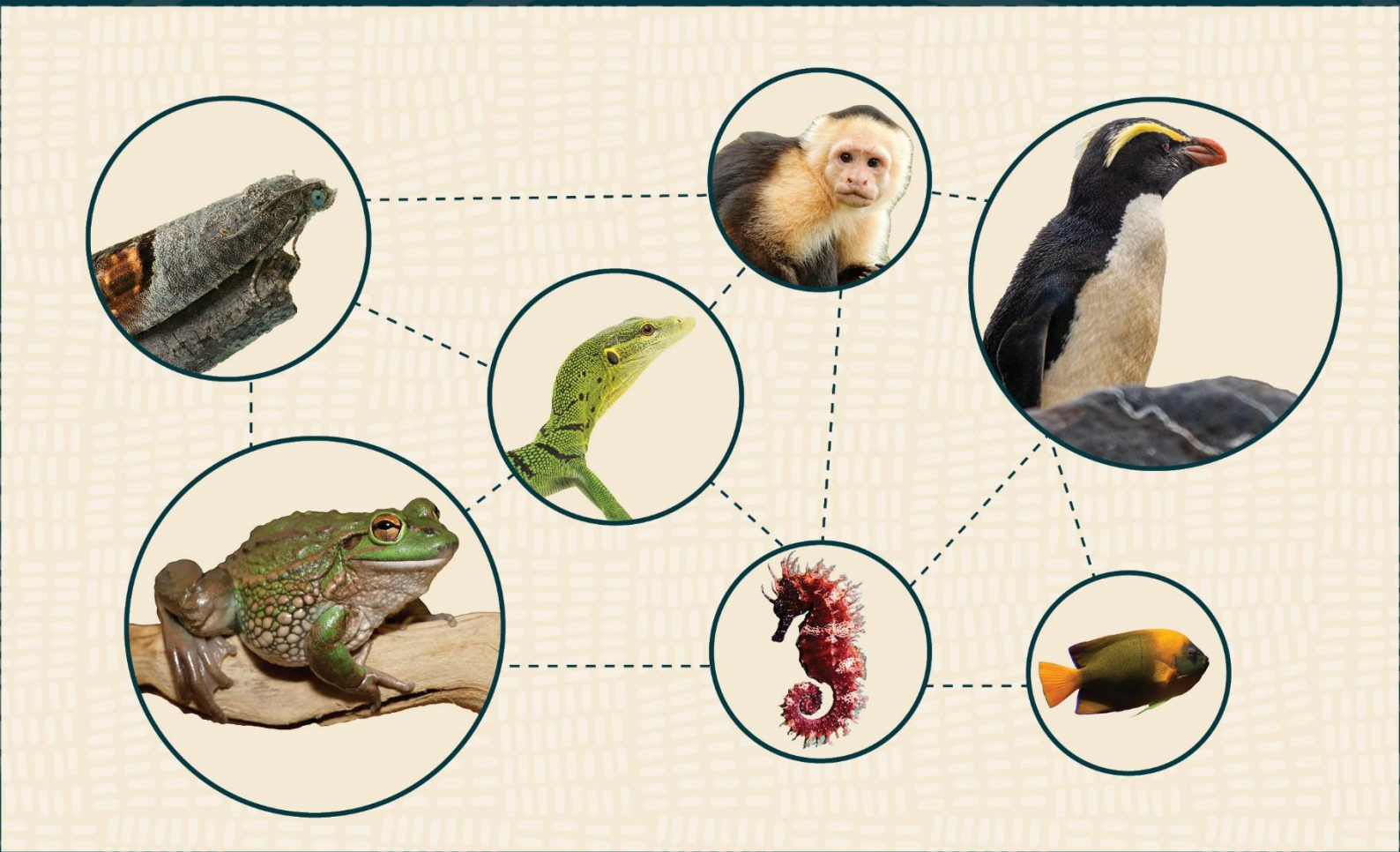
Australian Government
Department of Climate Change, Energy, the Environment and Water

Assessment of the Potential Impacts of 6 Species from the Genus Pseudomugil 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



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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

In 2022, applications to amend the Live Import List to include 6 species of rainbowfish from the genus *Pseudomugil* were submitted to the Department of Climate Change, Energy, the Environment and Water (DCCEEW). The applications were prepared in accordance with s 303EE of the EPBC Act.

The 6 species were:

- *Pseudomugil connieae* (Popondetta rainbowfish)
- *Pseudomugil furcatus* (forktail rainbowfish)
- *Pseudomugil ivantsoffi* (Ivantsoff's blue-eye)
- *Pseudomugil luminatus* (red neon blue-eye)
- *Pseudomugil paskai* (Paska's blue-eye)
- *Pseudomugil reticulatus* (Vogelkop blue-eye)

Risk assessments were undertaken to evaluate the likelihood of establishment and spread of the species in Australia, and the potential impact(s) on the Australian environment. Several factors were considered during the assessments, 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.

The *Pseudomugil* genus contains 16 species of rainbowfishes endemic to Australia and New Guinea. They are small, colourful fishes rarely exceeding 5cm TL, with striking blue irises. The 6 species under assessment have highly restricted distributions in New Guinea, and relatively little is known about their biology and ecology in their natural habitats. These species typically inhabit shallow water in rainforest streams, creeks and swampy marshes where temperatures range from 12-36°C; but require temperatures over 23°C to spawn and hatch fry.

Results from the Fish Invasiveness Screening Kit (FISK) showed that all 6 *Pseudomugil* species have a low risk of invasiveness, and the impacts assessment suggest minor potential impacts on the environment if they were to establish. All species inhabit similar climate zones to areas of coastal northern Queensland in Australia; and 2 species would likely be able to establish across tropical freshwater ecosystems in northern Australia. They have few undesirable traits, and would be eaten by predatory fish, water birds and aquatic reptiles.

Under ss 391(1) of the EPBC Act, the Minister must take account of the precautionary principle in making decisions. The precautionary principle is triggered by two threshold conditions: (1) a threat of serious or irreversible environmental damage (direct or indirect); and (2) scientific uncertainty as to the environmental damage. The department has determined that the 6 *Pseudomugil* species do not pose a threat of serious irreversible damage.

The conservation status of these species is of concern, with 5 listed as Critically Endangered or Endangered on the IUCN Red List of Threatened Species, and 1 species listed as Data Deficient. Subsection 303EN(3) of the EPBC Act states that the Minister must not issue a permit 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 our jurisdiction do not cause damage to the environment of other states or areas. It is important that listing of threatened species in the Live Import List does not place pressure on wild stocks.

Recommendation: In consideration of their conservation status, the department recommends listing *Pseudomugil connieae, Pseudomugil furcatus, Pseudomugil ivantsoffi, Pseudomugil luminatus* and *Pseudomugil reticulatus* in Part 2 of the Live Import List with the condition:

- Captive-bred specimens only, of minimum length 2cm SL.

In consideration of its status as Critically Endangered and the likelihood that imported specimens will be collected from the wild, the department **does not recommend** adding *Pseudomugil paskai* to the Live Import List.

Contents

Executive summary ..... **iii**

1 Introduction **1**

1.1 Purpose of the proposed import 1

1.2 Background on the Act 1

2 Biology and Ecology **3**

2.1 Taxonomy 3

2.2 Description 4

2.3 Geographic distribution 10

2.4 Habitat 12

3 Species status and conservation **13**

3.1 History in Australia 13

3.2 Related Live Import List listings 13

3.3 Related threat category listings 13

3.4 Conservation status 13

4 Risk Assessment **16**

4.1 The FISK Risk Assessment Model 16

4.2 Consequences for the environment 25

4.3 Risk Rating 29

4.4 Consultation - Concerns raised 29

4.5 Risk Mitigation 30

5 Discussion **31**

6 Conclusion **33**

Appendix A: FISK Model results for 6 *Pseudomugil* species **34**

Appendix B: Impacts assessment scoring criteria **39**

Appendix C: Comments received on the proposal to include 6 *Pseudomugil* species in the Live Import List **45**

Glossary **60**

References **61**

Tables

Table 1 Scientific and common names of the 6 *Pseudomugil* species under assessment 4
Table 2 Maximum length and physical descriptions of the 6 *Pseudomugil* species under assessment . 5
Table 3 Geographic distribution of the 6 *Pseudomugil* species under assessment 10
Table 4 Habitat preferences of the 6 *Pseudomugil* species under assessment 12
Table 5 Non-endemic rainbowfish species in the Live Import List 13
Table 6 Conservation status of species under assessment 14
Table 7 Decision matrix to combine the level of climate match with water temperature match to determine the FISK response rating for Q2.01 17
Table 8 Introductions of species from the family Melanotaeniidae 20
Table 9 Outcome of the FISK for the 6 *Pseudomugil* species under assessment, including certainty factor and sectors affected 25
Table 10 Potential impacts from the establishment of *Pseudomugil* species populations in Australia 25
Table 11 Threatened native rainbowfish species that may share a niche with *Pseudomugil* species if they were to become established 28
Table 12 Summary of main concerns raised and the applicant's responses 29
Table 13 Impacts assessment scoring criteria 39
Table 14 Comments received during public consultation and response from applicant 45
Table 15 Comments received during consultation Round 2 with states and territory governments... 59

Figures

Figure 1 Physical characteristics of the genus *Pseudomugil* 5
Figure 2 *Pseudomugil connieae* 8
Figure 3 *Pseudomugil furcatus* 8
Figure 4 *Pseudomugil ivantsoffi* 8
Figure 5 *Pseudomugil luminatus,* male (upper) and female, approximately 2 and 1.5 cm SL 9
Figure 6 *Pseudomugil paskai,* male (left) and female, approximately 2 cm SL 9
Figure 7 *Pseudomugil reticulatus,* approximately 2.4 cm SL 9
Figure 8 Geographic distribution of the 6 *Pseudomugil* species under assessment in New Guinea 11
Figure 9 Köppen-Geiger map of Oceania 19
Figure 10 Distribution of *Pseudomugil tenellus* in northern Australia 19

1 Introduction

1.1 Purpose of the proposed import

The applicant seeks to amend the *List of Specimens Taken to be Suitable for Live Import* (the Live Import List) to include 6 *Pseudomugil* species for the ornamental aquarium fish trade. The 6 species are:

- *Pseudomugil connieae* (Popondetta rainbowfish)
- *Pseudomugil furcatus* (forktail rainbowfish)
- *Pseudomugil ivantsoffi* (Ivantsoff's blue-eye)
- *Pseudomugil luminatus* (red neon blue-eye)
- *Pseudomugil paskai* (Paska's blue-eye)
- *Pseudomugil reticulatus* (Vogelkop blue-eye)

The applicant reports that 2 of these species (*P. connieae* and *P. furcatus*) are already in the trade in Australia, and so the request for these species to be added to the Live Import List is to legitimise the use of the species within Australia.

