

***Danio margaritatus*: Report 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)**

Submitted by the Aquarium Industry Association of Australia



16 December 2020

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 Rasbora galaxy (*Danio margaritatus*) indicates the risk of allowing the importation of the species would pose minimal biosecurity risk to Australia. Notably, *D. margaritatus* is not reported to have established breeding populations outside its natural range overseas despite being traded internationally for over 15 years and similar species such as *D. albolineatus* have not established self-maintaining wild populations in Australia despite decades of importation. Captive breeding populations of *D. margaritatus* currently exist in the Australian hobby supplying a limited domestic trade – these populations have not led to the establishment of feral populations in Australia.

D. margaritatus would be a welcome addition to the species permitted live importation, especially given the growing popularity of the hobby in Australia and the significant economic and social benefits of the aquarium fish trade to Australia. Furthermore, the addition of *D. margaritatus* would be a common-sense decision given that the species is likely present in Australia and given that it is closely related to and shares a similar environmental risk profile with other species currently permitted live importation to Australia.

A structured risk assessment of *D. margaritatus* based on the methodology of Bomford (2008) estimated a 'moderate' risk, 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. margaritatus* is added to the Live Import List.

DAWE terms of reference

1. *Provide information on the taxonomy of the species.*
 - Rasbora galaxy *Danio margaritatus* Roberts 2007.
 - Actinopterygii (ray-finned fishes); Cypriniformes (Carps); Cyprinidae (Minnows or carps); Sub-family Danioninae.
 - Synonyms: *Celestichthys margaritatus*.
 - Common names: Celestial Pearl Danio, Galaxy 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.*
 - *D. margaritatus* is not CITES listed. The specie is listed on IUCN's Red List of Threatened Species as 'data deficient' (Vishwanath 2012).
 - Roberts (2007) noted that captive breeding of the species could ease pressure on wild stocks from commercial fish collectors. The species is now commercially bred worldwide.

3. *Provide information about the ecology of the species.*

- *Lifespan of the species:* 3-5 Years (Woods 2018)
- *Size and weight range:* 2-2.5 cm standard length (Wikipedia n.d.). Maximum length is reported at 2.1 cm SL male/unsexed and 2.1 cm SL (female) (Froese and Pauly n.d.—a).
- *Natural geographic range:* The species is found east of Taunggyi, Myanmar, at an altitude of over 1,000 m. Its habitat is part of the Salween basin (Nam Lang and Nam Pawn rivers). It is also found in the Shan plateau (Salween River basin) east of Inle, as well as the northwest corner of Thailand adjacent to the border with Myanmar (Vishwanath 2012).
- *Habitat:* It is a tropical pelagic species found in the Nam Lang and Nam Pawn Rivers in Myanmar, inhabiting small, shallow clear water ponds (30 cm deep at most) at 22-24°C (Wikipedia n.d.). The type locality is an area of permanently-flooded grassland formed by the damming of a spring for agricultural purposes (Seriously Fish n.d.). The ponds have luxuriant submerged aquatic vegetation, mainly one or two species of Elodea or Anacharis. Present terrestrial vegetation is open grassland (Froese and Pauly n.d.—a). Unlike many danios, this species prefers slightly alkaline water (Wikipedia n.d.).
- *Diet, including potential to feed on agricultural plants:* *D. margaritatus* is an omnivore and known in captivity to feed on small invertebrates (Woods 2018). There are no reports of the species posing a threat to agricultural crops.
- *Social behaviour and groupings:* *D. margaritatus* is not a true shoaling species in that they do not typically see large numbers together. In aquarium settings, the species is considered to have a timid, peaceful nature cohabiting with other similar species such as guppies, mollies and tetras (Woods 2018).
- *Territorial and aggressive behaviours:* There are no reports of territorial or aggressive behaviours in this species.
- *Natural predators:* Not reported in the scientific literature but the species would likely be prey to piscivorous birds, mammals or fish in their natural habitat. With its conspicuous patterning and coloration, the young and adults of the species would be highly prone to predation by many Australian predatory freshwater fish species such as such as tarpon, Eleotrids, Apogonids and gudgeons.
- *Characteristics that may cause harm to humans and other species:* No characteristics that may cause harm to human or other species have been reported in this species.

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

Roberts 2007 has described the reproductive biology of *D. margaritatus* in detail. The female lays eggs hidden away as a loose batch in a vegetated area which the male fertilises and protects from other males. Larvae hatch after 3-4 days (at 24-25°C) and hide between substrate and detritus. The larvae metamorphose to adults form 8-10 weeks after hatching and the colour pattern starts to appear after 12 weeks.

