensive surveys of all known and potential habitat have been undertaken for the species and all known sites are mapped with georeferenced polygons. These georeferenced sites are used to calculate the area of habitat for the species. Note that the specific habitat must be clearly defined at a scale relevant to the life history of the species.

	Continuing decline	A species of fish is known to only occur in arid zone springs. The area of habitat was defined as polygons around the springs in which the species has been found during comprehensive surveys over the past three generations. Due to aquifer drawdown, the area occupied by springs (and mapped as polygons during repeat surveys) has been declining in the past two generations. This decline can be considered an observed continuing decline in the area and extent of habitat if it is liable to continue. The same spring endemic species is known to rely on clear water to complete its life cycle, and therefore water turbidity can be considered a key component of habitat quality. Water turbidity has been sampled at every spring occupied by the species in the past three generations. The number of springs that have turbidity levels exceeding the species' tolerance is increasing due to feral pigs. Therefore, this can be considered an observed decline in quality of habitat.
Estimated	*Area of habitat*	Surveys have been taken at representative sites across the species' distribution and specimen records from these sites have been lodged to relevant collection institutions. The georeferenced sites are used to estimate the area of habitat for the species.
	Continuing decline	Woody debris cover is identified as an important habitat component for a frog. Monitoring at representative sample sites at two points in time indicate it is declining by an average of 15% each year. The decline is attributed to feral pigs, which smash the logs in search of food, which is liable to continue. This information can be used to estimate a continuing decline in habitat quality for the frog species. Invasive weeds are known to outcompete a plant species. Monitoring at representative sample sites at two points in time indicate invasive weed cover is increasing by 30% every 2 years. This information can be used to estimate a continuing decline in area of habitat for the plant species.
	Reduction	A bird species that occurs in the Brigalow Belt depends on Allocasuarina vegetation for feeding habitat. Using Regional Ecosystem mapping, a reduction of >80% in the past 3 generations (80 years) can be quantified and attributed to expansion of cropping lands. This information can be used to estimate a reduction in the area, extent and quality of habitat for the species, and to suspect a population reduction under Criterion A1-4c.
Projected	*Area of habitat*	Surveys have been taken at representative sites across the species' distribution and specimen records from these sites have been lodged to relevant collection institutions. The georeferenced sites are used to generate a potential habitat model (extrapolated in space). This area can be considered a projected area of habitat for the species.
	Continuing decline	Moisture availability is crucial to the survival of the species. Climate change modelling indicates a projected decline in moisture availability for the area where a montane species occurs. Studies of moisture requirements and tolerance thresholds for the species have been established. By combining moisture tolerance thresholds for the species, with the projected rate of decline in moisture availability for the area where the species occurs, a future decline in habitat quality can be projected. *Although this decline has not yet commenced, it has a high likelihood of occurring (merely plausible future continuing declines are not eligible under Criterion B or C).* Continuing decline in area/extent of habitat predicted by a statistical model of land cover change, based on landcover changes from remote-sensing data.

Inferred	*Habitat quality*	There is no data available on habitat requirements for the study species of plant, but research on a closely related taxa has estimated that moisture availability is crucial for survival. Therefore, moisture availability can be inferred to be an important component of habitat quality for the study species.
	Continuing decline	Climate change modelling indicates a projected change in moisture availability for the general area where a montane species occurs. Moisture availability is crucial to the survival of the species and is projected to decline with high certainty. Although the change to moisture availability has been projected, the moisture requirements thresholds for the species have not been specifically studied. Therefore, this can only be used to infer a decline in habitat quality for the species, as there are assumptions that changes in moisture availability will be outside the tolerance of the species. A species of frog depends on seasonal wetlands to complete its life cycle. Feral pig damage to these sites occurs throughout the distribution of the frog species, compacting soils and damaging the microhabitat provided by the plant. Although the mechanism of decline is well established, there is no quantitative data, so this information can be used to infer a continuing decline in habitat quality. *Although these declines have not yet commenced, they have a high likelihood of occurring and are eligible under criterion B and C (merely plausible future continuing declines are not eligible under criterion B or C).* *Minimum data quality for criterion B.*
Suspected	*Habitat quality*	Field surveys in a very limited area of the species distribution have found it commonly associated with riparian areas with high levels of canopy cover. Canopy cover appears to be an important component of habitat quality; however, surveys have been limited and rely on substantial assumptions of the habitat occupied by the species in other areas. Therefore, it is suspected that canopy cover is an important component of habitat quality.
	Continuing decline	Flowering melaleuca trees are a substantial component of a bat's diet throughout the year and are inferred to be an important component of habitat quality. Feral pigs cause substantial damage to the ground layer vegetation, including declines in recruitment of the bat's favoured food tree species. The bat is known to switch between food sources, and there is no clear indication that recruitment will cause a long-term loss of food trees. As this relies on circumstantial evidence, this continuing decline is suspected. *Not eligible under criteria B.*
Number of locations/subpopulations		
Observed	*Number of subpopulations*	Comprehensive surveys of all known and potential habitat have been undertaken for the species and used to determine the number of subpopulations. Delineation of subpopulations includes quantitative data on dispersal rates between and within sites to ensure there is typically <1 successful gamete per year.
	Continuing decline	A recent population census including all subpopulations/locations documented a local extinction of two subpopulations/locations, and substantial decline in another subpopulation/location. The threat causing the decline is ongoing, and therefore this can be considered an observed continuing decline in the number of subpopulations/locations for the species.