1.2 Background on the Act

Under s 303EC of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the responsible Minister may amend the 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 submitting an application to the department to amend the Live Import List, all applicants are required to provide a draft assessment report that addresses specific Terms of Reference published on the department website.

The department 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. The department also considers comments and information received through the public consultation process (including from states and territories). The applications and accompanying draft

reports for the proposed amendment to the Live Import List to allow the import of 6 *Pseudomugil* species were released for public comment from 14 October to 24 November 2022. The assessment report on the potential environmental impacts of listing the species was prepared in accordance with s 303EE of the EPBC Act. Under para 303EC(5)(a) the Minister must consider this report before amending the list.

Under ss 391(1) of the EPBC Act, the Minister must take account of the precautionary principle in making decisions. The precautionary principle is triggered by two threshold conditions: (1) a threat of serious or irreversible environmental damage (direct or indirect); and (2) scientific uncertainty as to the environmental damage.

2 Biology and Ecology

2.1 Taxonomy

Rainbowfishes are one of the most abundant families of freshwater fish in Australia and New Guinea with 112 species across 7 genera (Fricke, Eschmeyer & Van der Laan 2022). The genus *Pseudomugil* was erected by Kner in 1865 when he described *P. signifer* from Sydney. He and many other authors have placed this genus in a distinct Old World atherinoid family, Pseudomugilidae (Kner 1865, Saeed, Ivantsoff & Allen 1989). Others place it in the family Melanotaeniidae (and consider it to be the most primitive member of this family) based on two shared characters-the jaw structure and the unique modification of pelvic fins (Allen 1980, Allen & Cross 1982).

The Pseudomugilidae family has been well studied in recent years, but controversy persists as to whether they should be regarded as a separate family or as in a subfamily of Melanotaeniidae (Tappin 2015). Some taxonomic databases, including FishBase (Froese & Pauly 2022), Catalogue of Life (2022), the IUCN (2022) and Eschmeyer's Catalog of Fishes (Fricke, Eschmeyer & Fong 2022) assign it to family Pseudomugilidae. Others assign it to Melanotaeniidae, including ITIS (2022), the Atlas of Living Australia (2022) and Fishes of the World (Nelson et al. 2016). For the purposes of this assessment, the taxonomy as described in FishBase is adopted (

Table 1).

Family Pseudomugilidae contains 19 species across 3 genera – *Pseudomugil* (16 species), *Kiunga* (2 species) and *Scaturiginichthys* (1 species). The *Pseudomugil* genus contains 16 species that are endemic to Australia and New Guinea, with the 6 species under assessment found only in New Guinea. Genetic investigations have revealed that the 3 recognised genera are nested among *Pseudomugil*, which strongly suggests that only a single genus is warranted, but this is yet to be confirmed (Allen, Unmack & Hadiaty 2016).

Kingdom: Animalia

Phylum: Chordata

Superclass: Osteichthyes

Class: Actinopterygii

Infraclass: Teleostei

Order: Atheriniformes

Family: Pseudomugilidae

Genus*:* *Pseudomugil* (Kner 1865)

Table 1 Scientific and common names of the 6 *Pseudomugil* species under assessment

Scientific name	Common name(s)	Synonyms
Pseudomugil connieae (Allen 1981)	Popondetta rainbowfish, Popondetta blue-eye	*Popondichthys connieae, Popondetta connieae*
Pseudomugil furcatus (Nichols 1955)	Forktail rainbowfish	*Popondetta furcata, Popondichthys furcatus*
Pseudomugil ivantsoffi (Allen & Renyaan 1999)	Ivantsoff's blue-eye	*Kiunga paskai*
Pseudomugil luminatus (Allen, Unmack & Hadiaty 2016)	Red neon blue-eye	-
Pseudomugil paskai (Allen & Ivantsoff 1986)	Paska's blue-eye	-
Pseudomugil reticulatus (Allen & Ivantsoff 1986)	Vogelkop blue-eye	-

Taxonomic reference: Fricke, Eschmeyer & Van der Laan (2022)

2.2 Description

Family Pseudomugilidae, known as 'blue-eyes', are small, colourful fishes rarely exceeding 5cm TL, with striking blue irises (Allen 2004). In general, males are brightly coloured with elongated fin filaments that are used during courtship displays (Tappin 2011).

They are differentiated from other rainbowfish (family Melanotaeniidae) by the following features:

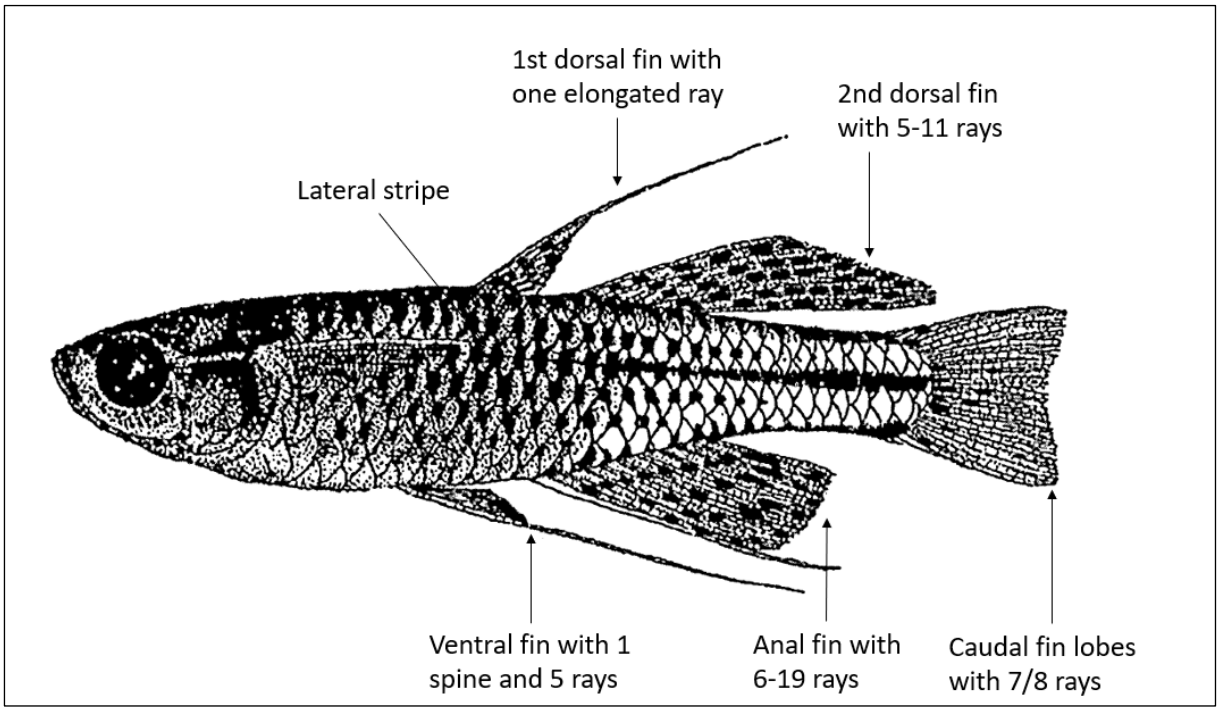
Body: *Pseudomugil* species have slender, elongate, moderately compressed bodies; narrow lateral stripe on side of body usually present; lateral line absent; eyes blue or green; scales cycloid; few scales on cheek and head, variable in size from few large to many small; and, if sexually dimorphic, males characterized by extremely elongated fin rays and brighter colouration (Saeed, Ivantsoff & Allen 1989, Tappin 2011) (Figure 1). There are also several differences in the skeletal structure evident on dissection.

Fins: 2 dorsal fins which are close to each other but separated; no spines on the second dorsal or pectoral fins; longest spine of first dorsal fin does not reach the origin of second dorsal fin; second dorsal fin with 5-11 branched segmented rays; anal fin originating on posterior half of body just behind origin of second dorsal, with 6-19 branched segmented rays; ventral fin not reaching origin of anal fin and consisting of one spine and five segmented rays; principal caudal fin rays 8 + 7 (Saeed, Ivantsoff & Allen 1989, Tappin 2011, Figure 1).

Members of the genus *Pseudomugil* can be differentiated from genus *Kiunga* due to their well-developed first dorsal fin (vestigial in *Kiunga*), with 3-8 flexible cylindrical spines (2-3 spines in *Kiunga*), 3-12 second dorsal fin rays (13-16 in *Kiunga*) and no keel-like structure between pelvic and anal fins (Saeed, Ivantsoff & Allen 1989).

Morphological characteristics of each species are described in Table 2.

Figure 1 Physical characteristics of the genus *Pseudomugil*



Source: Adapted from Allen, Unmack & Hadiaty (2016)

Table 2 Maximum length and physical descriptions of the 6 *Pseudomugil* species under assessment

Scientific name	Maximum length (cm)[a]	Description
Pseudomugil connieae	5.0	Body yellow-green. Female colouration is less intense, and they have smaller fins which lack the markings of the males (Tappin 2011). Sexually dimorphic - males easily distinguished from females by their brighter colouration and longer, elongated dorsal fin (Saeed, Ivantsoff & Allen 1989). Scales cycloid, relatively large and arranged in regular horizontal rows; 2 – 4 scales below eye covering cheek (Allen 1981). Dorsal and anal fins of males have a broad white/yellow outer margin and black band across the middle; outer region of the first dorsal fin is yellow. First ray of second dorsal and anal fins are a flexible, unsegmented spine (Allen 1981). Caudal fin has whitish lobes, a dusty central portion and lacks dark margins. Pelvic fins are whitish on the upper edge (Saeed, Ivantsoff & Allen 1989). Pelvic fin tips just reach origin of anal fin in males, do not quite reach this point in females (Allen 1981). 5 – 8 dorsal spines; 10 – 12 dorsal soft rays; 1 anal spine; 16 – 19 anal soft rays (Allen 1981) (Figure 2).
Pseudomugil furcatus	4.0	Elongate, laterally compressed body (Allen 1987). Body colour is yellow-green in both males and females (Tappin 2011). Sexually dimorphic - males are easily distinguished from females by their brighter colours and longer and more elongated dorsal fin. Two dorsal fins (the first much smaller than the second) separated by a small gap. Dorsal and anal fins mainly transparent to slightly dusky with a relatively narrow outer margin of yellow. Pelvic and pectoral fins tinged with red.

