Australian Government

Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Melanotaenia sp. nov. 'Malanda' (Malanda rainbowfish)

You are invited to provide your views and supporting reasons related to:

1) the eligibility of *Melanotaenia* sp. nov. 'Malanda' (Malanda rainbowfish) for inclusion on the EPBC Act threatened species list in the Critically Endangered category; and

2) the necessary conservation actions for the above species.

The purpose of this consultation document is to elicit additional information to better understand the status of the species and help inform on conservation actions and further planning. As such, the below draft assessment should be considered to be **tentative** as it may change following responses to this consultation process.

Evidence provided by experts, stakeholders and the general public are welcome. Responses can be provided by any interested person.

Anyone may nominate a native species, ecological community or threatening process for listing under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or for a transfer of an item already on the list to a new listing category. The Threatened Species Scientific Committee (the Committee) undertakes the assessment of species to determine eligibility for inclusion in the list of threatened species and provides its recommendation to the Australian Government Minister for the Environment.

Responses are to be provided in writing by email to: species.consultation@awe.gov.au

Please include species scientific name in Subject field.

or by mail to:

The Director
Bushfire Affected Species Assessments Section
Department of Agriculture, Water and the Environment
John Gorton Building, King Edward Terrace
GPO Box 858
Canberra ACT 2601

Responses are required to be submitted by 5 January 2022.

Contents of this information package	**Page**

General background information about listing threatened species

The Australian Government helps protect species at risk of extinction by listing them as threatened under Part 13 of the EPBC Act. Once listed under the EPBC Act, the species becomes a Matter of National Environmental Significance (MNES) and must be protected from significant impacts through the assessment and approval provisions of the EPBC Act. More information about threatened species is available on the department's website at: https://www.awe.gov.au/environment/biodiversity/threatened/recovery-plans.

Public nominations to list threatened species under the EPBC Act are received annually by the department. In order to determine if a species is eligible for listing as threatened under the EPBC Act, the Threatened Species Scientific Committee (the Committee) undertakes a rigorous scientific assessment of its status to determine if the species is eligible for listing against a set of criteria. These criteria are available on the Department's website at: https://www.awe.gov.au/sites/default/files/env/pages/d72dfd1a-f0d8-4699-8d43-5d95bbb02428/files/tssc-guidelines-assessing-species-2021.pdf.

As part of the assessment process, the Committee consults with the public and stakeholders to obtain specific details about the species, as well as advice on what conservation actions might be appropriate. Information provided through the consultation process is considered by the Committee in its assessment. The Committee provides its advice on the assessment (together with comments received) to the Minister regarding the eligibility of the species for listing under a particular category and what conservation actions might be appropriate. The Minister decides to add, or not to add, the species to the list of threatened species under the EPBC Act. More detailed information about the listing process is at: https://www.awe.gov.au/environment/biodiversity/threatened/nominations.

To promote the recovery of listed threatened species and ecological communities, conservation advices and where required, recovery plans are made or adopted in accordance with Part 13 of the EPBC Act. Conservation advices provide guidance at the time of listing on known threats and priority recovery actions that can be undertaken at a local and regional level. Recovery plans describe key threats and identify specific recovery actions that can be undertaken to enable recovery activities to occur within a planned and logical national framework. Information about recovery plans is available on the department's website at: https://www.awe.gov.au/environment/biodiversity/threatened/recovery-plans.

Privacy notice

The Department will collect, use, store and disclose the personal information you provide in a manner consistent with the Department's obligations under the Privacy Act 1988 (Cth) and the Department's Privacy Policy.

Any personal information that you provide within, or in addition to, your comments in the threatened species assessment process may be used by the Department for the purposes of its functions relating to threatened species assessments, including contacting you if we have any questions about your comments in the future.

Further, the Commonwealth, State and Territory governments have agreed to share threatened species assessment documentation (including comments) to ensure that all States and Territories have access to the same documentation when making a decision on the status of a potentially threatened species. This is also known as the 'Common Assessment Method' (CAM). As a result, any personal information that you have provided in connection with your comments may be shared between Commonwealth, State or Territory government entities to assist with their assessment processes.

The Department's Privacy Policy contains details about how respondents may access and make corrections to personal information that the Department holds about the respondent, how respondents may make a complaint about a breach of an Australian Privacy Principle, and how the Department will deal with that complaint. A copy of the Department's Privacy Policy is available at: https://www.awe.gov.au/about/commitment/privacy .

Information about this consultation process

Responses to this consultation can be provided electronically or in hard copy to the contact addresses provided on Page 1. All responses received will be provided in full to the Committee and then to the Australian Government Minister for the Environment.

In providing comments, please provide references to published data where possible. Should the Committee use the information you provide in formulating its advice, the information will be attributed to you and referenced as a 'personal communication' unless you provide references or otherwise attribute this information (please specify if your organisation requires that this information is attributed to your organisation instead of yourself). The final advice by the Committee will be published on the department's website following the listing decision by the Minister.

Information provided through consultation may be subject to freedom of information legislation and court processes. It is also important to note that under the EPBC Act, the deliberations and recommendations of the Committee are confidential until the Minister has made a final decision on the nomination, unless otherwise determined by the Minister.

CONSULTATION QUESTIONS FOR *Melanotaenia* sp. nov. 'Malanda' (Malanda Rainbowfish)

Please note, this list of questions is provided as a guide only. Respondents are not required to address every question.

SECTION A - GENERAL

1. Is the information used to assess the nationally threatened status of the species robust? Have all the underlying assumptions been made explicit? Please provide justification for your response.

2. Can you provide additional data or information relevant to this assessment?

3. Have you been involved in previous state, territory or national assessments of this species? If so, in what capacity?

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

SECTION B DO YOU HAVE ADDITIONAL INFORMATION ON THE ECOLOGY OR BIOLOGY OF THE SPECIES? (If no, skip to section C)

Biological information

4. Can you provide any additional or alternative references, information or estimates on longevity, average life span and generation length?

5. Do you have any additional information on the ecology or biology of the species not in the current advice?

SECTION C ARE YOU AWARE OF THE STATUS OF THE TOTAL NATIONAL POPULATION OF THE SPECIES? (If no, skip to section D)

Population size

6. Has the survey effort for this taxon been adequate to determine its national adult population size? If not, please provide justification for your response.

7. Do you consider the way the population size has been derived to be appropriate? Are there any assumptions and unquantified biases in the estimates? Did the estimates measure relative or absolute abundance? Do you accept the estimate of the total population size of the species? If not, please provide justification for your response.

8. If not, can you provide a further estimate of the current population size of mature adults of the species (national extent)? Please provide supporting justification or other information.

   If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of possible species numbers, and also choose the level of confidence you have in this estimate:

Number of mature individuals is estimated to be in the range of:

☐ 0–25 ☐ 25–50 ☐ 50–100 ☐ >100 ☐ >200

Level of your confidence in this estimate:

☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, information suggests this range

☐ 95–100% - high level of certainty, information indicates quantity within this range

☐ 99–100% - very high level of certainty, data are accurate within this range

9. Do you know if any of the six subpopulations sampled between 2014-2018 have gone extinct? If so, do you know which?

SECTION D **ARE YOU AWARE OF TRENDS IN THE OVERALL POPULATION OF THE SPECIES? (If no, skip to section E)**

10. Does the current and predicted rate of decline used in the assessment seem reasonable? Do you consider that the way this estimate has been derived is appropriate? If not, please provide justification of your response.

Evidence of total population size change

11. Are you able to provide an estimate of the total population size during the early 1990s? Please provide justification for your response.

    If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of possible species numbers, and also choose the level of confidence you have in this estimate.

    Number of mature individuals is estimated to be in the range of:

    ☐ 0–25 ☐ 25–50 ☐ 50–100 ☐ >100 ☐ >200

    Level of your confidence in this estimate:

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, information suggests this range

☐ 95–100% - high level of certainty, information indicates quantity within this range

☐ 99–100% - very high level of certainty, data are accurate within this range

12. Are you able to comment on the extent of decline in the species’ total population size over the last approximately 10 years? Please provide justification for your response.

    If, because of uncertainty, you are unable to provide an estimate of decline, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of decline, and also choose the level of confidence you have in this estimated range.

    Decline estimated to be in the range of:

    ☐ 1–30% ☐31–50% ☐51–80% ☐81–100% ☐90–100%

    Level of your confidence in this estimated decline:

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

    ☐ 51–95% - reasonably certain, suggests this range of decline

    ☐ 95–100% - high level of certainty, information indicates a decline within this range

    ☐ 99–100% - very high level of certainty, data are accurate within this range

13. Please provide (if known) any additional evidence which shows the population is stable, increasing or declining.

<u>SECTION E</u> ARE YOU AWARE OF INFORMATION ON THE TOTAL RANGE OF THE SPECIES? (If no, skip to section F)

Current Distribution/range/extent of occurrence, area of occupancy

14. Does the assessment consider the entire geographic extent and national extent of the species? If not, please provide justification for your response.

15. Has the survey effort for this species been adequate to determine its national distribution? If not, please provide justification for your response.

16. Is the distribution described in the assessment accurate? If not, please provide justification for your response and provide alternate information.

17. Do you agree that the way the current extent of occurrence and/or area of occupancy have been estimated is appropriate? Please provide justification for your response.

18. Can you provide estimates (or if you disagree with the estimates provided, alternative estimates) of the extent of occurrence and/or area of occupancy.

    If, because of uncertainty, you are unable to provide an estimate of extent of occurrence, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of extent of occurrence, and also choose the level of confidence you have in this estimated range.

    Current extent of occurrence is estimated to be in the range of:

    ☐ <100 km^2 ☐ 100 – 5 000 km^2 ☐ 5 001 – 20 000 km^2 ☐ >20 000 km^2

    Level of your confidence in this estimated extent of occurrence

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

    ☐ 51–95% - reasonably certain, data suggests this range of decline

    ☐ 95–100% - high level of certainty, data indicates a decline within this range

    ☐ 99–100% - very high level of certainty, data is accurate within this range

    If, because of uncertainty, you are unable to provide an estimate of area of occupancy, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of area of occupancy, and also choose the level of confidence you have in this estimated range.

