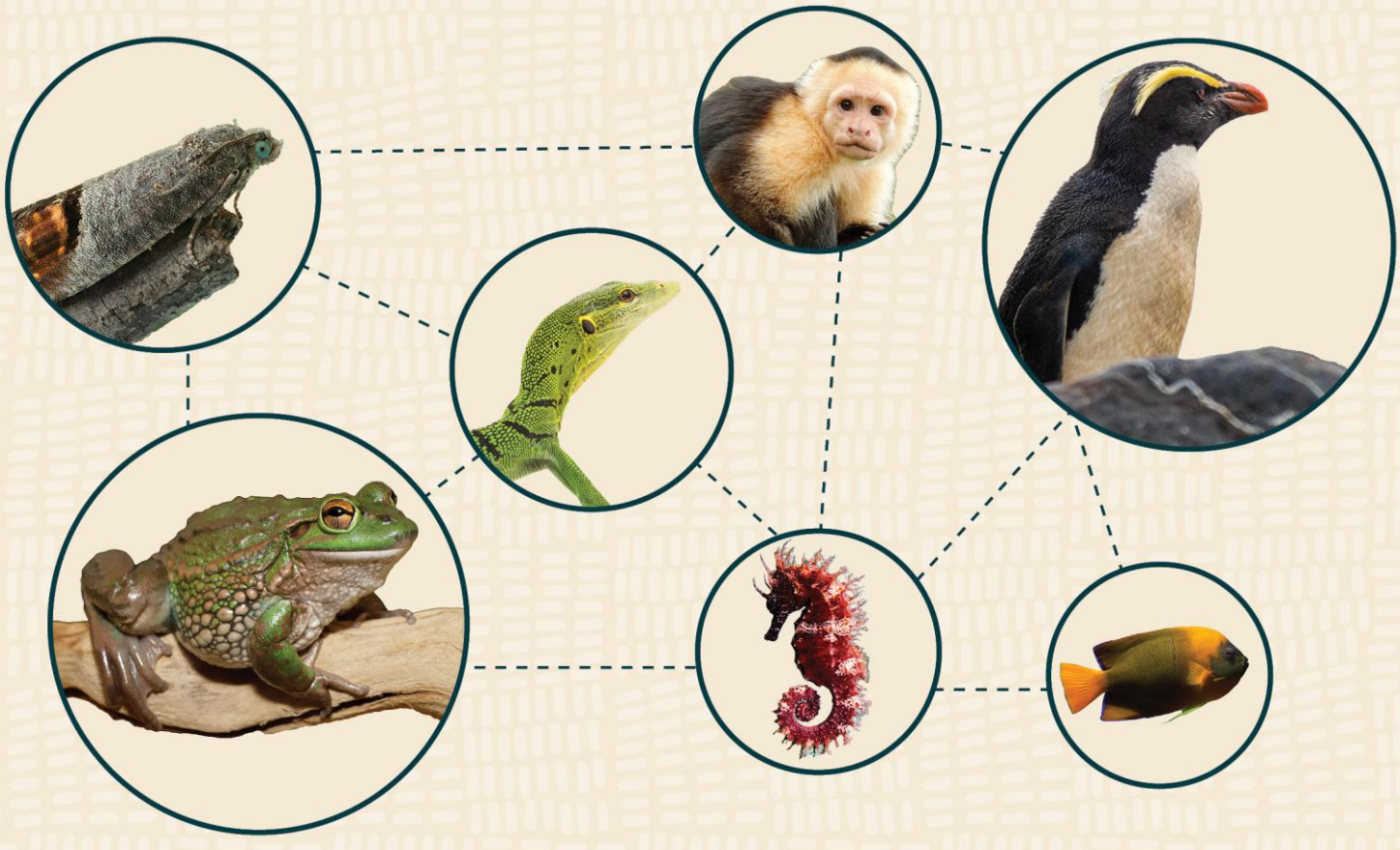
Australian Government
Department of Climate Change, Energy, the Environment and Water

Assessment of the Potential Impacts of *Dawkinsia denisonii* (torpedo barb) on the Environment

Consideration of an application under the *Environment Protection and Biodiversity Conservation Act 1999* to amend the List of Specimens taken to be Suitable for Live Import

September 2024



© Commonwealth of Australia 2024

Ownership of intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights) in this publication is owned by the Commonwealth of Australia (referred to as the Commonwealth).

Creative Commons licence

All material in this publication is licensed under a Creative Commons Attribution 4.0 International Licence except content supplied by third parties, logos and the Commonwealth Coat of Arms.

Inquiries about the licence and any use of this document should be emailed to copyright@dcceew.gov.au.



Cataloguing data

This publication (and any material sourced from it) should be attributed as: DCCEEW 2024, *Assessment of the Potential Impacts of* Dawkinsia denisonii *(torpedo barb) on the Environment*, Department of Climate Change, Energy, the Environment and Water, Canberra, CC BY 4.0.

Department of Climate Change, Energy, the Environment and Water
GPO Box 3090 Canberra ACT 2601
Telephone 1800 900 090
Web dcceew.gov.au

Disclaimer

The Australian Government acting through the Department of Climate Change, Energy, the Environment and Water has exercised due care and skill in preparing and compiling the information and data in this publication. Notwithstanding, the Department of Climate Change, Energy, the Environment and Water, its employees and advisers disclaim all liability, including liability for negligence and for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying on any of the information or data in this publication to the maximum extent permitted by law.

Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

Executive summary

An application was submitted to the Department of Climate Change, Energy, the Environment and Water to amend the List of Specimens taken to be Suitable for Live Import (Live Import List) to include *Dawkinsia denisonii* (torpedo barb). The application was prepared in accordance with section 303EE of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The applicant proposes to import this species for the ornamental freshwater fish trade in Australia.

A risk assessment was undertaken to evaluate the likelihood of establishment and spread in Australia, and the potential consequences of these impact(s) on the Australian environment. Several factors were considered during the assessment, including, but not limited to, available scientific evidence, biological and ecological traits of the species, environmental conditions for establishment (current and potential distribution of the species), conservation status, and potential impacts in the event of the establishment or spread of the species.

Dawkinsia denisonii is a species of cyprinid fish endemic to fast-flowing streams and rivers of the Western Ghats in India. It is commonly seen in the aquarium trade. *D. denisonii* has not established outside its natural range and is not considered an invasive pest, although several closely related species have established self-sustaining populations outside their natural range, including in Australia. Results from the risk assessment indicate that *D. denisonii* poses an unknown risk to the Australian environment. There is a lack of scientific understanding of this species, with little information on its micro-level distribution, ecology and demography.

After critically examining and reviewing all available evidence and information, DCCEEW has determined that the scientific knowledge on this species is inadequate to allow reliable predictions of the impacts and consequences of establishment. Given the threat of serious or irreversible environmental harm and the scientific uncertainty as to the environmental damage, the minister must take account of precautionary principle in making a decision on amending the Live Import List to include *D. denisonii*. DCCEEW therefore does not recommend including it in the Live Import List for commercial trade.

Several stakeholders sought advice of the likely pathways through which these fish species have arrived in Australia or suggested that the species was illegally imported. DCCEEW has been advised that *D. denisonii* can be challenging to differentiate from other species at the border. DCCEEW has formed the view that there is value in allowing limited import to facilitate improved identification of this species at the border. Strict conditions are necessary to ensure specimens are imported for this purpose only.

DCCEEW **does not recommend** listing *Dawkinsia denisonii* in Part 1 of the Live Import List for commercial trade but **recommends** listing *Dawkinsia denisonii* on Part 2 of the Live Import List, with the conditions:

- For identification purposes only. High security facilities only. Specimens bred in captivity only.

Contents

Executive summary ..... **ii**

1 Introduction **1**

1.1 Purpose of the proposed import 1

1.2 Background on the Act 1

2 Biology and ecology **2**

2.1 Taxonomy 2

2.2 Description 2

2.3 Geographic distribution 3

2.4 Habitat 4

2.5 Diet 4

2.6 Reproductive biology 5

2.7 Environmental tolerances 5

2.8 Hybridisation 5

3 Current status in Australia **7**

3.1 History in Australia 7

3.2 Related Live Import List listings 8

3.3 Related threat category listings 8

3.4 Conservation status 8

4 Risk assessment **10**

4.1 The Bomford risk assessment model 10

4.2 Bomford model results 17

4.3 Consequences for the environment 17

4.4 Risk rating 21

4.5 Consultation – concerns raised 21

4.6 Risk mitigation 23

5 Discussion **24**

6 Conclusion **27**

Appendix A: Impacts assessment scoring criteria **30**

Appendix B: Comments received on the proposal to include *Dawkinsia denisonii* on the Live Import List 36

Glossary **45**

References **46**

Tables

Table 1 Preferred and tolerable ranges of environmental parameters 5

Table 2 Non-endemic *Dawkinsia* and *Puntius* species on the Live Import List 8

Table 3 Environmental tolerances of established ornamental species in Australia, with comparisons to *Dawkinsia denisonii*. 11

Table 4 Species from the genus *Dawkinsia* that have been introduced outside their range 14

Table 5 Cyprinidae species that have been introduced outside their range 15

Table 6 Bomford exotic freshwater fish model results for *Dawkinsia denisonii* 17

Table 7 Significance of impacts from the potential establishment of *Dawkinsia denisonii* populations in Australia 18

Table 8 Considerations when forming a Live Import List recommendation for Dawkinsia denisonii .. 28

Table 9 Impacts assessment scoring criteria adapted from Kumschick et al. (2012) and Nentwig et al. (2016) 30

Table 10 Comments received during public consultation and response from applicant 36

Table 11 Comments received during consultation with relevant state and territory government agencies. 43

Figures

Figure 1 *Dawkinsia denisonii* 3

Figure 2 Geographic distribution of *Dawkinsia denisonii* 4

Figure 3 *Dawkinsia denisonii* (left) and *Rasbora trilineata* (right) 7

Figure 4 Australian climate-matching map for *Dawkinsia denisonii* 11

Figure 5 Köppen-Geiger climate map of India 12

Figure 6 Köppen-Geiger climate map of Australia 13

Figure 7 Overseas range score for *Dawkinsia denisonii*, with distribution spanning six 1-degree grid squares 13

1 Introduction

1.1 Purpose of the proposed import

An application was submitted by the Aquarium Industry Association of Australia (AIAA) to amend the Live Import List to include *Dawkinsia denisonii* (the application was made under the previous scientific name *Sahyadria denisonii*). The applicant proposes to import this species for the ornamental freshwater fish trade in Australia.

1.2 Background on the Act

Under section 303EC of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the responsible minister may amend the List of Specimens taken to be Suitable for Live Import (Live Import List) by, relevantly, including a specimen in the list. Section 303EB of the EPBC Act dictates two parts to the Live Import List:

- Part 1 comprises specimens that can be imported without a permit under the EPBC Act. Part 1 must not include any organism listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); and
- Part 2 comprises specimens that require a permit under the EPBC Act to be imported. For each specimen included in Part 2 of the list there is to be a notation regarding whether the inclusion is subject to restrictions or conditions. Restrictions or conditions may relate to a quantitative limit, the circumstances of import, the source of the specimen or the circumstances in which it was taken. Additional conditions may also be applied when the permit for import is issued.

Before amending the Live Import List, the minister must consult with appropriate state, territory and Commonwealth ministers and may consult with other persons as appropriate and consider a report assessing the potential environmental impacts of the proposed amendment (s 303EC of the EPBC Act). When applying to DCCEEW to amend the Live Import List, all applicants are required to provide a draft assessment report that addresses specific Terms of Reference published on DCCEEW's website.

DCCEEW undertakes an assessment of the potential environmental impacts of the proposed amendment using the information in the applicant's draft report and any other sources of relevant information. DCCEEW also considers comments and information received through the public consultation process (including states and territories). The applicant's report addressing the Terms of Reference for the proposed import of *Dawkinsia denisonii* was released for public comment between 16 February and 7 April 2021. This assessment report on the potential environmental impacts of listing the species was prepared as required by section303EE(3), in accordance with 303EF of the EPBC Act. Under para 303EC(5)(a) the minister must consider this report before amending the list.

The minister must also consider the precautionary principle when making a decision to amend the Live Import List to include an item to the list, in accordance with section 391(1) of the EPBC Act.

2 Biology and ecology

2.1 Taxonomy

Dawkinsia denisonii has been extremely popular in the aquarium trade since the late 1990s. It was first described as a member of the genus *Labeo* and has also been placed in *Barbus, Crossocheilus* and most recently *Puntius*. It was resolved in the genus *Sahyadria* (Raghavan et al. 2013a), but it has recently been placed in the genus *Dawkinsia* (Arunkumar and Manimekalan 2018, Ren et al. 2020, Van der Laan, Eschmeyer and Fricke 2022). Common names for *D. denisonii* include Denison barb, torpedo barb, red line torpedo barb, Miss Kerala, red comet barb, redline barb, roseline shark, Denison's flying fox and bleeding eye barb.

Kingdom:	Animalia
Phylum:	Chordata
Superclass:	Osteichthyes
Class:	Actinopterygii
Infraclass:	Teleostei
Order:	Cypriniformes
Family:	Cyprinidae
Genus:	*Dawkinsia*
Species:	*Dawkinsia denisonii* (Day 1865)
Synonyms:	*Labeo denisonii*, *Barbus denisonii*, *Crossocheilus denisonii*, *Puntius denisonii*, *Sahyadria denisonii*

2.2 Description

There is a paucity of data relating to this species, particularly with regards to the species' ecology and behaviour. A search for the species name (including both *Sahyadria denisonii* and *Puntius denisonii*, the genera to which it previously belonged (Raghavan et al. 2013a)) in Google Scholar, Semantic Scholar and ResearchGate resulted in a total of 31 species-specific papers and 22 papers in which the species was mentioned. Of the 31 papers specifically related to this species, 18 were in the area of captive breeding (techniques, health/veterinary procedures, reproductive or growth parameters); 6 papers discussed the species' conservation status; 4 discussed taxonomy; and only 3 discussed any aspect of their ecology in the wild.

Sizes in the wild populations range from 33 mm up to a maximum of 190 mm in total length, with the most common length being 50-60 mm (Solomon et al. 2011, Sajan, Mercy and Malika 2015).

Studies of the species in different river systems indicate stock-specific variation in population structure (Sajan, Mercy and Malika 2015).