Scientific name	Maximum length (cm)[a]	Description
		Caudal fin has pale yellow lobes with thin black dorsal and ventral margins; pelvic fins are yellow (Saeed, Ivantsoff & Allen 1989). Females caudal fin lobes are yellowish, pectoral and pelvic fins are transparent. The body scales have a slight dark edge (Tappin 2011). Caudal fin is longer and more deeply forked than other *Pseudomugil* species (Nichols 1955). 4 – 7 dorsal spines; 7 – 9 dorsal soft rays; 1 anal spine; 15 – 18 anal soft rays (Allen 1991). Can be differentiated from *P. connieae* by the male coloration, the ray counts on the second dorsal and anal fins, the absence of palatine dorsal notch and a narrow pterosphenoid lateral process (Tappin 2011) (Figure 3).
Pseudomugil ivantsoffi	3.1	Obvious sexual dimorphism, first three spines of first dorsal fin of males often extended as filaments, dorsal and ventral fins of female shorter. Head and body of males is semitransparent, with a blue or red hue. Upper half of dorsal fins, anterior half of second dorsal and edge of anal fin are bright red. Pelvic fins are pinkish. Edges of some scales on abdomen have narrow black margins (Allen & Renyaan 1999). Females overall semi-transparent lacking bright red shades on abdomen with narrow black margins; opercle, abdomen and swim bladder region silvery; some scales on anterior half of body with faint, fine black margins; fins mainly translucent to faintly yellowish, the outer tips of the first and second dorsal fins yellow (Allen & Renyaan 1999) (Figure 4). Iris of eye intensely blue. Opercle, abdomen and swim bladder region silvery. This is a small species, slender and laterally compressed (Tappin 2011). Body scales cycloid, dorsoventrally elongated and obvious; sensory pits on dorsum of head large (Allen & Renyaan 1999). 4 – 7 dorsal spines; 7 – 10 dorsal soft rays; 1 anal spine; 9 – 13 anal soft rays; 6– 7 transverse scale rows; 11 – 14 predorsal scales count; 27 – 30 midlateral scales (Allen & Renyaan 1999). Originally identified as *P. reticulatus* but differentiated by colour pattern and shape, with *P. ivantsoffi* being slenderer and having a tall first dorsal fin that greatly overlaps the second dorsal fin when folded against the body; and body scales faintly outlined with dark pigment (Allen & Renyaan 1999).
Pseudomugil luminatus	2.2	Males body colour generally yellowish to reddish with neon blue stripe on uppermost part of body extending from the rear part of the head to the base of the uppermost caudal-fin rays. Scales thinly outlined with brown, sometimes silvery white on belly. The snout and upper part of the head is pale greyish to blue grey, usually with a red hue on the opercle due to the underlying red gill filaments and transparent nature of the thin outer covering of scales and bone. The eye pupil is black and iris bright blue (Allen, Unmack & Hadiaty 2016). The females' body colour is generally similar to that of the male, although smaller individuals are more yellowish and semitransparent; fins mainly translucent to slightly yellowish, usually without spots (Tappin 2011, Allen, Unmack & Hadiaty 2016). Median fins yellowish-tan to pale-orange, marked with widely scattered small black spots; the anal and caudal fins generally have fewer spots, and those of the anal fin are mainly confined to the basal half or posterior-most section. The first dorsal fin has a narrow white anterior margin, white colour extending onto elongate fin filament. The caudal fin has prominent white tips on dorsal and ventral lobes; pelvic fins translucent yellowish with elongate orange filament anteriorly. The pectoral fins are mainly translucent with bright yellow or white mark along the upper edge of fin (Allen, Unmack & Hadiaty 2016). 3 – 5 dorsal spines; 5 – 7 dorsal soft rays; 1 anal spine; 8 – 10 anal soft rays; 25 – 27 lateral scales (usually 26) (Allen, Unmack & Hadiaty 2016) (Figure 5).

Scientific name	Maximum length (cm)[a]	Description
		Similar in appearance to *P. paskai* but differentiated by 10 (rather than 11) anal fin rays, and fewer pectoral fin rays and lateral scales; body and fins of adult males darker; possession of neon-blue stripe along upper body (Allen, Unmack & Hadiaty 2016).
Pseudomugil paskai	2.5	Males have a semi-translucent body colour that is bluish ventrally and yellowish above the mid-lateral line, with narrow dark scale outlines. Opercular region pink. Dichromatic, with spots on fins and colour on pectorals and pelvic distinguishing males (Saeed, Ivantsoff & Allen 1989). Sexually dimorphic, with elongate first dorsal and pelvic rays in males. Two dorsal fins, very close together, the first much smaller than the second. The fins are generally translucent with white or yellow margins and scattered oval black spots. Lobes of the caudal fin have either white, yellow or reddish tips. Pelvic fins are yellowish with elongated anterior rays. Females do not have spots on their fins and do not show the colours of the males (Tappin 2011). 3 – 5 dorsal spines; 6 – 7 dorsal soft ray; 1 anal spine; 9 - 11 anal soft rays (Allen 1991). Can be differentiated from *P. luminatus* by less vivid colouration, lack of neon-blue stripe along the upper body and more anal fin rays and lateral scales (Allen, Unmack & Hadiaty 2016). Distinguished from other species under assessment by the presence of large dark spots on the median and caudal fins (Saeed, Ivantsoff & Allen 1989) (Figure 6).
Pseudomugil reticulatus	2.8	Laterally compressed; males light brown; abdomen and swim bladder region silvery. The ventral part of the breast is yellow. The upper half of the first dorsal fin, anterior half of the second dorsal and the edge of the anal fin is coloured brick-red. The dorsal and ventral contour posterior to the second dorsal and anal fins are edged with a similar red. The upper and lower third of the caudal fin is also red. The head has a red tinge while the ventral fins are pinkish-red. The eyes are intensely blue. The edges of some scales on the abdomen are edged with black. Female specimens show a stronger reticular pattern and yellow fins. Body colour yellow brown, edges of scales outlined with chromatophores, edges of rays and spines peppered with chromatophores. Eggs are orange-red in colour (Tappin 2011). 3 dorsal spines; 9 – 10 dorsal soft rays; 0 anal spines; 12 – 14 anal soft rays (Allen 1991, Allen & Renyaan 1999). Distinguished from other species under assessment by the lack of anal fin spine (Saeed, Ivantsoff & Allen 1989) (Figure 7).

a size data from IUCN listings except *P. connieae* (Froese & Pauly 2022).

Figure 2 *Pseudomugil connieae*



Source: Gunther Schmida (permission for use obtained from applicant)

Figure 3 *Pseudomugil furcatus*



Source: Gunther Schmida (permission for use obtained from applicant)

Figure 4 *Pseudomugil ivantsoffi*



Source: Gary Lange (permission for use obtained from applicant)

Figure 5 *Pseudomugil luminatus,* male (upper) and female, approximately 2 and 1.5 cm SL



Source: Taoyeah Deng (permission for use obtained from applicant)

Figure 6 *Pseudomugil paskai,* male (left) and female, approximately 2 cm SL



Source: Neil Armstrong (permission for use obtained from applicant)

Figure 7 *Pseudomugil reticulatus,* approximately 2.4 cm SL



Source: Gerald Allen (permission for use obtained from applicant)

2.3 Geographic distribution

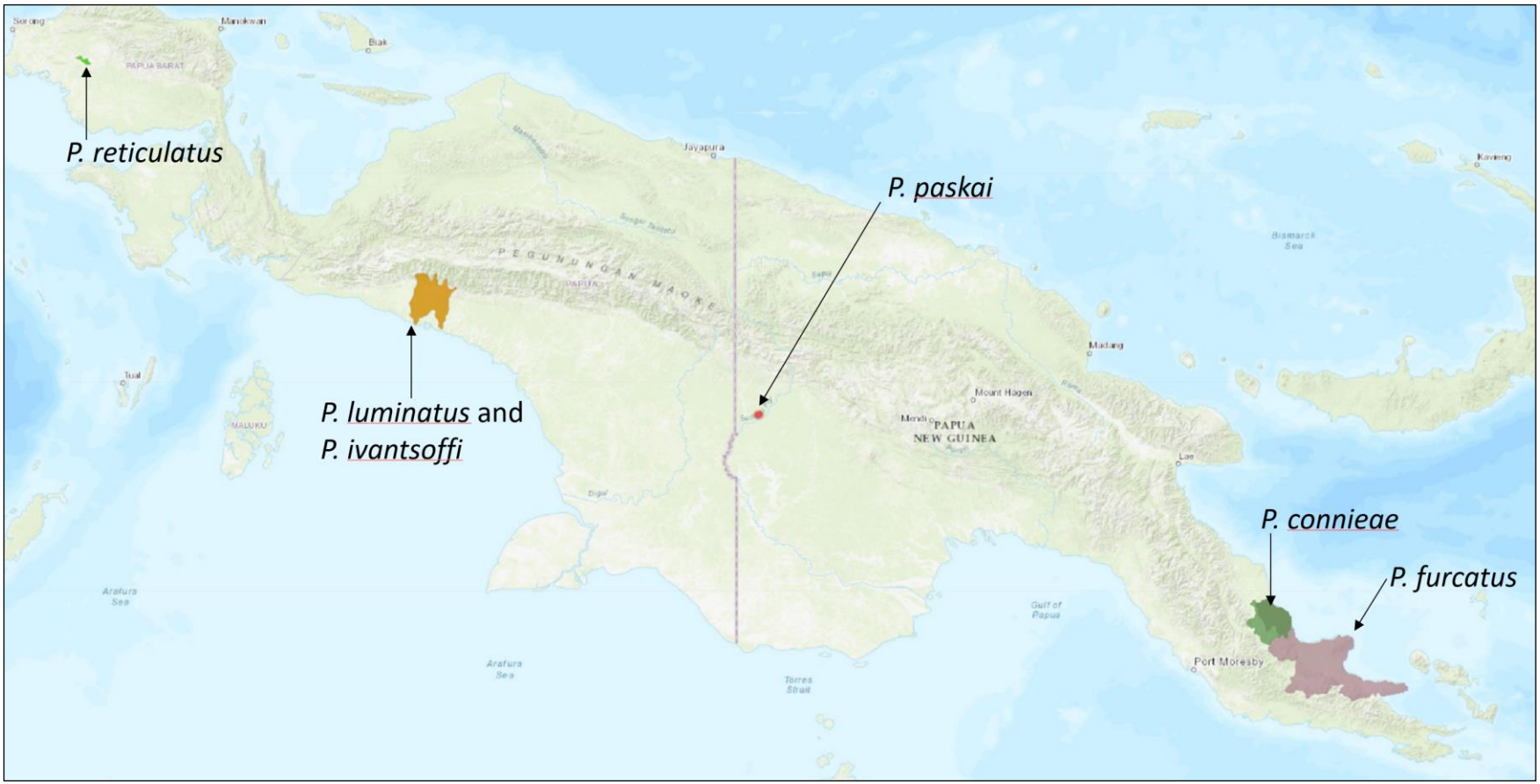
Members of the genus *Pseudomugil* are endemic to Australia and the island of New Guinea (Indonesia and Papua New Guinea) and adjacent islands, including the Aru Islands (Saeed, Ivantsoff & Allen 1989). *Pseudomugil* species occur along the eastern coast of Australia, from southern New South Wales to northern Queensland, as well as the Northern Territory and north-western Australia. The New Guinea members occur in northern and southern New Guinea and the Vogelkop Peninsula. Three species (*P. tenellus, P. inconspicuus* and *P. gertrudae*) are known to be common to both the New Guinean and the northern Australian regions.