    Current area of occupancy is estimated to be in the range of:

    ☐ <10 km^2 ☐ 11 – 500 km^2 ☐ 501 – 2000 km^2 ☐ >2000 km^2

    Level of your confidence in this estimated extent of occurrence:

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, data suggests this range of decline

☐ 95–100% - high level of certainty, data indicates a decline within this range

☐ 99–100% - very high level of certainty, data is accurate within this range

<u>SECTION F</u> ARE YOU AWARE OF TRENDS IN THE TOTAL RANGE OF THE SPECIES? (If no, skip to section G)

Past Distribution/range/extent of occurrence, area of occupancy

19. Do you consider that the way the historic distribution has been estimated is appropriate? Please provide justification for your response.

20. Can you provide estimates (or if you disagree with the estimates provided, alternative estimates) of the former extent of occurrence and/or area of occupancy.

    If, because of uncertainty, you are unable to provide an estimate of past extent of occurrence, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of past extent of occurrence, and also choose the level of confidence you have in this estimated range.

    Past extent of occurrence is estimated to be in the range of:

    ☐ <100 km^2 ☐ 100 – 5 000 km^2 ☐ 5 001 – 20 000 km^2 ☐ >20 000 km^2

    Level of your confidence in this estimated extent of occurrence

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

    ☐ 51–95% - reasonably certain, data suggests this range of decline

    ☐ 95–100% - high level of certainty, data indicates a decline within this range

    ☐ 99–100% - very high level of certainty, data is accurate within this range

    If, because of uncertainty, you are unable to provide an estimate of past area of occupancy, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of past area of occupancy, and also choose the level of confidence you have in this estimated range:

    Past area of occupancy is estimated to be in the range of:

☐ <10 km^2 ☐ 11 – 500 km^2 ☐ 501 – 2000 km^2 ☐ >2000 km^2

Level of your confidence in this estimated extent of occurrence:

☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, data suggests this range of decline

☐ 95–100% -high level of certainty, data indicates a decline within this range

☐ 99–100% - very high level of certainty, data is accurate within this range

PART 2 – INFORMATION FOR CONSERVATION ADVICE ON THREATS AND CONSERVATION ACTIONS

SECTION G DO YOU HAVE INFORMATION ON THREATS TO THE SURVIVAL OF THE SPECIES? (If no, skip to section H)

21. Do you consider that all major threats have been identified and described adequately?

22. To what degree are the identified threats likely to impact on the species in the future?

23. Are the threats impacting on different populations equally, or do the threats vary across different populations?

24. Can you provide additional or alternative information on past, current or potential threats that may adversely affect the species at any stage of its life cycle?

25. Can you provide supporting data/justification or other information for your responses to these questions about threats?

SECTION H DO YOU HAVE INFORMATION ON CURRENT OR FUTURE MANAGEMENT FOR THE RECOVERY OF THE SPECIES? (If no, skip to section I)

26. What planning, management and recovery actions are currently in place supporting protection and recovery of the species? To what extent have they been effective?

27. Can you recommend any additional or alternative specific threat abatement or conservation actions that would aid the protection and recovery of the species?

28. Would you recommend translocation (outside of the species' historic range) as a viable option as a conservation actions for this species?

SECTION I DO YOU HAVE INFORMATION ON STAKEHOLDERS IN THE RECOVERY OF THE SPECIES?

29. Are you aware of other knowledge (e.g. traditional ecological knowledge) or individuals/groups with knowledge that may help better understand population trends/fluctuations, or critical areas of habitat?

30. Are you aware of any cultural or social importance or use that the species has?

31. What individuals or organisations are currently, or potentially could be, involved in management and recovery of the species?

32. How aware of this species are land managers where the species is found?

33. What level of awareness is there with individuals or organisations around the issues affecting the species?

    a. Where there is awareness, what are these interests of these individuals/organisations?

    b. Are there populations or areas of habitat that are particularly important to the community?

PART 3 – ANY OTHER INFORMATION

34. Do you have comments on any other matters relevant to the assessment of this species?

Conservation Advice for *Melanotaenia* sp. nov. 'Malanda' (Malanda rainbowfish)

This draft document is being released for consultation on the species listing eligibility and conservation actions

The purpose of this consultation document is to elicit additional information to better understand the status of the species and help inform conservation actions, further planning and a potential recovery plan. The draft assessment below should therefore be considered **tentative** at this stage, as it may change as a result of responses to this consultation process.

Note: Specific consultation questions relating to the below draft assessment and preliminary determination have been included in the consultation cover paper for your consideration.

This document combines the proposed conservation advice and listing assessment for the species. It provides a foundation for conservation action and further planning.

Conservation status

Melanotaenia sp. nov. 'Malanda' (Malanda rainbowfish) is being assessed by the Threatened Species Scientific Committee to be eligible for listing as Critically Endangered under Criterion 2 and Vulnerable under Criterion 1. The Committee's assessment is at Attachment A.
The Committee's assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: A2ace Vulnerable
- Criterion 2**:** B1ab(i,ii,iii,iv,v): Critically Endangered
- Criterion 3: Insufficient data
- Criterion 4: Insufficient data
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Critically Endangered category are a very restricted and severely fragmented distribution, and a small number of locations. There is ongoing decline in Extent of Occurrence (EOO); Area of Occupancy (AOO); area, extent and quality of habitat; number of locations and subpopulations; and number of mature individuals.

Species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species under relevant state or territory legislation, see the Species Profile and Threat Database.

Species information

Taxonomy

Malanda rainbowfish has not yet been formally described. The species was first recognised as genetically distinct in the 1990s, however a lack of taxonomic capacity and increasing introgression has hindered formal diagnosis and description. A project using combined nuclear genetic sequencing and morphology has been initiated to review the rainbowfishes of the Atherton Tablelands and ultimately describe several new distinct species (Hammer 2018). As part of this project, Malanda rainbowfish is being described using specimens stored at the Northern Territory Museum (Brown et al. 2019).

Malanda rainbowfish have a distinct mitochondrial DNA (mtDNA) lineage (McGuigan 2001) and are divergent at nuclear markers diagnosable in ordination space (Hammer 2018). However, there is introgression with eastern rainbowfish (*Melanotaenia splendida splendida*) (Hammer 2018), a native but widespread species. Hybridization is common in freshwater fishes, and in this case is occurring between Malanda rainbowfish and a quite different, larger species (Hammer 2018).

Description

The description of Malanda rainbowfish has been determined by examination of subpopulations that have been genetically confirmed to consist of pure individuals, allowing for the separation of the species' morphology from similar taxa that occur in the same area. Similar taxa include eastern rainbowfish and *Melanotaenia eachamensis* (Lake Eacham rainbowfish) (Unmack et al. 2016), as well as hybrids of eastern rainbowfish and Malanda rainbowfish.

Malanda rainbowfish is a dwarf species. Males grow up to 61 mm (though usually under 50 mm), and females are slightly smaller. The body is laterally compressed, similar to Lake Eacham Rainbowfish but considerably more than eastern rainbowfish and is shorter than the other two species. Males possess a very tall, flag-like first dorsal fin and have square-shaped second dorsal and anal fins when extended. All of these fins are shorter than in the other two species, and the second dorsal and anal fins never overlap the caudal peduncle (region where the caudal fin attaches to the body) in Malanda rainbowfish, whereas they do in the other two species. The head of Malanda rainbowfish is rounded, and the eye is large and close to the snout, giving the face a 'bullnosed' appearance, particularly when compared with the pointed snout of eastern rainbowfish. Male Malanda rainbowfish are brown-golden with thin orange to brown lateral body stripes, with colour intensifying during the breeding season to bright golden with thin red stripes and reddish dorsal, anal and caudal fins. All fins may be edged in black in breeding males. Female Malanda rainbowfish have a distinctly oval-shaped body and triangular first dorsal fin. The body is silver-brown with paler orange-brown lateral stripes. It is difficult to distinguish female Malanda rainbowfish from females of the other two species other than by size. This information was gathered from Unmack et al. (2016).

Distribution

Naturally Occurring Subpopulations

Malanda rainbowfish are found in the Atherton Tablelands of northern Queensland (Qld). The species has a highly restricted range, with natural subpopulations isolated in small tributaries of the Northern Johnstone River in the Malanda district (Map 1). The species is present in three major creek systems: Ithaca River and its tributaries (Thiaki and Molo Creeks), Williams Creek, and an unnamed creek at Wallace Road (hereafter referred to as Wallace Road Creek). It occurs at elevations of 650–800 m above sea level (Unmack et al. 2016). Before European settlement this area consisted of dense rainforest, but now consists primarily of exotic grassland used for dairy grazing with fragments of remnant rainforest (Moy et al. 2021).

Observations suggest that there has been a rapid decline in the distribution of Malanda rainbowfish. It is difficult to determine the former range of the species, but it was almost certainly found in creeks beyond the three systems from which it is currently known (Unmack et al. 2016). There may be some genetic evidence confirming the species was more widespread, but insufficient DNA sequencing has been conducted (Unmack et al. 2016). Intensive sampling undertaken between 2014 and 2018 identified six remaining subpopulations. These are found in various parts of Williams Creek, an unnamed tributary to Molo Creek, and several instream dams on an unnamed tributary of Thiaki Creek and Wallace Road Creek. One Williams Creek subpopulation is on the verge of extinction, while a major subpopulation from the mid Ithaca River and Thiaki Creek was nearing extinction by 2014 (Moy et al. 2021). An IUCN assessment in 2019 suggested that only four subpopulations were extant (Brown et al. 2019), though did not clearly stipulate which two of the six subpopulations sampled between 2014-2018 have gone extinct.

Ithaca River system (*Thiaki & Molo creeks*)
The Ithaca River system consists of several major tributaries that include a large unnamed tributary, Thiaki Creek and its tributary (Molo Creek), and an unnamed tributary to Molo Creek. Ithaca River joins the North Johnstone River approximately 20 km downstream from Malanda (Unmack et al. 2016). Prior to 2000, Malanda rainbowfish were present well downstream in Ithaca River, though were not found in the upper section due to two waterfalls that act as barriers. However, as of 2016, all of the previously occupied Ithaca/Thiaki system was considered to contain eastern rainbowfish and/or hybrids with Malanda rainbowfish. Only the upper-most section of the unnamed tributary to Molo Creek and two small dams adjacent to lower Thiaki Creek on a small side tributary have not undergone introgression (Unmack et al. 2016).

