

***Danio erythromicron*: Application addressing the Department of Agriculture, Water and the Environment terms of reference for proposed amendments to the *List of Specimens taken to be Suitable for Live Import* (Live Import List)**



September 2021

Executive Summary

Consideration of the Department of Agriculture, Water and the Environment (DAWE) terms of reference for proposed amendments to the List of Specimens taken to be Suitable for Live Import (Live Import List) against information available for the emerald dwarf rasbora (*Danio erythromicron*) indicates the risk of allowing the importation of the species would pose minimal biosecurity risk to Australia. Notably, *D. erythromicron* is not reported to have established breeding populations outside its natural range overseas despite being traded internationally for over 10 years. A larger related species such as *Danio albolineatus* (Pearl Danio) have not established self-maintaining wild populations in Australia despite over 40 years of importation. Furthermore, small numbers of *D. erythromicron* already exist in the domestic hobby, having been locally bred and intermittently traded in Australia over the last 10 years – although these are not large commercial numbers of fish, these populations have not led to the establishment of feral populations in Australia.

Importantly, most of the information available about this species is from the ornamental fish hobby literature; there is little information in the scientific literature, especially as it relates to establishment risks. The absence of such reports is an indication of the benign nature of the species since scientific study (and associated literature) focuses almost exclusively on invasive species that have some ecological impact. Of the many species that would add value to the ornamental fish hobby sector in Australia, this species has been selected for application to add to the Live Import List largely because it is not considered invasive or otherwise ecologically harmful, nor associated with diseases exotic to Australia. It is a relatively small, benign species similar in many respects to fish already deemed appropriate to be imported into Australia.

D. erythromicron would be a welcome addition to the species available to ornamental fish hobbyists, especially given the growing popularity of the hobby in Australia and the significant economic and social benefits of the aquarium fish trade to Australia. The addition of the species would be consistent with current import policy given it is closely related to and likely shares a similar environmental risk profile to many other *Danio* species currently permitted live importation to Australia.

A structured risk assessment based on the methodology of Bomford (2008) estimated a 'moderate' risk, generally consistent with the risk that would likely be posed by most of the species currently permitted live importation to Australia. It is recommended that *D. erythromicron* is added to the list of species suitable for live import.

DAWE terms of reference

1. Provide information on the taxonomy of the species.

- Emerald dwarf rasbora, *Danio erythromicron* Annandale 1918.
- Actinopterygii (ray-finned fishes); Cypriniformes (Carps); Cyprinidae (Minnows or carps); Sub-family Danioninae.
- *Synonyms: Celestichthys erythromicron, Microrasbora erythromicron* (Froese and Pauly n.d.–a)
- Common names: Emerald dwarf danio, Emerald dwarf rasbora, Burmese zebra rasbora, Crossbanded dwarf rasbora (Froese and Pauly n.d.–a).

2. Provide information on the status of the species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). For example, is the species listed on CITES Appendix I, II or III, and if so, are there any specific restrictions on the movement of this species? Include information on the conservation value of the species.

- *Danio erythromicron* is not CITES listed.
- The species is listed on IUCN's Red List of Threatened Species as 'endangered' on the basis of its restricted and diminishing range (known only from Inlé Lake and close to Loi Kaw township in central-eastern Myanmar), predation/competition impact from introduced fish species, and harvesting for the ornamental trade (Vidthayanon 2013).
- *B. erythromicron* is bred commercially for the aquarium trade.