The 6 species of *Pseudomugi*l under assessment occur only in New Guinea and have restricted ranges (Table 3, Figure 8).

Table 3 Geographic distribution of the 6 *Pseudomugil* species under assessment

Scientific name	Geographic distribution
Pseudomugil connieae	Occurs within a 25 km radius of the town of Popondetta in eastern Papua New Guinea (Hammer & Allen 2020).
Pseudomugil furcatus	Known only from 2 localities in the lowlands of the Northern Province in eastern Papua New Guinea, in the Kwagila and Musa River basins (Palmer-Newton 2020a).
Pseudomugil ivantsoffi	Only known from the Timika region of Papua Province, Indonesia (Allen & Kadarusman 2020a).
Pseudomugil luminatus	This species is currently known only from south-central New Guinea in the vicinity of Timika, Papua Province, Indonesia (Allen & Kadarusman 2020b).
Pseudomugil paskai	Known only from south-central New Guinea in the vicinity of Timika, in small creeks near Kiunga in the upper Fly River system, Papua New Guinea (Palmer-Newton 2020b).
Pseudomugil reticulatus	This species is known from tributary streams flowing into Lake Ayamaru in the central Bird's Head Peninsula of West Papua Province, Indonesia. Aside from the holotype collected in 1982, the species was known only from 15 other specimens deposited at the Western Australian Museum collected in 1999. After extensive searches, a few individuals were also found at a single site in 2019 (Allen, Kadarusman & Unmack 2020). Recent research suggests they are also found within Lake Ayamaru itself (Hidayah et al. 2021).

Figure 8 Geographic distribution of the 6 *Pseudomugil* species under assessment in New Guinea



Source: Map data taken from IUCN Red List, compiled by DCCEEW

2.4 Habitat

The habitat preferences of *Pseudomugil* are similar to other rainbowfishes, although they are usually found in shallower water in rainforest streams, creeks and swampy marshes. While other rainbowfish species live exclusively in fresh water, several *Pseudomugil* species (*P. signifer, P. gertrudae, P. paludicola* and *P. majusculus*) are found in intertidal mangroves with waters that vary from saline to brackish to fresh (Tappin 2011, Table 4).

Table 4 Habitat preferences of the 6 *Pseudomugil* species under assessment

Scientific name	Habitat preference
Pseudomugil connieae	Suitable habitats include permanent rivers/streams/creeks, freshwater marshes/pools. Generally found in very clear, moderate to fairly rapid flowing streams and creeks (Allen 1981, Saeed, Ivantsoff & Allen 1989) in both shaded rainforest or sunlit, exposed sections such as cleared grassland, below an elevation of about 150 m (Hammer & Allen 2020). It can be found in rocky pools situated in well-shaded positions (Hammer & Allen 2020) and has been found in brackish water (Tappin 2008). Temperature and pH in these streams ranged from 24-27°C and 7.7-7.9 respectively (Allen 1981).
Pseudomugil furcatus	Suitable habitats include permanent rivers/streams/creeks, freshwater marshes/ pools. Occurs in rainforest streams (Palmer-Newton 2020a), generally in small, clear, relatively swift-flowing freshwater streams with abundant aquatic vegetation (Tappin 2011). Water conditions reported from their natural habitats are temperature 24-28.5°C; pH 7.0-8.0 and hardness 90-180 ppm (Tappin 2011).
Pseudomugil ivantsoffi	Suitable habitats include permanent rivers/streams/creeks, bogs, marshes, swamps, fens, peatlands. Small (1 – 2m wide), shallow, clear, slow-flowing creeks and streams in dense lowland rainforest at an altitude of 100 – 150 m above sea level (Allen & Renyaan 1999) and can also be found in sago-Pandanus swamps (Allen & Kadarusman 2020a). Water is generally clear but may be tannin stained due to extensive heath forest in the area, with sparse aquatic vegetation. Bottom conditions included sand, gravel, cobble, and rocks. Water temperature from 24-28°C and pH values ranged from 6.7-7.8 (Allen & Renyaan 1999).
Pseudomugil luminatus	Suitable habitats include permanent rivers/streams/creeks, bogs, marshes, swamps, fens, peatlands. Previously locally common in sago-Pandanus swamp habitat with clear but darkly stained, slow-flowing water. This locality was severely altered by sediment tailings from the Freeport gold and copper mine and this species is presumed to be no longer present (Allen, Unmack & Hadiaty 2016). It is now primarily found in streams in forests at elevations of 45–60 m above sea level (Allen & Kadarusman 2020b) with a water temperature of 26–28°C and a pH of 4.8–7.2.
Pseudomugil paskai	Suitable habitats include permanent rivers/streams/creeks. Occurs in swampy lagoons, lakes, and small side channels of larger rivers, usually where there is abundant aquatic vegetation. Habitat is in low-hill terrain at elevations of about 100-150 m. Its streams are slow-flowing and either turbid or tea-coloured with abundant aquatic vegetation (Palmer-Newton 2020b) and temperature ranges of 25-26°C and pH 6.0-6.5 (Tappin 2011).
Pseudomugil reticulatus	Suitable habitats include permanent rivers/streams/creeks. Found in tributary streams flowing into Lake Ayamaru - small, clear-water streams running through secondary forest with a sand/mud bottom and minimal aquatic vegetation (Allen, Kadarusman & Unmack 2020). Water temperature 24 - 28 °C, pH always slightly above neutral (7.1-7.6). The habitat of this species is subject to broad fluctuations in water levels (Tappin 2011). Recent studies showing them to be present in Lake Ayamaru, a clear, alkaline lake, with temperatures between 24.0 – 31.7°C and pH 7.5-8.2 (Hidayah et al. 2021).

3 Species status and conservation

3.1 History in Australia

The applicant states that *P. connieae* and *P. furcatus* are well known in the Australian aquarium trade and have been kept and bred since 1983 (by the applicant) until import controls were placed on live ornamental fish imports in 1986. The applicant also states that *P. ivantsoffi* and *P. luminatus* are also available in the trade. None of these species are reported to have established self-sustaining populations in the wild in Australia (Corfield et al. 2008, Ayres & Clunie 2010).

The introduction of new aquatic species is inherently difficult to monitor as, unlike land-based spread of an 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 species.

3.2 Related Live Import List listings

There are currently no species from the genus *Pseudomugil* or the family Pseudomugilidae in the Live import List. There are 2 rainbowfish species from the family Melanotaeniidae listed in Part 1 of the Live Import List (Table 5).

Table 5 Non-endemic rainbowfish species in the Live Import List

Scientific name	Common name(s)	Import condition(s)
Glossolepis incisus	red rainbow fish	of minimum length of 3.5 cm SL
Glossolepis leggetti	Leggett's rainbowfish	of minimum length 4 cm SL

3.3 Related threat category listings

Within their native habitat, none of these species are considered invasive. None of these species are listed as a pest on the Australian National Priority List of Exotic Environmental Pests, Weeds and Diseases (DAFF 2022).

3.4 Conservation status

3.4.1 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

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

None of these rainbowfish species are 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.

Five of the 6 species are listed as either Critically Endangered or Endangered on the IUCN Red List, with the remaining species (*P. furcatus*) listed as Data Deficient (Table 6).

Table 6 Conservation status of species under assessment

Scientific name	Listing	Population trend	Year of assessment	Justification and threats
Pseudomugil connieae	Endangered	Decreasing	2019	It has an extent of occurrence (EOO) of 2,500 km^2. There are between one and three locations based on threats related to development, which have resulted in a loss of the specific rainforest habitat of this species. Research into the population and distribution is urgently required, especially as this area is relatively unsurveyed and heavily developed. This species is threatened by habitat conversion due to settlements, logging, oil palm plantations, and alluvial gold mining and associated pollution. There is very little natural rainforest left in the known distribution area of this species, which suggests the population will have declined since collection in the 1980s. Invasive species are likely to be present but there has been a lack of surveys to confirm this. This species is much sought after in the aquarium trade (Hammer & Allen 2020).
Pseudomugil furcatus	Data Deficient	Unknown	2020	This species is known only from 2 localities in eastern Papua New Guinea, in the Kwagila and Musa River basins. The population in the Musa River basin around Safia is probably threatened by logging, while threats to the population in the Kwagila basin are unknown. Given its restricted distribution and the limited information available on its population status and overall threats, it is assessed as Data Deficient. It is likely that this species is threatened by habitat conversion due to logging around Safia. Other potential threats that occur within that area include oil palm plantations and alluvial gold mining with its associated pollution. Invasive species are also probably present, but there has been a lack of surveys to confirm this. This species occurs in the international aquarium trade, but most specimens are commercially bred. The level of take from wild stocks is unknown. (Palmer-Newton 2020a).
Pseudomugil ivantsoffi	Endangered	Decreasing	2019	It has an extent of occurrence (EOO) of 2,000 km^2, occurs in 2 locations (1 in the forest tributaries and 1 in the peat swamps and associated main channel), and there is continuing decline in habitat. Related threats to this species include land clearance for housing, oil palm plantations and invasive species (Allen & Kadarusman 2020a).
Pseudomugil luminatus	Endangered	Decreasing	2019	It has an extent of occurrence (EOO) of 2,000 km^2, occurs in 2 locations (1 in the forest tributaries and 1 in the main channel and associated peat swamps (in which the species may now be extinct)), and there is continuing decline in habitat. Related threats to this species include land clearance for housing, oil palm plantations and invasive species (Allen & Kadarusman 2020b).
Pseudomugil paskai	Critically Endangered	Decreasing	2020	This species is known only from small creeks around Kiunga, with an area of occupancy (AOO) and extent of occurrence (EOO) both with best estimates of 4 km^2 (and not thought to exceed 200 km^2). It was formerly common in the 1980s but is now considered rare, with recent attempts to find it being unsuccessful. This decline may be due to the threats of surrounding human settlements, mining activities and resulting pollution, which are likely causing ongoing declines in habitat quality and area (Palmer-Newton 2020b).