Estimated	*Number of subpopulations*	Surveys have been taken at representative sites across the species' potential habitat area and specimen records from these sites have been lodged to relevant collection institutions. These have been analysed to estimate the number of subpopulations with reference to the known dispersal mechanism of the species.
	Continuing decline	Sampling across the range of the species indicates one subpopulation has become locally extinct and two subpopulations are no longer large enough to be viable. As the surveys were based on systematic sampling rather than a full census, a continuing decline in the number of subpopulations is estimated.
Projected	*Number of subpopulations*	The number of subpopulations expected to persist based on estimated data (as above), plus future threat impacts can be used to project the number of subpopulations that may persist in the future. Surveys have been taken at representative sites across the species' habitat and have been used to determine additional areas of potential habitat where the species is likely to occur. The number of additional subpopulations that could be present in the unsurveyed areas is calculated within using the dispersal capacity of the taxon.
	Continuing decline	Sampling across the range of the species indicates one subpopulation has become locally extinct and two subpopulations are no longer large enough to be viable. As the threat causing the decline is pervasive, and liable to continue, the rate and magnitude of decline can be extrapolated into the future to project a continuing decline in the number of subpopulations.
Inferred	*Number of subpopulations*	Surveys have been taken at some sites throughout the species range, and areas of other suitable habitat where the species is highly likely to occur have been identified via expert elicitation. The dispersal mechanisms for the species are not known but are known for a closely-related taxa. This information was used to infer the presence of two additional subpopulations in nearby, but geographically isolated habitat. *Note that such inferences should only be used to generate a maximum plausible bound for number of subpopulations.*
	Continuing decline	Feral cats occur throughout the range of a small mammal that has three subpopulations. There is no species-specific data exploring predation by feral cats for the species, but feral cats are known to have severe impacts on another, closely related species that is a similar size. Predation of the similar species has been significant enough to cause local extinctions (and loss of subpopulations). Therefore, it can be inferred that the study species is also experiencing a continuing decline in the number of subpopulations.
Suspected	*Number of subpopulations*	The species is generally poorly known with only two collection records at one site. Anecdotal information suggests the species may be more widespread in the adjacent mountain range, and this is used to suspect the presence of an additional subpopulation. *Note that such suspicions should only be used to generate a maximum plausible bound for subpopulations.* *Not eligible under criterion C.*

	Continuing decline	The species occurs in an area where climate change impacts, specifically an increase in severe cyclones, will occur. However, the species can recover well from disturbance as it has strong resprouting capacity. Cyclones may create opportunities for invasive weeds to establish. As this information is largely circumstantial, and no clear mechanism of decline is identified, this should be considered a suspected continuing decline. A bat occurs in an area where feral pigs cause substantial damage to the ground layer vegetation, including declines in recruitment of the bat's favoured food tree species. The bat is known to switch between food sources, and there is no clear indication that recruitment will cause a long-term loss of food trees. As this relies on circumstantial evidence, this continuing decline is suspected. Part of a species' distribution occurs in a mineral exploration permit. Because the permit does not equate to guaranteed mining activity, this threat can only be suspected. *Not eligible under criterion B and C.*
Number of mature individuals		
Observed	*Number of mature individuals*	A complete census of all mature individuals within a population.
	Reduction	A census involving a direct count of all known individuals within a population is made at three time periods relevant to the life history of the species. The data indicates 50% of the mature individuals have died over the past 10 years. This data can be used to observe a reduction under Criterion A1 or A2.
	Continuing decline	If the abovementioned census involved multiple survey periods and there is no indication the decline will cease, this data can be used to observe a continuing decline under Criterion B and C.
Estimated	*Number of mature individuals*	Population counts at a representative suite of sites across the species' distribution. May involve statistical assumptions regarding the proportion of mature individuals at a site (of the total number of individuals), and/or be extrapolated (i.e., estimate of densities across the species' known range to derive an overall population size) (Criteria C, D). A botanist regularly visits three monitoring sites for a threatened plant. At these sites, the number of mature individuals within 6 x 1ha plots are recorded to obtain an average density of plants per ha. The average density per ha is then extrapolated over the known habitat of the species to provide an estimated number of mature individuals. For a vocal bird, transect counts of singing males may be used with assumptions about the overall proportions of mature males these represent, and about sex ratios to estimate the number of mature individuals (Criteria C, D). An estimate of the proportion of mature individuals in the population derived from demographic information of the population.
	Continuing decline	A continuing decline in the number of mature individuals could be estimated for a species from population size estimates from two or more time points. Mark-recapture studies have found the relative abundance of a small mammal has declined over the past three generations. The species is known prey of feral cats and has been frequently found in stomach contents analysis from cats in the region. As the threat of feral cats is liable to continue, a continuing decline can be estimated for the species.