At lower Molo Creek, there is a concrete causeway about 900 m above the junction with Thiaki Creek (Unmack et al. 2016). As of 2016, the rainbowfish assemblage below this causeway was dominated by eastern rainbowfish hybrids. Above the causeway their appearance was more like Malanda rainbowfish, though there was very likely some introgression with eastern rainbowfish. It is expected that the frequency of hybrids will expand upstream to this area, as there are no known barriers to stop invasion (Unmack et al. 2016).

Williams Creek
Williams Creek rises just north of Thiaki Creek and flows north to meet the North Johnstone River just upstream of Malanda. There are two major branches, both with the same name. Following the names used by Unmack et al. (2016), the branches are differentiated in this advice by using ‘eastern branch’ and ‘western branch’.

Two causeways around 950 m apart are present in the mid-section of the eastern branch, both of which are considered easily passable by eastern rainbowfish during slightly higher flows

(Unmack et al. 2016). As of 2016, rainbowfish below the lower causeway were dominated by eastern rainbowfish hybrids, whilst fish above the causeway had the appearance of Malanda rainbowfish. Above the upper causeway, only Malanda rainbowfish were observed, though it is suspected that fish both below and above this upper causeway probably have some degree of introgression (Unmack et al. 2016).

In the western branch of Williams Creek, Malanda rainbowfish are restricted to only the uppermost 1250 m of creek, above a very minor barrier (a small dam) (Unmack et al. 2016).

Wallace Road Creek
Wallace Road Creek is a small tributary on the eastern side of the North Johnstone River. It is the only known creek system occupied by Malanda rainbowfish that has major barriers which exclude Eastern rainbowfish. These barriers include three waterfalls, all approximately 5–10 m high, as well as a very large dam between the middle and uppermost waterfalls (Unmack et al. 2016).

As of 2016, eastern rainbowfish were only present below the lowermost waterfall at this site. Malanda rainbowfish were found in 2.7 km of creek from immediately above the large dam upstream to within 500 m of the creek source, below a small rock barrier (Unmack et al. 2016). No rainbowfish were present between the lower waterfall and the large dam. Although Malanda rainbowfish are assumed to have been present there historically, there is a large population of eastern gambusia in this reach (Unmack et al. 2016) and Malanda rainbowfish may have been outcompeted.

Translocated Subpopulations
Malanda rainbowfish have been translocated from wild genetically pure populations to refuge areas (e.g., farm dams) in the upper North Johnstone catchment. Subpopulations are also being established in other sub-catchments that likely formerly contained Malanda rainbowfish, or lack rainbowfish completely. These new subpopulations are being established by translocating sustainable numbers of wild adult fish with equal sex ratio, and all translocations have taken place on private land (Unmack et al. 2016; Moy et al. 2021). A summary of translocated subpopulations is given in Table 1. The upper Ithaca River was considered the best release site due to the presence of two large waterfalls which have prevented eastern rainbowfish from moving upstream.

Table 1 Translocated Malanda rainbowfish subpopulation information

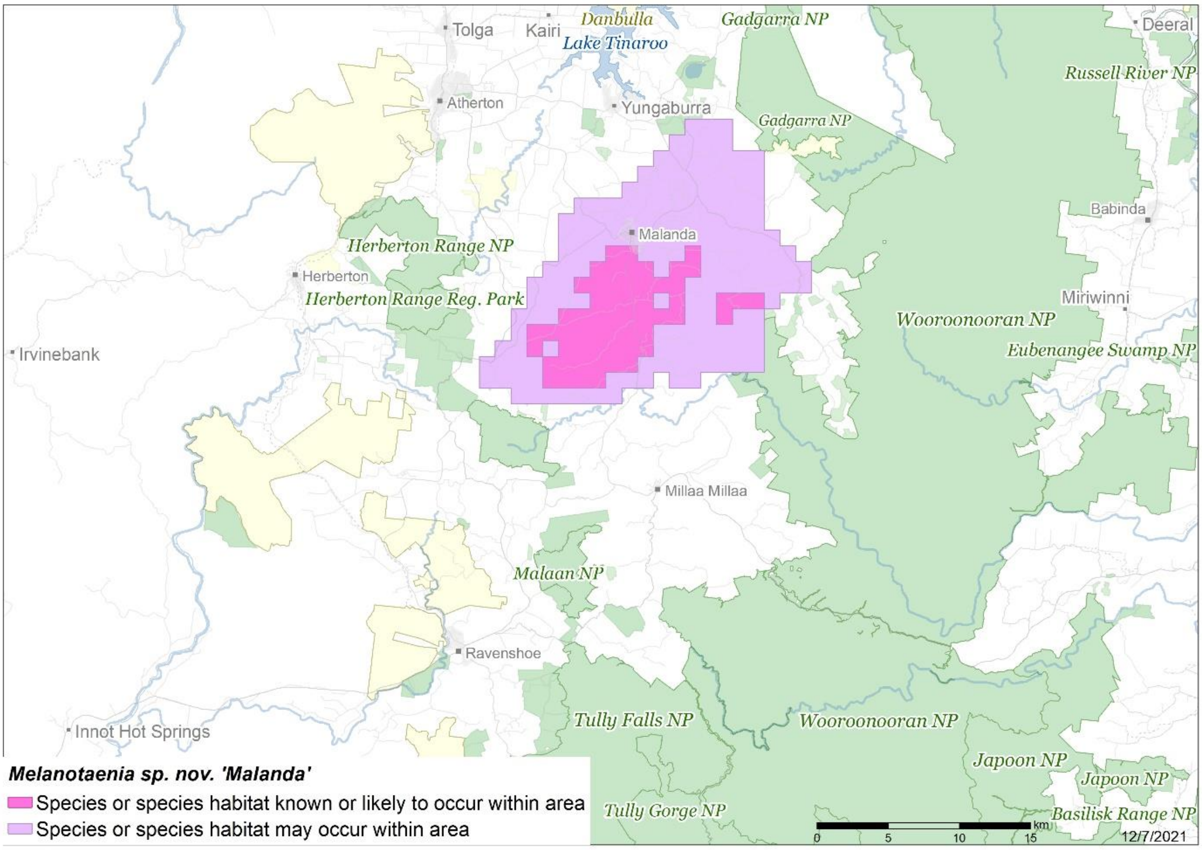
Translocation site	Translocation date	Site fish were sourced from	Number of individuals translocated
Upper Ithaca River	November 2016	Molo Creek tributary, two Williams Creek subpopulations	300 at 3 sites. 100 individuals per site.
Unnamed creek south of Wallace Road Creek	November 2016	Wallace Road Creek	50
Brodie Creek, north of Wallace Road Creek	November 2016	Wallace Road Creek	50
Dam on a tributary of Williams Creek western branch	November 2016	Upper Williams creek western branch	100

Dam by Thiaki Creek	November 2016	Upper Molo Creek tributary	100
Dam by Thiaki Creek	November 2016	Molo Creek tributary, small creek immediately below the dam wall	180. 100 from Molo Creek tributary, 80 from a small creek immediately below the dam wall
Mungalli Creek	May 2019	Molo Creek tributary, Williams Creek east branch, Thiaki Creek tributary, Wallace Road Creek	400 at four sites. 100 individuals at each site.

Translocation information sourced from Unmack et al. (2016) & Moy et al. (2021).

Since the 2016 translocations, there have been two monitoring events for the Ithaca River and farm dam subpopulations. Surveys in March 2017 detected juvenile Malanda rainbowfish in Ithaca River, and found that the fish had shifted approximately 100 m downstream from the release location (Moy et al. 2021). Surveys in May 2019 detected Malanda rainbowfish up to 1.3 km downstream, and the subpopulation is considered abundant (Moy et al. 2021). Releases into farm dams have been more difficult to assess due to dense aquatic vegetation and limited water clarity. In May 2019, fish were found in three of the five stocked dams. One dam had no evidence of rainbowfish and one dam was not sampled. However, due to their substantial depth, thorough sampling is required to conclude the absence of Malanda rainbowfish from these dams (Moy et al. 2021).

Map 1 Modelled distribution of Malanda rainbowfish



Source: Base map Geoscience Australia; species distribution data Species of National Environmental Significance database.
Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for

errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.
Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the habitat or geographic feature that represents to recent observed locations of the species (known to occur) or habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

This section describes some published examples of this significance but is not intended to be comprehensive, applicable to, or speak for, all Indigenous people. Such knowledge may be only held by Indigenous groups and individuals who are the custodians of this knowledge.

The cultural significance of Malanda rainbowfish is unknown. However, the name 'Malanda' is derived from Malanda Creek, which is reportedly an Aboriginal name for the Upper Johnstone river, possibly meaning 'little stream with big stone' (Queensland Government 2021). The region around Malanda is considered to be the traditional land of the Ngadjon-Jii People (Pannell 2005), and there is a Native title grant for 132 km^2 of land and waters in the Malanda area for Choorechillum (Ngadjon Jii PBC) Aboriginal Corporation (Native Title Tribunal 2007). This includes parts of Wooroonooran National Park (NP), Topaz Road NP, Malanda Falls Conservation Park and two quarry reserves near Malanda (Native Title Tribunal 2007). The Ngadjon-Jii People have tales from the Dreaming about how features in the region were created, including by Yamani (the rainbow serpent), which is considered by Ngadjon-Jii people to inhabit many of the waters of the region (Pannell 2005). Ascertaining the cultural significance of Malanda rainbowfish is a research priority highlighted in the conservation actions.

Malanda rainbowfish are identified as one of the Australian freshwater fishes that are at the highest risk of extinction (Lintermans et al. 2020) and is therefore of importance to the scientific community. Rainbowfishes are also collected by aquarists and traded in the aquarium trade.