Scientific name	Listing	Population trend	Year of assessment	Justification and threats
Pseudomugil reticulatus	Critically Endangered	Unknown	2020	It is a poorly known species with only a few specimens available. Collections in 1982 and 1999 found the species, but only following extensive searches for the species was it found again in 2019 in a single locality. It has a restricted extent of occurrence (EOO) of 20 km^2, is known only from 1 location based on the primary threat of predation by invasive species and is experiencing continuing decline in the number of mature individuals due to this threat. The primary threats are predation by birds and invasive species (including snakehead, tilapia, carp and goldfish) (Allen, Kadarusman & Unmack 2020).

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.

None of these species are listed on the Convention on the Conservation of Migratory Species of Wild Animals.

4 Risk Assessment

4.1 The FISK Risk Assessment Model

The likelihood of invasiveness was assessed using the Fish Invasiveness Screening Kit (FISK) (Copp et al. 2005). FISK is a proven tool to determine which species to restrict or ban with regard to importation and/or sale as ornamental or fishery enhancement species (Vilizzi et al. 2019). Focusing on multiple aspects of a species' biology, including life history (e.g., fecundity) and physiological tolerance, as well as indicators of a species' ecology, such as distributional range, trait-based risk assessments identify a species' innate likelihood of succeeding at an invasion stage in an introduced environment. Through the quantification of biological and ecological species traits, these risk assessments provide a straightforward and accurate means of identifying and predicting high- and low-risk species.

Using information compiled from research into these factors, the potential impacts of the establishment of feral populations can be estimated.

4.1.1 Domestication/Cultivation

Domestication is considered to have the potential of enhancing the fitness of some freshwater fishes (i.e., increased growth rate, mating success, and/or fecundity) over wild strains, and commercial production of ornamental species may also increase the intensity of introductions (i.e., propagule pressure) (Moyle & Marchetti 2006, Gozlan, Pinder, & Shelley 2002, Copp, Templeton & Gozlan 2007, Ebner et al. 2020, Chan, Zeng & Yeo 2021). Conversely, commercially produced ornamental fish are often selected for traits that may reduce their fitness, such as bright colouration or increased fin length which increases their vulnerability to predation and reduces their likelihood of establishment in new environments (Hill, Kapuscinsk & Pavlowich 2011, Thompson, Hill & Nico 2012).

None of these species are reported to be highly domesticated or as being captive bred for at least 20 generations. There are no invasive subspecies or varieties recorded.

4.1.2 Climate and distribution

The likelihood of successful establishment and negative impacts is thought to be influenced by the similarity of the climatic conditions between the source and recipient areas. The risk of establishment increases as the climatic similarity between the species' native area and potential area of introduction increases (Moyle & Marchetti 2006, Hayes & Barry 2007, Chan, Zeng & Yeo 2021).

Climatch

Climatch v2.0 (ABARES 2020) was used for climate matching of target regions for each species to Australia, using the World Clim v2 sample (2019) dataset and all 16 climatic parameters for matching locations. Results were output in an Australia 20k Grid, showing climate matches to Australia. Due to their highly limited ranges, there were less than 12 meteorological stations in the input area for all species and so the highest possible response score to the climate matching question was applied by default to invoke the precautionary approach recommended for FISK (Copp et al. 2005, Lawson et al. 2013). The level of climate matching derived at Euclidian Sum Level 5 is **High.**

Water temperature

Water temperature is the most limiting environmental factor in Australia's freshwater determining whether an exotic fish would establish self-sustaining populations. The lower lethal temperature is often the most important environmental factor limiting the distribution and spread of exotic tropical fish outside their native range, and this has been determined for several exotic freshwater fish species (Shafland & Pestrak 1982, Arthington et al. 1999, Gestring, Shafland & Standford 2010). In Australia, rainbowfish species are found almost everywhere that water is present, excluding extremely arid regions (which are mainly devoid of fishes) and the southernmost regions, where distribution is controlled by winter minimum temperatures (Tappin 2011). The *Pseudomugil* species under assessment inhabit streams ranging from 24-29°C, but this does not necessarily represent their tolerable ranges. In their natural environment, rainbowfishes are exposed to highly variable temperatures depending on the size and depth of the water body, with an overall water temperature range for other members of the genus *Pseudomugil* reported from 12-38°C (Tappin 2011). While in the wild, *P. connieae* has been collected from streams ranging from 24-27°C, Tappin (2011) reports breeding them in captivity at temperatures of 19-31°C.

In addition to the Climatch tool, water temperature suitability assessments, based on ABARES Water Temperature Reference Tool (WTRT) (Warnakula, Parsons & Mitchell 2023) with temperature tolerance data from Tappin (2011) assumed to be at least 19-31°C, indicated that water temperatures in some areas of Australia (e.g., Cape York Peninsula, Wet Tropics of Queensland) are **suitable** for these *Pseudomugil* species. The rivers in tropical north-eastern Australia have average surface water temperatures of 30°C but may range from 25-38°C (Tappin 2011). For example, median water temperatures of the Tully-Murray floodplains range from 22.6-32.4°C (Godfrey et al. 2016). It is highly probable that the rivers and floodplains of tropical north Queensland would provide suitable habitat for the *Pseudomugil* species under assessment.

The results from Climatch and WTRF were combined using the decision matrix (Table 7) (Warnakula, Parsons & Mitchell 2023) resulting in an overall climate match of high.

Table 7 Decision matrix to combine the level of climate match with water temperature match to determine the FISK response rating for Q2.01

The level of climate match based on Climatch analysis	**Water temperature**	
	Suitable	Not suitable
High	High	Medium
Medium	High	Low
Low	Medium	Low

Quality of climate match data is considered **Medium** as climate matching was based on terrestrial climate data (Climatch v 2.0) and water temperature data (Warnakula, Parsons & Mitchell 2023). The WTRT relies on national datasets, which are limited for the tropics, and may also not capture micro-environmental variation or gradients in the water column. These limitations may create false instances of predicted unsuitability. If there are no water bodies that appear suitable this may be due to deficient data (Warnakula, Parsons & Mitchell 2023).

Köppen-Geiger Climate Zones

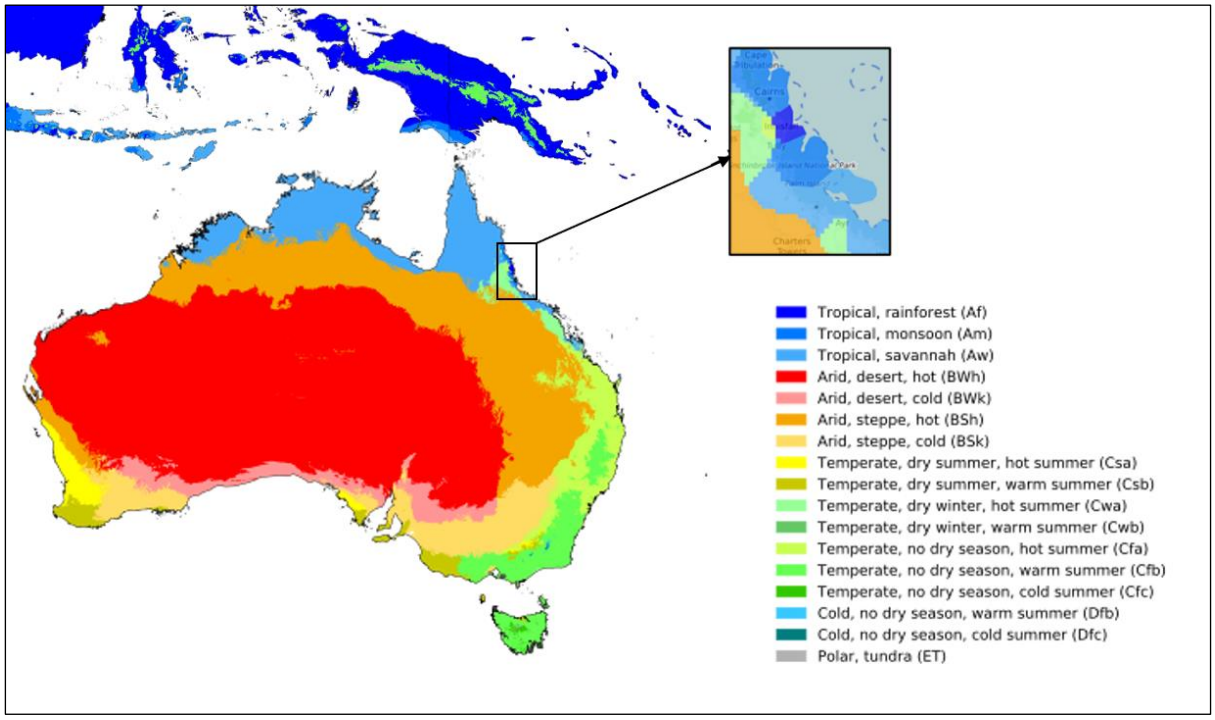
The Köppen-Geiger system classifies climate into 5 main classes and 30 sub-types and is based on threshold values and seasonality of monthly air temperature and precipitation (Beck et al. 2018). In species distribution models, climate variables are considered the primary driver to explain species ranges at larger spatial extents (Guisan & Zimmermann 2000).