- *Age at maturity (first breeding):* 2 years (Anthony Ramsey, Pet Industry Association of Australia, pers. com.).

- *How frequently breeding occurs*: The species does not have a dedicated spawning season, nor do the females lay continuously (Wikipedia n.d.). Breeding frequency in the wild has not been reported. About three spawns a year are expected under aquaculture conditions (Anthony Ramsey, Pet Industry Association of Australia, pers. com.).
 - *Can the female store sperm*: Females do not store sperm. Fertilisation is external (Roberts 2007)
 - *How many eggs or live-born young are produced at each breeding event*: Females produce small batches of around 30 eggs per spawning episode (Roberts 2007).
 - *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 as an aquarium species for over 13 years, with an estimated 4 million fish traded per year (Jared Patrick, Premier Pet, pers. com.).

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, small numbers of this species are known to exist in the Australian hobby (Jared Patrick, Premier Pet, pers. com.).

However, the species is known to be captive bred and traded domestically in Australia (Jared Patrick, Premier Pet, pers. com.). 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 on the current Live Import List (Anthony Ramsey, Pet Industry Association of Australia, pers. com.).

The addition of *D. margaritatus* to the Live Import List would be generally consistent with Australia's biosecurity arrangements for live fish given that the species is present in Australia and given that it is closely related to and 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 template terms of reference 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.

- *Propagule pressure—the release of large numbers of animals at different times and places enhances the chance of successful establishment: D. margaritatus* is not a true schooling species which means that it has a lower likelihood of establishing than schooling species. A moderate to high probability of establishing a self-sustaining population would require deliberate introduction of sufficient numbers of fish by a knowledgeable individual into very specific waterways (given its natural habitat is permanently flooded grassland pools). This is unlikely to happen at random (DAWE 2020a). The possible locations where establishment may occur are generally remote from populated areas; this includes areas in Arnhem Land and far Northern Australia. It is highly unlikely that enough fish would be accidentally or deliberately released into a suitable receiving environment to establish a breeding population.
- *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 Inle Lake in central-eastern Myanmar from where the species was described by Roberts 2007 and the broader 'extant and probably extant' geographical range described in the IUCN species assessment (Vishwanath 2012). 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 1033, 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 new 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.
- *Overseas range:* The species is found east of Taunggyi, Myanmar. Its habitat is part of the Salween basin (Nam Lang and Nam Pawn rivers). It is also found in the Shan plateau (Salween River basin) east of Inle, as well as the northwest corner of Thailand adjacent to the border with Myanmar (Vishwanath 2012). It is considered conservatively to occupy a total 4, 1° latitude x 1° longitude grid squares (Bomford 2008).
- *History of establishment elsewhere—previous successful establishment:* There is no evidence that the species has established outside its known natural range, despite being actively traded internationally for many years. *D. margaritatus* is found in a part of the Salween basin, namely the Nam Lang and Nam Pawn Rivers in central-eastern

Myanmar. It is a tropical pelagic species inhabiting small and shallow ponds, at most 30 cm deep and is not known to have spread beyond this within Myanmar/Thailand or elsewhere in the world despite likely inadvertent or deliberate introductions as an internationally traded aquarium species. The species is considered to have been “introduce but never established” (Bomford 2008).

- *Introduction success*: The species is not known to have been released or established. However, after over 13 years of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction 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. margaritatus* 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). If the Bomford (2008) methodology is applied to the genus *Danio*, then of a total 26 species, 6 are traded as ornamental species and of this 6, there are 12 reported populations (representing two species) that have been found established 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 50 introductions for the purposes of this risk assessment, and this level of introductions has resulted in 12 established populations of two species. The ‘genus level’ taxa risk is therefore 2/50 (4%). Notably, *Danio albolineatus* a species similar to *D. margaritatus* is on the current list of specimens taken to be suitable for live import, have been imported to Australia for many decades and have not established wild populations.

- *Ability to find food sources*: As an omnivorous column feeder with a diet in the wild of small invertebrates, algae and zooplankton (Seriously Fish 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)*: *D. margaritatus* is a tropical pelagic species inhabiting small, clear, slightly alkaline shallow ponds at 22-24°C with luxuriant submerged aquatic vegetation (Roberts 2007). Such a specific natural habitat severely limits the potential geographical range where the species could establish — most habitats like this at this temperature range in Australia will be temporary waterbodies unless they are over a permanent spring.