Dawkinsia denisonii is characterised by a torpedo-shaped silver body. Colour pattern comprising an upper red stripe extending from snout to midbody, a wide blackish lateral stripe extending along the lateral line from snout to caudal-fin base, a yellow stripe extending from the operculum to the hypural region between the black and scarlet stripes, caudal fin lobes with oblique black bands covering the posterior quarter and subterminal oblique yellow bands, dorsal fin with or without a black blotch. It has two dorsal spines; dorsal fin with 3-4 unbranched and eight branched rays, posterior branched ray sometimes bifurcate at the base giving the appearance of a 9th branched ray; anal fin with 2-3 unbranched and five branched rays; lateral line complete, with 26–28 pored scales (Seriously Fish 2022). Juveniles with scarlet pigmentation on the anterior dorsal-fin rays (Seriously Fish 2022, Figure 1). As they mature, the top of the body becomes greener, and a distinctive green/blue marking develops on top of the head. It is of note that there is a high level of genetic divergence among geographically separated populations of *D. denisonii,* suggesting the possibility of at least two cryptic species within them (John, Peter and Gopalakrishnan 2013).

Identification of this species is difficult, as it has similarities to *Dawkinsia chalakkudiensis*, only differentiated by mouth position, absence of a black marking in the dorsal-fin and a brighter scarlet body stripe terminating beneath the centre of the dorsal-fin.

Figure 1 *Dawkinsia denisonii*

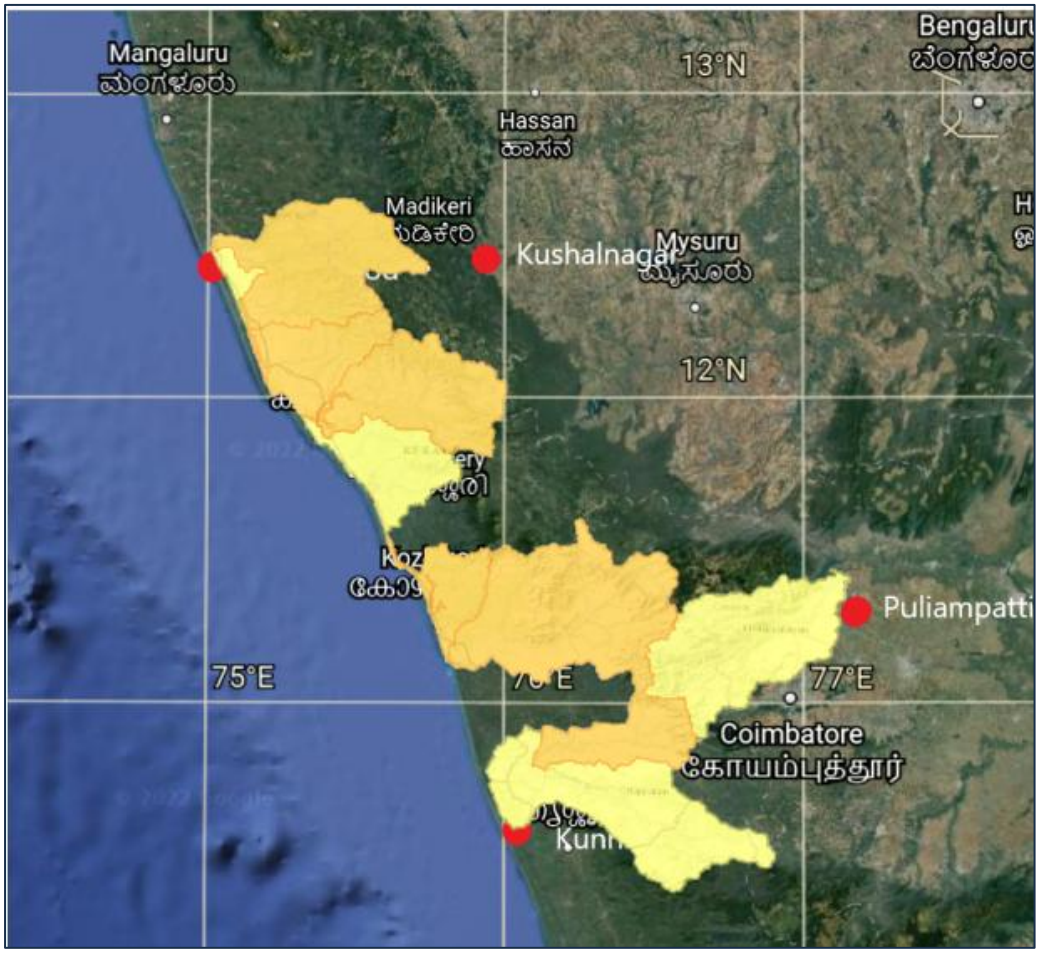


Source: Creative Commons Attribution-Share Alike 3.0

2.3 Geographic distribution

D. denisonii is endemic to Kerala and south Karnataka in southern India and has a fragmented range across less than 300 km^2 (Ali, Raghavan and Dahanukar 2015, Figure 2). Its modern distribution is highly fragmented with small populations remaining in 14 small westward-flowing river systems draining the Western Ghats (Raghavan et al. 2013a).

Figure 2 Geographic distribution of *Dawkinsia denisonii*, (Karnataka State south-west India)



Key: Orange = Extant, Yellow = probably extant.

Source: Google Earth, Ali, Raghavan and Dahanukar (2015)

2.4 Habitat

D. denisonii is a stream and river dwelling fish with an affinity towards rocky pools and stream edges with thick overhanging vegetation along banks (Ali, Raghavan and Dahanukar 2015). However, it has also been observed from riverine habitats including run, glide and riffles with sand, gravel, cobble and boulder substrates (Ali, Raghavan and Dahanukar 2015).

2.5 Diet

The applicant claims they are herbivorous as per Raghavan et al. (2009), but this paper cites that this was preliminary information extracted from the grey literature. Other literature reports that *D. denisonii* are omnivorous, feeding on a variety of worms, insects, crustaceans, plant material, and other organic debris (Mercy et al. 2007, Mahadevi et al. 2020).

2.6 Reproductive biology

D. denisonii is a gregarious, shoaling species (Ali, Raghavan and Dahanukar 2015) with a relatively short life cycle and a fast growth rate. The sex ratio in wild aggregations of mature fish is highly skewed favouring males (1:25, Raghavan et al. 2009).

Spawning occurs from October to March (mainly during November to February) (Solomon et al. 2011, Sajan, Mercy and Malika 2015). Fertilisation is external; all fish in this family are egg-layers and like most cyprinids, this species does not show parental care. The fertilised eggs of *D. denisonii* are heavily yolked, transparent, spherical and yellow in colour. The eggs are adhesive, like other *Puntius* species, the genus in which the species was historically classified (Mercy, Sajan and Mailka 2015).

Individuals mature from May to July with peak maturity in June (Radhakrishnan and Kurup 2005). Solomon et al. (2011) reported size at first maturity to be 95 mm for females and 85 mm for males, approximating to 1+ year class fish (12-18 months old).

D. denisonii is capable of producing 293-1098 ova per female (Solomon et al. 2011, Mercy, Sajan and Mailka 2015)

D. denisonii has been reported to live for approximately 3.75 years (Sajan, Mercy and Malika 2015)

D. denisonii is capable of doubling its population in less than 15 months (Froese and Pauly 2022).

2.7 Environmental tolerances

A stream and river-dwelling species that thrives in subtropical climatic conditions. The species prefers water with a 6.5-7.8 pH, a water hardness of 90-447 ppm and a temperature range of 15-25 °C (Seriously Fish 2022). However, these are preferred ranges in an aquarium, and tolerable parameters may exceed these figures. For example, adults have spawned in waters that were softer and more acidic than the stated preferred ranges (pH 5.7, Seriously Fish 2022).

Table 1 Preferred and tolerable ranges of environmental parameters

Water quality factor	Preferred ranges [a]	Tolerable ranges
Temperature	15 –25°C	Unknown
pH	6.5 – 7.8	Unknown
dH (hardness)	90 – 447	Unknown
Alkalinity	Unknown	Unknown
Carbon dioxide	Unknown	Unknown
Dissolved oxygen	Unknown	Unknown

a Seriously Fish (2022)

2.8 Hybridisation

Hybridisation occurs when two individuals from separate species reproduce to form offspring (hybrids). Fish hybrids between closely related species can generally live to adulthood, and some are

fertile, producing functioning gametes and a viable second generation. Those between distantly related species belonging to a different genus or family, on the other hand, have a hard time surviving, and even if they do, most of the hybrids produced lack reproductive ability. Interspecific hybrids have long been used in the aquaculture industry to transfer desirable traits such as increased growth rate or environmental tolerances (Bartley et al. 2000). These hybrids may be selected for aesthetic reasons, growth rate, or even to be fraudulently passed off as species with a high market value (Ng 2010). There is also the possibility of accidental, indiscriminate breeding of hybrids at farms.

The applicant did not supply information regarding the potential for hybridisation in this species. There is no scientific literature regarding hybridisation, but it has been selectively bred by ornamental breeders to produce a 'veil tail' form and a 'golden' form and has also been hybridised with other *Dawkinsia* species (Katwate et al. 2014).

3 Current status in Australia

3.1 History in Australia

There is very little information available on the status of this species in Australia. The species is not reported to have established self-sustaining populations in the wild in Australia (Corfield et al. 2008), though the applicant states it has been bred and traded domestically in Australia for decades, possibly due to inadvertent import because of misidentification with closely related species. *D. denisonii* may bear a resemblance to other species, including *Rasbora trilineata* which is listed in Part 1 of the Live Import List and is therefore unregulated, and these 2 species have been flagged as particularly challenging to differentiate by officers who inspect fish at the border. Whilst healthy adult specimens of a certain size can be distinguished, transportation induces physiological stress requiring prolonged recovery, and stress-induced changes in skin or eye colour are reported, making accurate identification even more challenging (Hungtingford et al. 2006).

It should be noted that, as the specimen is not listed on the Live Import List, it is an offence under section 303GN of the EPBC Act for any person to possess a specimen or the progeny of such specimens.

The introduction of new aquatic species is inherently difficult to monitor as, unlike the spread of a land-based invasive species, alien fish often have the advantage of proliferating significantly before being detected (Ebner et al. 2020). The detection of invasive species is further hindered in remote, infrequently visited areas like northern Australia, where regular flooding events in the wet season assist the spread of alien aquatic species.

Figure 3 *Dawkinsia denisonii* (left) and *Rasbora trilineata* (right)



Source: Creative Commons

3.2 Related Live Import List listings

There are currently 5 non-endemic *Puntius* species listed on Part 1 of the Live Import List (Table 2).

Table 2 Non-endemic *Dawkinsia* and *Puntius* species on the Live Import List

Scientific name	Common name(s)
Dawkinsia arulius	longfin barb, Arulius barb
Puntius bimaculatus	two spot barb, redside barb
Dawkinsia filamentosa	black spot barb
Puntius titteya	cherry barb
Puntius vittatus	Kooli barb, greenstripe barb

3.3 Related threat category listings

Within its native habitat in India, *D. denisonii* is not considered a pest. This species is not considered invasive or a pest on the National Priority List of Exotic Environmental Pests, Weeds and Diseases.

3.4 Conservation status

D. denisonii is one of the most sought after and exported Indian native ornamental fish (Adikari et al. 2018) and has been indiscriminately collected for the aquarium pet trade (Bijukumar et al. 2013), with over 300,000 wild-caught fish exported from India between 2005 and 2012 (Raghavan et al. 2013b). Their low abundance, gregarious and aggregating nature, easily accessible habitats, together with an increasing market demand and popularity, make *D. denisonii* particularly vulnerable to overfishing (Raghavan et al. 2009).

Despite being listed as Endangered, high demand for this species has resulted in unlawful exploitation and subsequent population reduction. Local wild populations show high mortality rates, and fish are exploited before reaching maturity leading to unsustainable levels of exploitation, and populations facing impending collapse (Raghavan et al. 2018). To allow *D. denisonii* to mature before they are collected for trade, Raghavan et al. (2018) suggested a minimum size limit of 110 mm be set for wild caught specimens.

Captive breeding and larval rearing programs have been initiated by some fisheries research institutes to reduce the pressure on wild stocks (Prasad, Ali and Raghavan 2008, Adikari et al. 2018). Captive breeding of *D. denisonii* requires induced breeding and artificial fertilisation techniques (Mahadevi et al. 2020).

3.4.1 Convention on International Trade in Endangered Species (CITES)

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species.

D. denisonii is not CITES-listed.

3.4.2 IUCN Red List of Threatened Species

Established in 1964, the International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species is the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.

D. denisonii was assessed by Ali, Raghavan and Dahanukar on 6 July 2010 as Endangered A2acde+3cde; B2ab(iii) with a declining population (published in 2015). This was justified as populations have declined by more than 50% in the recent past due to indiscriminate exploitation for the international aquarium pet trade. These declines are expected to continue in the foreseeable future unless local management plans, as well as national and international legislations are created and implemented. The species also has a restricted range with an area of occupancy of less than 300 km² with continuing decline in quality of key habitats (Ali, Raghavan and Dahanukar 2015).

3.4.3 Convention on the Conservation of Migratory Species of Wild Animals

The Convention on the Conservation of Migratory Species of Wild Animals is an environmental treaty of the United Nations. It provides a global platform for the conservation and sustainable use of migratory animals and their habitats.

D. denisonii is not listed on the Convention on the Conservation of Migratory Species of Wild Animals.

4 Risk assessment

4.1 The Bomford risk assessment model

Modelling is used to assesses the risk of *D. denisonii* establishing and spreading in Australia, and any likely impacts on the Australian environment.

The likelihood of *D. denisonii* establishing was assessed under the Bomford Risk Assessment Model (Bomford 2008 - Chapter 4. Freshwater Fish) in accordance with the five key risk factors:

- Climate match
- Overseas Range Score
- Establishment Overseas
- Introduction Success
- Taxa Risk

Using information compiled from research into the above factors for *D. denisonii*, the potential impacts of the establishment of feral populations can be estimated.

4.1.1 Climate match

Climatch was used to assist in identifying possible suitable habitat in Australia that the species could inhabit if released.