When comparing the Köppen-Geiger climate classification map (Figure 9Figure 9) to the species' native ranges, all species are found in the Af (Tropical rainforest) zone (Beck et al. 2018). This climate has year–round average precipitation of at least 60 mm per month, and usually occurs within 5–10° latitude (North and South) of the equator. In some eastern-coastal areas, they may extend to as much as 25° away from the equator. This climate is dominated by the doldrums low-pressure system all year round, so has no natural seasons. The Af zone is only found in a very restricted area of coastal northern Queensland in Australia (Figure 9) from approximately Mission Beach in the south to Fishery Falls in the north.

P. connieae and *P. furcatus* are also found in the Aw (Tropical savannah) zone (Beck et al. 2018), which is found throughout the tropical northern areas of Western Australia, the Northern Territory and Queensland. 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. Extensive floodplains lie adjacent to some of the largest northern rivers in this zone. For example, Kakadu may be inundated with floodwaters covering 2,700 km^2 in the wet season, and, during major floods, several rivers in the Gulf of Carpentaria merge to create wetlands covering 20,000 km^2 (Tappin 2011).

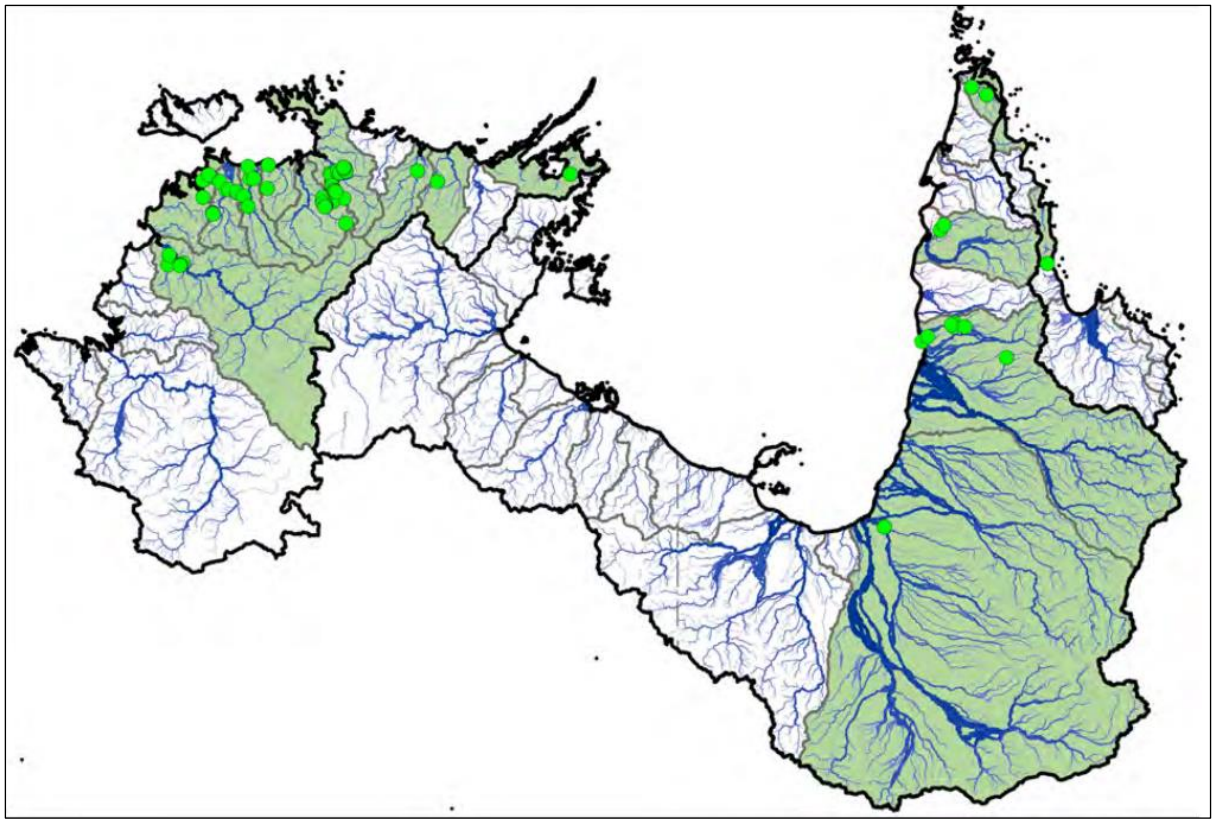
The Aw zone covers the Australian distribution of another *Pseudomugil* species*, P. tenellus*. This species has a patchy distribution throughout the northern areas of the Northern Territory, around the Gulf of Carpentaria to Cape York Peninsula in Queensland, in slow-flowing streams with dense aquatic vegetation (Figure 10). *P. tenellus* shares similar preferred environmental parameters to *P. connieae* and *P. furcatus,* with a preference for warmer waters and requiring temperatures above 24°C for spawning (Tappin 2011). It is probable therefore that *P. connieae* and *P. furcatus* would also be able to establish in these waterways.

Figure 9 Köppen-Geiger map of Oceania



Source: Beck et al. 2018

Figure 10 Distribution of *Pseudomugil tenellus* in northern Australia



Source: Creative Commons

4.1.3 Invasive elsewhere

Invasive history of a species or its congeners is a good predictor of invasiveness potential (Kolar & Lodge 2022, Ribeiro et al. 2008, Chan, Zeng & Yeo 2021). 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.

To date, there are no records in FishBase of previous successful establishments of any *Pseudomugil* species outside their natural range (Froese & Pauly 2022).

There are 7 genera and 96 species in the family Melanotaeniidae, all freshwater species originating from northern and eastern Australia and Papua New Guinea. There are reports that 4 species have been introduced outside their natural range, with no known establishments (Table 8). There have been no known introductions of species in the genus *Pseudomugil*.

Many species that are potential exotics have not been transported to and released in new environments, so they have not had the opportunity to demonstrate their establishment potential. Caution should be applied when using a history of establishment elsewhere to predict a species' establishment potential in Australia if the species being assessed has little or no history of previous introductions (Bomford 2008).

Table 8 Introductions of species from the family Melanotaeniidae

Scientific name	Introduced to	Year	Establishment [a]
Iriatherina werneri	Philippines	1996	Unknown
Melanotaenia boesemani	Philippines	1993	Unknown
Melanotaenia lacustris	Philippines	Unknown	Unknown
Melanotaenia nigrans	Philippines	1992	Unknown
Melanotaenia nigrans	USA	1930	Unknown

a data from Froese & Pauly (2022)

4.1.4 Undesirable traits

Freshwater fish introductions may have negative impacts due to one or more undesirable traits, such as competition, habitat alteration, parasitism, predation, disease transmission, hybridisation and/or alteration of habitat quality and function (Copp, Garthwaite & Gozlan 2005). The probable absence of natural predators in the receiving environment, traits relating to toxicity or dangers to human health, and the ultimate size of the species are also considered.

Species that reach large ultimate size (greater than 15 cm) are more likely to outgrow their housing and be released into the wild than small species (Marchetti et al. 2004, Copp et al. 2005, Vila-Gispert Alcaraz & García-Berthou 2005, Duggan et al. 2006, Liu et al. 2017, Liang et al. 2020). Additionally, moderate size (i.e., larger than 10cm and shorter than 80cm adult length), is a good predictor of its ability to become abundant (Moyle & Marchetti 2006). As described in 2.2, all of the *Pseudomugil* species in this assessment are less than 5cm TL.

Species in the genus *Pseudomugil* are not poisonous or venomous, nor do they pose a risk to human health. There is no information to suggest that any member of this genus is parasitic of other species.

Primary prey species are small crustaceans and insect larvae. *Pseudomugil* would not prey on any native species previously subjected to low (or no) predation.

These species are not unpalatable to predators. *Pseudomugil* species are eaten by predatory fish, water birds, aquatic reptiles and humans. Predatory fish families known to eat rainbowfishes include Ambassidae, Anguillidae, Apogonidae, Ariidae, Belonidae, Butidae, Carcharhinidae, Dasyatidae, Eleotridae, Gobiidae, Kuhliidae, Latidae, Lutjanidae, Megalopidae, Muraenidae, Osteoglossidae, Plotosidae, Sciaenidae, Synbranchidae, Terapontidae and Toxotidae (Froese & Pauly 2022). All families but Butidae, Dasyatidae, Latidae, Megalopidae, Muraenidae and Sciaenidae have native species present in Australia (NFA 2022).

P. connieae is reported to have been found in brackish waters (Tappin 2008), and some other *Pseudomugil* are salt tolerant, preferring brackish and intertidal mangrove forests. Salt tolerance is not reported in the other species under assessment here. In general, rainbowfishes will not survive in barren environments and require cover to protect them from predators and to provide refuge from flow, which can include rocks, logs, fallen branches and vegetation (Tappin 2011). The *Pseudomugil* species under assessment have specific habitat preferences and no information suggests they are versatile in their habitat use.

Rainbowfishes can perform aquatic surface respiration to survive low oxygen concentrations for short periods (Tappin 2011).

Disease

A variety of pathogens and parasites infect rainbowfishes, including *Ichthyophthirius multifilis* (causes white spot disease or 'Ich'), *Psicinoodinium pillulare* (causes velvet disease) and *Trichodina* (causes trichodiniasis) (Tappin 2011). Mortality of the desert rainbowfish (*Melanotaenia splendida* subsp. *tatei*) in the Finke River in Australia was attributed to an outbreak of the protozoan *Chilpodonella hexasticha* (Langdon et al. 1985). Leeches are occasionally seen on wild rainbowfishes causing chronic anaemia and development of secondary infections (Tappin 2011). Monogenean flatworms, cestodes, nematodes and coccdiai are also fairly common (Tappin 2011).

The bacteria *Aeromonas, Pseudomonas* and *Flavobacterium* can cause fin and tail rot. *Flavobactrium columnare*, which causes Columnaris disease, is ubiquitous on the skin of healthy fish worldwide and is a significant problem in warm water species (Bernardet & Grimont 1996). Hypoxia and death can occur in acute cases, and the disease is transmitted by direct contact with infected fish or contaminated water (Tappin 2011). Achlya, a fungus, is commonly found on wild-caught rainbowfish, and epizootic ulcerative syndrome ('red spot') disease has been reported from rainbowfish species in the Northern Territory (Tappin 2011).

A review of diseases associated with rainbowfish did not identify any pests or diseases associated with the family Melanotaeniidae that were not already identified in Australia (Hardy-Smith, Jones & Kailola 2007). Disease transmission as a result of the introduction of a *Pseduomugil* species into the natural environment is unlikely to pose any further risk than other endemic freshwater fish species as there are no known fish diseases or strains specific to Melanotaeniids.