	Reduction	A population reduction could be estimated for a species using metrics such as an index of abundance (catch per unit effort, density, number of nesting females, abundance based on mark-recapture).
Projected	*Number of mature individuals*	Data from current population estimates can be used to project a future population size for the species, particularly where a rate of decline or increase is known.
	Continuing decline	An ecologist obtains estimates for the number of mature individuals from representative permanent monitoring plots that are monitored annually. Based on data from the past three monitoring periods, the species is declining at a rate of 10% each year. The threats are ongoing, and the decline is liable to continue into the future. By extrapolating this rate of decline into the future, a continuing decline in the number of mature individuals can be projected for the species under Criterion B and C.
	Reduction	If the generation length is known, a reduction can be projected under Criterion A. If the decline was going to occur in a discrete area (i.e., infrastructure impact site that is spatially constrained), this may constitute a projected reduction rather than continuing decline. Projected reductions can be assessed under Criterion A4.
Inferred	*Number of mature individuals*	Catch statistics were used to infer a population size for a marine fish at a particular point in time. Inference may also involve extrapolating an observed or estimated quantity from known subpopulations to calculate the same quantity for other subpopulations. Number of mature individuals calculated by combining information from density estimates at sample sites that are not representative of the population as a whole (i.e. one subpopulation not included). Number of mature individuals calculated from closely related species with similar ecology and subject to similar threats, where they can be plausibly assumed to have similar densities. An estimate of the proportion of mature individuals based on demographic data from a similar species. For example, Species Y has a population size of 500 and 25% are mature. Species X has a population size of 100 and % mature are unknown, however it can be inferred the number of mature individuals is 25 (i.e., 25% of 100). Field observations of mature plants (but not from systematic monitoring plots) are used to determine a rough estimate of mature individuals at a particular site. This can be extrapolated over an area of habitat by an expert to give an inferred number of mature individuals. *Not eligible under criterion C and D.*
	Continuing decline	A survey on one subpopulation estimated a continuing decline in the number of mature individuals. A continuing decline could be inferred for the subpopulations where similar threats are occurring. A montane mammal has highly specific habitat requirements to suit its narrow thermal range, and only occurs above 1,000m. A combination of climate change projections and habitat suitability modelling indicates its known microhabitat will experience temperatures in excess of its thermal tolerance in the next two generations. Therefore, a continuing decline in the number of mature individuals is inferred for the species. *Although this decline has not yet commenced, it has a high likelihood of occurring (merely plausible future continuing declines are not eligible under*

		criterion B or C).
	Reduction	Catch statistics from multiple time points were used to infer a reduction in population size for a marine fish. The cause of the reduction is well understood and has not ceased, therefore a continuing decline can also be inferred.
Suspected	*Number of mature individuals*	The number of mature individuals based on a best guess using minimal or no field knowledge for the species (i.e., knowledge from a very limited number of sites or knowledge that may be outdated). *Not eligible under criterion C and D.*
	Continuing decline	While feral cats are known to cause declines in critical weight range mammals, their impact on smaller, cryptic species is less understood. While they are known to successfully predate similar species, the impact on the population is poorly understood. But there is some evidence a decline may be occurring. Climate change is projected to cause a decline in moisture availability for high elevation plants. A short-lived grass that occurs at a variety of elevations (500-1,200m) is likely to experience habitat change, particularly at the higher elevations in coming years. However, as grasses can be resilient to moisture deficits, the mechanism for decline is not clear. It may even outcompete other, more sensitive taxa. A decline in habitat quality is suspected, however cannot be inferred for this species. *Not eligible under criterion B and C.*
	Reduction	Anecdotal information indicating a species used to be seen regularly but is now rarely encountered can be used to suspect a population reduction and/or continuing decline. Population reduction in the number of mature individuals based on information on trends in harvest, habitat quality, and sightings (e.g., from a structured elicitation of information from multiple experts familiar with the taxon).