3. Provide information about the ecology of the species.

- *Lifespan of the species*: 3-5 years (Aqua-Fish.net n.d.).
- *Size and weight range*: 3 cm maximum length (Froese and Pauly n.d.—a).
- *Natural geographic range*: *Danio erythromicron* inhabits Lake Inlé in Shan state, eastern Myanmar (Vidthayanon 2013), and near Loi Kaw in the catchment of Lake Inlé in Kayah State (Aquainfo n.d.).
- *Habitat*: In its natural habitat in Lake Inlé, the species is mainly found in densely vegetated water, where on occasion it is so dense as to form "floating islands". *D. erythromicron* is occasionally caught between the plants that form these islands. The lake is mostly 2 to 3 metres deep, with very clear water and a fertile, loamy substrate (Aquainfo n.d.). Lake Inlé lies in a karstic valley known as the Yawnghwe basin located almost 900m above sea level in the Shan Plateau region and is home to many endemic animals including fish species (Seriously fish n.d.). Water temperatures in Lake Inlé are 20-24°C (Seriously Fish n.d.)
- *Diet, including potential to feed on agricultural plants*: *Danio erythromicron* is an omnivore that feeds on small insects and their larvae as well as plankton and algae (Aquainfo n.d.). The species is not considered a threat to any agricultural plants.
- *Social behaviour and groupings*: *Danio erythromicron* and *Danio margaritatus* are probably allopatric (Kullander 2015) and likely to share some behavioural characteristics. Thus, *D. erythromicron* it is probably not a true shoaling species that congregates in large numbers. In aquarium settings, the species is considered peaceful with other species (Aqua-Fish.net n.d., Aquainfo n.d.).
- *Territorial and aggressive behaviours*: There are no reports of territorial or aggressive behaviours in this species.
- *Natural predators*: As a relatively small, slow moving species with conspicuous patterning and coloration, the young and/or adults of the species would be highly prone (as young and adults) to predation by many Australian freshwater fish including species such as barramundi, grunters, tarpon, Eleotrids, Apogonids and gudgeons, as well as piscivorous birds and mammals.

- *Characteristics that may cause harm to humans and other species:* No characteristics that may cause harm to human or other species have been reported.

4. *Provide information on the reproductive biology of the species.*

4. *D. erythromicron* breeds readily under aquarium conditions in community tanks. As these Danios tend to eat their own fry, not many of the eggs will eventually grow to mature fish. The species spawns about 30 eggs which hatch after 72 hours, and another 3-4 days later the fry begin swimming freely (Aquainfo n.d.).

- *Age at maturity (first breeding):* 2 years
- *How frequently breeding occurs:* The species does not have a dedicated spawning season, nor do the females lay continuously. The time between spawnings in the wild is unknown. About three to four spawns per year are expected from a female under commercial aquaculture conditions
- *Can the female store sperm:* Females do not store sperm. Fertilisation is external.
- *How many eggs or live-born young are produced at each breeding event:* Females produce small batches of around 30 eggs per spawning episode (Aquainfo n.d.).
- *Has the species hybridised with other species (both in the wild and in captivity) or has it the potential to hybridise with any other species:* the species is not reported to have hybridised with any other species.
- *If the species can hybridise, are the progeny fertile:* n/a.

5. *Provide information on whether this species has established feral populations, and if so, where those populations are. Include information on whether this species has been introduced to other countries, even if it has not established feral populations.*

The species has not been reported as having established feral population outside of their natural geographic distribution (Froese and Pauly n.d.—a), despite being traded internationally for the aquarium trade for about 10 years in volumes in the order of 1.5 million fish per year

6. *Provide information on, and the results of any other environmental risk assessments undertaken on the species both in Australia and overseas, including any Import Risk Analyses undertaken.*

A search of the scientific literature did not identify any previous environmental risk assessment of this species. The species is not on the BRS 'grey list' of ornamental fish species, i.e. non-native species that are present in Australia through historical imports that are not on the Live Import List, nor is it one of the species of non-native freshwater fish that are reported to have established self-sustaining populations in the wild in Australia (Corfield *et al.* 2008). However, the species was known to have been captive bred and traded domestically in Australia previously. It is unknown how the first individuals arrived in Australia — it is plausible that they may have been shipped to Australia inadvertently as they resemble some closely related species already approved for live import. The addition of *D. erythromicron* to the Live Import List would be generally consistent with Australia's biosecurity arrangements for live fish given that the species is or was present in

Australia and given that it is closely related to and likely shares a similar environmental risk profile with species of *Danio* and *Devario* currently permitted live importation to Australia.