4.1.5 Diet and feeding guild

Many fish species vary their diets due to ontogeny or opportunity (Jackson et al. 2001), and those that are predatory or omnivorous at some point in their life cycle are more likely to be successful

invaders (Ricciardi & Rasmussen 1998), likely related to the high availability of food during the establishment phase of the invasion (Moyle & Marchetti 2006).

All members of the *Pseudomugil* genus are opportunistic omnivores, eating a variety of small aquatic and terrestrial animals and plant matter. The diet includes algae, ants, aquatic insect larvae and small crustaceans (Tappin 2011). Rainbowfishes have villiform teeth that extend outside their mouth around their lips to enable them to scrape algae from submerged hard surfaces. They are generally mid water feeders and are unlikely to reduce habitat quality via their foraging behaviours.

4.1.6 Reproduction

Invasive ability is directly influenced by a species' life history traits including fecundity, spawning requirements, gamete viability and reproductive strategy. Species that have multiple spawning events, extended spawning seasons (Alcaraz, Vila-Gispert & García-Berthou 2005) and/or rapid growth rates all increase the likelihood of invasion (Moyle & Marchetti 2006). High fecundity is associated with invasion success, supported by a large body of work (Vila-Gispert et al. 2005, Howeth et al. 2016, Liu et al. 2017, Liang et al. 2020). However, Chan, Zeng & Yeo (2021) found that K-strategists with a lower absolute fecundity (such as *Poecilia reticulata*) that produce fewer but larger and more developed offspring, coupled with parental care, were more invasive. In some cases, parental investment may be more important to establishment than fecundity (Drake 2007). The dependence of a species on other species or specific habitat feature to complete its life cycle would limit invasive potential into areas in which these features are lacking.

Pseudomugil live approximately 4 years in the wild and up to 8 years in captivity (Allen & Cross 1982). Rainbowfish start to breed at the age of 6 months, although Allen (1981) reports *P. connieae* spawning at only 3-4 months of age.

Rainbowfish are non-seasonal spawners, spawning over a 4-5 month period when food is plentiful, aquatic vegetation is dense and larval survival is maximised. In floodplain rivers, there is a peak during the early wet season, but spawning also occurs in streams during the dry season (Tappin 2011). The extensive spawning strategy serves to offset the high mortality rates of larvae (as high as 99.99%) (Tappin 2011). There is no information available for the species under assessment, but other *Pseudomugil* species spawn in summer (Howe 1987, Tappin 2011), in the morning (Allen 1981) to early afternoon with multiple releases of eggs amongst submerged vegetation (Semple 1991).

Rainbowfish are egg scatterers with viable eggs and sperm ejected simultaneously requiring both sexes for fertile offspring to be produced (Tappin 2011). *Pseudomugil* produce about 5 to 15 viable eggs a day for several consecutive days over 7 – 9 day period, with a total of 42-125 eggs released (Semple 1991, Tappin 2011). Eggs adhere on submerged aquatic and riparian vegetation for 5-20 days before hatching into fry (Allen 1981). Eggs hatch after 12 – 14 days (Semple 1991). In controlled settings, egg mortality was total at temperatures below 23°C (Semple 1991).

Males are highly territorial over spawning sites, displaying to other males by flashing their erected dorsal, anal and pelvic fins (Allen 1981, Semple 1991). Once they have a spawning site, males will court a female, pursuing her rapidly, circling closely without nudging or direct contact (Howe 1987). Once they spawn, males remain to defend the fertilised eggs once the female leaves (Tappin 2011).

Hermaphroditism facilitates successful establishment by allowing individuals to mate with any member of their species (Ho 2004). Hermaphroditism has been reported in rainbowfish, in that both

male and female reproductive organs are present in the same individual and may be relatively widespread (Tappin 2011).

Hybridisation

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, the majority 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 fish farms.

Genetic evidence for hybridisation between some of the more closely related rainbowfish species exists (Unmack, Allen & Johnson 2013). At least 10 species of rainbowfish in Australia have been involved in hybridisation (Tappin 2011) - Allen & Cross (1982) reported on 2 naturally existing hybrids between the genera *Melanotaenia* and *Chilatherina*; McGuigan et al. (2000) and Unmack (2016) identified hybrids between *Melanotaenia* populations in the Northern Territory; and other *Melanotaenia* hybrids have been reported (Zhu et al. 1998, McGuigan 2001). Four taxa in the genus *Melantaenia* have been listed as threatened in Australia due to introgressive hybridisation with the translocated *M. splendida* (Moy et al. 2018). In Australia, there are 12 native *Melanotaenia* species and 8 native *Pseudomugil* species (Hoese 2014).

No naturally occurring hybrids within the *Pseudomugil* genus, nor between *Pseudomugil* species and *Melanotaenia* species, are known. There are reports, both published and anecdotal, of hybridisation between the various species of *Melanotaenia, Pseudomugil, Chilatherina* and *Rhadinocentrus* as well as between genera under artificial conditions in captivity.

4.1.7 Dispersal mechanisms

Dispersal ability primary determinant of invasiveness, both via natural and human-induced pathways (Moyle & Marchetti 2006). Dispersal mechanisms can be human assisted including deliberate or accidental stocking, bait bucket introductions, escapes, discarding or abandonment of aquarium fish, or cultural releases (Lintermans 2004). Natural abiotic factors can trigger dispersal such as floods (Arthington & Pusey 2003, King, Humphries & Lake 2003), use of stepping stone habitats and water velocity and flow (Pavlov 1994, Humphries, Serafini & King 2002). Dispersal may also be determined by biotic factors such as larval developmental stage (Lechner et al. 2016), migration (Lintermans 2004, Pavlov & Mikheev 2017), or through vector assistance (e.g., moved from one water body to another by birds).

Pseudomugil species may be intentionally dispersed by humans as a result of discardment from aquarium. Some aquarists consider their actions to be a humane method of dumping unwanted pets and are likely unaware of the consequences to the environment (Padilla & Williams 2004, Duggan et al. 2006, Gertzen et al. 2008). Surveys of aquarium owners indicate that 2-10% of consumers deliberately release unwanted fish (Duggan et al. 2006, Chang et al. 2009, Strecker et al. 2011).

Once released, juvenile or adult *Pseudomugil* species would disperse via upstream and downstream migration, particularly during times of greater flow and flood. As described in 4.1.2, many rivers in

northern Australia lie adjacent to expansive floodplains, covering large areas of land during wet season inundations (Tappin 2011).

4.1.8 Persistence attributes

Species that are tolerant of a wide range of environmental conditions (including temperature, salinity, water velocity, environmental disturbance and oxygen) are more likely to successfully establish than less tolerant species (Marchetti et al. 2004, Moyle & Marchetti 2006, Garcia de Lomas et al. 2009). Species under predation pressure are less likely to establish than those that have characteristics that resist predation or are introduced into areas where predators are absent (Moyle & Light 1996, Bajer et al. 2019, Poole et al. 2019). A host of studies have linked invasiveness with a lack of native predators in the invaded region (Bajer et al. 2012). However, susceptibility to predation does not preclude invasiveness (Copp et al. 2005, Hackerott et al. 2013).

As described in 4.1.2, the natural environment of *Pseudomugil* species is subjected to seasonal variations in temperatures from 12-36°C, pH (5.0-9.2) and hardness levels (Tappin 2011). Rainbowfishes can also perform aquatic surface respiration to survive low oxygen concentrations for short periods (Tappin 2011).

Species survival would be enhanced by floods, with spawning known to peak in floodplain areas during the wet season (Tappin 2011). Flooding typically increases the extent of aquatic habitat for fish and facilitates fish movement between river channels and floodplain waterbodies for activities including foraging, spawning and larval recruitment (Pusey et al. 2017). Floodplain and temporary wetland habitats are important for rainbowfish, and extensive floodplains lie adjacent to some of the largest northern rivers. In Australia's wet tropics, there is regular connectivity between elements of the freshwater landscape via channels and overland flows (Karim et al. 2014). For example, in tropical Queensland, the Tully-Murray floodplain covers 2825 km^2 and, during extensive seasonal flooding, the whole floodplain can be inundated (DCCEEW 2022). These events would assist dispersal of *Pseudomugil* species.

Pseudomugil species are eaten by predatory fish, water birds and aquatic reptiles, all of which would be present in Australia and are known to prey upon native rainbowfish.

It is unknown if *Pseudomugil* species are susceptible to piscicides, chemical substances poisonous to fish, at the doses legally permitted for use in Australia.

4.1.9 FISK Results

The FISK produced the same results for all species under assessment, and so results are collated for the 6 *Pseudomugil* species. The full results table is at Appendix A.

It should be noted that the results presented below are applicable only to *Pseudomugil connieae, Pseudomugil furcatus, Pseudomugil ivantsoffi, Pseudomugil luminatus, Pseudomugil paskai* or *Pseudomugil reticulatus.* They are not applicable across the whole genus - other *Pseudomugil* species are known to be salt tolerant and therefore results would differ.

The FISK Risk Assessment Model returned a risk rating of **low** for all species (

Table 9). Aquaculture, environmental or nuisance sectors are highly unlikely to be impacted should these *Pseudomugil* species establish (

Table 9).

The certainty factor (range from 0.25 (low certainty) to 1 (high certainty) for all 6 *Pseudomugil* species was 0.81, and there were 6 (12%) 'don't know' responses. The certainty factor suggests there was enough information to make robust risk assessments.

Aquaculture, environmental and other sectors are highly unlikely to be impacted, should any of these 6 species establish.

Table 9 Outcome of the FISK for the 6 *Pseudomugil* species under assessment, including certainty factor and sectors affected

Outcome:	Low
Certainty Factor:	0.81
Sectors affected	
Aquacultural	-2
Environmental	2
Nuisance	0

4.2 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 & Williams 2004). Biological invasions of freshwater ecosystems have a large number of known and potential impacts on community structure and ecosystem function.

Eleven impact categories were assessed (Appendix B). 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 potential impacts to the environment, based on published evidence as detailed throughout this report, may be predominantly from competition for resources, and predation (Table 10). The ratings are estimates as the impacts are mostly unknown but, using the Precautionary Principle, a risk rating of **minor** for potential environmental impacts is appropriate.