Appendix 5. Data qualifier examples for common threats

Land clearing	
Observed *(quantitative)*	Comprehensive surveys have been undertaken for a plant species, and it is known to only occur at three sites. These sites were cleared for agriculture (cropping) and comprehensive follow up surveys have failed to relocate the species. This can be considered an observed reduction in population size due to land clearing.
Estimated *(quantitative)*	A bird species that occurs in the Brigalow Belt depends on *Allocasuarina* vegetation for feeding habitat. Using Regional Ecosystem mapping, a reduction of >80% in the past 3 generations (80 years) can be quantified and attributed to expansion of cropping lands. This information can be used to estimate a reduction in the area, extent and quality of habitat for the species, and to **suspect a population reduction** under Criterion A1-4c.
Projected *(quantitative)*	A skink occurs in remnant patches of Brigalow Forest within the Brigalow Belt. The habitat for the species is well-defined and has been mapped on GIS. Some of the habitat patches are too small to be protected and occur on freehold land where clearing is likely to occur in the near future. This information can be used to project a population reduction in the future under Criterion A4.
Inferred *(qualitative)*	A daisy is closely associated with Brigalow, which is the dominant tree species in a number of Regional Ecosystems in the Brigalow Belt. An 80% reduction in Brigalow-dominated REs has been documented. Because the two species are closely associated, a continuing decline in the area of habitat can be inferred for the daisy.
Suspected *(qualitative)*	Collection records indicate a species has a strong affinity for fertile soils at low elevations. Current collection records occur in close proximity to cleared areas. However, the species was only identified 50 years ago, and no collection records occur in these cleared areas. Given the close proximity to these cleared areas, botanists suspect it has undergone historic declines due to land clearing. This information is based on suspicion, and therefore can be used to suspect a continuing decline or reduction due to land clearing for the species.
Inappropriate fire regimes	
Observed *(quantitative)*	A census has been undertaken for a species at three-year intervals for the past 20 years. Data from the last three census' indicate the species has become progressively absent at several formerly known sites. Research has demonstrated that the species is fire-sensitive, and the localised extinctions correspond to recent, high intensity fire scar mapping. At each census year, the AOO has become smaller. Therefore, there is an observed continuing decline in the AOO for this species. If the AOO retracted and stabilised, this could only be considered an observed reduction in AOO (rather than continuing decline) and could be used to **suspect** a population reduction in mature individuals under Criterion A1-4c.
Estimated *(quantitative)*	Based on monitoring data from a representative suite of sample sites, the number of mature individuals is declining in concert with an increase in fire frequencies. Fire regimes in the area are projected to become more frequent with heating and drying associated with climate change. This data can be used to estimate a continuing decline for a species.
Projected *(quantitative)*	Based on monitoring data from a representative suite of sample sites, the number of mature individuals is declining at a rate of 6% annually due to an increase in fire frequency. This rate of decline can be used with the known generation length of a species to project a percentage decline in the future under Criterion A3 and A4.
Inferred (qualitative)	An obligate seeder, which is killed by fires, requires a minimum fire-free interval of 15 years to maintain a stable population size. Thus, appropriately timed fire is an important component of habitat quality for the species. Fire frequency determined from remote-sensing data indicates an average return interval of 7 years over the past 20 year period. It can also be inferred the

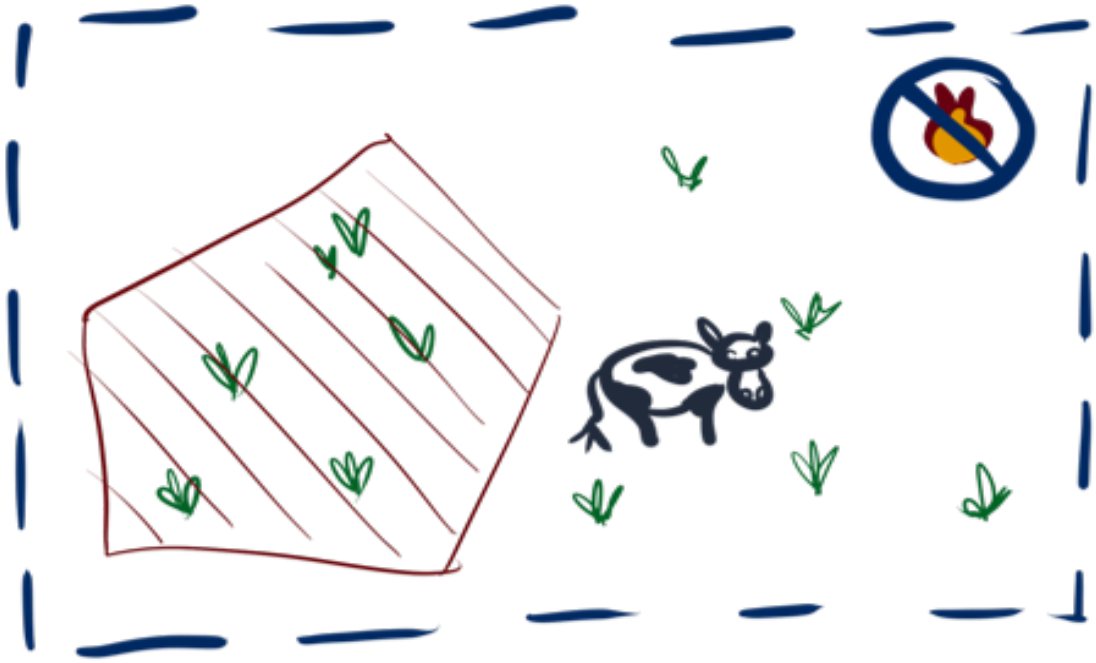
	specific microhabitat of the species was burnt during these fires as the vegetation accumulates substantial, flammable biomass. This information can be used to infer a continuing decline in habitat quality and number of mature individuals for the species.
Suspected *(qualitative)*	The northern part of an *Acacia* sp. distribution is experiencing more frequent fire regimes. However, the species occurs in microhabitat with low biomass and the time between fires remains long enough to allow juvenile plants to become mature and produce seed. Therefore, a continuing decline in EOO can only be suspected in relation to this threat. A small, insectivorous mammal lives in rocky scarps and fire regimes are becoming more frequent in the landscape. However, the rocky scarps are thought to act as a pyric buffer and prevent direct impacts to the species. Although it's prey may be impacted in the broader landscape, a continuing decline in EOO can only be suspected for the species.
Invasive weeds	
Observed *(quantitative)*	A census has been undertaken for the population and the distribution of invasive weeds within each subpopulation has been mapped. Follow up surveys have been undertaken at two additional time points and found localised extinctions for three subpopulations have occurred. Because this data is based on a comprehensive survey (i.e., census) this can be used to observe a continuing decline in subpopulations for the species.
Estimated *(quantitative)*	Invasive weeds are known to outcompete a plant species. Monitoring at representative sample sites at two points in time indicate invasive weed cover is increasing by 30% every 2 years. This information can be used to estimate a continuing decline in habitat quality for the plant species.
Projected *(quantitative)*	Monitoring plots are established at 10 core habitat sites in part of the species range. The other part of the species' range is very difficult to access and there are no monitoring sites there. Monitoring at 3 time periods indicates the species' range is retracting due to invasive weeds. By extrapolating the trend estimated within the monitored part of the species' range, a **continuing decline** can be projected across the species range.
Inferred *(qualitative)*	Lantana is known to be present within the specific habitat occupied by the species. The species is fire sensitive, and remote sensing indicates there have been recent fires in the area. Although there are no quantitative data available, a continuing decline in habitat quality can be inferred for the species, as fire-free habitat is an important component of habitat quality for the species that lantana is altering.
Suspected *(qualitative)*	Invasive weeds are known to be present within the general area where the species occurs, however the specific impacts to the species are not known. Therefore, it is suspected that a continuing decline may be occurring for the species.
Vertebrate pests (cattle, pigs, cats)	
Observed *(quantitative)*	A species of fish is known to only occur in arid zone springs and is known to rely on clear water to complete its life cycle, therefore water turbidity can be considered a key component of habitat quality. Water turbidity has been annually sampled at every spring occupied by the species in the past three generations. The number of springs that have turbidity levels exceeding the species' tolerance is increasing due to feral pigs. Therefore, this can be considered an observed decline in quality of habitat.
Estimated *(quantitative)*	Woody debris cover is identified as an important habitat component for a frog. Monitoring at representative sample sites at two points in time indicate it is declining by an average of 15% each year. The decline is attributed to feral pigs, which smash the logs in search of food, which is liable to continue. This information can be used to estimate a continuing decline in habitat quality for the frog species. Mark-recapture studies have found the relative abundance of a small mammal has declined over the past three generations. The species is known prey of feral cats and has been frequently found in stomach contents analysis from cats in the region. As the threat of feral cats