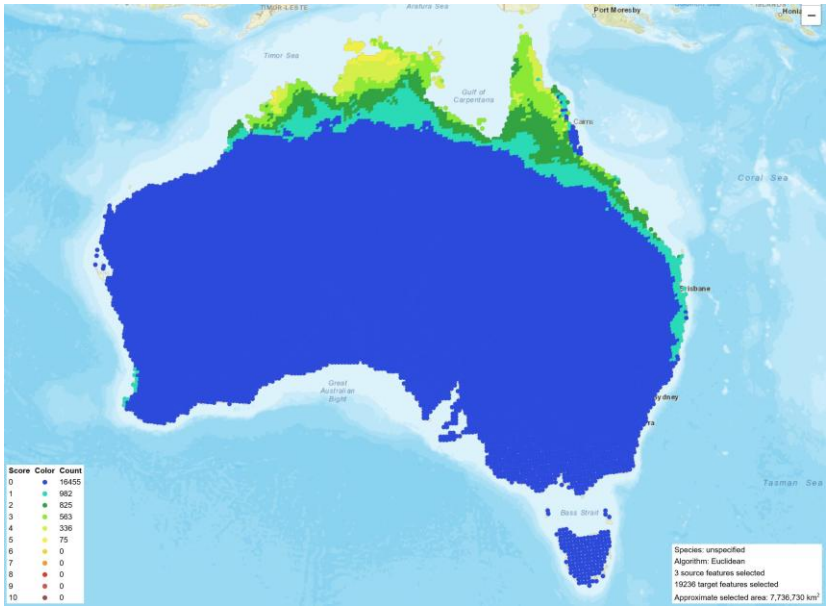
The Climatch map for this species generated from the distribution cited in Ali, Raghavan and Dahanukar (2015) indicates a low climate match for the majority of Australia (Figure 4). Climatch calculated the level of climate matching at Euclidian Sum Level 5 to be 75 that gives a closest match score of 2, **low**. However, for fish species, around 20 input points are usually sufficient to give a fairly accurate climate match score (Bomford et al. 2010), but if the input area has 12 or fewer meteorological stations, then it is likely to underestimate the climate match to Australia (Bomford et al. 2010; Bomford 2008). There were only 3 meteorological stations used for *D. denisonii* and when there are less than 12 meteorological stations used Bomford (2008) recommends the score is increased by +1, this would give a score of 3, still **low**.

It is of note that Climatch is based on terrestrial climate data and the target species is a freshwater fish, therefore the generated map is not a completely accurate indicator of possible inhabitation. Arthington et al. (1999) considered that temperature is the most limiting environmental factor in Australia's freshwater that affects exotic finfish establishment. Water temperature is a major determinant of whether exotic fish establish breeding populations (Nico et al. 2019).

Two specimens previously classified as *Puntius* (*Puntigrus tetrazona* and *Pethia conchonius*) have successfully established in Australia (Table 3) (Lever, 1996, Gomon, 2024). Both species are from Asia and have comparable temperature, pH and water hardness tolerances to *D. denisonii* (Table 3). Both species have established in locations well outside the Climatch range indicated as a climate match

for *D. denisonii* – for example, *P. conchonius* has established populations in waterways around Brisbane, Queensland, and Margaret River, Western Australia (Corfield et al. 2008). Given the similar environmental tolerances between these species, it would be reasonable to expect that *D. denisonii* would be able to establish in similar habitats.

Figure 4 Australian climate-matching map for *Dawkinsia denisonii*



Source: Climatch (ABARES 2020)

Table 3 Environmental tolerances of established ornamental species in Australia, with comparisons to *Dawkinsia denisonii.*

Scientific name	Common name(s)	Habitat	Thermal range (°C)	pH	Water hardness (dGH)	Locations in Australia
Puntigrus tetrazona	tiger barb, Sumatra barb	Moderately flowing streams	20-26	6-8	5-19	Established in the wild, no distributional data available.
Pethia conchonius	rosy barb	Fast flowing streams	18-22	6-8	5-19	Streams in and south of Brisbane (Queensland Government 2022); Margaret River area Western Australia (DPIRD 2022).
Dawkinsia denisonii	torpedo barb	Fast flowing streams	15-25	6.8-7.8	5-25	

Tolerance data sourced from Froese and Pauly (2021), Corfield et al. (2008).

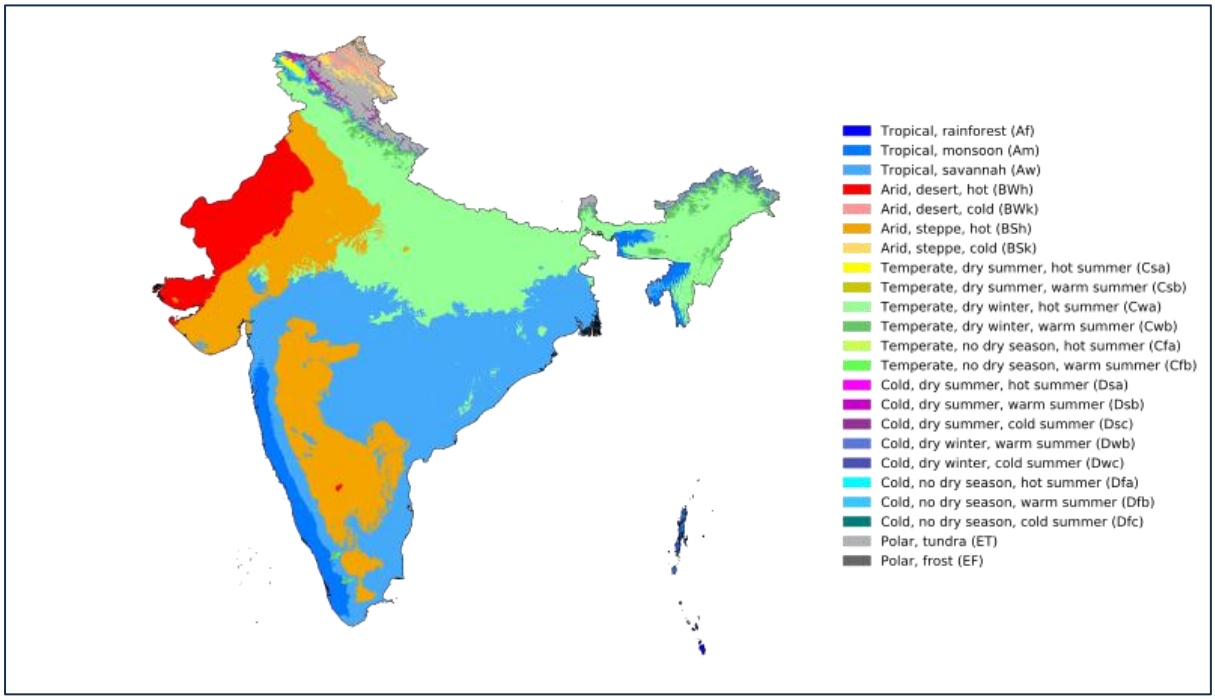
Köppen Geiger

The Köppen-Geiger system classifies climate into five main classes and 30 sub-types and is based on threshold values and seasonality of monthly air temperature and precipitation (Beck et al. 2018). In species distribution models, climate variables are considered the primary driver to explain species ranges at larger spatial extents (Guisan and Zimmermann 2000).

The Köppen-Geiger system was loaded in Google Earth to give a high resolution map of the climate classification areas in relation to the species distribution (Peel et al. 2007).

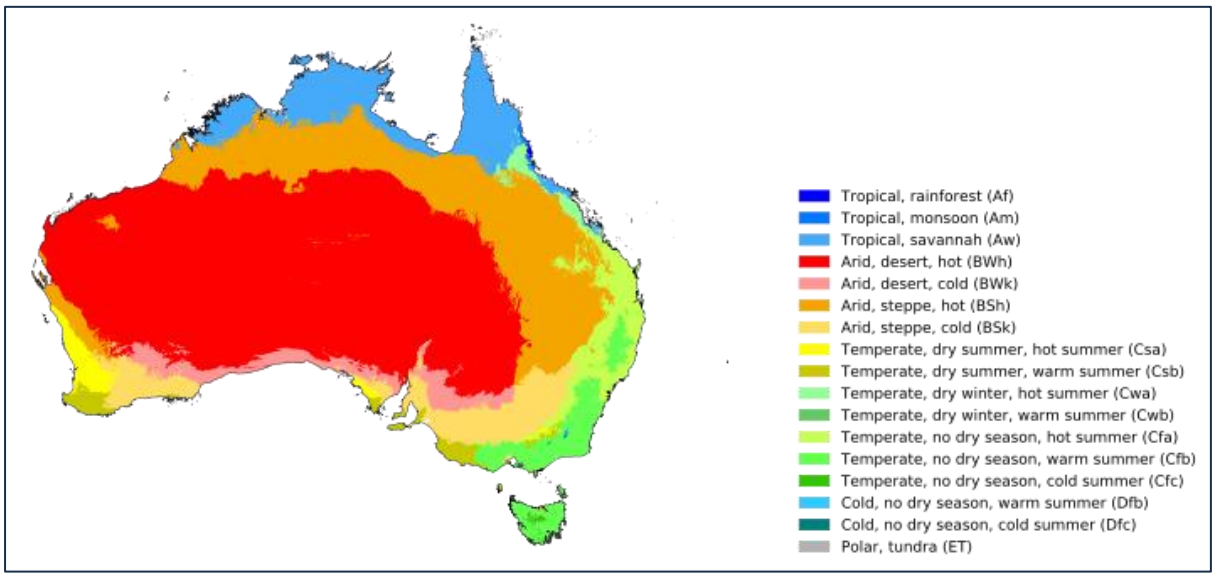
D. denisonii is endemic to Kerala and south Karnataka in southern India, which is represented by 2 climatic zones of the Köppen-Geiger: Am (tropical monsoon) and Aw (tropical savanna, Figure 5**Error! Reference source not found.**). These zones are present in Australia, found throughout the tropical northern areas of Western Australia, the Northern Territory and Queensland (Figure 6**Error! Reference source not found.**). The tropical freshwater ecosystems in northern Australia extend from north-eastern WA across the top end to Cape York in the north and extending south along eastern Queensland to Rockhampton.

Figure 5 Köppen-Geiger climate map of India



Source: Beck et al. (2018)

Figure 6 Köppen-Geiger climate map of Australia

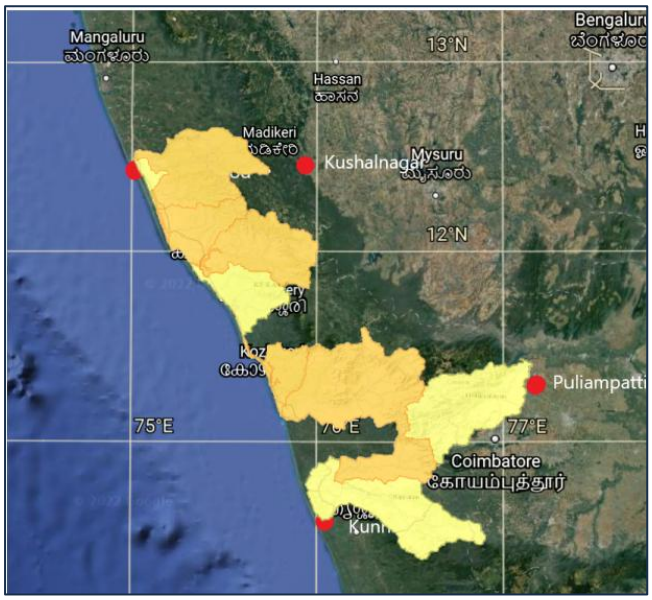


Source: Beck et al. (2018)

4.1.2 Overseas range

The distribution map was overlaid onto Google Earth to enable a count of the number of grid squares (1° latitude x 1° longitude) in which an occurrence of the species is recorded. *D. denisonii* is found in 6 grid squares (Figure 7), resulting in an overseas range **score of 1**.

Figure 7 Overseas range score for *Dawkinsia denisonii*, with distribution spanning six 1-degree grid squares (Karnataka State south west India)



Source: Google Earth, Ali, Raghavan and Dahanukar (2015)

4.1.3 History of establishment elsewhere

A proven history of establishing exotic populations may indicate that a species has attributes that increase the risk of it successfully establishing in other areas (Bomford 2008). *D. denisonii* has been recorded outside of its natural range in Hong Kong (Chan et al. 2023), although it is not clear if the species is successfully breeding or has recently escaped from the aquarium trade.

A risk rank score of **2** is given where there are recorded introductions **'Only established exotic populations on an Island or one continent – Asia'**.

4.1.4 Introduction success

There has been one documented introduction of *D. denisonii* worldwide (Chan et al. 2023), giving a **score of 3.**

4.1.5 Taxonomic group history of invasiveness

For fish species with a history of introductions to new areas, or with relatives in the same genus or family with such a history, previous establishment success rates should be considered a key predictor of future establishment success. The taxa risk score is either a species' genus risk score, if there are greater than or equal to 4 introduction events for the species' genus, or a species' family risk score, if there are less than 4 introduction events (Bomford 2008).

Genus *Dawkinsia*

There are 11 species in the genus *Dawkinsia* (including the 2 species formerly included in the *Sahyadria* genus). There are 2 records of introductions of *Dawkinsia* species outside their natural range (Table 4). *D. filamentosa* has established populations in Hawaii; and *D. arulius* was introduced to the Philippines but it is unknown if it has established.

Table 4 Species from the genus *Dawkinsia* that have been introduced outside their range

Scientific name	Common name	Total number of introductions	Number of successful introductions [a]
Dawkinsia arulius	arulius barb	1	unknown
Dawkinsia filamentosa	blackspot barb	1	1
TOTAL		**2**	**1**

a Where introduction has occurred, but establishment is 'Unknown', it is not counted as a successful introduction.
Source: Froese and Pauly (2022)

Family Cyprinidae

Given that there are less than 4 reports of introductions at the genus level, it is appropriate to assess the risk at the Family level (Bomford 2008). *D. denisonii* is a member of the large and diverse Cyprinidae family, comprising over 1700 species divided into 370 genera. Sixty-three species have been introduced outside their natural range (Froese and Pauly 2022, Table 5).

The Cyprinidae family includes a number of highly invasive fish species that have established populations in Australia, including the carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*). The

International Union for Conservation of Nature has named carp one of the world's most invasive fish species. On every continent where it has been introduced, it has reduced water quality and degraded aquatic habitats (Koehn, Brumley and Gehrke 2000). Carp impact on biodiversity and have decimated native fish populations in many areas since they first became established. Carp dominates the country's largest river basin, the Murray Darling Basin, making up to 80-90% of fish biomass (Boutier et al. 2019).