- *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:* Roberts 2007 reports that female *D. margaritatus* produces about 30 eggs during spawning, although this can be much less in captive breeding conditions – the frequency between spawning events in the wild has not been reported but under aquaculture conditions, females are productive for about two years and can spawn up to eight times per year (Anthony Ramsey, Pet Industry Association of Australia, pers. com.). 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 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. margaritatus* 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 over 13 years 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. margaritatus* with similar species such as *Danio albolineatus*, which has not established self-maintaining wild populations despite decades of importation to Australia for the aquarium trade. Furthermore, there currently exists breeding populations of *D. margaritatus* in the Australian hobby – these have not led to the establishment of feral populations in Australia.

The above information is presented as a structured Bomford (2008) risk assessment at Appendix A.

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, *D. margaritatus* may compete with other small omnivores in tropical waters (22-24°C), typically in still (pond), well vegetated habitats. As this species inhabits heavily vegetated ponds it could potentially compete with various species of blue-eyes (*Pseudomugil* spp.) and juvenile species of mid-water fish such as *Crateropcephalus* and *Melanotaenia* spp.
 - *Is the species susceptible to, or could it transmit any pests or disease:* No significant pests or diseases have been associated with *D. margaritatus*, 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:* *D. margaritatus* has not been reported to pose any threat to agricultural crops or pose a threat as a predator.

- *Habitat and local environmental conditions:* *D. margaritatus* has not been reported to change its environment or habitat. It is a tropical pelagic species inhabiting small, clean water, well vegetated, shallow ponds, at most 30 cm 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. margaritatus*, importation under Australia's current import conditions would reduce potential disease risks to an acceptable level, consistent with previous Australian Government disease risk analyses (AQIS, 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. Aside from creating employment and contributing to the economy of all States and Territories, it has become especially important during the CoViD 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 4 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 (Jared Patrick, Premier Pet, pers. com.).
 - *Potential trade in the species:* The species is routinely traded internationally (and to a much smaller extent, domestically) and would be a welcome addition to the species permitted importation. In the order of 4 million fish of the species are traded internationally and given the growing popularity of the hobby in Australia, the likely market demand in Australia for imported *D. margaritatus* stock would represent about one percent of this (Jared Patrick, Premier Pet, pers. com.).
 - *Why this species has been chosen:* Internationally, the species is in high demand by hobbyists because aquacultured specimens are very affordable to the average hobbyist. *D. margaritatus* is extremely popular in Australia but is prohibitively priced due to unavailability of imported stock and as a result, beyond the reach of most hobbyists. Permitting importation will mean that the species could be offered at a more affordable price, with associated benefits to the trade and the hobby. The species is not aggressive and compatible to keep in aquaria with other tropical species.
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* (DAWE 2020b) and in accordance with the Pet Industry Association of Australia (PIAA) National Code of Practice (PIAA 2008).
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.

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

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 margaritatus* (Roberts 2007) 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
D. margaritatus is not a true schooling species which means that it has a lower likelihood of establishing than schooling species. A moderate to high probability of establishing a self-sustaining population would require deliberate introduction of sufficient numbers of fish by a knowledgeable individual into very specific waterways (given its natural habitat is permanently flooded grassland pools). This is unlikely to happen at random (DAWE 2020a). The possible locations where establishment may occur are generally remote from populated areas; this includes areas in Arnhem Land and far Northern Australia. It is highly unlikely that enough fish would be accidentally or deliberately released into a suitable receiving environment to establish a breeding population.

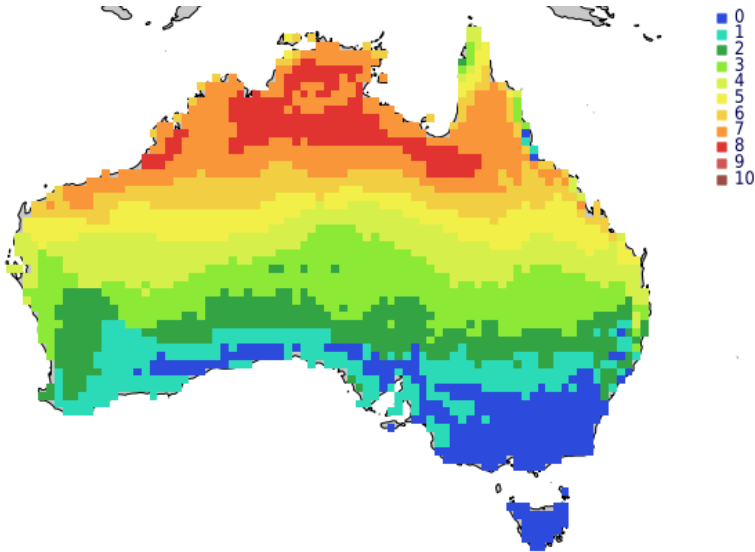
If permitted importation *D. margaritatus* would be freely available in Australia through aquarium stores. The species would be common enough in Australia that theft due to lack of availability is unlikely.