	is liable to continue, a continuing decline can be estimated for the species.
Projected *(quantitative)*	An ecologist obtains estimates for the number of mature individuals from representative permanent monitoring plots that are monitored annually. Based on data from the past three monitoring periods, the species is declining at a rate of 10% each year due to feral cat predation. This data can be used to project a percentage reduction within three generations for assessment under Criterion A4b.
Inferred *(qualitative)*	A species of frog depends on seasonal wetlands to complete its life cycle. Feral pig damage to these sites occurs throughout the distribution of the frog species, compacting soils and damaging the microhabitat provided by the plant. Although the mechanism of decline is well established, there is no quantitative data, so this information can be used to infer a continuing decline in habitat quality. A species within the same genus has an estimated continuing decline in EOO due to feral pig impacts. The study species has very similar ecology and habitat, and feral pigs are known to occur in high densities at the northern extent of the species' EOO. Therefore, a continuing decline in the EOO can be estimated for this species. Feral cats occur throughout the range of a small mammal that has three subpopulations. There is no species-specific data exploring predation by feral cats for the species, but feral cats are known to have severe impacts on another, closely related species that is a similar size. Predation of the similar species has been significant enough to cause local extinctions (and loss of subpopulations). Therefore, it can be inferred that the study species is also experiencing a continuing decline in the number of subpopulations.
Suspected *(qualitative)*	Flowering melaleuca trees comprise up a substantial component of a bat's diet throughout the year and are inferred to be an important component of habitat quality. Feral pigs cause substantial damage to the ground layer vegetation, including declines in recruitment of the bat's favoured food tree species. The bat is known to switch between food sources, and there is no clear indication that declines in recruitment will cause a long-term loss of food trees. As this relies on circumstantial evidence, this continuing decline is suspected and therefore is not eligible under Criterion B and C. While feral cats are known to cause declines in critical weight range mammals, their impact on smaller, cryptic species is less understood. The impact on the population is poorly understood and therefore a continuing decline is only suspected.
Climate change/ severe weather/ cyclones etc.	
Observed *(quantitative)*	A census is undertaken every three years for a threatened plant species. A severe cyclone impacted the distribution of the species and a follow up census revealed tree death of 30% for the same species. This information can be used as an observed reduction under Criterion A1-2a.
Estimated *(quantitative)*	Mark-recapture studies indicate a montane mammal has decreased in abundance over a 5-year period. This has been correlated to an increase in temperature in the area, which exceeds the thermal tolerance of the species. This data can be used to estimate a continuing decline in the number of mature individuals under Criterion B.
Projected *(quantitative)*	Moisture availability is crucial to the survival of the species. Climate change modelling indicates a projected decline in moisture availability for the area where a montane species occurs. Studies of moisture requirements and tolerance thresholds for the species have been established. By combining moisture tolerance thresholds for the species, with the projected rate of decline in moisture availability for the area where the species occurs, a future decline in habitat quality can be projected. Although this decline has not yet commenced, it has a high likelihood of occurring (merely plausible future continuing declines are not eligible under Criterion B or C).
Inferred	Climate change modelling indicates a projected change in moisture availability for the general area where a montane species occurs. Moisture availability is crucial to the survival of the