7. *Assess the likelihood that the species could establish a breeding population in the Australian environment should it ever be released from effective human control.*

Assessing the risk of the potential of introducing a new organism into the environment involves assessing the risk of it becoming established and spreading and the likely impacts if establishment occurred. The risk assessment method 'Exotic Freshwater Fish Model 1' developed by Mary Bomford has been adopted by DAWE for its freshwater fish risk assessments (Bomford 2008). The following considers each of the risk factors considered by Bomford to be applicable to freshwater fish and is guided by the recent Australian Government risk assessment of glass catfish (DAWE 2020a). The specific criteria in the DAWE terms of reference template are also covered. The potential impacts of established feral populations are addressed in the next term of reference (#8). A structured risk assessment based on the Bomford methodology is at Appendix A.

Importantly, most of the information available about this species is from the ornamental fish hobby literature; there is little information in the scientific literature, especially as it relates to establishment risks. The absence of such reports is an indication of the benign nature of the species since scientific study and associated literature focuses almost exclusively on invasive species that have some ecological impact. Of the many species that would add value to the ornamental fish hobby sector in Australia, this species has been selected for application to add to the Live Import List largely because it is not considered invasive or otherwise ecologically harmful.

- *Propagule pressure—the release of large numbers of animals at different times and places enhances the chance of successful establishment: *Danio erythromicron* is not a true schooling species which means that it has a lower likelihood to establish than schooling species. A moderate to high probability of establishing a self-sustaining population would require deliberate actions by a knowledgeable individual to introduce a large number of fish into very specific aquatic habitats – it is unlikely to happen at random (DAWE 2020a). The habitat requirements could be met in a small number of highland tropical environments, although all Northern Australian areas have wider temperature fluctuations than Lake Inle and surrounds, and most have populations of predatory fish. It is very unlikely that enough fish would be randomly released into a suitable receiving environment to establish a breeding population as a result of an accident or being deliberately released into local waterways in or near populated areas.*
- *Climate match—introduction to an area with a climate that closely matches that of the species' original range: Climatch (original v1.0) was run with the source region set to circumscribe 12 weather stations around Lake Inlé in central-eastern Myanmar where the species naturally found (Vidthayanon 2013). A climate match prediction was generated using the Euclidian algorithm applied to the 'world stations' data set. Climatch calculated a 'value X' (Climate Euclidian Sum Level 5) of 1011, equating to a climate match score of 6. DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements. The recently released upgraded version of Climatch (v2.0) was not used in this assessment because its improved mapping*

resolution results in higher output values that are yet to be calibrated for purposes of applying the Bomford methodology.

- *History of establishment elsewhere—previous successful establishment:* There is no evidence that the species has established outside its known natural range, Inlé Lake and surrounds, Shan State, Myanmar (Froese and Pauly n.d.—a). This is despite being actively traded internationally as an aquarium species for many years. It is a tropical pelagic species found mainly in densely vegetated water or areas with emergent vegetation (Aquainfo n.d.).
- *Overseas range:* The species is endemic to Inlé Lake and surrounds, Shan State, Myanmar. The reported extent of occurrence is ca. 116 km², although now considered to be less than 50 km² because the net open area of the lake has declined in recent decades (Vidthayanon 2013). It is considered conservatively to occupy a total <3, 1° latitude x 1° longitude grid squares (Bomford 2008).
- *Introduction success:* The species is not known to have been released or established. However, after over 10 years of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction success rate is conservatively considered to be less than 0.25 (Bomford 2008).
- *Taxonomic group—belonging to a family or genus which has a high establishment success rate:* *D. erythromicron* belongs to the family Cyprinidae (freshwater fish that includes the carps, the true minnows, and their relatives such as barb and barbels) and the subfamily Danioninae. There are four ornamental cyprinid species that have reported to have established self-maintaining populations in Australian waters; namely goldfish (*Carassius auratus*), rosy barb (*Puntius conchonius*), Sumatra barb (*Puntius tetrazona*) and white cloud mountain minnow (*Tanichthys albonubes*) (Corfield *et al.* 2008). However, there is limited value in assigning a level of invasiveness risk to the family as a whole because the Cyprinidae is the largest and most diverse fish family and the largest vertebrate animal family in general, with about 1750 valid species, representing approximately 150 genera (Fricke *et al.* 2020) (Froese and Pauly n.d.—b).