The ornamental goldfish, *Carassius auratus*, now has an almost worldwide range. It was imported to Australia in 1876 as an ornamental fish and is now possibly one of the most widespread of the exotic species introduced to Australia. It appears in most freshwater systems in the southern half of Australia, extending from the Fitzroy River in Queensland, throughout New South Wales, Victoria, and South Australia in the inland Murry-Darling system and Cooper Creek, to the south-west of Western Australia (Centre for Invasive Species Solutions 2012). The taxa risk **score is 5, extreme (>60%).**

Table 5 Cyprinidae species that have been introduced outside their range

Scientific name	Common name(s)	Total number of introductions	Number of successful introductions [a]
Balantiocheilos melanopterus	tricolor sharkminnow	4	?
Barbodes binotatus	spotted barb	2	2
Barbodes lateristriga	spanner barb	2	1
Barbodes rhombeus		1	1
Barbodes semifasciolatus	Chinese barb	4	2
Barbonymus gonionotus	silver barb	11	8
Barbonymus schwanefeldii	tinfoil barb	6	2
Barbus balcanicus	Danube barbel	1	1
Barbus barbus	barbel	3	3
Barbus cyclolepis	round-scaled barbell	2	2
Barbus meridionalis	Mediterranean barbel	2	2
Barbus peloponnesius		1	1
Barbus plebejus		1	0
Capoeta buhsei		1	?
Capoeta capoeta	Seven khramulya	2	0
Capoeta sevangi	Sevan khramulya	1	0
Capoeta tinca	Anatolian khramulya	1	0
Carasobarbus apoensis		1	0
Carasobarbus canis		1	1
Carassius auratus	Goldfish	88	81
Carassius carassius	Crucian carp	24	14
Carassius cuvieri	Japanese white crucian carp	3	2
Carassius gibelio	Prussian carp	19	17
Cirrhinus cirrhosus	Mrigal carp	15	7
Cirrhinus molitorella	Mud carp	10	2

Scientific name	Common name(s)	Total number of introductions	Number of successful introductions [a]
Cyprinion acinaces		1	0
Cyprinus carpio	common carp	173	135
Dawkinsia arulius	Arulius barb	1	?
Dawkinsia filamentosa	blackspot barb	1	1
Desmopuntius johorensis	striped barb	1	?
Enteromius anoplus	chubbyhead barb	1	1
Epalzeorhynchos bicolor	redtail sharkminnow	1	?
Epalzeorhynchos frenatum	rainbow sharkminnow	1	?
Epalzeorhynchos kalopterum	flying fox	1	?
Gibelion catla	catla	16	6
Hampala macrolepidota	hampala barb	2	1
Hypsibarbus pierrei		1	1
Labeo bata	Bata	1	1
Labeo calbasu	orangefin labeo	1	1
Labeo chrysophekadion	black sharkminnow	2	0
Labeo rohita	Roho labeo	17	5
Labeobarbus aeneus	Smallmouth yellowfish	1	1
Labeobarbus kimberleyensis	Largemouth yellowfish	1	0
Labeobarbus natalensis	Scaly	1	1
Luciobarbus graellsii		1	1
Neolissochilus hexagonolepis	opper mahseer	1	?
Oliotius oligolepis	Checkered barb	2	1
Osteochilus vittatus	Bonylip barb	2	1
Pethia conchonius	Rosy barb	8	4
Pethia gelius	golden barb	3	2
Pethia nigrofasciata	Black ruby barb	1	1
Puntigrus partipentazona		1	1
Puntigrus tetrazona	tiger barb, Sumatra barb	9	5
Puntius sachsii	goldfinned barb	1	?
Puntius sealei		1	1
Puntius sophore	pool barb	1	1
Puntius titteya	cherry barb	3	2
Puntius vittatus	greenstripe barb	1	?
Schizothorax richardsonii	snowtrout	1	?
Systomus pleurotaenia	black lined barb	1	?
Systomus rubripinnis	Javaen barb	2	1
Tor putitora	putitor mahseer	3	1
Tor tor	Tor barb	1	0
TOTAL		**473**	**325 (69%)**

a Where introduction has occurred, but establishment is 'Unknown', it is not counted as a successful introduction.
Source: Froese and Pauly (2022)

4.2 Bomford model results

Results from the Bomford model (2008) for *D. denisonii* are presented in Table 6. An exotic finfish species' establishment risk score is calculated from the sum of the five scores as detailed in section 4.1. This risk assessment and its results should be evaluated with additional information and data when it becomes available.

Table 6 Bomford exotic freshwater fish model results for *Dawkinsia denisonii*

Scores	Value	Explanation
A: Climate Match (1-8)	3	**Low** If there are less than 12 meteorological stations used in the climate match analysis, Bomford (2008) recommends the score is increased by +1 (CMS 2 +1 =3). For fish species, if the input area has 12 or fewer meteorological stations, then it is likely to underestimate the climate match to Australia (Bomford et al. 2010; Bomford 2008). As Climatch and Köppen-Geiger models are based on terrestrial climate data they are not an accurate indicator of suitable conditions for freshwater fish. As described in 4.1.5, 2 closely related species with comparable temperature, pH and water hardness tolerances to *D denisonii* have successfully established in locations in Australia well outside the Climatch range indicated, so it is likely *D. denisonii* would be able to establish outside the Climatch range given.
B. Overseas Range Score (0-4)	1	5-10 grid squares
C. Establishment Score (0-3)	2	Never introduced
D. Introduction Success Score (0-4)	3	Success rate of >0.25 ≤ 0.5 OR never introduced
E. Taxa Risk Score (0-5)	5	Extreme
Establishment Risk Score	**14**	**Moderate**

Table 1.2 of the Bomford Risk Assessment Model (Bomford 2008) (reproduced as Table 7) shows that 23-38% of species with a moderate Establishment Risk Rank, assessed in that report, succeeded in establishing an exotic population.

Table 7 Establishment success rates for risk assessment models from Bomford (2008)

Establishment Risk Rank	Species success rates*
Low	0–6%
Moderate	23–38%
Serious	56–77%
Extreme	82–100%

* Percentage of introduced species with this risk ranking that succeeded in establishing an exotic population for the eight models presented in this report.

4.3 Consequences for the environment

The magnitude and type of impacts by alien taxa vary greatly among ecosystems, and many of these impacts only become obvious or influential after the onset of invasion. Moreover, many impacts remain or are difficult to redress even if the alien taxa of concern are removed or controlled (Havel et al. 2015). In several ecosystems, spread, and/or impacts of non-native species occur several years or even decades following their introduction (Havel et al. 2015). Such time lags create difficulties for predicting their impacts.

Aquarium releases, either intentional or accidental, are commonplace events. Worldwide, these releases have led to the establishment of over 150 species, many on the 'worst invasive species' list (Padilla and Williams 2004). Biological invasions of freshwater ecosystems have a large number of known and potential impacts on community structure and ecosystem function.

There are no reports of *D. denisonii* establishing feral populations. For the 325 species in the family Cyprinidae that have established populations outside their natural range, many (e.g., common carp, goldfish) have had major impacts on the receiving environments. For example, invasive omnivores like the common carp (*Cyprinus carpio*) increase turbidity and destroy aquatic plant beds when foraging, leading to abrupt shifts from clear to turbid water in lake habitats (Matsuzaki et al. 2009).

As Bomford (2008) does not model the environmental impacts of freshwater fish, DCCEEW uses a model adapted from Kumschick et al. (2012) and Nentwig et al. (2016) to assess impact (Appendix A). In each of the 11 impact categories, the magnitude of impact is quantified with levels ranging from Minimal to Critical (Minimal, Minor, Moderate, Major, Critical). The impact results are based on published evidence as detailed throughout this report (Table 8**Error! Reference source not found.Error! Reference source not found.**). Note that for most of these impacts, the scientific knowledge is sparse and for freshwater fish in general currently inadequate to allow reliable predictions.

Table 8 Significance of impacts from the potential establishment of *Dawkinsia denisonii* populations in Australia

Type of impact	Assessment	Rating
ENVIRONMENTAL IMPACTS		
Herbivory e.g., grazing, bark stripping, antler rubbing, feeding on algae, uprooting of aquatic macrophytes, restrictions in establishment, pollination, or seed dispersal of native species.	*No impact known or detectable; or very low level of herbivory.* No major damage documented.	Minimal
Competition e.g., competition for nutrients, food, water, space or other resources. May outcompete native species due to higher reproduction, resistance, longevity. In the beginning, might be slow change in species abundance but might lead to the local/global disappearance of a native	Competition by exotic fish has the potential to be highly detrimental to native species but scientific knowledge is lacking. The presence of exotic fish may significantly increase the amount of prey available to native predators (Elvira 2001). *D. denisonii* would compete with native fish for food and resources, including bottom feeders such as rainbowfishes	Unknown

Type of impact	Assessment	Rating
species. Includes behavioural changes in outcompeted species and ranges from population decline to population loss.	(*Melanotaenia* spp.), *Pseudomugil* spp. and other small omnivores. Little is known about the ecology of this species, so the extent to which this would impact on native populations cannot be predicted.	
Predation e.g., predation, parasitism, or intoxication, measurable as reductions in reproduction, survival, growth, or abundance. These impacts range from population decline to population loss, including minor changes in the food web.	*Predators directly or indirectly resulting in a decline of populations size of at least one native species but no changes in community composition.* Generalist feeders may have more potential to have competitive impacts than specialist feeders (Elvira 2001). *D. denisonii* are omnivorous, feeding on a variety of worms, insects, crustaceans, plant material, and other organic debris (Mercy et al. 2007, Mahadevi et al. 2020). The species is therefore likely to influence the structuring of food webs. They would likely feed on native worms, insects, crustaceans and plant material.	Moderate
Habitat and ecological community e.g., changes in nutrient pools, increased water turbidity, modification of soil or water body properties, changes in hydrology, erosion, ecosystem functions, or other physical or structural changes. Includes modification of successional processes that may lead to reduced suitability (e.g., shelter) for native species, thus causing their disappearance.	*Moderate change in chemical, physical and/or structural characteristics, affecting fitness of native individuals without decline of their populations.* The most common effects of introduced fish are the displacement of aquatic vegetation and the degradation of water quality - turbidity can be caused by the behaviours of bottom feeding species, which can in turn disrupt breeding, growth and respiratory functions of native species (Bomford and Glover 2004). *D. denisonii's* diet includes aquatic plant species so these impacts are possible. No information is available on natural predators, but it is possible they would provide prey for larger native predatory freshwater fish species such as barramundi, grunters, tarpon, Eleotrids, Apogonids and gudgeons.	Minor
Hybridisation Hybridisation with native species, leading to a reduced or lost opportunity for reproduction, sterile or fertile hybrid offspring, gradual loss of the genetic identity of a species, and/or disappearance of a native species, i.e., extinction.	*No hybridisation between alien species and native species observed in the wild, may be possible in captivity.* Hybridisation is not reported in the wild. *D. denisonii* has been artificially hybridised with a member of the genus *Puntius,* but no reports of hybridisation outside this genus.	Minimal
Disease transmission Host or alternate host for native or alien diseases (viruses, fungi, protozoans or other pathogens) or parasites, impacts by transmission of diseases or parasites to native species.	*Parasites or pathogens directly or indirectly resulting in local or population extinction of at least one native species leading to changes in community composition, but changes are reversible when introduced species is removed.* Live aquarium fish are the greatest risk group for introducing aquatic animal diseases in Australia (Corfield et al. 2008). While no significant diseases have been associated with this species, this may be more a result of lack of research, rather than a lack of disease. Significant diseases of concern are present in the Cyprinidae family, including several known to impact native fish (Hoole et al. 2001). For example, more than 100 native fish species are known to be susceptible to infection with *Aphanomyces invadans* (red spot disease), associated with the movement of ornamental fish (Department of Agriculture 2019, World Organisation for Animal Health 2021). Aquarium fish led to	Major

Type of impact	Assessment	Rating
	the spread of the goldfish ulcer disease that was introduced into Australia via infected goldfish, and which subsequently spread to native fish such as *Bidyanus bidyanus* (silver perch) (Corfield et al. 2008).	
ECONOMIC, SOCIAL AND CULTURAL IMPACTS		
Agriculture and forestry Damage to crops, pastures or plantations, horticultural and stored products, forests or forest products. Include direct feeding damage, seed dispersal, browsing on young trees, bark gnawing or stripping and antler rubbing, felling trees, defoliating them for nesting material.	*None, or only occasional damage or yield loss to crops or plantations (e.g., orchards), damage similar to native species, no change to forest structure or regeneration. No adverse impacts on crops, plantations or forestry would be expected.* If it became established in Australia, it is unlikely to have any negative impacts on agriculture.	Minimal
Animal production Competition with livestock, transmission of diseases or parasites, predation, affecting livestock health, weakening or injuring livestock, pollution by droppings on farmland which domestic stock are then reluctant to graze, reduction of livestock accessibility to grazing land.	*None, or occasional competition with, or loss of yield in livestock or animal production.* If it became established in Australia, it is unlikely to have any negative impacts on animal production.	Minimal
Infrastructure Damage to human infrastructure, roads, buildings, dams, docks, fences, electricity cables (e.g., by gnawing or nesting on them) or through pollution (e.g., by droppings), digging activities.	*None or biological traits and lifestyle suggest potential damage to infrastructure (e.g., potential to increase soil erosion and decrease road stability, physical damage to property and infrastructure, disruption to transport and communications) but not yet reported.* If it became established in Australia, it is unlikely to have any negative impacts on infrastructure.	Minimal
Human health Injuries (e.g., bites, stings, scratches, rashes, accidents), transmission of diseases and parasites to humans. Impacts might affect human safety and cause traffic accidents. Via health costs, impacts usually lead to economic costs due to medication and treatments costs, as well as the consequences in productive losses from these impacts on workforce.	*None, or host of one or more harmless diseases with the possibility of infecting humans, not yet reported.* There are no reported zoonoses, and no risk if injury or harm from this species.	Minimal
Social impacts Impact on human wellbeing. Noise disturbance, pollution of recreational areas, damage by trampling and overgrazing, restrictions in accessibility to habitats or landscapes of recreational value. Restrictions or loss of recreational activities, aesthetic attraction, touristic value, or employment possibilities, aesthetic values and natural or cultural heritage	If this species were to establish in the wild in Australia, there may be impacts to fishing activities (whether directly through changes to fish structures through competition, or indirectly e.g., closures due to eradication or management activities). Disease introduced to wild populations could also impact on recreational pursuits. Significant mortality and morbidity can be experienced by native fish. The distribution, abundance and impacts are hard to predict. There have been no studies of the economic consequences	Unknown

Type of impact	Assessment	Rating
	of previous introduction of similar species elsewhere in the world.	
ECONOMIC IMPACTS		
Cost to control/eradicate, cost to natural resources and amenity, cost to agriculture, fisheries and forestry industries, cost to potential export markets, cost to tourism	Possible economic impacts associated with control and eradication; and loss of recreational/tourism resulting from disease transmission. Once established, it is often impossible to eradicate an alien species, and control efforts are time-consuming and expensive (Kolar and Lodge 2001). Invasive alien fish have cost at least US$37 billion globally, and US$215 million in Oceania alone, since the 1960s (Haubrock et al. 2022).	Unknown

Source: Adapted from Kumschick et al. (2012) and Nentwig et al. (2016)

The consequences for the environment may be predominantly from competition for resources, disease transmission and predation.