Only a very deliberate and planned release might result in establishment of the species, although the limited potentially suitable habitats and their remoteness from populated areas makes this scenario highly unlikely.

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

Climatch (v1.0) was run with the source region set conservatively to circumscribe weather stations around Inle Lake in central-eastern Myanmar from where the species was described by Roberts 2007 and the broader extant and probably extant geographical range described in the IUCN species assessment (Vishwanath 2012). A climate match prediction was generated using the Euclidian algorithm applied to the 'world stations' data set (Figure 1). Climatch calculated a 'value X' (Climate Euclidian Sum Level 5) of 1033, 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	293	299	343	458	359	247	246	365	175	0	0

Figure 1 Climatch output for *Danio margaritatus*

History of establishment elsewhere—previous successful establishment:

There is no evidence that the species has established outside its known natural range, despite being actively traded internationally for many years. *D. margaritatus* is found in a part of the Salween basin, namely the Nam Lang and Nam Pawn Rivers in central-eastern Myanmar. It is a tropical pelagic species inhabiting small and shallow ponds, at most 30 cm deep and is not known to have spread beyond this within Myanmar/Thailand or elsewhere in the world despite likely inadvertent or deliberate introductions as an internationally traded aquarium species. The species is considered to have been “introduce but never established” (Bomford 2008).

Overseas range:

The species is found east of Taunggyi, Myanmar. Its habitat is part of the Salween basin (Nam Lang and Nam Pawn rivers). It is also found in the Shan plateau (Salween River basin) east of Inle, as well as the northwest corner of Thailand adjacent to the border with Myanmar (Vishwanath 2012). It is considered conservatively to occupy a total 4, 1o latitude x 1o longitude grid squares (Bomford 2008).

Introduction success:

The species is not known to have been released or established. However, after over 13 years of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction 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. margaritatus belongs to the family Cyprinidae (freshwater fish that includes the carps, the true minnows, and their relatives such as barbs and barbels) and the subfamily Danioninae. There are four ornamental cyprinid species that have been 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). If the Bomford (2008) methodology is applied to the genus *Danio*, then of a total 26 species, 6 are traded as ornamental species and of this 6, there are 12 reported populations (representing two species) that have been found established 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 50 introductions for the purposes of this risk assessment, and this level of introductions has resulted in 12 established populations of two species. The ‘genus level’ taxa risk is therefore 2/50 (4%). Notably, *Danio albolineatus* a species similar to *D. margaritatus* is on the current list of specimens taken to be suitable for live import, have been imported to Australia for many decades and have not established wild populations.

Potential impacts of established feral populations

In the unlikely event this species establishes in the wild in Australia, *Danio margaritatus* may compete with other small omnivores in tropical waters (22-24°C), typically in still (pond), well vegetated habitats. As this species inhabits heavily vegetated ponds it could potentially compete with various species of blue-eyes (*Pseudomugil* spp.) and juvenile species of mid-water fish such as *Crateropcephalus* and *Melanotaenia* spp. *Danio margaritatus* has not been reported to change its environment or habitat. It is a tropical pelagic species inhabiting small, well vegetated, shallow ponds, at most 30 cm deep and maintained by seepage or springs. *Danio margaritatus* has not been reported to pose any threat to agricultural crops or pose a threat as a predator. There are no reports of this species exhibiting any behaviours that may cause land degradation, nor has the species been reported as posing any threat to humans.

Danio margaritatus poses a minor impact risk to the Australian environment as they have been freely traded internationally for many years with no evidence of establishment of feral populations or 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	Rasbora galaxy
Scientific name	<i>Danio margaritatus</i>
Date assessed	10 October 2020
Literature Search Type and Date:	FishBase October 2020

Risk criterion	Value	Explanation
A. Climate Match Score (1–8)	6	Climatch (v1.0) Euclidian Sum Level 5 (Value X) = 1033. This value equates to a climate match score of 6.
B. Overseas Range Score (0–4)	1	Applying an estimate of four, 1-degree grid squares; score = 1
C. Establishment Score (0–3)	0	The species is considered to have been “introduce 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 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)	1	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. If the Bomford (2008) methodology is applied to the genus <i>Danio</i> , then of a total 26 species, 6 are traded as ornamental species and of this 6, there are 12 reported populations (representing two species) that have been found established 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 in the past, and this level of introductions has resulted in the relatively few (12) established populations of two species, then the ‘genus level’ taxa risk is 2/6 (33%), i.e. a taxa risk score of 3.

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. margaritatus* is added to the Live Import List.