FishBase recognises 26 species of *Danio* of which two species, *Danio albolineatus* and *Danio rerio* are reported as having established in the wild outside the countries of their natural range (Froese and Pauly n.d.—c). Of a total 26 *Danio* species, 6 are traded internationally as ornamental species and of this 6, there are 7 known established populations (representing two species) outside the countries to which they are native. As internationally traded aquarium species, it is reasonable to assume that there would have been many instances of inadvertent or deliberate introduction of these 6 species around the world – conservatively assumed to be more than 50 introductions for the purposes of this risk assessment, and this level of introductions has resulted in 7 known established populations of two species.

If the Bomford (2008) methodology is applied to the genus *Danio*, where the genus success rate % = 100(Number of successful introductions to all countries of species in the genus/Total number of introductions to all countries of species in the genus), the 'genus level' taxa risk is 7/50 (14%). Notably, *Danio albolineatus* a species similar to *D. margaritatus* is on the current list of specimens taken to be suitable for live import, has been imported to Australia for many decades and has not established wild populations.

- *Ability to find food sources:* As an omnivore feeding on insect larvae, phytoplankton and zooplankton (Aquainfo n.d.), the species is expected to find food sources in the unlikely event it is introduced into the wild.
- *Ability to survive and adapt to different climatic conditions (e.g. temperatures, rainfall patterns):* The species' natural habitat in Lake Inlé in Myanmar is a very specific one. Lake Inlé lies in a karstic valley known as the Yawnghwe basin located almost 900m above sea level in the Shan Plateau region and is home to many endemic animals including nine species of fish and numerous gastropods (Seriouslyfish n.d.). The species is found in densely vegetated water at 20-24°C, where it can sometimes be so dense as to form "floating islands". *D. erythromicron* is occasionally caught between the plants that form these islands. The lake itself is mostly 2 to 3 meters deep and consist of very clear water. The substrate is very fertile and loamy in texture (Aquainfo n.d., Seriously Fish n.d.). Such a specific natural habitat likely limits the potential geographical range where the species could establish outside its natural range.
- *Ability to find shelter:* As a pond dwelling fish used to shallow waters with thick vegetation, there would be opportunity to find shelter in the event of release, at least for a short period of time.
- *Rate of reproducing:* The females spawn about 30 eggs which hatch after 72 hours, another 3-4 days after which the fry start to swim freely (Aquainfo n.d.). The frequency between spawning events in the wild is not known, but in commercial aquaculture females reach maturity after two years and spawn about three times per year. The net reproductive rate (the number of offspring that a female produces during its lifetime) is uncertain but given the low fecundity (30 eggs per spawning and recuperation needed between spawnings), it is considered very low compared to other species of invasive cyprinids.
- *Any characteristics that the species has which could increase its chance of survival in the Australian environment:* The species is not considered to have any characteristics that would increase its likelihood of survival in the wild in Australia.

In summary, *D. erythromicron* is considered unlikely to establish, in main because the species is not reported to have established breeding populations outside its natural range despite being traded internationally as an ornamental species for many decades and there are few areas in Australia expected to have habitat suitable for the species to establish. This conclusion can be ground-truthed to an extent by comparing *D. erythromicron* with similar species such as *Danio albolineatus*, which has not established self-maintaining wild populations despite several decades of importation to Australia for the aquarium trade. Furthermore, small numbers of *D. erythromicron* exist in the domestic hobby having been bred and intermittently traded in Australia over the last 10 years — although these are not large commercial numbers of fish, these populations have not led to the establishment of feral populations in Australia.