(qualitative)	species and is projected to decline with high certainty. Although the change to moisture availability has been projected, the moisture requirements thresholds for the species have not been specifically studied. Therefore, this can only be used to infer a decline in habitat quality for the species, as there are assumptions that the changes in moisture availability will be outside the tolerance of the species. A montane mammal has highly specific habitat requirements to suit its narrow thermal range, and only occurs above 1,000m. A combination of climate change projections and habitat suitability modelling indicates its known microhabitat will experience temperatures in excess of its thermal tolerance in the next two generations. Therefore, a continuing decline is inferred for the species. Although this decline has not yet commenced, it has a high likelihood of occurring (merely plausible future continuing declines are not eligible under Criterion B or C).
Suspected *(qualitative)*	The species occurs in an area where climate change impacts, specifically an increase in severe cyclones, will occur. However, the species can recover well from disturbance as it has strong resprouting capacity. Cyclones may create opportunities for invasive weeds to establish. As this information is largely circumstantial, and no clear mechanism of decline is identified, this should be considered a suspected continuing decline and therefore is not eligible under Criterion B and C. Climate change is projected to cause a decline in moisture availability for high elevation plants. A short-lived grass that occurs at a variety of elevations (500-1,200m) is likely to experience habitat change, particularly at the higher elevations in coming years. However, as grasses can be resilient to moisture deficits, the mechanism for decline is not clear. It may even outcompete other, more sensitive taxa. A decline in habitat quality is suspected, however cannot be inferred for this species.
Mining activities + road/ transport infrastructure	
Observed *(quantitative)*	A census was undertaken for a plant known from a single site, that occurs in a road expansion area. After the road construction, a follow up census was undertaken. During this follow up survey it was recorded that the species range and number of mature individuals had been reduced due to construction. This can be used to observe a reduction in the number of mature individuals for the species. If the impacts were liable to continue, this could be used to observe a continuing decline in the number of mature individuals.
Estimated *(quantitative)*	Monitoring sites were established at a mine impact site to determine the number of plants likely to be impacted by a mining pit. Population estimates were made by calculating the average density of mature individuals at six survey sites and extrapolated over the area of suitable habitat in the impact area to calculate the population size for the species. This information can be used to estimate a reduction in mature individuals for the species.
Projected *(quantitative)*	Monitoring plots are established at 10 core habitat sites across the species range. A mine has been approved for development along the northern boundary of the species range which equates to 50% of its estimated EOO. Although production has not commenced, future reductions are highly likely to occur, and can be quantified. Therefore, a reduction in EOO can be projected for the species. Projected reductions in EOO can be used to **suspect** a reduction under Criterion A1-4c.
Inferred *(qualitative)*	A long-lived, perennial plant is known to occur within a coal seam gas mining lease. Areas of vegetation in which it is known to grow have been cleared, invasive weeds have been introduced and fire has now been excluded from the area. A continuing decline in habitat quality can be inferred for the species.
Suspected *(qualitative)*	Part of a species' distribution occurs in a mineral exploration permit. Because the permit does not equate to guaranteed mining activity, this threat can only be suspected.
Disease – myrtle rust, phytophthora, chytrid fungus	
Observed	A census was undertaken for a restricted Myrtaceae species in 2010. Myrtle rust was