Relevant Biology/Ecology

Habitat

Malanda rainbowfish are found in small, fast-flowing cool streams at elevations of 650–800 m in the upper reaches of the North Johnstone River. Little is known about the microhabitat of the species, though it is likely to be similar to other rainbowfish species (Brown et al. 2019).
The related Lake Eacham Rainbowfish are also found exclusively in the Atherton Tablelands, and are usually found close to the riverbed in specific locations with rock and cobble substrates, grasses (including invasive para grass (*Brachiara muticai*)), other riparian vegetation, and low flow (Pusey et al. 2004). In contrast, eastern rainbowfish are usually found closer to the surface in small freshwater streams, and may occur in clear or turbid water with or without vegetation (Gomon & Bray 2021).

The microhabitat of Malanda rainbowfish may have been altered by land use changes. Before European settlement, the vegetation in the area consisted of dense rainforest, but now comprises primarily exotic grassland used for dairy grazing with fragments of remnant rainforest. This land use change has resulted in most stream habitats changing from narrow, cooler, fast flowing, rocky bottomed creeks (still found in some of the rainforest remnants) to wide, exposed, slow flowing, mud bottomed creeks choked with para grass (Moy et al. 2021).

The distribution of Malanda rainbowfish may intersect with Mabi forest, a critically endangered ecological community occurring in small patches on the Atherton tablelands (DEH 2004). As of 2004, there was only 1050 ha of Mabi forest remaining, and these remnant patches were being invaded by exotic smothering vines and feral animals, and were threatened by trampling, grazing and soil compaction by domestic animals (DEH 2004). Though known Malanda rainbowfish subpopulations are not found within Mabi forest, the potential distribution intersects with multiple remnant patches.

Diet

The diet of Malanda rainbowfish has not been reported. However, the species is likely to be omnivorous, like other rainbowfish, with the diet probably consisting of filamentous algae, aquatic and terrestrial insects, micro-crustaceans and other small invertebrates (Leggett & Merrick 1987; Gomon & Bray 2021).

Reproductive ecology

The reproductive ecology of Malanda rainbowfish is largely unknown but is likely to be similar to other rainbowfish, which usually spawn year-round and grow rapidly (Brown 2019). Given the habitat of Malanda rainbowfish was formerly streams in closed rainforest, it is possible that the species is adapted to spawning in cooler conditions, and recent invasion by other species has been enabled by the removal of vegetation shading. In eastern rainbowfish, spawning occurs throughout the year when water temperatures range 26–28°C, and 60–70 eggs per spawning event are produced and deposited onto aquatic vegetation (Badger 2004; Gomon & Bray 2021). The majority of reproductive activity appears to occur during August–November, perhaps due to slower stream flow and greater food availability than during the wet season (Pusey et al. 2001). A similar concentration of reproductive effort has been observed in other tropical stream-dwelling fishes (Milton & Arthington 1983, 84, 85). Eastern rainbowfish mature quickly and reach sexual maturity after around three months for both sexes, at 3–4 cm long (Pusey et al. 2001; Humphrey et al. 2003).

Habitat critical to the survival

Habitat critical to the survival of the species includes:

- All known streams, catchments and dams where the species is currently found or has previously been found, including translocated subpopulations.
- Hydrologically connected riverine ecosystems that have the required substrate, riparian vegetation and water quality characteristics within 20 km of known sites (e.g. habitat that will be available in the future for translocated subpopulations).
- Native riparian vegetation surrounding known and potential habitat, particularly natural vegetation that provides shading to creeks and streams.

Whenever possible, habitat critical to the survival of the species should not be destroyed or modified. Actions that have indirect impacts on habitat critical to survival should be minimised (e.g., riparian vegetation clearing, cattle grazing), and actions that compromise adult and juvenile survival should also be avoided, such as the introduction of exotic fishes and weeds.

No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat.

Important populations

In this section, the word population is used to refer to subpopulation, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

All known natural and translocated populations of Malanda rainbowfish, and any newly discovered and established populations, are considered to be critical to the survival of the species.

Threats

Table 2 Threats impacting Malanda rainbowfish

Threat	Status and severity [a]	Evidence
Introduced species		
Loss of genetic integrity due to invasion by eastern rainbowfish	• Timing: current/future • Confidence: observed • Consequence: catastrophic • Trend: increasing • Extent: across the entire range	The principal threat to Malanda Rainbowfish is hybridisation with eastern rainbowfish. Eastern rainbowfish has been present in the Upper North Johnstone catchment since at least 1978, though there no precise details for these early recordings (Unmack et al. 2016). It is unclear if the species naturally occurs within the distribution of Malanda rainbowfish, though it is suggested they were translocated into the area. Currently, eastern rainbowfish are rapidly invading areas where they were previously not recorded, leading to introgression with Malanda rainbowfish. Eastern rainbowfish can easily invade known the known distribution of Malanda Rainbowfish due to the lack of barriers in the small streams occupied by the species. Indeed, Wallace Road Creek is the only known creek system naturally occupied by Malanda rainbowfish that has any major barriers to exclude eastern rainbowfish (Unmack et al. 2016). Unmack et al. (2016) suggest that eastern rainbowfish is rapidly expanding into Malanda rainbowfish habitat because the latter is better adapted to living in cooler rainforest-covered streams, which have become warmer due to loss of riparian shading, increased sedimentation and climate change. Humphries et al. (2001) documented temperature trends at five Northern Qld sites, including Northern Johnstone River. It was observed that the annual water temperature range was more restricted at North Johnstone River than at any of the other sites. The site also appeared to have a lower maximum temperature when compared to most other sites, though this requires further research to be accurately determined. This lends support to the hypothesis that Malanda rainbowfish is adapted to cooler, more stable stream temperatures. In comparison, eastern rainbowfish is a generalist species found in many lowland freshwater habitats and are subjected to seasonal variations in water temperature (12-36°C) (Tappin 2013).

Threat	Status and severity [a]	Evidence
		Therefore, the species is likely more suited to warmer waters than Malanda rainbowfish. When eastern rainbowfish enter the distribution of Malanda rainbowfish, the species begin to interbreed and hybridise. Hybrid offspring may possess competitive advantages over individuals for parental species (Hammer et al. 2013, cited in Moy et al. 2019). Introgression may then occur, whereby hybrids backcross with one or both parental species, resulting in movement of genetic material from one species to another (Hammer et al. 2013, cited in Moy et al. 2019). This results in a sharp decline in the abundance and frequency of genetically pure Malanda rainbowfish individuals. This process is a widespread phenomenon, though is more common in fishes compared to other vertebrate taxa (Verspoor & Hammart 1991; Scribner et al. 2000). Hybridisation between native and alien species can lead to population decline or extinction through genetic swamping, wasted reproductive effort or reduced offspring survival. As there are only four natural subpopulations remaining, there is a high risk of extinction through introgression (Unmack et al. 2016; Brown et al. 2019). Releases and escapes of alien ornamental fish have resulted in increasing numbers of these species in waterways (García-Díaz et al. 2018). This has already occurred for some rainbowfishes (Brown et al. 2013; Martin 2017, cited in Moy et al. 2019), including eastern rainbowfish, which is considerably larger than most other narrow range rainbowfishes (Moy et al. 2019). A study investigating the interaction of eastern rainbowfish with another narrow range endemic rainbowfish species identified no definite barriers to hybridisation, suggesting the introduction of the eastern rainbowfish outside its natural range is very high risk for narrow range endemic species (Moy et al. 2019).
Predation by, and competition with, other introduced fish species	• Timing: current/future • Confidence: inferred • Consequence: major • Trend: increasing • Extent: across parts of the range	Exotic species including eastern gambusia (*Gambusia holbrooki*), tilapia (*Oreochromis* spp.) and guppies (*Poecilia reticulata*) have been observed in the North Johnstone River catchment and are likely to have negative impacts on Malanda rainbowfish subpopulations (Unmack et al. 2016). Eastern gambusia are known to compete with native fish for food and resources and display aggressive behaviour (e.g., fin nipping) towards native species (DPI 2021). The high reproductive rate of eastern gambusia, combined with its broad feeding habits, allows it to over-populate areas and deplete food resources for native species (Pyke 2008; MacDonald & Tonkin 2008; DPI 2021). Previous studies have identified eastern gambusia competition and aggression towards native fishes including *Melanotaenia duboulayi* (Duboulay's rainbowfish) and *Rhadinocentrus ornatus* (ornate rainbowfish). This competition and aggression may increase with eastern

Threat	Status and severity [a]	Evidence
		gambusia density (Knight 1999 cited in Macdonald & Tomkin 2008; Breen 2000 cited in Macdonald & Tomkin 2008; Conte 2001 cited in Macdonald & Tomkin 2008). Eastern gambusia is already established at a section of the Wallace Road Creek and has likely outcompeted Malanda rainbowfish and excluded the species from the area (Unmack et al. 2016). If the species invades other subpopulations, it will likely lead to subpopulation decline. Similarly, guppies have also invaded waterways throughout Australia and are aggressive and exhibit fin nipping behaviour towards native fish. Like eastern gambusia, guppies rapidly outnumber small native fish populations due to their rapid reproductive rate (Lindholm et al. 2005; DoF 2012; DAWR 2020). They have been observed in the North Johnstone River catchment (Unmack et al. 2016). Tilapia are also present in the catchment and can invade and dominate areas due to their aggression, highly efficient breeding strategies, ability to survive in a variety of conditions and habitats, and generalist diet. They rapidly outnumber native fish and dominate aquatic communities by aggressively competing for habitat and food, predating on eggs, and damaging plant communities through nest building (Hutchison et al. 2011; DAF 2020; DPI 2021).
Habitat loss, disturbance and modifications		
Land clearing	• Timing: historical/current • Confidence: observed • Consequence: major • Trend: static • Extent: across the entire range	Forest and freshwater ecosystems exchange water, energy and inorganic materials (Studinski et al. 2012; Tanentzap et al. 2014; Chase et al. 2016; Lo et al. 2020), and processes that impact terrestrial ecosystems will likely lead to effects on freshwater systems. In the tropics, forests are important for fish diversity, and there is greater species diversity in areas where there is more forest cover (Lo et al. 2020). Forest cover may also increase the abundance of tropical freshwater fishes, though this is dependent on species-specific habitat preferences (Lo et al. 2020). As such, land clearing may lead to the loss of abundance and species diversity through the loss of rare species like Malanda rainbowfish. Large-scale land clearing for agriculture has occurred in catchments across the entire known distribution of Malanda rainbowfish. This may have contributed to habitat fragmentation for the species, as all known subpopulations are now isolated (Unmack et al. 2016). Most of this clearing is historical, as all subpopulations are located in streams surrounded by land which has been used for dairy farming for some time. However, some land clearing is ongoing in the North Johnstone river catchment, with 347 ha cleared from 2000–2018 and 110 ha cleared from 2010–2018 (DES 2018). Assuming a total catchment area of 1031 km^2 (DES 2013), this represents clearing of 0.33% and 0.1% of