8. *Provide a comprehensive assessment of the potential impact of the species should it establish feral population/s in Australia. Include, but do not restrict your assessment to the impact of this species on:*
- *Similar niche species (i.e. competition with other species for food, shelter etc.):* In the unlikely event this species establishes in the wild in Australia, *Danio erythromicron* may compete with other small omnivores in tropical waters, typically in still (pond), well

vegetated habitats with a neutral pH. These niche species could include rainbowfishes (e.g. threadfin rainbowfish *Iriatherina wernerii*), pennyfish (*Denariusa bandata*) blue-eyes (*Pseudomugil* spp) and other similar species. It is unlikely any competition from *D. erythromicron* with the aforementioned native species would be negligible and have little if any impact other than providing a ready food source for larger piscivorous native species. As noted in TOR 7 above, the absence of such reports is an indication of the benign nature of the species since scientific literature focuses almost exclusively on species that have some ecological impact.

- *Is the species susceptible to, or could it transmit any pests or disease:*
No significant pests or diseases have been associated with *Danio erythromicron*, including any of the diseases to which there are disease-specific risk management measures applied for importation of ornamental fish to Australia. The danios as a group are considered of low risk in terms of disease risk in that they are subject to the minimum one-week post arrival quarantine isolation on importation to Australia (DAWE 2020b).
- *Probable prey/food sources, including agricultural crops:* *Danio erythromicron* has not been reported to pose any threat to agricultural crops or pose a threat as a predatory species.
- *Habitat and local environmental conditions:* *Danio erythromicron* has not been reported to change its environment or habitat. It is a tropical pelagic species inhabiting small, well vegetated, shallow ponds and lakes, at most 3 m deep.
- *Control/eradication programs that could be applied in Australia if the species was released or escaped:* Potential controls measures include listing as a noxious species; eradication or containment programs (including movement controls) or broader education/awareness building campaigns such as the NAQS program for labelling fish bags in aquarium shops in northern Australia.
- *Characteristic or behaviour of the species which may cause land degradation i.e. soil erosion from hooves, digging:* There are no reports of this species exhibiting any behaviours that may cause land degradation.
- *Potential threat to humans:* The species is not reported as posing any threat to humans.

9. *What conditions or restrictions, if any, could be applied to the import of the species to reduce any potential for negative environmental impacts (e.g. single sex imports, de-sexing animal prior to import etc.).*

Potential environmental impacts from importation of live animals into Australia can take the form of direct pest risks or indirect risks associated with the introduction of new diseases that may be carried in imported stock. In the case of *D. erythromicron*, importation under Australia's current import conditions would reduce potential disease risks to an acceptable level, consistent with previous Australian Government disease risk analyses (Kahn *et al.* 1999, DOA 2014).

10. *Provide a summary of the types of activities that the specimen may be used for if imported into Australia (e.g. pet, commercial, scientific).*

- *Benefit of this species for these activities:* Permitting importation of this species will support the ornamental fish industry. In a broader context, the ornamental fish hobby is an important one. Besides creating employment and contributing to the economy of all States and Territories, the aquarium fish sector has become especially important during the CoViD-19 pandemic where individuals subject to movement restrictions are turning increasingly to the hobby for recreation – the hobby therefore plays a significant part in helping alleviate the stressors associated with the pandemic and post-CoViD recovery, both from economic and social perspectives.

The direct and indirect economic benefits of ornamental fish importation carry through the aquarium industry supply chain and into the hobby. The economic beneficiaries include, but are not limited to, aquarium fish importers, wholesalers, aquarium hard goods distributors, retail pet and aquarium shops, commercial and hobby breeders as well as freight and logistics providers and other associated vendors.

Importantly, keeping ornamental fish fosters companion animal care which has benefits to society beyond the direct economic value of the trade. There are companionship as well as mental health benefits. There has never been a more important time for these benefits to flow through Australian society. The aquarium hobby also plays an often undervalued educational role, especially relevant to younger Australians. The benefits in this respect include, but are not limited to, an increased understanding of, and appreciation for, biology, chemistry, physiology as well as geography and natural history.