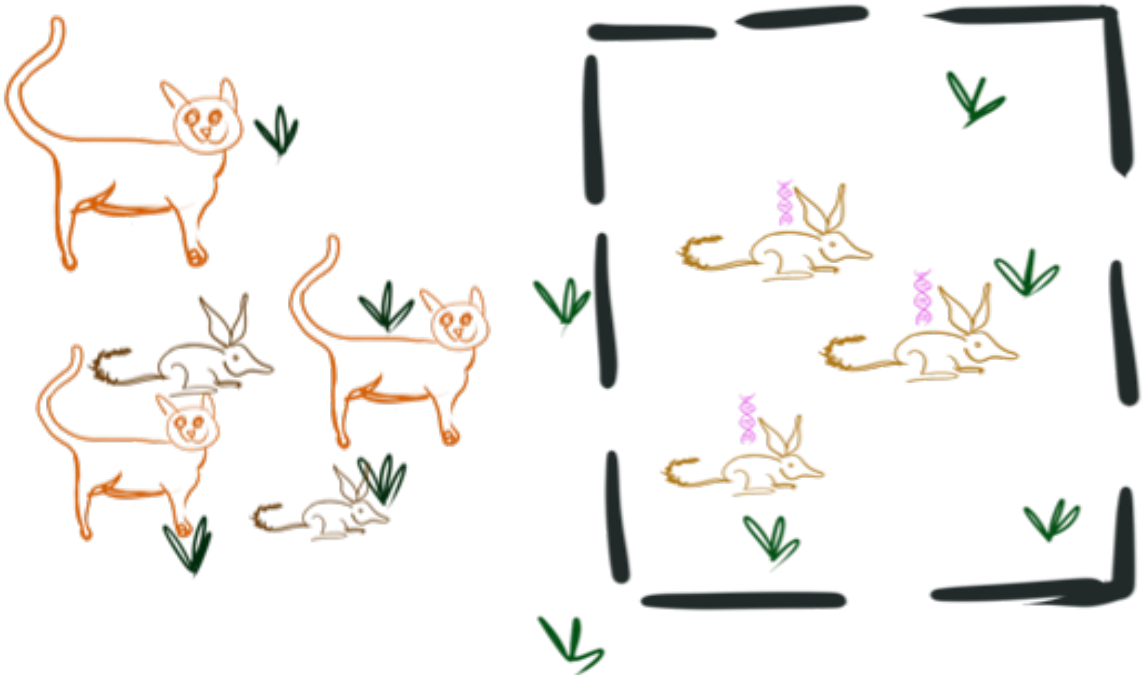
(quantitative)	introduced to the population in 2015, and a follow up census was undertaken and found 90% of mature plants are now dead. This can be used as an observed reduction under Criterion A. The decline is liable to continue, so this can also be applied as a continuing decline in the number of mature individuals.
Estimated *(quantitative)*	Monitoring plots have been established at representative sites across a species range. The species is in the Myrtaceae family and is susceptible to myrtle rust. After two surveys three years apart the number of mature individuals has declined by 40% and can be used as an estimated reduction under Criterion A. The decline is liable to continue, so this can also be applied as a continuing decline in the number of mature individuals.
Projected *(quantitative)*	Mark-recapture data indicates the relative abundance of a once common frog is decreasing at a rate of 30% each breeding season due to chytrid fungus and is now locally extinct from some sites at the south of its range. This data can be used to project a continuing decline in mature individuals in other areas of its range as the disease spreads. Because the local extinctions caused a decline in EOO and AOO, this can also be included under Criterion B, and used to suspect a reduction under Criterion A3-4c.
Inferred *(qualitative)*	A plant within the Myrtaceae family grows within the naturalised distribution of myrtle rust. Minimal field surveys have been undertaken for this species. However, it is severely impacted by myrtle rust in an *ex-situ* garden. This information can be used to infer a continuing decline for the species based on the presence of myrtle rust in the area that the species occupies.
Suspected *(qualitative)*	A plant within the Myrtaceae family grows within the naturalised distribution of myrtle rust. There is no information on whether it is susceptible to infection, and other species in the genus can be highly susceptible or display no symptoms at all. This information can be used to suspect a continuing decline in habitat quality for the species.

Appendix 4. Locations with multiple threats



When there are two or more serious plausible threats, nominators should apply the threat that results in the smallest number of locations. In the above example, the nominate species (an obligate seeding plant represented by the green drawing) is threatened by a mine site in one area (brown cross hatching), over-grazing by cattle (outside of the mine impact area), and fire exclusion to protect grazing pasture and the mine site (fire symbol). The whole population is represented inside blue dashed line. When assessing the locations, the threat resulting in the smallest number of locations would be lack of fire, which equates to one location, as it impacts the entire distribution of the species, rather than just parts of it.

Appendix 5. Locations with different threats



Where the most serious plausible threat is different across the species' range, nominators should assess each of these areas independently according to the corresponding threat. In the above example, the nominate species, a small mammal occurs in an area with abundant feral cats. The nominate species is also protected in an enclosure where feral cats cannot enter. In the enclosure, the most serious plausible threat is genetic depression via inbreeding. When assessing locations, nominators would assign one location to the area outside the enclosure fence, where feral cats can simultaneously impact all individuals. A second location would be assigned to the area within the enclosure fence where genetic inbreeding could rapidly impact all individuals. Therefore, there would be two locations for the nominate species.

Appendix 6. Locations with cumulative threat impacts

Where the most serious plausible threat is habitat loss that occurs gradually and cumulatively via many small-scale events, locations should be defined by, "*the area over which the population will be eliminated or severely reduced within a single generation or three years, whichever is longer*" (IUCN SPC 2022, pg. 61). In the scenario above, the nominate species (green) is a perennial shrub that has a generation length of 10 years, which occurs in an area being developed for housing (orange). Only parts of the population are currently impacted, but the housing footprint extends across the whole population (orange). The housing footprint is expected to be fully developed within the next 6 years. Rather than defining locations at the scale of a single house or property, locations should be defined as the cumulative impact area. Therefore, the nominate species occurs at one location.

Appendix 7. Locations with unimpacted areas

Where part of the population is not impacted by a threat, nominators should

- Consider not using locations if area impacted is <50%; or
- Use subpopulations as a proxy for locations in the unimpacted areas; or
- Transpose size of smallest location from impacted areas to non-impacted areas.