All impact types are weighted equally, and the ratings given are estimates, as the impacts are mostly unknown. A precautionary approach is therefore adopted and, considering the information above, an overall risk rating of **unknown** for the environmental consequences if the species were to establish in Australia is appropriate.

4.4 Risk rating

The establishment risk score is the chance or probability that establishment will occur (Bomford 2008). Based on the risk assessment, the likelihood *D. denisonii* establishing is **moderate**. Based on the impacts assessment, there are too many **unknowns** to be able to determine the consequence of *D. denisonii* establishing. There is not enough information available on this species to determine the impacts to the environment should the species become established in Australia.

4.5 Consultation – concerns raised

The first consultation round seeking comment from the public and state and territory government agencies on the applicant's report was undertaken from 16 February to 7 April 2021.

Four submissions containing comments to be addressed were received. The specific comments are at Appendix B. A number of industry stakeholders cited the economic benefit of permitting the import of *D. denisonii* for the aquarium industry as the price and ready availability will make them extremely popular ensuring the industry stays economically strong.

General concerns raised included:

- **Conservation status and sustainability**: the lack of robust checks in place to ensure the species is not illegally sourced from wild populations, especially given their Endangered IUCN status.
- **Current and potential status in Australian aquarium industry:** the current and potential status of the species in Australia, including present trade, and projected supply and demand;

and the likely pathways for the arrival of these species in Australia. If breeding populations already exist, why do they need to be imported?

- **Source of imports and impacts on wild populations:** the capacity of current breeding techniques to supply the demand, and the potential effects on wild populations in their natural range.
- **Misidentification with similar species:** the proponent should provide more specific information on the species that are similar enough to *D. denisonii* to allow its inadvertent importation in the past; and a minimum size limit should be considered to prevent further cases of mistaken identity if the fish were allowed to be imported.
- **Species already in Australia illegally:** *D. denisonii* is not on the Live Import List so current animals in Australia could be from illegal imports. Including it now would diminish the intent of the list due to the potential perception that it is possible to circumvent the legalities by applying retrospectively.
- **Consequences to the environment, economy or socio-cultural values** are not adequately considered if *D. denisonii* were to establish.
- **Risk of introduction of pathogens to native populations:** Australia has many endemic native freshwater fish and ecosystems that can be impacted by introduced diseases and pests. Should an exotic disease infect native species in our waterways, the impact could be devastating both in terms of biodiversity and conservation.

DCCEEW requested the applicant to provide an updated report which addressed the following deficiencies in their initial report addressing the Terms of Reference for *D. denisonii:*

- **Referenced information:** the information is not accompanied by references to support the claims. Please review comments that have been made without support from scientific literature.
- **Trade status in Australia:** this species has likely been traded in Australia for decades and may be being captive bred in Australia. Please provide further detail on the history of each species in Australia, and, for those already being captive bred here, the need for importing additional animals.
- **Environmental requirements:** available tolerance data is insufficient to ensure a rigorous risk assessment. Please provide peer reviewed references to support the information provided in relation to the environmental requirements of each species, and an assessment of potential invasive range.
- **Size limits:** the ToR recognises the challenges in species identification for smaller specimens. A minimum size limit could be applied to reduce the chance of mistaken identity of juveniles with other similar looking fish species at the border. The applicant is requested to provide referenced information describing appropriate sizes at which correct species identification is possible.
- **Propagule pressure:** the ToR states that, for all three species, there are limited suitable freshwater environments in Australia, and therefore establishment is highly unlikely to occur. Please provide references to support this claim. The ToR states that possible locations for establishment are remote (e.g., Arnhem Land and Northern Australia), but does not consider tropical cities like Darwin, Cairns and other tropical QLD towns. Please review the propagule pressure section to include areas of higher population densities.

- The ToR states that '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. This is unlikely to happen at random (DAWE 2020a)'. This citation refers to a risk assessment conducted on the glass catfish, which is in a different taxonomic Family (and Order) to the species in question here and has different habitat and environmental needs. Please update the ToR to consider the propagule pressure for each species separately.
- **Introduction success:** the ToR assume that, as the species have been traded worldwide, they have been released into non-native areas on many occasions, with an arbitrary value of 25-50 introductions assigned. Please provide peer-reviewed references to support the introduction values. Without evidence in support of these values, the Bomford Model should be applied using known, referenced data on introductions at either the Genus or Family level.
- **Impacts:** consider the consequence to the environment, economy or socio-cultural values if species were to establish. In consideration of the requirement under the EPBC Act to consider the Precautionary Principle when making a decision to amend the Live Import List to include an item on the list, the absence of scientific literature is not acceptable evidence that the species is benign and non-invasive. More information should be provided on possible impacts given known biology, behaviour and ecology of each species.

The applicant's updated report addressing the Terms of Reference and DCCEEW's environmental risk assessment report were circulated to relevant state and territory government agencies for comment between 31 May and 28 June 2023. DCCEEW's report included the recommendation that *D. denisonii* not be included for the commercial pet trade but be included on Part 2 of the Live Import List for identification purposes. The South Australian Government responded with comments supporting the amendment. The Western Australian Government responded supporting the findings and recommendations (Appendix B).

4.6 Risk mitigation

In response to the comments received during the consultation rounds, the applicant provided some additional information on potential risks and risk mitigation measures (Appendix B).

The applicant suggested that possible control measures to reduce impact to the environment if it was to be released include:

- Listing as a noxious species
- Eradication or control programs
- Education campaigns

Proposed restrictions by the applicant included the current biosecurity arrangements administered under the *Biosecurity Act 2015* to prevent the importation of pests that may directly or indirectly impact the environment.

5 Discussion

The global aquarium trade is arguably the greatest biosecurity threat to freshwater ecosystems (Ebner et al. 2020, Clavero et al. 2023). Over 550 species of freshwater fish have established self-sustaining populations outside their native ranges across the globe (Clavero et al. 2023). Ornamental fish present a significant risk to aquatic systems in Australia and have the potential to trigger or contribute to a future major aquatic animal pest or disease incursion, particularly in freshwater habitats (Moore, Marton and McNee 2010). Ebner et al. (2020) highlighted the numerous existing and potential pathways for incursions from the aquarium trade into freshwater ecosystems in tropical Australia, encompassing the lands and waterways north of the Tropic of Capricorn. The lack of consolidated information relevant to tropical Australia in terms of biotic incursion of even the better documented taxa (e.g., freshwater fishes) and a lack of information on most taxa in the aquarium trade (e.g., diseases in the wild) creates a major biosecurity risk (Ebner et al. 2020).

The scientific knowledge on *D. denisonii* is inadequate to allow reliable predictions of the impacts and consequences of establishment. Bomford (2008) advises a precautionary approach for fish that have little or no introduction history or have no relatives with an introduction history. Many potentially invasive species have not been able to demonstrate their establishment potential if they have not been released in new environments. The number of fish that escape or are released is likely to increase if more species are kept, in higher numbers, and in more locations. Repeated releases over an extended period will increase the chance of successful invasion simply because the release 'experiment' is repeated many times, under different biotic and abiotic conditions (Bomford and Glover 2004). In the absence of invasive and establishment data on this species, an assessment at the genus level revealed a 'very high' risk of establishment.

While the climate match in Australia was low, these values are based on terrestrial climate data, and are therefore not a completely accurate indicator of possible inhabitation by freshwater species. Two closely related ornamental species with near identical environmental requirements to *D. denisonii* have already established populations in Australia, in areas far south of the areas indicated by Climatch. It would be reasonable to expect that *D. denisonii* could also establish in similar locations, and that the Climatch generated map is not representative of its potential range. Impacts on other species (through competition for resources and predation) and habitats are unknown.

In the closely related *Puntigrus* and *Pethia* genera, both the *Puntigrus tetrazona* (Sumatra barb) and *Pethia conchonius* (rosy barb) have established feral populations in Australia (Corfield et al. 2008). Both these species share similar habitats, diets, and have almost identical environmental tolerances as *D. denisonii* (see 4.1.5). Given the taxa risk score, and that the 2 already established species have comparable habitat and environmental requirements to *D. denisonii*, the risk of release and establishment of this species in Australia could be considered very high.

According to the latest IUCN assessment, *D. denisonii* is listed as Endangered and collection for the international aquarium pet trade is the single major threat (Ali et al, 2015, Prasad et al. 2008).

Despite this, high demand for this species has resulted in unlawful exploitation of the wild populations and subsequent population reduction. Local wild populations show high mortality rates, and fish are exploited before reaching maturity leading to unsustainable levels of exploitation, and populations facing impending collapse. While India is not on the list of approved countries from which freshwater fish can be imported, other countries that are on the approved list may act as a transit hub for the distribution of wild-caught fish. For example, the main market for *D. denisonii* is Singapore, accounting for almost 50% of exports (Raghavan et al. 2013a), and Singapore is on the approved country list.

The over exploitation of this species for the aquarium trade raises concerns that including the species in the Live Import List may lead to further pressure on wild populations for collection for the aquarium industry in Australia. The applicant did not provide the requested information on the potential source, nor on methods to ensure the provenance, of imported animals.

Subsection 303EN(3) of the EPBC Act states that the minister must not issue a permit for specimens in Part 2 of the Live Import List unless the minister is satisfied that the proposed import would not be likely to threaten the conservation status of a species or ecological community; or likely to threaten biodiversity. As a signatory to the Convention on Biological Diversity, Australia has the responsibility to ensure that activities within its jurisdiction do not cause damage to the environment of other states or areas. Without information regarding the status of the population in the wild, or evidence that captive-bred animals would be available for import, it cannot be determined whether amending the Live Import List to include this species would impact wild populations.

In the absence of any history of invasiveness and establishment, and a low climate match, results from the Bomford model show that *D. denisonii* has a moderate establishment risk. Bomford (2008) ranks the moderate risk of establishment at 23-38%. success rate which represents an unacceptable level of risk.

There is not enough information available on this species to determine the impacts to the environment should the species become established in Australia.

The applicant, in addressing the Terms of Reference, undertook a risk assessment using the SARDI Model (Deveney 2018). This model was produced to facilitate the development of management strategies for the 'grey list' of ornamental fish, that is ornamental fish that are historically kept, bred and openly traded in Australia, but not approved for live import. As stated by the author, the SARDI model is '*inappropriate to assess risks associated with importation of new species.'* New species under consideration for import have a different interpretation of acceptable level of risk that reflects the difference posed by a new exotic species compared to a species already present. The model accepts that establishment had already occurred, so only species in which establishment has resulted in significant impacts rate as high risk.

The SARDI framework states that data deficiencies do not mean the risk posed by a species is increased or decreased, and unknown answers are scored neutrally rather than conservatively; and so, the framework does not comply with the precautionary principle, which must be considered by

the minister when making a decision to include an item on the Live Import List. Furthermore, the economic, social and commercial benefit of the species as assessed by the model are based on trade in the specimen not the social, cultural and economic impacts to the environment if it were to become established.

6 Conclusion

DCCEEW has reviewed the application to amend the Live Import List to include *Dawkinsia denisonii* (torpedo barb) and undertaken a risk assessment. During this process, DCCEEW independently reviewed all available information and consulted Commonwealth, state and territory agencies, the public and other experts, as is required under the *Environment Protection and Biodiversity Conservation Act 1999.*

Based on all available information and the results from application of the Bomford model, *D. denisonii* poses a moderate risk of establishing in the Australian environment which, at 23-38%. success rate, poses an unacceptable level of risk.

The available scientific knowledge on this species is inadequate to allow reliable predictions of the impacts and consequences of establishment.

There is a lack of scientific understanding of this species, with little information on its micro-level distribution, ecology and demography. The applicant states that the lack of scientific information is an indication of the benign nature of the species since scientific study focuses almost exclusively on invasive species that have some ecological impact. However, as per the precautionary principle set out at section 391 of the EPBC Act, a '*lack of full scientific certainty should not be used as a reason for postponing a measure to prevent degradation of the environment where there are threats of serious or irreversible environmental damage'.*

According to the latest IUCN assessment*, D. denisonii* is listed as Endangered, primarily because of over exploitation for the aquarium trade. Australia has the responsibility under the Convention on Biological Diversity to ensure that activities within its jurisdiction do not cause damage to the environment of other states or areas. Without information regarding impact of the aquarium trade on wild stocks, it cannot be determined whether amending the Live Import List to include this species would impact wild populations.

The applicant states that given the species' conservation listing, 'the applicant is willing to have discussions, if required, establishing import conditions ensuring S. *denisonii* sourced are captive bred'.

In addition to the factors assessed under the Bomford model, several other characters that are most frequently cited as being associated with successful fish invasions include exhibiting high physiological tolerance (Moyle and Marchetti 2006), r-selected life history strategies (high fecundity, rapid growth, early maturity) (Moyle and Marchetti 2006, Bomford 2008, Corfield et al. 2008, Chan et al. 2021), aggressive behaviour (Corfield et al. 2008), moderate size (Moyle and Marchetti 2006, Bomford 2008, Corfield et al. 2008), and dietary preferences (Moyle and Marchetti 2006). Therefore, in consideration of a recommendation for this species, DCCEEW considered the available information on this species, as summarised in Table 9.