- *Potential trade in the species:* The species is routinely traded internationally and would be a welcome addition to the species permitted importation. In the order of 1.5 million fish of the species are traded internationally and the likely market demand in Australia would represent about one percent of this, especially given the growing popularity of the hobby in Australia.

Why this species has been chosen: Internationally, the species is in high demand by hobbyists. *Danio erythromicron* would be popular in Australia, adding variety to the species available to Australian hobbyists. The species is not aggressive and compatible to keep in aquaria with other tropical species.

Although small numbers of this species are known to be present in the Australia hobby, these are not available with the reliability or in sufficiently large commercial volumes needed by the industry. Imported stock would provide reliable access to the numbers, range in sizes and varieties (such as new colour morphs) needed to meet Australian hobby demand.

11. *Provide detailed guidelines on the way in which the species should be kept, transported and disposed of in accordance with the types of activity that the species may be used for if imported into Australia.*

- *The containment (e.g. cage, enclosure) and management standards for this species to prevent escape or release. This should also talk about the security standards for this specimen:* The fish will be transported as per the International Air Transport Association (IATA) guidelines and the provisions of the *BICON Import Conditions for Freshwater Aquarium Fish: Effective 18 July 2020* (DAWE 2020b).

- *The disposal options for surplus specimens:* Fish will be imported for purposes of supplying the aquarium fish trade and as such no surplus specimens are expected. In the event of mortality, animals will be disposed as per the provisions of the *BICON Import Conditions for Freshwater Aquarium Fish: Effective 18 July 2020* and in accordance with the Pet Industry Association of Australia (PIAA) National Code of Practice (PIAA 2015).

12. *Provide information on all other Commonwealth, state and territory legislative controls on the species, including:*

- *The species' current quarantine status:* The species is not currently on the permitted species list.
- *Pest or noxious status:* The species is not list on any state or federal pest or noxious species list.
- *Whether it is prohibited or controlled by permit or licence in any state or territory:* The species is not prohibited or controlled by permit or licence in any state or territory.

2.

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Appendix A: Bomford model risk assessment: *Danio erythromicron*

Assessing the risk of the potential of introducing a new organism into the environment involves assessing the likelihood of it becoming established and spreading and the likely impacts if the species does establish. The following analysis applies the assessment method for determining the risk of establishment of exotic freshwater fish introduced to Australia (Model 1) described in Bomford (2008) and is guided by the recent DAWE risk assessment of glass catfish (DAWE 2020a).

Bomford (2008) identified a range of factors that determined establishment success of freshwater fish, including propagule pressure, climate match, history of establishment elsewhere, geographic range and taxonomic group. These risk factors together with potential impacts should *Danio erythromicron* Annandale 1918 establish wild populations in Australia are discussed below, as are the outputs of applying the Bomford (2008) methodology. These findings should be considered together with information addressing the DAWE terms of reference for proposed amendments to the *List of Specimens taken to be Suitable for Live Import (Live Import List)* in the body of this submission.

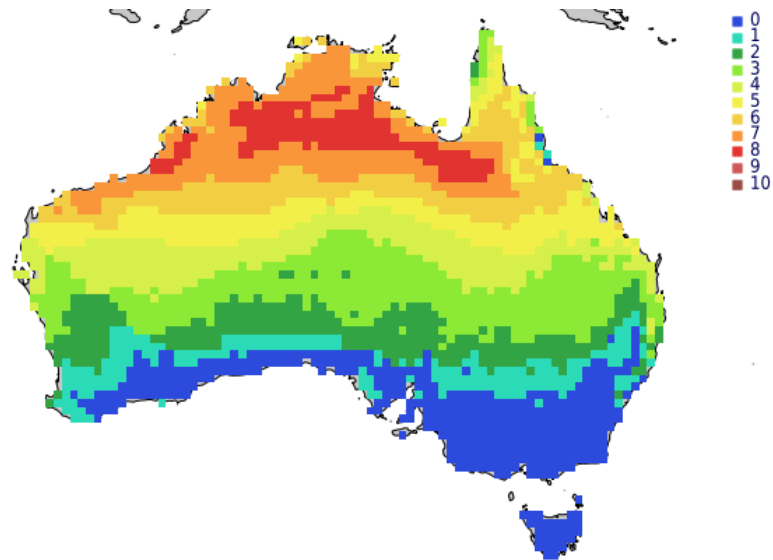
Establishment success

Propagule pressure—the release of large numbers of animals at different times and places