Threat	Status and severity [a]	Evidence
		catchment land since 2000 and 2010 respectively. It is unclear if any of this recently cleared land was in the distribution of Malanda rainbowfish, though it likely intersects with areas where habitat may occur (Map 1). Land clearing around streams occupied by Malanda rainbowfish has likely led to removal of riparian vegetation, increased erosion and sedimentation, increased water temperatures and other water quality issues (Ludwig & Tongway 2002), on top of the additional impacts of farming activities that have occurred on the cleared land. Loss of riparian features will ultimately lead to further changes in erosion, filtration, infiltration, shading and subsidisation (Caskenette 2021). Indeed, maintenance of riparian buffers in tropical agriculture regions is particularly important, and benefits hydrology, water quality and biodiversity (Luke et al. 2018). It is hypothesised that historic land clearing has resulted in increased water temperatures in the streams where Malanda rainbowfish are found, which has enabled eastern rainbowfish invasion. Land clearing of streamside riparian vegetation results in a loss of shading from the sun, increasing summer water temperatures, decreasing winter water temperatures and leading to greater temperature fluctuations (Lynch et al. 1984; Quinn et al. 1992; Rutherford et al. 1997; Pusey & Arthington 2003; Ghermandi et al. 2009; Bowler et al. 2012; Kalny et al. 2017; Knouft et al. 2021). Increased thermal transfer of heat may desynchronize the thermal regimen of the stream from the flow regimen, disrupting reproduction and having direct effects on mortality rates, body morphology, disease resistance and metabolic rates (Pusey & Arthington 2003). Direct sunlight warming stream waters would likely favour eastern rainbowfish and may allow for rapid invasion (see *Loss of genetic integrity due to invasion by eastern rainbowfish* above). However, much of the major land clearing in the area occurred some time ago, and therefore this explanation for the shift from cooler to warmer streams alone would not explain the recent observations of eastern rainbowfish invasion (Unmack et al. 2016). It is therefore likely that climate change is also helping facilitate the invasion by further warming the once-shaded streams.
Habitat degradation by cattle (*Bos taurus*)	• Timing: current/ future • Confidence: observed • Consequence: major • Trend: unknown • Extent: across the entire range	Malanda rainbowfish are at high risk from instream and bankside habitat degradation by domestic livestock, primarily cattle. All known subpopulations are found on dairy farms (Unmack et al. 2016), and pollution, grazing and trampling by cattle is occurring on the waterways inhabited by the species. Bank erosion, water pollution and stream sedimentation occur when stock is given uncontrolled access to rivers and streams, as well as microbial contamination and nutrient

Threat	Status and severity [a]	Evidence
		addition (Agouridis et al. 2007; Miller et al. 2010; Conroy et al. 2016; O'Callaghan et al. 2019).
Water pollution	• Timing: current/ future • Confidence: observed • Consequence: major • Trend: unknown • Extent: across the entire range	Livestock are also often associated with the addition of fertilisers, pesticides, herbicides and other chemicals to the land, which enter waterways. All these processes impact water quality, stream flow and stream temperature, which can impact upon aquatic community composition, species abundance and species richness (Conroy et al. 2016). Such changes to water quality have been implicated in the decline of Australian freshwater species, including rainbowfishes (Allan & Lintermans 2018; Driscoll et al. 2019; Morgan 2019; Lintermans et al. 2020).
Altered hydrology	• Timing: current/ future • Confidence: observed • Consequence: moderate • Trend: static • Extent: across parts of the range	Many of the streams containing Malanda rainbowfish subpopulations have weirs for water extraction (Brown et al. 2019). Studies have shown that water depth, flow velocity and substratum composition differ between areas upstream and downstream of weirs (Mueller et al. 2011). This leads to habitat fragmentation, habitat degradation and sedimentation (Gardner 2017). Weirs severely disrupt riverine connectivity and impede the natural flow regime, acting as physical, hydrological, and behavioural barriers to fish movement (DPI 2006). As a result, the abundance, diversity, community structure and functional ecological traits of all major taxonomic groups with habitat divided by weirs are discontinuous (Mueller et al. 2011). The weirs in streams occupied by Malanda rainbowfish likely act as a barrier to dispersal and may alter hydrology. However, artificial barriers are likely also protecting some Malanda rainbowfish subpopulations by preventing the invasion of eastern rainbowfish in some areas.
Climate change		
Changes to temperature patterns	• Timing: current/future • Confidence: known • Consequence: major • Trend: increasing • Extent: across the entire range	Since records began in the 1850s, average land temperatures in the Qld Wet Tropics cluster region have increased by approximately 0.9°C (Hilbert et al. 2014), and studies of stream temperatures and flow in North America have confirmed that air temperature increases can lead to corresponding increases in stream temperatures (Isaak et al. 2012, 2013; Holsinger et al. 2014). Rises in stream water temperatures due lack of shading by riparian vegetation (Kalny 2017; Knouft et al. 2021) will likely exacerbate these impacts, as riparian vegetation shading can partially mitigate the expected rise in temperatures due to climate change (Trimmel et al. 2018). Terrestrial temperature trends in the Wet Tropics may therefore be reflected in freshwater temperature trends and impact freshwater species which are adapted to cooler waters. Major shifts to species distributions are expected due to climate change (Bond et al.

Threat	Status and severity [a]	Evidence
		2011; James et al. 2017), and freshwater species may be particularly at risk due to their ectothermic physiology, limited habitat extent and narrow habitat tolerances (Hilbert et al. 2014; James et al. 2018). Such changes to freshwater temperatures in the Wet Tropics will likely favour eastern rainbowfish over Malanda rainbowfish (see '*Loss of genetic integrity*' above). Indeed, modelling of climate change induced alterations to stream flow and temperature, which suggest that high altitudinal, cold water species distributions contract due to the impacts of climate change, whilst lower elevation, warm water species distributions expand (Rogers et al 2020). Together, this suggests that climate change is likely warming the waters of the North Johnstone River and facilitating eastern rainbowfish invasion.

Each threat has been described in Table 2 in terms of the extent that it is operating on the subspecies. The risk matrix (Table 3) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life stage they affect; the duration of the impact; and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed in consultation with experts and using available literature.

Table 3 Malanda rainbowfish risk matrix

Likelihood	**Consequences**				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk	Very high risk	Very high risk **Land Clearing** **Habitat degradation by Cattle (*Bos taurus*)** **Changes to temperature patterns**	Very high risk **Loss of genetic integrity due to invasion by eastern rainbowfish**
Likely	Low risk	Moderate risk	High risk **Altered hydrology**	Very high risk **Predation by, and competition with, other introduced fish species** **Water pollution**	Very high risk
Possible	Low risk	Moderate risk	High risk	Very high risk	Very high risk

Likelihood	**Consequences**				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk
Unknown	Low risk	Low risk	Moderate risk	High risk	Very high risk

Priority actions have then been developed to manage the threat particularly where the risk was deemed to be ‘very high’ or ‘high’. For those threats with an unknown or low risk outcome it may be more appropriate to identify further research or maintain a watching brief.

Conservation and recovery actions

Primary conservation objective

Within the next three generations, natural subpopulations will have persisted, and the total population size and distribution will have increased through translocations.

Conservation and management priorities

Introduced species (including threats from introgression)

- Maintain existing in-stream barriers (natural or artificial) and construct new barriers, where appropriate, to prevent incursion of eastern rainbowfish and other invasive fish species into Malanda rainbowfish subpopulations. Barriers should be designed and managed to maintain natural flow regimes and connectivity without enabling further invasion by introduced species, and should be annually inspected and maintained to ensure barrier integrity and their continued effectiveness.
- Control numbers of introduced fish species in streams and catchments where Malanda rainbowfish occurs. Prevent any further incursions of introduced fish species into waterways where Malanda rainbowfish occurs.

Habitat loss, disturbance and modifications (including impacts of climate change)

- Secure important subpopulations and habitat by discontinuing potentially threatening land use practices, implementing habitat buffers for riparian vegetation and revegetating riparian zones.
- Protect subpopulations on private land by developing and implementing land management agreements, in consultation with landholders, that incorporate actions that benefit both landholders and Malanda rainbowfish.
- Protect and enhance the quality of known habitat.
- Fence waterways which contain Malanda rainbowfish subpopulations to protect the riparian zone from cattle and install off-stream watering points for cattle if required.
- If research finds that weirs in streams occupied by Malanda rainbowfish are having a substantial impact on the species’ connectivity and persistence, investigate options for increasing stream connectivity without facilitating eastern rainbowfish invasion.
- Identify and protect current and future habitat likely to remain or become suitable habitat due to climate change.

Breeding, seed collection, propagation and other ex situ recovery action

- Continue targeted surveys to identify appropriate streams, which are (or can be modified to be) suitable for the translocation of Malanda rainbowfish.
- Establish subpopulations in dams as artificial refuges, to conserve the genetic diversity of remaining natural populations.
- If required, conduct further translocations into suitable catchments and dams within the distribution of the species. Ensure these sites, especially riverine sites, are not easily accessed by eastern rainbowfish.
- Investigate techniques for captive breeding and stocking. If required, undertake captive breeding to provide sufficient numbers of fish to augment natural subpopulations and establish new translocated subpopulations.

Stakeholder engagement/community engagement

- Liaise with landholders that own the land on which Malanda rainbowfish is found to encourage appropriate protection and increase awareness of the species' requirements.
- Investigate the possibility for landowner engagement in the creation and maintenance of new translocated subpopulations.
- Continue to share information with government agencies and stakeholder groups responsible for management activities in Malanda rainbowfish catchments, including on areas where the species is present, potentially threatening processes and progress of recovery actions.
- Identify and implement opportunities for community involvement and Traditional Owner engagement in the conservation of Malanda rainbowfish.