Table 9 Considerations when forming a Live Import List recommendation for *Dawkinsia denisonii*

Consideration	Comments
Establishment risk	Moderate (23-38%. success rate) as per Bomford Risk Assessment
Impact analysis	There is a lack of data with which to assess impacts on the Australian environment
Climate match	Low but note that similar species that have established in Australia have comparable temperature, pH and water hardness tolerances to *D. denisonii* (Table 3). Both species have established in locations well outside the Climatch range indicated as a climate match for *D. denisonii*.
Physiological tolerances	The range of environmental conditions that can be tolerated is unknown (Table 1).
Fecundity	Low (Solomon, 2011). Capable of producing up to 1,100 eggs per spawn
Spawning	There is a lack of data relating to this species,
Aggressive behaviour	There is a lack of data relating to this species, particularly with regards to the species' ecology and behaviour.
Body size	Max size 190mm TL - most common length 50-60mm
Dietary preferences	Omnivorous, feeding on a variety of worms, insects, crustaceans, plant material, and other organic debris (Mercy et al. 2007, Mahadevi et al. 2020).

After critically examining and reviewing all available evidence and information and given the unknown environmental risk and the conservation status of this species, DCCEEW recommends that *Dawkinsia denisonii* is not listed in Part 1 of the Live Import List.

It is conceded that *Dawkinsia denisonii* is in Australia; the applicant stating in his application 'Furthermore, captive breeding populations of *S. denisonii* currently exist in the Australian hobby supplying a limited domestic trade', and several members of the public raised it during the consultation period. A mechanism for the species' entry into Australia was suggested by South Australia. This is that juvenile *D. denisonii* may bear a resemblance to other species, including *Rasbora trilineata* which is listed in Part 1 of the Live Import List and may be freely imported.

Biosecurity officers inspecting consignments of aquarium fish at the border have indicated that *D. denisonii* and *Rasbora trilineata* are particularly challenging to differentiate. Whilst healthy adult specimens of a certain size can be distinguished from each other transportation induces physiological stress requiring prolonged recovery, and stress-induced changes in skin or eye colour are reported, making accurate identification even more challenging (Hungtingford et al. 2006).

Feedback received during consultation supports this position, several correspondents raising issues relating to likely pathways for the introduction of *D. denisonii,* seeking advice of the likely pathways through which these fish species have arrived in Australia, particularly in the period following the publication of the BRS 'grey list' in 2008 or suggesting that the species was illegally imported.

DCCEEW has formed the view that there is value in allowing limited import to facilitate improved identification of this species at the border. This might take the form of *inter alia*:

- post transport photographs

- taxonomy and
- training of AI tools to enhance computer identification at the border.

Strict conditions are necessary to ensure specimens are imported for this purpose only.

Therefore, cognisant of the issues faced by officers identifying fish at the border in relation to differentiating between *Dawkinsia denisonii* and *Rasbora trilineata,* and recognising the risk to native populations, and that captive bred specimens are available, DCCEEW **recommends** that *Dawkinsia denisonii* be included on Part 2 of the Live Import List, with the conditions:

- For identification purposes only. High security facilities only. Specimens bred in captivity only.

Appendix A: Impacts assessment scoring criteria

Table 10 Impacts assessment scoring criteria adapted from Kumschick et al. (2012) and Nentwig et al. (2016)

Impact	Description	Minimal	Minor	Moderate	Major	Critical
Herbivory	Can cause changes in reproduction, survival, growth, and abundance of plants in the invaded community, e.g., herbivory, grazing, bark stripping, antler rubbing, feeding on algae, or uprooting of aquatic macrophytes. Result in restrictions in establishment, pollination, or seed dispersal of native species. Range from population decline to population loss and include minor changes in the food web.	No impact known or detectable; or very low level of herbivory, no major damage reported.	Herbivory affecting several native species, without significant impact on affected species or decline of their populations.	Herbivory affecting several native species, at least one native species declining.	Herbivory affecting many native species, several declining in population size, recorded community change is reversible.	Herbivory or toxicity affecting native threatened species, decline of these species, replacement or even extinction of species, recorded community change is irreversible.
Competition	Concern at least one native species, e.g., by competition for nutrients, food, water, space or other resources. May outcompete native species due to higher reproduction, resistance, longevity. In the beginning, might be slow change in species abundance but might lead to the local/global disappearance of a native species. Includes behavioural changes in outcompeted species and ranges from population decline to population loss.	No effect on fitness of native species.	Causes reductions in individual fitness but no declines in native populations densities.	Causes declines in populations densities, but no changes in community composition.	Causes changes in community composition – reversible if alien species is removed.	Causes at least local extinction of species and irreversible changes in community composition.

Impact	Description	Minimal	Minor	Moderate	Major	Critical
Predation	May concern single animal species or a guild, e.g., through predation, parasitism, or intoxication, measurable as reductions in reproduction, survival, growth, or abundance. These impacts range from population decline to population loss, including minor changes in the food web. These impacts concern only free-living animals in the wild.	Negligible level of predation.	Predation on several abundant species, without significant impact on affected species or decline of their populations.	Predators directly or indirectly resulting in a decline of populations size of at least one native species but no changes in community composition.	Predators directly or indirectly resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when introduced species removed.	Predators directly or indirectly resulting in extinction of one or more native species (i.e., species vanish from communities at sites where they occurred before alien arrival), changes in community composition are irreversible.
Habitat and ecological community	Impacts on characteristics of an ecosystem, its nutritional status (e.g., changes in nutrient pools, increased water turbidity, faecal droppings), modification of soil or water body properties, and disturbance regimes (changes in hydrology, erosion or soil compacting), changes in ecosystem functions (e.g., pollination or decomposition rates), or other physical or structural changes. Includes modification of successional processes that may lead to reduced suitability (e.g., shelter) for native species, thus causing their disappearance. The application of pesticides to control impacts might have side effects on non-target organisms.	Change in chemical (e.g., eutrophication, nutrient-cycling), physical (e.g., soil compaction, structure, hydrology) and/or structural (e.g., felled trees, burrows, disturbance dynamics) characteristics detectable, with no reduction of fitness of native individuals.	Moderate change in chemical, physical and/or structural characteristics, affecting fitness of native individuals without decline of their populations.	Major change in chemical, physical and/or structural characteristics, change in fauna and flora and/or successional processes, reversible.	Severe changes in chemical, physical and/or structural characteristics, decline of species and/or change in species composition, resulting in local extinction of at least one native species, leading to changes in community composition, but change are reversible when introduced species is removed.	Massive changes in chemical, physical and/or structural characteristics, endemic species and/or threatened species affected, decline of species and/or change in species composition, loss of habitat characteristics, damage of sites of conservation importance, irreversible.

Impact	Description	Minimal	Minor	Moderate	Major	Critical
Hybridisation	Impacts are through hybridisation with native species, usually closely related to the alien taxon, leading to a reduced or lost opportunity for reproduction, sterile or fertile hybrid offspring, gradual loss of the genetic identity of a species, and/or disappearance of a native species, i.e., extinction.	No hybridisation between alien species and native species observed in the wild, may be possible in captivity.	Hybridisation is observed in the wild but rare; hybrids weak, do not reach maturity, no decline of native populations.	Hybridisation is regularly observed in the wild; hybrids are vigorous but sterile, local decline of pure native populations but pure native species persists.	Hybridisation is common in the wild; F1 hybrids are vigorous and fertile, however offspring of F1 hybrids are weak and sterile; individuals of introduced species and hybrids discernible from pre natives, pure native populations can be recovered by removing the introduced species and hybrids.	Hybridisation is common in the wild; hybrids are vigorous and fertile, pure native populations cannot be recovered by removing the introduced species and hybrids resulting in local extinction of native species.
Disease transmission	Host or alternate host for native or alien diseases (viruses, fungi, protozoans or other pathogens) or parasites, impacts by transmission of diseases or parasites to native species.	Not a host of diseases transmissible to native species, or very low level of transmission; reduction of fitness of native individuals is not detectable.	Parasites or pathogens directly or indirectly affecting fitness of native individuals without declines of their populations.	Parasites or pathogens directly or indirectly resulting in a decline of populations size of at least one native species but no changes in community composition.	Parasites or pathogens directly or indirectly resulting in local or population extinction of at least one native species leading to changes in community composition, but changes are reversible when introduced species is removed.	Parasites or pathogens directly or indirectly resulting in local or population extinction of at least one native species, community changes are irreversible.

Impact	Description	Minimal	Minor	Moderate	Major	Critical
Agriculture and forestry	Damage to crops, pastures or plantations, horticultural and stored products, forests or forest products. Include competition with crops by weeds, direct feeding damage, seed dispersal, reduced accessibility, usability or marketability through contamination and cosmetic changes. Impacts might affect forest regeneration through browsing on young trees, bark gnawing or stripping and antler rubbing. Damage includes felling trees, defoliating them for nesting material. Includes the need for applying pesticides which involve additional costs, reducing market quality. Impacts usually lead to an economic loss.	None, or only occasional damage or yield loss to crops or plantations (e.g., orchards), damage similar to native species, no change to forest structure or regeneration.	Damage or yield loss to crops common, damage or yield loss similar to native species, minor effect on forest growth, impact on seed dispersal. Some trade disruptions.	Regular damage or yield loss similar to native species through feeding on crops or through competition, occasional threat to stored food, constrains forest regeneration through browsing on young trees, damage to plantations, gnawing of bark, losses exceed impact of the native fauna, sometimes reaching high levels. Moderate trade disruptions.	Regular high damage or yield loss in fields or to stored food, fruit consumption; moderate to strong damage to mature forest through seed consumption, bark stripping or antler rubbing, death of trees by felling or flooding. Killing trees by defoliating them for nesting material. High trade disruptions.	Complete loss of yield or destruction of fields or plantations (e.g., orchards), or of stored food by consumption and contamination; very strong damage to mature forest through seed consumption, bark stripping. Massive trade disruptions.
Animal production	Competition with livestock, transmission of diseases or parasites, predation, affecting livestock health, weakening or injuring livestock, e.g., by stinging or biting, pollution by droppings on farmland which domestic stock are then reluctant to graze, reduction of livestock accessibility to grazing land, the need for applying pesticides which involve additional costs, reducing market quality. Impacts usually lead to an economic loss. This category refers to livestock, poultry, game animals, fisheries and aquaculture.	None, or occasional competition with, or loss of yield in livestock or animal production.	Competition with, or loss of yield in livestock or animal production, transmission of diseases to livestock or production animals in the native area, but not yet reported from the area of introduction. Little operational obstruction or removal/control cost. Some trade disruptions.	Competition more frequent with several livestock or production animal species, transmission of diseases reported, but infection rates low. Pollution by droppings on farmland which domestic stock are then reluctant to graze. Moderate trade disruptions.	Transmission of economically important diseases or hybridization with economically important game animals, fatalities uncommon. Large trade disruptions.	For animals, transmission of harmful diseases to or hybridization with livestock or production animals, fatalities reported. Massive trade disruptions.

Impact	Description	Minimal	Minor	Moderate	Major	Critical
Infrastructure	Damage to human infrastructure, roads, buildings, dams, docks, fences, electricity cables (e.g., by gnawing or nesting on them) or through pollution (e.g., by droppings), digging activities on watersides, roadside embankments and buildings which may affect flood defence systems, traffic infrastructure or stability of buildings. Includes the need for applying pesticides and performing management and eradication programmes, their development and further administration costs, as well as costs for research and control. Impacts usually lead to an economic loss.	None or biological traits and lifestyle suggest potential damage to infrastructure (e.g., potential to increase soil erosion and decrease road stability, physical damage to property and infrastructure, disruption to transport and communications) but not yet reported.	Occasional damage with minor economic losses, e.g., damage to fences, impact through pollution, accumulations of droppings, minor increases in soil erosion.	Damage to fences and/or plantations, gnawing electricity cables, causing road accidents, nesting on current conductions. Moderate increase in soil erosion, moderate damage to property, buildings and infrastructure, frequent obstruction of waterways.	Considerable damage to property and infrastructure, with considerable economic costs, damage through burrowing or nesting in buildings. Major obstruction of waterway.	Considerable damage to flood defence systems or other critical infrastructure, major soil erosion, danger to human safety, threat to transport safety.
Human health	Injuries (e.g., bites, stings, scratches, rashes, accidents), transmission of diseases and parasites to humans, bioaccumulation of noxious substances, health hazard due to contamination with pathogens or parasites (e.g., through contaminated water, soil, food, or by faeces or droppings). Impacts might affect human safety and cause traffic accidents. Includes the need for applying pesticides which due to their low selectivity and/or residues might have side-effects on humans. Via health costs, impacts usually lead to economic costs due to medication and treatments costs, as well as the consequences in productive losses from these impacts on workforce.	None, or host of one or more harmless diseases with the possibility of infecting humans, not yet reported.	Host of several harmless diseases, indirect transmission or possibility of direct transmission, but only a small percentage of the human population at risk, health hazard from soil and water contamination caused by droppings, few cases reported.	Direct infection with one or more harmless diseases, occasional health threat through bites or other attacks, moderate number of cases reported.	Direct transmission of several diseases. Health threat through bites or other injuries happen more often, rarely fatal.	Vector of harmful diseases to humans and/or many diseases frequently transmitted. Health threat through bites or other injuries happen frequently, more often fatal.

Impact	Description	Minimal	Minor	Moderate	Major	Critical
Social impacts	Impact on human wellbeing. Noise disturbance, pollution of recreational areas (water bodies, rural parks, golf courses or city parks), fouling, eutrophication, damage by trampling and overgrazing, restrictions in accessibility to habitats or landscapes of recreational value. Restrictions or loss of recreational activities, aesthetic attraction, touristic value, or employment possibilities, aesthetic values and natural or cultural heritage.	None, or biological traits and lifestyle suggest potential for disturbance in recreational or residence areas (e.g., by noise, pollution).	Occasional small disturbance, only small percentage of human population affected.	Regular small disturbance, or occasional larger disturbance.	Regular larger disturbance. Recreational value of a habitat or a landscape strongly affected.	Massive disturbance; complete loss of recreational value of a habitat or a landscape.

Appendix B: Summary of comments received on the proposal to include *Dawkinsia denisonii* on the Live Import List

Round 1

The first consultation round seeking comment from state and territory government agencies on the applicants' report was undertaken from 16 February to 7 April 2021. Four submissions containing comments to be addressed were received (Table 11**Error! Reference source not found.**). Fifteen email responses supporting the proposal were received from members of the pet and aquarium industry. These raised no issues requiring additional information. A number of industry stakeholders cited the economic benefit for the aquarium industry as the price and ready availability will make them extremely popular ensuring the industry stays economically strong.