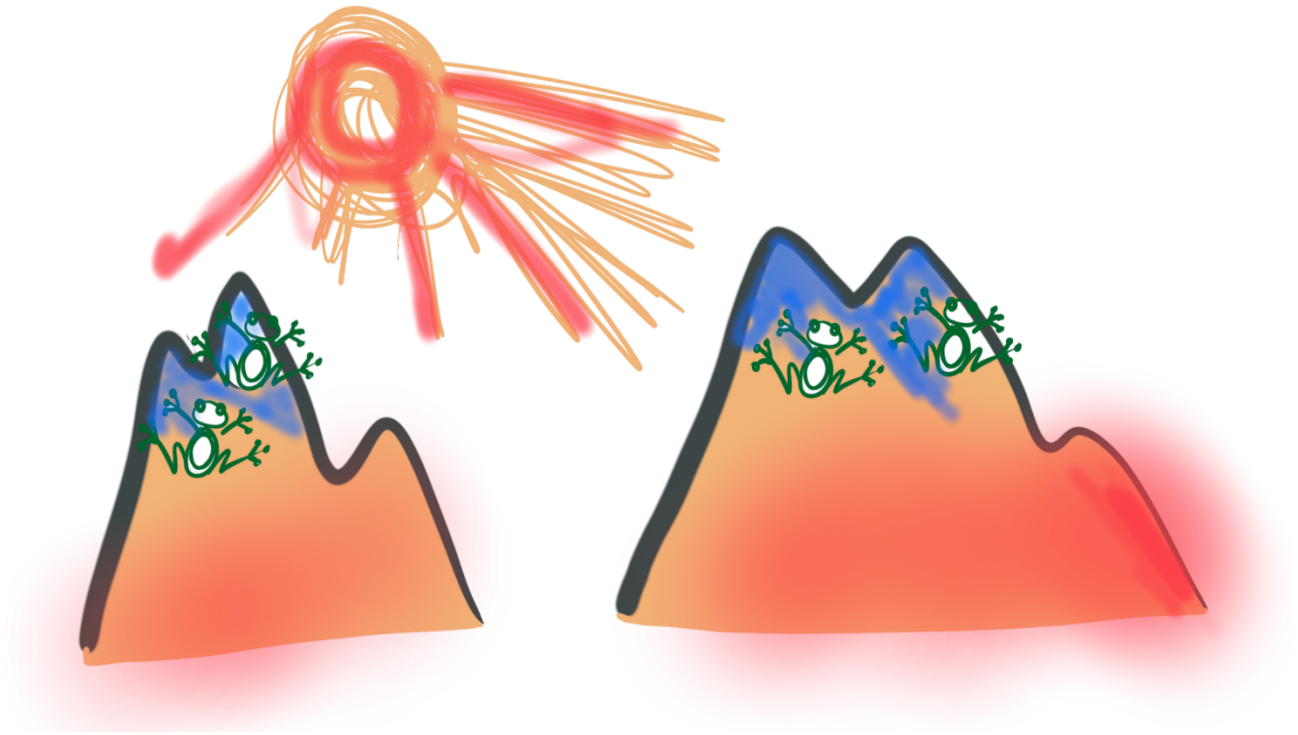
In the above example, the nominate species is a shrub (green) with a generation length of 10 years, which occurs in three subpopulations. One subpopulation occurs within a housing development (orange dashed line). The other subpopulations are not impacted by any threat.

When delineating locations, the following thought process could be followed:

- The most serious plausible threat is housing development, which only impacts part of the population. The part of the population impacted by this threat will be one location, as the development is likely to be fully completed within 6 years (shorter than one generation for the species).
- For the part of the population not impacted by this threat, there could be two additional locations based on the subpopulations if the subpopulations were used as a proxy for the size of locations.
- Alternatively, the size of the location impacted by houses could be transposed onto the remaining distribution of the species. This would also result in two additional locations.
- The nominator could decide that it is not appropriate to assess the locations for the species as >50% of the population is not impacted by any threat. In this situation, the species would not be eligible under Criterion B or D.

Therefore, the nominate species could be argued to have three locations.

Appendix 8. Locations for climate change



Climate change should only be used as the most serious plausible threat to define locations when the direct mechanism can be clearly defined. The IUCN SPC (2022) use the term ‘proximate causes’, but direct mechanism is used here for clarity. If the threat identified is an increase in temperature or decrease in precipitation due to climate change, this should not be used to define locations. This is because the direct mechanism has not been clearly defined. Rather, if the threat was an increase in temperature, such that it would exceed the thermal tolerance of a species, this could be used to define locations.

If the direct threat mechanism is identified to be increased temperatures that exceed the thermal tolerance of a frog species, this could be used to count locations. Particularly where the frog species relies on cooler temperatures in high-altitude environments, which are projected to disappear in the next 20-50 years. In this scenario, the following approaches might be used to delineate locations:

- If both mountains occur in a similar climatic region (i.e., latitude/longitude and/or bioregion), then you could argue that both mountain tops will experience the impacts of increased temperatures simultaneously. Therefore, the species may occur at one location.
- If the mountains were sufficiently geographically separated, occurred at different latitudes or longitudes, or even in a different bioregion, you may consider that the increase in temperatures will occur at different rates, or to different severities, and may not impact the species simultaneously. Therefore, each mountain peak may be considered a separate location, resulting in two locations for the species.

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