Survey and monitoring priorities

- Survey past known locations, and areas in catchments with the potential to support the species, to locate any additional subpopulations/occurrences/remnants in order to assess population size and distribution more precisely.
- Undertake detailed population monitoring to collect subpopulation health and demographic information. This may include annual monitoring of eastern rainbowfish and other invasive competitors (e.g. presence and abundance).
- Monitor translocated subpopulations to determine the success of historical translocation actions, and how their effectiveness can be improved.
- Undertake annual monitoring of habitat condition, noting any degradation (including from impacts of farming activities), and monitor and evaluate the efficacy of management interventions.

Information and research priorities

- Undertake research into key ecological processes for the species, such as:
  - habitat critical to survival,
  - diet,
  - reproductive ecology and longevity, and

  - genetic structure, levels of genetic diversity and minimum viable population size.
- Complete formal taxonomic description of the species.
- Investigate the mechanisms behind the invasion of Malanda rainbowfish's distribution by eastern rainbowfish. This includes investigating the impact of vegetation shading on stream temperature, and long-term trends in stream temperatures in northern Qld.
- Determine the extent to which artificially constructed barriers and weirs are impacting the hydrology of streams in which Malanda rainbowfish is found, and if these features are aiding Malanda rainbowfish by stalling the invasion of eastern rainbowfish. Determine the overall cost/benefit of barriers to the survival and persistence of Malanda rainbowfish.
- Investigate options to enhance the resilience of the species' habitat to climate change, and options for providing new areas that would be suitable for the species under climate change scenarios.
- Work with Traditional Owners to research and document cultural significance of the species.

Recovery plan decision

No recovery plan is in place for Malanda rainbowfish.

A decision about whether there should be a recovery plan for this species has not yet been determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

Conservation Advice and Listing Assessment references

Agouridis CT, Workman SR, Warner RC & Jennings GD (2007) Livestock grazing management impacts on stream water quality: a review. *JAWRA Journal of the American Water Resources Association* 41, 591–606.

Allan H & Lintermans M (2018) The threat from feral horses to a critically endangered fish. In GL Worboys, DA Driscoll & P Crabb (eds) *Feral Horse Impacts: The Kosciuszko Science Conference,* pp. 88–89.

Bond N, Thomson J, Reich P & Stein J (2011). Using species distribution models to infer potential climate change-induced range shifts of freshwater fish in south-eastern Australia. *Marine and Freshwater Research* 62, 1043–1061.

Brown C (2019) Melanotaenia australis. *The IUCN Red List of Threatened Species.* Viewed: 2 June 2021. Available on the internet at: https://www.iucnredlist.org/species/122905787/123382231

Brown C, Aksoy Y, Varinli H & Gillings M (2013) Identification of the rainbowfish in Lake Eacham using DNA sequencing. *Australian Journal of Zoology* 60, 334–339.

Brown C, Hammer M, Unmack P & Ebner B (2019) Melanotaenia *sp. nov. 'Malanda'*. *The IUCN Red List of Threatened Species*. Viewed: 2 June 2021. Available on the internet at: https://www.iucnredlist.org/species/123321483/123382516.

Chase JW, Benoy GA, Hann SWR, Culp JM. 2016. Small differences in riparian vegetation significantly reduce land use impacts on stream flow and water quality in small agricultural watersheds. *Journal of Soil and Water Conservation* 71: 194–205.

Conroy E, Turner JN, Rymszewicz A, O'sullivan JJ, Bruen M, Lawler D, Lally H & Kelly-Quinn M (2016) The impact of cattle access on ecological water quality in streams: Examples from agricultural catchments within Ireland. *Science of the Total Environment* 547, 17–29.

Caskenette A, Durhack T, Hnytka S, Kovachik C & Enders E (2021). Evidence of effect of riparian attributes on listed freshwater fishes and mussels and their aquatic critical habitat: a systematic map protocol. *Environmental Evidence*, 10, 1–10.

DAF (Department of Agriculture and Fisheries) (Qld) (2020) *Tilapia* Oreochromis mossambicus *and* Tilapia mariae*.* Viewed: 2 June 2021. Available on the internet at: https://www.daf.qld.gov.au/__data/assets/pdf_file/0009/1238076/tilapia.pdf

DAWR (Department of Agriculture and Water Resources) (Northern territory) (2021) *Freshwater pest identification guide* Viewed: 2 June 2021. Available on the internet at: https://industry.nt.gov.au/data/assets/pdf_file/0011/589574/freshwater-pests.pdf

DEH (Department of Environment and Heritage) (2004) *Nationally threatened species and ecological communities - Mabi Forest*. Department of Environment and Heritage (Cwlth), Canberra.

DES (Queensland Department of Environment and Science) (2018). Land cover change in Queensland 2016–17 and 2017–18: Statewide Landcover and Trees Study (SLATS) data summaries 1988–2018 version 1.0. DES, Brisbane.

DES (Queensland Department of Environment and Science) (2013). North Johnstone River drainage sub-basin – facts and maps. Wetland*Info* website. Viewed: 21 September 2021. Available on the internet at : https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/sub-basin-north-johnstone-river/

DoF (Department of Fisheries) (WA) (2012) *Invasive species identification guide*. Viewed: 2 June 2021. Available on the internet at: http://www.fish.wa.gov.au/documents/biosecurity/introduced-pests-guide-freshwater.pdf

DPI (Department of Primary Industries) (NSW) (2021) *Eastern Gambusia*. Viewed: 29 May 2021. Available on the internet at: https://www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/pests-diseases/freshwater-pests/finfish-species/gambusia.

DPI (Department of Primary Industries) (NSW) (2021) *Tilapia.* Viewed: 2 June 2021. Available on the internet at: https://www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/pests-diseases/freshwater-pests/finfish-species/tilapia.

DPI (Department of Primary Industries) (NSW) (2006*) Reducing the Impact of Weirs on Aquatic Habitat - New South Wales Detailed Weir Review*. Southern Rivers CMA region. Report to the New South Wales Environmental Trust. NSW Department of Primary Industries, Flemington, NSW.

Driscoll DA, Worboys GL, Allan H, Banks SC, Beeton NJ, Cherubin RC, Doherty TS, Finlayson M, Green K, Hartley R, Hope G, Johnson CN, Lintermans M, Mackey B, Paull D, Pittock J, Porfirio LL, Ritchie EG, Sato CF, Scheele BC, Slattery DA, Venn S, Watson D, Watson M & Williams RM (2019) Impacts of feral horses in the Australian Alps and evidence-based solutions. *Ecological Management & Restoration* 20, 63–72.

García-Díaz P, Kerezsy A, Unmack PJ, Lintermans M, Beatty SJ, Butler GL, Freeman R, Hammer MP, Hardie S, Kennard MJ, Morgan DL, Pusey DJ, Raadik TA, Thiem JD Whiterod NS, Cassey P & Duncan RP (2018) Transport pathways shape the biogeography of alien freshwater fishes in Australia. *Diversity and Distributions* 24, 1405–1415.

Gardner C (2017) *How Weirs Affect Fish Communities*. South East River Trust. Viewed: 29 May 2021. Available on the internet at: https://www.southeastriverstrust.org/how-weirs-affect-fish-communities/

Ghermandi A, Vandenberghe V, Benedetti L, Bauwens W & Vanrolleghem PA (2009) Model-based assessment of shading effect by riparian vegetation on river water quality. *Ecological Engineering* 35, 92–104.

Gomon MF & Bray DJ (2021) Melanotaenia splendida splendida *in Fishes of Australia*. Viewed: 2 Jun 2021. Available on the internet at: http://136.154.202.208/home/species/3046.

Hammer M (2018) *Imperilled fish SEAP TSSC rainbowfish statement*. Unpublished email, April 2018.

Hilbert DW, Hill R, Moran C, Turton SM, Bohnet I, Marshall NA, Pert PL, Stoeckl N, Murphy HT, Reside AE, Laurance SGW, Alamgir M, Coles R, Crowley G, Curnock M, Dale A, Duke NC, Esparon M, Farr M, Gillet S, Gooch M, Fuentes M, Hamman M, James CS, Kroon FJ, Larson S, Lyons P, Marsh H, Meyer Steiger D, Sheaves M & Westcott DA (2014) *Climate Change Issues and Impacts in the Wet Tropics NRM Cluster Region*. James Cook University, Cairns.

Humphrey C, Klumpp DW & Pearson R (2003) Early development and growth of the eastern rainbowfish, *Melanotaenia splendida splendida* (Peters) I. Morphogenesis and ontogeny. *Marine and Freshwater Research* 54, 17–25.

Holsinger L, Keane, RE, Isaak DJ, Eby L & Young MK (2014) Relative effects of climate change and wildfires on stream temperatures: a simulation modeling approach in a Rocky Mountain watershed. *Climatic Change* 124, 191–206.

Isaak DJ & Rieman BE (2013) Stream isotherm shifts from climate change and implications for distributions of ectothermic organisms. *Global Change Biology* 19, 742–751.

Isaak DJ, Wollrab S, Horan D & Chandler G (2012) Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. *Climatic change* 113, 499–524.

James CS, Reside AE, VanDerWal J, Pearson RG, Burrows D, Capon SJ, Harwood TD, Hodgson L & Waltham NJ (2017). Sink or swim? Potential for high faunal turnover in Australian rivers under climate change. *Journal of Biogeography* 44, 489–501.

Kalny G, Laaha G, Melcher A, Trimmel H, Weihs P & Rauch HP (2017) The influence of riparian vegetation shading on water temperature during low flow conditions in a medium sized river. *Knowledge & Management of Aquatic Ecosystems* 418, 5.

Knouft JH, Botero-Acosta A, Wu CL, Charry B, Chu ML, Dell AI, Hall D & Herrington SJ (2021). Forested Riparian Buffers as Climate Adaptation Tools for Management of Riverine Flow and Thermal Regimes: A Case Study in the Meramec River Basin*. Sustainability*, 13, 1877.

Leggett R & Merrick JR (1987) *Australian native fishes for aquariums.* J.R. Merrick Publications, Artamon, New South Wales.

Lindholm AK, Breden F, Alexander HJ, Chan WK, Thakurta SG & Brooks R (2005) Invasion success and genetic diversity of introduced populations of guppies *Poecilia reticulata* in Australia. *Molecular Ecology* 14, 3671–3682.