Table 11 Comments received during public consultation and response from applicant

Respondent	Major comments	Further information requested	Applicant response
De-identified	Seeks additional information to help clarify the current and potential status of this fish species in the Australian aquarium industry. - The extent to which these three fish species [a] are already present and domestically traded in Australia, and - The likely pathways through which these fish species have arrived in Australia, particularly in the period following the publication of the BRS 'grey list' in 2008, and - The estimated demand in Australia for these species as aquarium fish; and	Please provide further detail on: 1. The extent to which these three fish species are already present and domestically traded in Australia. 2. The likely pathways for the arrival of these species in Australia, if they are already present and importation following the publication of the BRS 'grey list' in 2008 3. estimated demand for this species. 4. The capacity of current breeding techniques to supply this demand. 5. The potential source countries for this species. 6. The potential effects on wild populations in their natural range.	1. The updated ToR did not address this request. 2. The applicant did not update the ToR to address this request, but commented: The Grey List is not and was never designed as a comprehensive list of all ornamental species that were present and traded in Australia. This is directly acknowledged in the 2006 report that published the grey list "A strategic approach to Ornamental fish management in Australia" (Appendix 2, Grey List, pg29). In any case regardless of how a species already present in Australia may have arrived in the past, does not (and should not) change or influence the process of a formal risk assessment when considering approval for addition to the allowable import list. There are some species on the grey list that were once allowable imports.

Respondent	Major comments	Further information requested	Applicant response
	- The capacity of current captive breeding techniques to supply this demand; and - The potential source countries for these three fish species, and the approval status of these countries to export live freshwater fish to Australia; and - The potential effects on wild populations of these three fish species in their natural range, should these populations be used to supply demand in Australia.		3. The updated ToR did not address this request. 4. *S. denisonii* is commercially farmed in large numbers throughout Indonesia and Malaysia, more than capable of satisfying international aquarium trade demand. No comments on the other species. No references provided. 5. It is not industry's intent to import or trade in wild caught *S. denisonii*. *S. denisonii* is commercially farmed in large numbers throughout Indonesia and Malaysia, more than capable of satisfying international aquarium trade demand. India from where the species originates is not an approved country to export of freshwater ornamental fish to Australia. 6. The updated ToR did not address this request.
NSW Department of Primary Industries	NSW DPI supports the amendment to add the 3 species to the Live Import List, provided the following conditions are met: A minimum size limit should be applied to the importation of *D. denisonii* to reduce the chance of mistaken identity of juveniles with other similar looking fish species at the border.	Please suggest and justify a suitable size limit for *D denisonii* to allow positive identification, with supporting evidence (Such as photos of fish at differing life stages – showing their similarities and differences to other similar fish).	The updated ToR did not address this request, but commented: This issue is outside of the terms of reference for the application. Under the current import conditions, fish specimens that cannot be identified as the species stated in import documentation (including health certification) are not released on inspection by DAWE. Size and sex limits have never been the responsibility of the applicant, but rather something that DAWE operations would usually handle. Over the years industry have worked with DAWE on mechanisms to ensure identification is easy, but size and sex should not impact an 'environmental' review as to whether the species can be added to the list. Applicant added further to this that: We will be happy to work with the relevant department when this species is approved on implementation of an appropriate size limit should it be deemed necessary. It is also noted that the

Respondent	Major comments	Further information requested	Applicant response
			fish species most likely to be confused with *S. denisonii* are already approved for live import into Australia.
NT Department of Industry, Tourism and Trade	This species in not allowed into the NT – it is not an allowable import. There are several comments in all three applications that are certainly not correct or not valid, e.g. - The addition of *Dawkinsia denisonii*, to the Live import List would be "consistent with current import policy given that the species are present in Australia" is certainly not correct and is not a justification to add this species to the list. - Propagule pressure: "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 accidently or deliberately released into a suitable receiving environment to establish a breeding population" – this does not take into account tropical cities like Darwin, Cairns and other tropical QLD towns – there is a significant population that do live in the tropics, so this justification is invalid. - Allowing a species in and therefore making it more affordable is not a valid reason for listing.	1. What is the 'current import policy' which is referred to in the applications and how is adding these species to the Live Import List consistent with this policy – please amend the draft report to reflect this. 2. Please review the propagule pressure section to include areas of higher population densities as detailed in the NT response. 3. How would the fish be identified as captive bred? 4. Where would fish be sourced? 5. Taxonomic Group: Why isn't *Cyprinus carpio* (carp) included here? 6. Provide more detail on the other members of Cyprinidae that are highly invasive and established around the globe. 7. How often can a female spawn in a breeding season in the wild? 8. Similar Niche Species: Is there a risk of competition or destruction of spawning sites for native fish? 9. Please provide details including scientific references for diseases that are found in carp species. 10. Please provide peer reviewed references which support the information provided in relation to the environmental requirements of the species. 11. Please amend the report to reflect that the species are not permitted in all jurisdictions.	The updated ToR did not address this request, but commented: 1. This issue is outside of the terms of reference for the application and is not relevant. Philosophical objections to adding more species to the permitted import list are not valid and need to be disregarded in any assessment. 2. This issue is outside of the terms of reference for the application and is not relevant. Philosophical objections to adding more species to the permitted import list are not valid and need to be disregarded in any assessment. It is further noted that the only mechanism for Industry to have the keeping of new species recognised in Jurisdictions such as NT, WA and TAS is to have them listed as suitable for live import in the EPBC act. 3. The updated ToR did not address this request. 4. It is not industry's intent to import or trade in wild caught *D. denisonii. D. denisonii* is commercially farmed in large numbers throughout Indonesia and Malaysia, more than capable of satisfying international aquarium trade demand. India from where the species originates is not an approved country to export of freshwater ornamental fish to Australia. 5. The updated ToR did not address this request, but commented: The purpose of the EPBC process and the associated Bomford assessment to ascertain the invasiveness of individual species. This process takes into account the number of recognised

Respondent	Major comments	Further information requested	Applicant response
	- Do not believe that the species were inadvertently shipped here. How was the species imported in large enough numbers to establish captive breeding? - The fact that the fish is already in Australia is not a reason to allow it – it is an illegal import! - Several members of Cyprinidae are highly invasive and established around the globe. - 'The species thrives in a subtropical climate in water with a 6.8-7.8 pH, a water hardness of 5-25 dGH and a temperature range of 18 to 26°C'. So, it can thrive across a relatively large range of water qualities! - Ability to find shelter: These habitat characteristics are common in many Australian waterways so ability to find shelter is NOT limited.		invasive species in broader taxa, which has been done for the species proposed for addition to the Permitted Species list. 6. The purpose of the EPBC process and the associated Bomford assessment to ascertain the invasiveness of individual species. This process takes into account the number of recognised invasive species in broader taxa, which has been done for the species proposed for addition to the Permitted Species list. Furthermore, disease risk is assessed by Biosecurity Australia (BA), Independent of this process. The Import risk assessment for ornamental finfish (1999) adequately addresses these risks. Industry will continue to work with BA as required to ensure Australia maintains its appropriate level of protection. 7. The updated ToR did not address this request. 8. There are no reports in the scientific literature of any ecological impacts as a result of the species establishing outside its natural range in other countries. 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. 9. The updated ToR did not address this request. 10. The updated ToR did not address this request. Applicant states 'environmental requirements, of *S. denisonii* is not available in the peer reviewed scientific literature.' 11. It is reasonable to suggest aquarium industry and hobby literature have thoroughly explored the tolerances of species commonly kept and traded. It is unreasonable to exclude or deem invalid the wealth of specific industry and hobbyist knowledge of a given species simply because it didn't come from

Respondent	Major comments	Further information requested	Applicant response
			a scientific journal, particularly when such information is not available in scientific journals. Most importantly, any judgement in this regard must be based on a sound understanding of the drivers for scientific research. Scientific research is typically undertaken on species that are considered to be problematic. The species that have been submitted for consideration for adding to the permitted species list have been chosen on the basis that these are not considered ecologically problematic despite years of international trade. Thus, the harmless nature of these species is precisely and logically the reason they have not been the subject of scientific research. 12. The updated ToR did not address this request. The applicant still states that 'The species is not prohibited or controlled by permit or licence in any state or territory.'
WA Department of Primary Industries and Regional Development	DPIRD does not support the inclusion of *D. denisonii*, as: - This species on not on either the white or grey list, suggesting it could be from illegal imports, therefore on principle it should not be included on the Live Import list. To include it now, diminishes the intent of the list as it may be seen by others that you can get around the legalities by applying after the fact. - The applicant only presents an assessment of establishment likelihood, not biosecurity risk, as they have not considered the consequence to the environment, economy or socio-cultural values if *D. denisonii* were to establish.	1. Please amend the report to consider the consequence to the environment, economy or socio-cultural values if *D. denisonii* were to establish. 2. Please reference fish biological information based on scientific literature – can the species survive outside the industry recommended tolerances? 3. Lyer (2016) outlines how trade in listed species (and specifically mentions wild harvest of Torpedo Barbs) can be counterproductive to protection and compromise conservation efforts due to increased harvesting. Please detail how you can assure that only captive bred fish will be imported, and that listing would not impact the wild populations?	1. The updated ToR did not address this request but commented: With respect to risks associated with pathogens/diseases that may be carried in imported ornamental fish, a review of the scientific literature did not identify any hazards beyond those identified in the DEWA IRA (1999) and subsequent reviews (see TOR #8). These risks would be managed under the baseline import conditions that currently apply to all imported ornamental fish, which includes consideration of likely environmental, economic and social consequences of disease establishment, consistent with the Biosecurity Act (2015). Furthermore, it is our understanding based on DEWA advice that each species proposed for addition to the Live Import List is additionally reviewed by DEWA against its import risk analyses as part of the Live Import List approval process. If the intent of the stakeholder comment relates to the environmental, social and economic consequences of the fish species establishing in the wild in Australia, this is a core

Respondent	Major comments	Further information requested	Applicant response
	- Many species in the aquarium industry often have very little in the scientific literature particularly on tolerances (etc) and much of the information is garnished from industry and hobbyist websites. Consequently, it must be assumed that tolerances are likely to be greater than what is often just an ideal range. - *D. denisonii* is IUCN listed (Endangered Category) and has a limited distribution. DPIRD is not satisfied there are robust checks and balances in place to ensure the species would not be sourced from the wild for import into Australia and would not support the addition of this species to the list.		element of the TORs set out by DEWA and which the applicant has addressed (see TOR# 8), noting that there are no reports in the scientific literature of any ecological impacts as a result of the species establishing outside its natural range in other countries and that 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. 2. The updated ToR did not address this request but commented: Scientific research is typically undertaken on species that are considered to be problematic. The species that have been submitted for consideration for adding to the permitted species list have been chosen on the basis that these are not considered ecologically problematic despite years of international trade. Thus, the harmless nature of these species is precisely and logically the reason they have not been the subject of scientific research. 3. The updated ToR did not address this request but commented: IUCN listed status does not prevent or preclude international trade in a species; while it should always be a consideration it is not in itself a justification to not support approval. It is not industry's intent to import or trade in wild caught *D. denisonii.* *D. denisonii* is commercially farmed in large numbers throughout Indonesia and Malaysia, more than capable of satisfying international aquarium trade demand. There is currently little to no wild harvest remaining in this species as it has become cost prohibitive when compared to aquaculture produced specimens (wild caught fish are 20 times more expensive than farmed fish). The importation of wild caught specimens would simply not be commercially viable. Furthermore, India from where the species originates is not an

Respondent	Major comments	Further information requested	Applicant response
			approved country to export of freshwater ornamental fish to Australia.
Australian Government	- The applications indicate that the three species are present in Australia and there is no evidence of them having an environmental impact. - Details on the natural environmental requirements and reproductive potential of the three species in the wild are poorly known. An accurate environmental risk assessment cannot be completed without knowing the conditions that the fish survive in in the wild. A lack of scientifically reviewed data will make it impossible to carry out a risk assessment. - Australia has a responsibility to ensure that we do not encourage illegal wildlife trade in this or other countries.	1. Please provide evidence that the species have not established in Australia or, if they have, that they have not had any environmental impacts. 2. Please provide peer reviewed references which support the information provided in relation to the environmental requirements of the three species.	1. The updated ToR did not address this request, but commented: This matter is directly and clearly addressed in DCCEEW's TORs. There are no known diseases specific to this species that are exotic to Australia. The species is not reported to be invasive. In any case, this species is relatively benign, relatively small and similar in many respects to fish already deemed appropriate to be imported into Australia. The absence of information in formal scientific literature is not an adequate reason to suggest the species could be harmful in some respects. If there were problems with the species, then scientific studies would have been undertaken. Scientific research is typically undertaken on species that are considered to be problematic. The species that have been submitted for consideration for adding to the permitted species list have been chosen precisely because they are not considered ecologically problematic despite years of international trade. 2. The updated ToR did not address this request. Applicant states that 'environmental requirements, of *S. denisonii* is not available in the peer reviewed scientific literature.'

Round 2

The updated applicant's report against the ToR and DCCEEW's risk assessment report were circulated with relevant state and territory government agencies for comment between 31 May and 28 June 2023. The South Australian Government responded with comments supporting the amendment. The Western Australian Government responded supporting the findings and recommendations (Table 11).

Table 12 Comments received during consultation with relevant state and territory government agencies.

Respondent	Major comments	Department's response
South Australian Government	• The SA government supports the recommendations to not list 7 species, and to list 2 species under Part 2 with specific import conditions. The SA departments would also like to provide the following comments: o Supportive of listing *Dawkinsia denisonii* (torpedo barb) in Part 2 of the Live Import List with the conditions: For identification only. High security facilities only. o Captive-bred specimens only. o Listing *Dawkinsia denisonii* with the condition for identification only will assist with differentiating between *Dawkinsia denisonii* and *Rasbora trilineata*, a species listed on Part 1 of the Live Import List, at the border. o Housing in high security facilities will significantly reduce the risk of this species escaping or being introduced into the Australian environment. o The condition of captive-bred specimens only will ensure that no pressure is placed on wild populations, given the conservation status of this species – listed as endangered on the IUCN Red List of Threatened Species. • It would be beneficial if the risk assessments undertaken by the applicants displayed the assessed risks against Australia's acceptable level of protection (ALOP), per the Animal Quarantine Policy Memorandum 1999/26. Being transparent as to when ALOP is not met is important for equivalence with other import processes.	Assessing risks against Australia's acceptable level of protection (ALOP), per the Animal Quarantine Policy Memorandum 1999/26 is outside the scope of assessments to amend the List of Specimens taken to be Suitable for Live Import under the *EPBC Act.*
Western Australian Government	The Western Australian Government notes and supports the recommendations and does not have any further comment.	