Danio erythromicron is not a true schooling species which means that it has a lower likelihood to establish than schooling species. A moderate to high probability of establishing a self-sustaining population would require deliberate actions by a knowledgeable individual to introduce a large number of fish into very specific aquatic habitats – it is unlikely to happen at random (DAWE 2020a). The habitat requirements could be met in a small number of highland tropical environments, although all Northern Australian areas have wider temperature fluctuations than Lake Inlé and surrounds, and most have populations of predatory fish. It is very unlikely that enough fish would be randomly released into a suitable receiving environment to establish a breeding population as a result of an accident or being deliberately released into local waterways in or near populated areas.

Climate match—introduction to an area with a climate that closely matches that of the species' original range

Climatch (original v1.0) was run with the source region set to circumscribe 12 weather stations around Lake Inlé in central-eastern Myanmar where the species naturally found (Vidthayanon 2013). A climate match prediction was generated using the Euclidian algorithm applied to the 'world stations' data set. Climatch calculated a 'value X' (Climate Euclidian Sum Level 5) of 1011, equating to a climate match score of 6. DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements. The recently released upgraded version of Climatch (v2.0) was not used in this assessment because its improved mapping resolution results in higher output values that are yet to be calibrated for purposes of applying the Bomford methodology.



Score	0	1	2	3	4	5	6	7	8	9	10
Count	424	212	316	483	339	274	282	300	155	0	0

Figure 1 Climatch output for *Danio erythromicron*

History of establishment elsewhere—previous successful establishment

There is no evidence that the species has established outside its known natural range, Inlé Lake and surrounds, Shan State, Myanmar (Froese and Pauly n.d.—a). This is despite being actively traded internationally as an aquarium species for many years. It is a tropical pelagic species found mainly in densely vegetated water or areas with emergent vegetation (Aquainfo n.d.).

Overseas range:

The species is endemic to Inlé Lake and surrounds, Shan State, Myanmar. The reported extent of occurrence is ca. 116 km², although now considered to be less than 50 km² because the net open area of the lake has declined in recent decades (Vidthayanon 2013). It is considered conservatively to occupy a total <3, 1° latitude x 1° longitude grid squares (Bomford 2008).

Introduction success:

The species is not known to have been released or established. However, after over 10 years of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction success rate is conservatively considered to be less than 0.25 (Bomford 2008).

Taxonomic group—belonging to a family or genus which has a high establishment success rate

D. erythromicron belongs to the family Cyprinidae (freshwater fish that includes the carps, the true minnows, and their relatives such as barb and barbels) and the subfamily Danioninae. There are four ornamental cyprinid species that have reported to have established self-maintaining populations in Australian waters; namely goldfish (*Carassius auratus*), rosy barb

(*Puntius conchoni*), Sumatra barb (*Puntius tetrazona*) and white cloud mountain minnow (*Tanichthys albonubes*) (Corfield *et al.* 2008). However, there is limited value in assigning a level of invasiveness risk to the family as a whole because the Cyprinidae is the largest and most diverse fish family and the largest vertebrate animal family in general, with about 1750 valid species, representing approximately 150 genera (Fricke *et al.* 2020) (Froese and Pauly n.d.—b).

FishBase recognises 26 species of *Danio* of which two species, *Danio albolineatus* and *Danio rerio* are reported as having established in the wild outside the countries of their natural range (Froese and Pauly n.d.—c). Of a total 26 *Danio* species, 6 are traded internationally as ornamental species and of this 6, there are 7 known established populations (representing two species) outside the countries to which they are native. As internationally traded aquarium species, it is reasonable to assume that there would have been many instances of inadvertent or deliberate introduction of these 6 species around the world – conservatively assumed to be over 50 introductions for the purposes of this risk assessment, and this level of introductions has resulted in 7 known established populations of two species.