Lintermans M, Geyle HM, Beatty S, Brown C, Ebner BC, Freeman R, Hammer MP, Humphreys WF, Kennard MJ, Kern P, Martin K, Morgan DL, Raadik TA, Unmack PJ, Wager R, Woinarski JCZ & Garnett ST (2020) Big trouble for little fish: identifying Australian freshwater fishes in imminent risk of extinction. *Pacific Conservation Biology* 26, 365–377.

Lo M, Reed J, Castello L, Steel EA, Frimpong EA & Ickowitz A (2020). The influence of forests on freshwater fish in the tropics: A systematic review. *BioScience,* 70, 404-414.

Ludwig J & Tongway D (2002) Clearing savannas for use as rangelands in Queensland: altered landscapes and water-erosion processes. *The Rangeland Journal* 24, 83–95.

Luke SH, Slade, EM, Gray CL, Annammala KV, Drewer J, Williamson J, Agama AL, Ationg M, Mitchell SL, Vairappan MJ & Struebig MJ (2018). Riparian buffers in tropical agriculture: Scientific support, effectiveness and directions for policy. *Journal of Applied Ecology* 56, 85-92.

Lynch JA., Rishel, GB & Corbett ES (1984) Thermal alteration of streams draining clearcut watersheds: quantification and biological implications. *Hydrobiologia* 111, 161–169.

Macdonald J & Tonkin Z (2008) *A review of the impact of eastern gambusia on native fishes of the Murray-Darling Basin*. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria.

McGuigan KL (2001) An addition to the rainbowfish (Melanotaeniidae) fauna of north Queensland. *Memoirs of the Queensland Museum* 46, 647–655.

Miller J, Chanasyk D, Curtis T, Entz T, Williams TW (2010) Influence of stream bank fencing with a cattle crossing on riparian health and water quality of the Lower Little Bow River in Southern Alberta, Canada. *Agricultural Water Management* 9, 247258.

Milton DA & Arthington AH (1983) Reproduction and growth of *Craterocephalus marjoriae* Whitley and *C. stercusmuscarum* (Gunther) (Pisces: Atherinidae) in south-eastern Queensland, Australia. *Freshwater Biology* 13, 589–598.

Milton DA & Arthington AH (1984) Reproductive strategy and growth of the crimson-spotted rainbowfish *Melanotaenia splendida fluviatilis* (Castelnau) (Pisces: Melanotaeniidae) in south-eastern Queensland, Australia. *Australian Journal of Marine and Freshwater Research* 35, 75–84.

Milton DA & Arthington AH (1985) Reproductive strategy Reproduction in three species of rainbowfish and growth of the Australian smelt, *Retropinna semoni* (Weber) (Pisces: Retropinnidae), and the olive perchlet, *Ambassis nigripinnis* (DeVis) (Pisces: Ambassidae), in Brisbane, south-eastern Queensland. *Australian Journal of Marine and Freshwater Research* 36, 329–341.

Morgan DL (2019) *Melanotaenia gracilis*. *The IUCN Red List of Threatened Species.* Viewed: 2 June 2021. Available on the internet at: https://www.iucnredlist.org/species/13062/123378303

Moy KG, Hammer MP, Martin KC, Ebner BC, Brown C & Unmack PJ (2021) *Conservation introductions of the Malanda rainbowfish in the wet tropics bioregion in Australia*, PS Soorae (ed.) *Global conservation translocation perspectives: 2021. Case studies from around the globe*. Gland, Switzerland: IUCN SSC Conservation Translocation Specialist Group, Environment Agency - Abu Dhabi and Calgary Zoo, Canada. pp 21–25

Moy KG, Unmack PJ, Lintermans M, Duncan RP & Brown C (2019) Barriers to hybridisation and their conservation implications for a highly threatened Australian fish species. *Ethology* 125, 142–152.

Mueller M, Pander J & Geist J (2011) The effects of weirs on structural stream habitat and biological communities. *Journal of Applied Ecology* 48, 1450–1461.

Native Title Tribunal (2007) Ngadjon-Jii People's native title determination. Viewed: 21 September 2021. Available on the internet at: http://www.nntt.gov.au/Information%20Publications/Determination%20brochure%20Ngadjon-Jii%20people%20December%202007.pdf

O'Callaghan P, Kelly-Quinn M, Jennings E, Antunes P, O'Sullivan M, Fenton O, & Huallachain DO (2019) The environmental impact of cattle access to watercourses: A review. *Journal of environmental quality* 48, 340-351.

Pannell S (2005) *Yamani Country: A Spatial History of the Atherton Tableland, North Queensland*. Cooperative Research Centre for Tropical Rainforest Ecology and Management. Rainforest CRC, Cairns.

Pusey BJ & Arthington AH (2003) Importance of the riparian zone to the conservation and management of freshwater fish: a review. *Marine and freshwater Research* 54, 1–16.

Pusey BJ, Arthington AH, Bird JR & Close PG (2001) Reproduction in three species of rainbowfish (Melanotaeniidae) from rainforest streams in northern Queensland, Australia. *Ecology of Freshwater Fish* 10, 75–87.

Pusey BJ, Kennard MJ & Arthington AH (2004) *Freshwater fishes of north-eastern Australia*. CSIRO publishing, Collingwood Victoria.

Pyke G (2008) Plague minnow or mosquito fish? A review of the biology and impacts of introduced Gambusia species. *Annual Review of Ecology, Evolution, and Systematics* 39, 171–191.

Queensland Government (2021) Queensland Place names search. Viewed: 21 September 2021. Available on the internet at: https://www.resources.qld.gov.au/qld/environment/land/place-names/search#/search=malanda&types=0&place=Malanda20684

Quinn JM, Williamson, RB, Smith RK & Vickers ML (1992). Effects of riparian grazing and channelisation on streams in Southland, New Zealand. 2. Benthic invertebrates. *New Zealand journal of marine and freshwater research* 26, 259–273.

Rhymer JM & Simberloff D (1996) Extinction by hybridization and introgression. *Annual review of ecology and systematics* 27, 83–109.

Rogers JB, Stein ED, Beck MW & Ambrose RF (2020) The impact of climate change induced alterations of streamflow and stream temperature on the distribution of riparian species. *PloS one*, 15, e0242682.

Rutherford JC, Blackett S, Blackett C, Saito L & Davies-Colley RJ (1997) Predicting the effects of shade on water temperature in small streams. *New Zealand journal of marine and freshwater research* 31, 707–721.

Scribner KT, Page KS & Bartron ML (2000) Hybridization in freshwater fishes: a review of case studies and cytonuclear methods of biological inference. *Reviews in Fish Biology and Fisheries*, 10, 293–323.

Studinski JM, Hartman KJ, Niles JM, Keyser P (2012) The effects of riparian forest disturbance on stream temperature, sedimentation, and morphology. *Hydrobiologia* 686: 107–117.

Tappin AR (2013) *Melanotaenia splendida* subsp. *splendida*. The Australian New Guinea Fishes Association. Viewed: 7 June 2021. Available on the internet at: https://rainbowfish.angfaqld.org.au/splendida.htm

Trimmel H, Weihs P, Leidinger D, Formayer H, Kalny G & Melcher A (2018). Can riparian vegetation shade mitigate the expected rise in stream temperatures due to climate change during heat waves in a human-impacted pre-alpine river? *Hydrology and Earth System Sciences*, 22 437–461.

Tanentzap AJ, Szkokan-Emilson EJ, Kielstra BW, Arts MT, Yan ND, Gunn JM (2014) Forests fuel fish growth in freshwater deltas*. Nature Communications* 5, 1–9.

Unmack PJ, Martin KC, Hammer MP, Ebner B, Moy K & Brown C (2016) Malanda Gold: the tale of a unique rainbowfish from the Atherton Tablelands, now on the verge of extinction. *Fishes of Sahul* 30, 1039–1054.

Verspoor E & Hammart J (1991) Introgressive hybridization in fishes: the biochemical evidence. *Journal of Fish Biology* 39, 309–334.

The Threatened Species Scientific Committee finalised this assessment on DD Month Year.

Attachment A: Listing Assessment for *Melanotaenia* sp. *nov.* 'Malanda'

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

This assessment uses the criteria set out in the EPBC Regulations. The thresholds used correspond with those in the IUCN Red List criteria except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

Key assessment parameters

Table 4 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria.

Table 4 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	Unknown	Unknown	Unknown	There is no reliable estimate of the population size of Malanda rainbowfish.
Trend	Declining			Surveys conducted from the 1990s to the 2010s suggest the population is hybridising with eastern rainbowfish. It is now known only from four isolated and rapidly declining subpopulations (Brown et al. 2019).
Generation time (years)	1	1	1	The generation time of the species is estimated at one year (Brown et al. 2019).
Extent of occurrence	58 km^2	30 km^2	unknown	The EOO is estimated at 58 km^2. This figure is based on the distribution given in Moy et al. (2021). The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019). The EOO is the convex hull of the known distribution as mapped (i.e., all the streams depicted in Moy et al. 2021). The maximum plausible value was gathered from Brown et al. (2019).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
	Contracting			The EOO has likely declined since European settlement due to land clearing and farming. It has also declined recently due to invasion by eastern rainbowfish and is likely to continue contracting if the current population trend continues.
Area of Occupancy	36km^2	28 km^2	Unknown	The AOO is estimated at 36 km^2. This figure is based on the distribution given in Moy et al. (2021) and was calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). The AOO is the approximate number of 2 km grids covered by known streams in Moy et al (2021). The minimum plausible value was gathered from Brown et al. (2019).
Trend	Contracting			The AOO has likely declined since European settlement due to land clearing and farming. It has also recently declined due to invasion by eastern rainbowfish and is likely to continue contracting if the current population trend continues.
Number of subpopulations	4	4	6	The species is now only known from four isolated subpopulations (Brown et al. 2019). Over 2014–2018 it was known from six subpopulations (Moy et al. 2021).
Trend	Declining			The distribution of the species and number of subpopulations has rapidly declined since the mid-2000s (Brown et al. 2019).
Basis of assessment of population number	An IUCN assessment written by species experts states there are now only four known subpopulations (Brown et al. 2019).			
No. locations	1	1	1	All subpopulations are plausibly impacted by hybridisation with eastern rainbowfish. Though much of the Wallace Road Creek subpopulation is protected from invasion by artificial barriers, eastern rainbowfish are present below the lowermost waterfall (Unmack et al. 2016).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	static			The number of locations cannot decrease unless the species goes extinct and has not increased as known threats are impacting all subpopulations.
Basis of assessment of location number	All subpopulations are plausibly impacted by hybridisation with eastern rainbowfish. Though much of the Wallace Road Creek subpopulation is protected from invasion by artificial barriers, eastern rainbowfish are present below the lowermost waterfall (Unmack et al. 2016).			
Fragmentation	Probably severely fragmented – more than 50% of AOO in habitat patches that likely cannot support minimum viable population, large distance between subpopulations, and no genetic exchange occurring between subpopulations.			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.			