Glossary

CITES	Convention on International Trade in Endangered Species
DAWE	Former Australian Department of Agriculture, Water and the Environment
DCCEEW	Department of Climate Change, Energy, the Environment and Water
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
GISD	Global Invasive Species Database
ISC	Invasive Species Compendium
IUCN	International Union for Conservation of Nature
mm	Millimetres
ppm	Parts per million
TL	Total length

References

ABARES (2020) Climatch v2.0, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, accessed 10 April 2022.

Adikari A, Edirisinghe U, Epasinghe ED, Kithsiri HM, Phalawathtaarachchi V and Karunarathne TA (2018) Development of an artificial breeding and hatchery technique for exotic ornamental fish *Sahyadria denisonii* (Day, 1865), *Tropical Agricultural Research*, vol. 29, no. 4, pp. 313–319.

Ali A, Raghavan R and Dahanukar N (2015) *Sahyadria denisonii.* The IUCN Red List of Threatened Species 2015, accessed 13 January 2022.

Arunkumar AA and Manimekalan A (2018) Freshwater fish fauna of rivers of the southern Western Ghats, India. *Earth System Science Data*, vol. 10, no. 3, pp. 1735–52.

Arthington AH, Kailola PJ, Woodland DJ and Zalucki JM (1999) *Baseline environmental data relevant to an evaluation of quarantine risk potentially associated with the importation to Australia of ornamental finfish*. Report to the Australian Quarantine and Inspection Service, Department of Agriculture, Fisheries and Forestry, Canberra.

Beck H, Zimmermann N, McVicar T, Vergopolan N, Berg A and Wood EF (2018) Present and future Köppen-Geiger climate classification maps at 1-km resolution. *Scientific Data*, vol. 5, 180214.

Bijukumar A, Philip S, Ali A, Sushama S. and Raghavan R (2013) Fishes of River Bharathapuzha, Kerala, India: diversity, distribution, threats and conservation. *Journal of Threatened Taxa*, vol. 5, no. 15, pp. 4979–4993.

Bomford M and Glover J (2004) *Risk assessment model for the import and keeping of exotic freshwater and estuarine finfish*. Commonwealth of Australia accessed 8 February 2022.

Bomford M (2008) *Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand: validating and refining risk assessment models.* Invasive Animals Cooperative Research Centre, Canberra.

Bomford M, Barry S and Lawrence E (2010) Predicting establishment success for introduced freshwater fishes: A role for climate matching. Biological Invasions. 12. 2559-2571. 10.1007/s10530-009-9665-3.

Boutier M, Donohoe O, Kopf RK, Humphries P, Becker JA, Marshall J and Vanderplasschen A (2019) Biocontrol of carp: the Australian plan does not stand up to a rational analysis of safety and efficacy. *Frontiers in microbiology*, p. 882, accessed 1 February 2022.

Centre for Invasive Species Solutions (2012) Introduction and distribution of carp in Australia, In: PestSmart, accessed 4 February 2022.

Chan J, Zeng Y and Yeo DC (2021) Invasive species trait-based risk assessment for non-native freshwater fishes in a tropical city basin in Southeast Asia. *PloS one*, vol. 16, no. 3, p. e0248480.

Chan JCF, Tsang AHF, Yau SM, Hui TCH, Lau A, Tan HH, Low BW, Dudgeon D and Liew JH (2023) 'The non-native freshwater fishes of Hong Kong : diversity, distributions and origins', *Raffles Bulletin of Zoology*, vol. 71, pp. 128-168. https://doi.org/10.26107/RBZ-2023-0012

Clavero M, Suh J, Franch N, Aparicio E, Buchaca T, Caner J, Garcia-Rodriguez S, Llimona F, Pou-Rovira Q, Rocaspana R and Ventura M (2023) Invaders they are a-changing: A recent, unexpected surge of invasive loaches in Catalonia. *Freshwater Biology*, 00, 1–11. https://doi.org/10.1111/fwb.14051

Corfield J, Diggles B, Jubb C, McDowall RM, Moore A, Richards A and Rowe DK (2008) Review of the impacts of introduced ornamental fish species that have established wild populations in Australia. Australian Government Department of the Environment, Water, Heritage and the Arts, accessed 24 January 2022.

Day F (1865) On the fishes of Cochin, on the Malabar Coast of India. Part II. Anacanthini, *Proceedings of the Zoological Society of London*, vol. 1865, no. 1, pp. 286–318.

Department of Agriculture (2019) Aquatic Animal Diseases Significant to Australia: Identification Field Guide, 5th Edition, Australian Government Department of Agriculture, Canberra, accessed 1 February 2022.

Department of Primary Industries and Regional Development (2022) Freshwater pest ID, Perth, accessed 8 February 2022.

Deveney M (2018) Assessing the risks associated with the Australian trade in live ornamental fish species: development of a risk assessment tool. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2018/000280-1. SARDI Research Report Series No. 991. 85pp.

Ebner BC, Millington M, Holmes BJ, Wilson D, Sydes T, Bickel TO, Power T, Hammer M, Lach L, Schaffer J, Lymbery A and Morgan DL (2020) Scoping the biosecurity risks and appropriate management relating to the freshwater ornamental aquarium trade across northern Australia, Centre for Tropical Water and Aquatic Ecosystem Research Publication 20/17, James Cook University, Cairns, accessed 24 January 2022.

Elvira B (2001) Identification of non-native freshwater fishes established in Europe and assessment of their potential threats to the biological diversity. In: *Convention on the Conservation of European Wildlife and Natural Habitats*, Strasbourg, November 2001.

Eschmeyer's Catalog of Fishes (2022) *Dawkinsia denisonii*, accessed 1 December 2022.

Froese R and Pauly D (Eds) (2022) FishBase, accessed January 2022.

Gomon MF (2024) *Puntius conchonius* in Fishes of Australia, accessed 07 Feb 2024, https://fishesofaustralia.net.au/home/species/1856

Guisan A and Zimmermann NE (2000) Predictive habitat distribution models in ecology. *Ecological Modelling*, vol. 135, no. 2–3, pp. 147–186.

Haubrock PJ, Cuthbert RN, Hudgins EJ, Crystal-Ornelas R, Kourantidou M, Moodley D, Liu C, Turbelin AJ, Leroy B and Courchamp F (2022) Geographic and taxonomic trends of rising biological invasion costs. *Science of the Total Environment*, vol. 15, no. 817, pp. 152948.

Havel JE, Kovalenko KE, Thomaz SM, Amalfitano S and Kats LB (2015) Aquatic invasive species: challenges for the future. *Hydrobiologi*a, vol. 750, no. 1, pp. 147–170.

Hoole D, Bucke D, Burgess P and Wellby I (2001) Diseases of carp and other cyprinid fishes, Blackwell Science, UK, accessed 8 February 2022.

Huntingford FA, Adams C, Braithwaite VA, Kadri S, Pottinger TG, Sandøe P. and Turnbull JF (2006) Current issues in fish welfare. *Journal of fish biology*, vol. 68, no. 2, pp.332–372.

ISC (2022) *Pethia conchonius*, In: Invasive Species Compendium, Wallingford, UK: CAB International, accessed 14 January 2022.

John L, Peter R and Gopalakrishnan A (2013) Population structure of Denison's Barb, *Puntius denisonii* (Pisces: Cyprinidae): a species complex endemic to the Western Ghats of India. *Journal of Phylogenetics and Evolutionary Biology*, pp. 1–12.

Katwate C, Pawar R, Shinde V, Apte D and Katwate U (2014) How long will social beliefs protect the pride of River Savitri. *MIN: The Newsletter of the IUCN SSC/WI Freshwater Fish Specialist Group (South Asia),* vol. 2, pp. 2124.

Koehn J, Brumley AR and Gehrke PC (2000) *Managing the impacts of carp*. Canberra: Bureau of Rural Sciences.

Kolar CS and Lodge DM (2001) Progress in invasion biology: predicting invaders. *Trends in ecology and evolution*, vol. 16, no. 4, pp. 199–204.

Kumschick S, Bacher S, Dawson W, Heikkilä J, Sendek A, Pluess T, Robinson TB and Kühn I (2012) A conceptual framework for prioritization of invasive alien species for management according to their impact. *NeoBiota,* vol. 15, pp. 69–100.

Lever C (1996) Naturalized fishes of the world. Academic Press, California, USA. 408 p.

Lyer P, Raghavan R, Dahanukar N, Sood N and Molur S (2016) All that is green does not conserve: green certification of aquarium fishes in India. *Current Science*, vol. 110, no. 11, pp. 2053–2056.

Mahadevi N, Felix S, Ahilan B and Rajagopalasamy CBT (2020) Evaluation of reproductive performance in indigenous endemic ornamental fish *Sahyadria denisonii* using hormones under captive environment. *Journal of Environmental Biology*, vol. 41, no. 3, pp. 549–555.

Matsuzaki SS, Mabuchi K, Takamura N, Nishida M and Washitani I (2009) Behavioural and morphological differences between feral and domesticated strains of common carp *Cyprinus carpio*. *Journal of Fish Biology*, vol. 75, no. 6, pp. 1206–20.

Mercy ATV, Gopalakrishnan A, Kapoor D and Lakra WS (2007) *Ornamental fishes of the Western Ghats of India*. National Bureau of Fish Genetic Resources.

Mercy TA, Sajan S and Malika V (2015) Captive breeding and developmental biology of *Sahyadria denisonii* (Day 1865, Cyprinidae), an endangered fish of the Western Ghats, India. *Indian Journal of Fisheries*, vol. 62, no. 2, pp. 19–28.

Mittal R (2009) Business unusual: Conserving Miss Kerala. *Aquarama Magazine* 12: 7-9.

Moore A, Marton N and McNee A (2010) A strategic approach to the management of ornamental fish in Australia. Communication strategy and grey list review-a report to OFMIG. Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry, Commonwealth of Australia, accessed 24 January 2022.

Moyle PB and Marchetti MP (2006) Predicting invasion success: freshwater fishes in California as a model. *BioScience*, vol. 56, no. 6, pp. 515–524.

Nentwig W, Bacher S, Pyšek P, Vilà M and Kumschick S (2016) The generic impact scoring system (GISS): a standardized tool to quantify the impacts of alien species. *Environmental monitoring and assessment,* vol. 188, no. 5, pp. 1–13.

Nico L and Neilson M (2013) *Pethia conchonius* (Hamilton, 1822): U.S. Geological Survey, Nonindigenous Aquatic Species Database, Gainesville, FL, accessed 8 February 2022.

Nico L, Fuller P, Neilson M and Loftus B (2019) *Puntigrus tetrazona* (Bleeker, 1855): U.S. Geological Survey, Nonindigenous Aquatic Species Database, Gainesville, FL, accessed 8 February 2022.

Padilla D and Williams SL (2004) Beyond ballast water: aquarium and ornamental trades as sources of invasive species in aquatic ecosystems. *Frontiers in Ecology and the Environment*, vol. 2, no. 3, pp.131–138.

Peel MC, Finlayson BL and McMahon TA (2007) Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences*, vol. 11, pp. 1633–1644.

Prasad G, Ali A and Raghavan R (2008) Threatened fishes of the world: *Puntius denisonii* (Day 1865, Cyprinidae). *Environmental biology of fishes,* vol. 83, no. 2*,* 189.

Radhakrishnan KV and Kurup BM (2005) Aspects of life history traits of *Puntius denisonii* (Day), an endemic and threatened ornamental fish of Kerala. In *Sustain Fish 2005 International Symposium on Sustainability of Fish Production Systems and Appropriate Technologies for Utilization*. Cochin University of Science and Technology.

Raghavan R, Prasad G, Pereira B, Anvar Ali PH and Sujarittanonta L (2009) 'Damsel in distress'-The tale of Miss Kerala, *Puntius denisonii* (Day), an endemic and endangered cyprinid of the Western Ghats biodiversity hotspot (South India). *Aquatic Conservation: Marine and Freshwater Ecosystems*, vol. 19, no. 1, pp. 67–74.

Raghavan R, Philip S, Ali A and Dahanukar N (2013a) *Sahyadria,* a new genus of Barbs (Teleostei: Cyprinidae) from Western Ghats of India. *Journal of Threatened Taxa*, vol. 5, no. 15, pp. 4932–4938.

Raghavan R, Dahanukar N, Tlusty MF, Rhyne AL, Kumar KK, Molur S and Rosser AM (2013b) Uncovering an obscure trade: threatened freshwater fishes and the aquarium pet markets. *Biological Conservation,* vol. 164*,* pp. 158–169.

Raghavan R, Ali A, Philip S and Dahanukar N (2018) Effect of unmanaged harvests for the aquarium trade on the population status and dynamics of redline Torpedo Barb: A threatened aquatic flagship. *Aquatic Conservation: Marine and Freshwater Ecosystems*, vol. 28, no. 3, pp. 567–574.

Ren Q, Yang L, Chang CH and Mayden RL (2020) Molecular phylogeny and divergence of major clades in the *Puntius* complex (Teleostei: Cypriniformes). *Zoologica Scripta*, vol. 49, no. 6, pp. 697–709.

Sajan S, Mercy TA, and Malika V (2015) Age, growth and population dynamics of an endangered fish *Sahyadria denisonii* (Day 1865) from the Western Ghats hotspot of India (PDF 545KB). *Asian Fisheries Science*, vol. 28, no. 3, pp. 130–142.

Seriously Fish (2022) *Sahyadria denisonii* – Red-line Torpedo Barb *(Barbus denisonii, Puntius denisonii),* accessed 4 April 2022.

Solomon S, Ramprasanth MR, Baby F, Pereira B, Tharian J, Ali A and Raghavan R (2011) Reproductive biology of *Puntius denisonii*, an endemic and threatened aquarium fish of the Western Ghats and its implications for conservation. *Journal of Threatened Taxa,* vol. 3, no. 9.

Van der Laan R, Eschmeyer WN and Fricke R (2022) Family-group names of Recent fishes. *Zootaxa Monograph*, vol. 3882, no. 1, pp. 1–230.

World Organisation for Animal Health (2021) Aquatic Animal Health Code 23rd Edition, accessed 8 February 2022.