If the Bomford (2008) methodology is applied to the genus *Danio*, where the genus success rate % = $100 \times (\text{Number of successful introductions to all countries of species in the genus} / \text{Total number of introductions to all countries of species in the genus})$, the 'genus level' taxa risk is 7/50 (14%). Notably, the related *Danio albolineatus* is on the current list of specimens taken to be suitable for live import, has been imported to Australia for many decades and has not established wild populations. Furthermore, small numbers of *D. erythromicron* likely exist in the domestic hobby having been intermittently traded in Australia over the last 10 years – although these are not large commercial numbers of fish, these populations have not led to the establishment of feral populations in Australia.

Potential impacts of established feral populations

In the unlikely event this species establishes in the wild in Australia, *Danio erythromicron* may compete with other small omnivores in tropical waters, typically in still (pond), well vegetated habitats with a neutral pH. These niche species could include rainbowfishes (e.g. threadfin rainbowfish *Iriatherina wernerii*), pennyfish (*Denariusa bandata*) blue-eyes (*Pseudomugil* spp) and other similar species.

D. erythromicron has not been reported to change its environment or habitat. It is a tropical pelagic species inhabiting small, well vegetated, shallow ponds. The species has not been reported to pose any threat to agricultural crops or pose a threat as a predator. There are no reports of the species exhibiting any behaviours that may cause land degradation, nor has the species been reported as posing any threat to humans. *D. erythromicron* would have little or no impact to the Australian environment as the species has been freely traded internationally for many years with no evidence of establishment of feral populations nor any detrimental impact in any other country.

Disease transmission to Australian fish and aquarium fish populations

No significant pests or diseases have been associated with this species, including any of the diseases to which there are disease-specific risk management measures applied for importation of ornamental fish to Australia. The danios as a group are considered of low risk in terms of disease risk in that they are subject to the minimum one-week post arrival quarantine isolation on importation to Australia (DAWE 2020b).

Bomford 2008 Exotic Freshwater Fish Risk Assessment Model

Common name	Emerald dwarf rasbora,
Scientific name	<i>Danio erythromicron</i> Annandale 1918
Date assessed	1 February 2021
Literature Search Type and Date:	FishBase January 2021

Risk criterion	Value	Explanation
A. Climate Match Score (1–8)	6	Climatch (v1.0) Euclidian Sum Level 5 (Value X) = 1011. This value equates to a climate match score of 6.
B. Overseas Range Score (0–4)	0	Applying an estimate of <3, 1-degree grid squares; score = 0
C. Establishment Score (0–3)	0	The species is considered to have been “introduced but never established”, representing an establishment score of 0.
D. Introduction Success Score (0–4)	1	The species is not known to have been released or established. However, after many years of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction success rate is conservatively considered to be less than 0.25, representing an <i>introduction success</i> score of <1.
E. Taxa Risk Score 1(0–5)	2	FishBase recognises 26 species of <i>Danio</i> of which two species, <i>Danio albolineatus</i> and <i>Danio rerio</i> are reported as having established in the wild outside the countries of their natural range. Of a total 26 species, 6 are traded as ornamental species and of this 6, there are 7 known established populations (representing two species) outside the countries to which they are native. If it is assumed that the traded ornamental species have been introduced to non-native environments many times (assumed 50+) in the past, and this level of introductions has resulted in 7 established populations of two species, then the ‘genus level’ taxa risk is 7/50 (14%), i.e. a taxa risk score of 2.

Summary	Score	Rank
Establishment Risk	9	Moderate

Conclusion

The estimated risk of ‘moderate’ using the Bomford (2008) methodology is generally consistent with the risk that would be posed by most of the species currently permitted live importation to Australia. It is recommended that *D. erythromicron* is added to the Live Import List.