Criterion 1 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 **Very severe reduction**	**Endangered** **Severe reduction**	**Vulnerable** **Substantial reduction**
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%

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 the following

(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, hybridization, pathogens, pollutants, competitors or parasites

Criterion 1 evidence

Eligible under Criterion A2ace for listing as Vulnerable

The generation length of Malanda rainbowfish is estimated at one year (Brown et al. 2019), therefore, a period of 10 years has been used for this criterion, as it is longer than three generations.

Surveys from the 1990s to the 2010s have documented a substantial loss of pure Malanda rainbowfish individuals due to introgression with eastern rainbowfish (Unmack et al. 2016), though there is no robust estimate of the rate of this decline and how much of the total population has been lost over the past 10-year period (Since 2011). Declines due to introgression have occurred in the Ithaca/Thiaki River system and at lower Molo Creek, and rainbowfish below the lower causeway in the Williams Creek eastern branch were predominantly eastern rainbowfish hybrids in 2016 after being pure in the 1990s and 2000s. Fish above the lower causeway are also probably slightly mixed. In the western branch of Williams Creek, Malanda rainbowfish are now restricted to only the uppermost section of creek, above a small dam (Unmack et al. 2016). It is expected that the frequency of eastern rainbowfish hybrids will gradually expand upstream over time in these systems, as there are no known barriers that will exclude or slow down the invasion of eastern rainbowfish (Unmack et al. 2016). Despite the lack of data on the precise level of population reduction that has occurred over the past 10 years, the population is almost certainly declining rapidly, and population decline at a similar rate is projected to continue into the future due to unhindered introgression at sites with no barriers.

Though the former range of Malanda Rainbowfish is unknown, they are considered to almost certainly have occurred in creeks beyond the known systems (Unmack et al. 2016), and population decline can be inferred based on declines in distribution. Unmack et al. (2016) suggests there has been a rapid decline in the distribution of the species, and noted that the species has been lost from 74 percent of Ithaca River, 72 percent of Williams Creek and 23 percent of the Unnamed Creek at Wallace Rd, with a total loss of 70 percent across all systems. These estimates also include reaches of Ithaca River and Williams Creek that are starting to show evidence of introgression, demonstrating that the distribution of the species is continuing to decline. However, the time period over which these declines have occurred was not provided and it is unclear how much of the species' distribution was lost over a 10-year period, though there is anecdotal evidence that rapid declines were first observed in the mid-2000s. It is possible these declines began earlier, but it is reasonable to suggest they would have been detected given that the species has been observed and collected by the same experts since the late 1990s. If rapid distributional declines began c. 2005, and occurred at a constant rate, this would suggest a total decline of approximately 44 percent over the past 10-year period. The maximum period in which these declines may have occurred is 21 years, as the species was recognised as an independent taxonomic unit in 2000 (Unmack et al. 2016). If there has been a constant rate of decline since 2000, this would suggest that there has been a decline of approximately 35 percent over the past 10-year period. Additional data on the rate of these distributional declines and the period in which they occurred would be invaluable, though based on the above evidence, it appears that a decline in the species' distribution of over 30 percent has occurred over a 10-year period. This meets the requirements for listing as Vulnerable under criterion A2c.

Other assessments by species experts provide insight into the population trajectory of Malanda rainbowfish in the past and the future. In an IUCN assessment, Brown et al. (2019) suggested that a decline of at least 80 percent has occurred over a 10-year period due mainly to hybridisation, and considered the species critically endangered under Criterion A. However, there was little evidence provided that supported such a rapid acceleration in population decline relative to the evidence in Unmack et al. (2016). Lintermans et al. (2021) consider the species to be in the top 22 most threatened Australian freshwater fish species, with over a 90 percent predicted probability of extinction in the next 20 years. Malanda rainbowfish was also given a threat rating of 100, the highest of any of the 22 freshwater fishes.

The above information indicates that the species meets the threshold for Vulnerable under Criterion 1, inferred from distributional reductions of 35–44 percent over a 10-year period. Though population reduction has occurred and is continuing to occur, it is difficult to directly estimate what proportion of the population has been lost over a 10-year period. It is possible that the species is eligible for listing as Endangered or Critically Endangered, but further evidence is required to support this.

Conclusion
The data presented above appear to demonstrate that the species is eligible for listing as **Vulnerable** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR area of occupancy

	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1. Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2. Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**
(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 populations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or populations; (iv) number of mature individuals			

Criterion 2 evidence

Eligible under Criterion 2 B1ab(i,ii,iii,iv,v) for listing as Critically Endangered

EOO and AOO
The EOO is estimated at 58 km² and the AOO is estimated at 36km². These figures are based on the distribution given in Moy et al. (2021). The EOO was calculated using a minimum convex hull and the AOO was calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). The EOO is the convex hull of the known distribution as mapped (i.e all

the streams depicted in Moy et al. 2021) whilst the AOO is the approximate number of 2 km grids covered by known streams in Moy et al (2021).

Given that the EOO is less than 100 km^2 the species meets the threshold for listing as Critically Endangered under sub-criterion B1.

Severely fragmented and number of locations
A taxon can be considered to be severely fragmented if most (>50 precent) of its total area of occupancy is in habitat patches that are smaller than would be required to support a viable population and are separated from other habitat patches by a large distance, relative to its ecology (IUCN 2019). Malanda rainbowfish is known only from four isolated subpopulations that are not undergoing genetic exchange and are separated by a large distance and multiple barriers. Minimum Viable Population size of Malanda rainbowfish is not known, though it is likely that these shrinking habitat patches are unable to sustain the population in the long term, particularly as incursion by eastern rainbowfish can be considered likely in the future. Other assessments of Malanda rainbowfish have also listed the species as severely fragmented (Brown et al. 2019).

Malanda rainbowfish is considered to occur at one location, based on the most plausible serious threats (introgression with eastern rainbowfish) as per the IUCN Guidelines (IUCN 2019). All subpopulations have been affected by both of these threats, as eastern rainbowfish is present adjacent to all known subpopulations and all subpopulations are found on land cleared for dairy farming (see Table 2).

The distribution is severely fragmented with one location; therefore, the species appears to meet the threshold for listing as Critically Endangered under sub-criterion (a).

Continuing decline
The EOO, AOO, extent and quality of habitat, number of subpopulations and number of mature individuals are observed and projected to be declining due to ongoing threats primarily from introgression, habitat degradation by cattle and land clearing, thereby meeting sub-criterion (b)(i,ii,iii,iv,v) (Table 2; Criterion 1). Surveys have documented extensive decline since the mid-2000s due to these ongoing threats. This decline is projected to continue into the future (Brown et al. 2019).

Fluctuations
There are no known extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.

Conclusion
The species' EOO and AOO are restricted, the geographic distribution is severely fragmented with one location, and there is a continuing decline in the EOO, AOO, habitat and number of mature individuals.

The data presented above appear to demonstrate that the species is eligible for listing as **Critically Endangered** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3 Population size and decline

		Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals		**< 250**	**< 2,500**	**< 10,000**
AND either (C1) or (C2) is true				
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)		**Very high rate** **25% in 3 years or 1 generation** **(whichever is longer)**	**High rate** **20% in 5 years or 2 generation** **(whichever is longer)**	**Substantial rate** **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 the following 3 conditions:				
(a)	(i) Number of mature individuals in each population	**≤ 50**	**≤ 250**	**≤ 1,000**
	(ii) % of mature individuals in 1 population =	**90 – 100%**	**95 – 100%**	**100%**
(b) Extreme fluctuations in the number of mature individuals				

Criterion 3 evidence

Insufficient data to determine eligibility

There is no reliable estimate of Malanda rainbowfish population size.

There are insufficient data to demonstrate if the subspecies is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 4 Number of mature individuals

	Critically Endangered Extremely low	**Endangered Very Low**	**Vulnerable Low**
D. Number of mature individuals	< 50	< 250	< 1,000
D2.[1] *Only applies to the Vulnerable category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km² or number of locations ≤ 5

[1] The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2. This information will not be considered by the Committee in making its recommendation of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the *common assessment method*.

Criterion 4 evidence

Insufficient data to determine eligibility

There is no reliable estimate of Malanda rainbowfish population size.

There are insufficient data to demonstrate if the subspecies is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 5 Quantitative analysis

	Critically Endangered Immediate future	**Endangered Near future**	**Vulnerable Medium-term future**
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% in 100 years

Criterion 5 evidence

Insufficient data to determine eligibility

A population viability analysis not been completed for Malanda rainbowfish.

There are insufficient data to demonstrate if the subspecies is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Adequacy of survey

The survey effort has been considered adequate and there is sufficient scientific evidence to support the assessment.

Listing and Recovery Plan Recommendations

No recovery plan is in place for Malanda rainbowfish.

A decision about whether there should be a recovery plan for this subspecies has not yet been determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the Environment 2021, *Conservation advice for Melanotaenia sp. nov. 'Malanda'* (Malanda rainbowfish), Canberra.

This publication is available at the SPRAT profile for Melanotaenia sp. nov. 'Malanda' (Malanda rainbowfish)

Department of Agriculture, Water and the Environment
GPO Box 858, Canberra ACT 2601
Telephone 1800 900 090
Web awe.gov.au

Version history table

Document type	Title	Date [dd mm yyyy]
–	–	–
–	–	–