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 10 Potential impacts from the establishment of *Pseudomugil* species populations in Australia

Type of impact	Assessment	Rating
ENVIRONMENTAL IMPACTS		

Type of impact	Assessment	Rating
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 reported.** *Pseudomugil* species have not been recorded as having any detectable impact on aquatic plants in its range. They are algae eaters with villiform teeth that extend outside their mouth around their lips to enable them to scrape algae from submerged hard surfaces. There may be low levels of impact on aquatic algae.	**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 species. Includes behavioural changes in outcompeted species and ranges from population decline to population loss.	**Causes declines in populations densities, but no changes in community composition.** *Pseudomugil* species would likely occupy a similar habitat to native rainbowfish in the NT and QLD, such as the Eastern rainbowfish (*Melanotaenia splendida* complex, Gomon & Bray 2022) and Running River rainbowfish (Bray 2017) and may compete with native fish for food. There are 16 native Melanotaeniidae species in Australia. Six of these native species are threatened, 4 of which would share a niche with the *Pseudomugil* species being assessed (Table 11), so competition and niche overlap between these species could impact upon these threatened native species. They may also compete for shelter. *Pseudomugil* are known to shelter under vegetation, logs or driftwood, so would compete with native species for similar refugia. They exhibit little aggression toward other fish except from conspecific breeding males, this aggression is non-physical stylised display.	**Moderate**
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.	**Predation on several abundant species, without significant impact on affected species or decline of their populations.** Omnivores can have large impacts on aquatic communities. For example, even when introduced to sites where native fishes already live, introduced fish have had large direct and indirect effects on stream invertebrates (Simon & Townsend 2003); and even tiny fish (e.g., *Gambusia* spp.) have reduced densities of native invertebrates and outcompeted native fishes (Pyke 2008). As an omnivore feeding primarily on small insects, *Pseudomugil* species are expected to find food sources and may impact on macroinvertebrate species in any waterway it is introduced into. However, these prey species are abundant and there are unlikely to be declines in their populations.	**Minor**
Habitat and ecological community impacts 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.	**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.** Rainbowfishes would be consumed by many predatory species of fish, water birds and aquatic reptiles (e.g., barramundi, grunters, file snakes). These species occupy a similar niche to native rainbowfish species and are therefore unlikely to impact or upset the ecological balance. They are mid water to surface swimmers (Tappin 2011) and would cause no disturbance to the substrate during feeding so would not contribute to declines in water quality. They breed by laying eggs on aquatic vegetation or debris and do not damage the habitat when doing so.	**Minimal**
Hybridisation Hybridization with native species, leading to a reduced or lost	**No hybridisation between alien species and native species observed in the wild, may be possible in captivity.**	**Minimal**

Type of impact	Assessment	Rating
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.	*Pseudomugil* spp. are not known to hybridise with other species within their genus nor with any other fish 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.	**Parasites or pathogens directly or indirectly affecting fitness of native individuals without declines of their populations.** Live aquarium fish are the greatest risk group for introducing aquatic animal diseases in Australia (Corfield et al. 2008). Aquarium fish led to 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). Introduced fish are also the source of the Asian fish tapeworm *(Bothriocephalus acheilognathi*), which has caused substantial mortalities in *Hypseleotris klunzingeri* (Western carp gudgeon) in the Canberra region (Dove & Fletcher 2000). This parasite has the potential to be a significant source of mortality for native fish species. A variety of pathogens and parasites infect rainbowfishes, including *Ichthyophthirius multifilis* (causes white spot disease or 'Ich'), *Psicinoodinium pillulare* (causes velvet disease) and *Trichodina* (causes trichodiniasis) (Tappin 2011). Mortality of the desert rainbowfish (*Melanotaenia splendida* subsp. *tatei*) in the Finke River in Australia was attributed to an outbreak of the protozoan *Chilpodonella hexasticha* (Langdon et al. 1985). Leeches are occasionally seen on wild rainbowfishes causing chronic anaemia and development of secondary infections (Tappin 2011). Monogenean flatworms, cestodes, nematodes and coccdiai are also fairly common (Tappin 2011). *Achlya*, a fungus, is commonly found on wild-caught rainbowfish, and epizootic ulcerative syndrome ('red spot') disease has been reported from rainbowfish species in the Northern Territory (Tappin 2011). A review of diseases associated with rainbowfish did not identify any pests or diseases associated with the family Melanotaeniidae that were not already identified in Australia (Hardy-Smith, Jones & Kailola 2007). The introduction of disease from the introduction of a *Pseduomugil* species into the natural environment is unlikely to pose any further risk than other endemic freshwater fish species as there are no known fish diseases or strains specific to Melanotaeniids.	**Minor**
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.	**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	**None, or occasional competition with, or loss of yield in livestock or animal production.** If *Pseudomugil* became established in Australia, it is unlikely to have any negative impacts on animal production, trade or aquaculture etc.	**Minimal**

Type of impact	Assessment	Rating
reluctant to graze, reduction of livestock accessibility to grazing land.		
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)** No impacts expected.	**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.** Not toxic nor harmful to humans.	**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.	**None, or biological traits and lifestyle suggest potential for disturbance in recreational or residence areas (e.g., by noise, pollution).** No impacts expected.	**Minimal**
TOTAL 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	No economic impacts are expected should *Pseudomugil* establish in Australian waterways.	**$0**

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

Table 11 Threatened native rainbowfish species that may share a niche with *Pseudomugil* species if they were to become established

Scientific name (Common name)	Environmental conditions [a]	Geographic range	Conversation status and population trend	*Pseudomugil* similar niche?[b]
Cairnsichthys rhombosomoides (Cairns rainbowfish)	Temperature: 21°C - 25°C pH range: 7.2 - 7.6	Small streams in the central Australian Wet Tropics. (Ebner et al. 2019)	EN Decreasing	Yes
Melanotaenia eachamensis (Lake Eacham rainbowfish)	Temperature: 23°C - 27°C pH range: 7.0 - 7.4	Endemic to the upper reaches of the Barron, North Johnstone and South Johnstone River catchments in Queensland (Unmack & Brown 2019)	EN Decreasing	Yes
Melanotaenia gracilis (slender rainbowfish)	Temperature: 22°C - 28°C	Endemic to the Drysdale River and one small tributary of each of the Morgan River,	EN Stable	Yes

Scientific name (Common name)	Environmental conditions [a]	Geographic range	Conversation status and population trend	*Pseudomugil* similar niche?[b]
	Habitat: clear waters and minimal flow	King George River and Durack River in the Kimberly region of far NW Australia (Morgan 2019a)		
Melanotaenia pygmaea (Pygmy rainbowfish)	Temperature: 22 – 28°C Habitat: Fast flowing streams with frequent cascades and rapids, very clear water with little to no vegetation cover (Morgan 2019b).	2 small tributaries of Prince Regent River; and at King's Cascade, in the Western Kimberly region of WA (Morgan 2019b).	VU Unknown	No
Melanotaenia utcheensis (Utchee rainbowfish)	Environmental tolerances unknown. Habitat: moderate to fast flowing waters (Brown, Hammer & Unmack 2019)	Restricted to lowland tributaries of the north and south Johnstone River in North Queensland (Brown, Hammer & Unmack 2019)	EN Unknown	Yes
Rhadinocentrus ornatus (ornate rainbowfish)	Temperature 20°C - 28°C pH range: 5.4 - 6.5 Habitat: stagnant pools or streams with little or no flow	Subtropical freshwaters of coastal areas of the Great Diving Range between Rockhampton and Coffs Harbour; and on sandy islands off southern QLD (Arthington & Butler 2019)	VU Decreasing	No

a Environmental preferences from FishBase (Froese & Pauly 2022) unless otherwise indicated
b *Pseudomugil* prefer temperature ranges 24-28.5°C, pH 6.0-8.0, habitat: moderate turbid to clear, slow to fast flowing water, clear-turbid water; sparse – abundant vegetation

4.3 Risk Rating

The FISK Model returned an invasiveness risk rating of low for all species. The environmental impact and consequences of these species, should they become established, is minor (Table 10). Therefore, the overall risk these species pose to the Australian environment is **low.**

4.4 Consultation - Concerns raised

The first consultation round seeking comment from state and territory government agencies and the public on the applicants' report was undertaken from 14 October to 24 November 2022.

A number of industry stakeholders and members of the public/hobbyists (Appendix C) cited that allowing the legal importation of such species could have the ability to reduce the 'need and desire' for the black-market trade in exotic fish.

Three submissions containing comments to be addressed were received. The specific comments are at Appendix C. Concerns raised and the applicants' responses are outlined in Table 12.

Table 12 Summary of main concerns raised and the applicant's responses

Concern	Applicant's Response
Conservation status and sustainability All but *P. furcatus* are IUCN listed as endangered (EN) or critically endangered (CR) and *P. furcatus* is listed as data deficient but has a very limited distribution, consequently it is likely to be vulnerable to overfishing. As a signatory to the Convention on Biological Diversity Australia has the responsibility to ensure that activities within our jurisdiction do not cause damage to the environment of other states or areas. If the species being considered are already under threat, adding the species to Australia's approved list, may further compound this issue by creating an incentive to harvest from the wild.	These species have various categories within the IUCN, and due to the threats of mining, palm oil, etc., they may become critically endangered and/or possibly extinct in their habitats. If they are added to the allowable import list as requested, the populations would be bred and maintained here, as many other rainbowfish have been for over 40 years - from one collection only. The owner of a Native Ornamental Fish producer has confirmed that if they are added, he will set up individual ponds for each species, and captive breed them for the ornamental fish trade in Australia. He currently farms other species, *Pseudomugil gertrudae*, (Spotted Blue-eye), *Pseudomugil tenellus*, (Delicate Blue-eye), *Pseudomugil cyanodorsalis* (Blue-back Blue-eye), *Pseudomugil sp.* (Golden Blue-eye), and has experience to produce them in large quantities for the trade.
Source of imports Consideration should be given to applying conditions which limit the potential for wild populations to be harvested for import as aquarium fish e.g., fish can only be sourced from established, captive-bred sources.	The applicant has stated that, with the exception of *P. paskai,* these species are being commercially and sustainably farmed and available from various fish farms in USA, Europe, and by Maju Aquarium in Indonesia. The applicant suggests that, as they are widely available overseas there should not be any wild harvesting. It is uncertain if *P. paskai* is being commercially bred in large volumes at this stage. The applicant stated that expeditions are planned to acquire this species.
Identification at the border As the maximum length of these species is generally no greater to 2cm to 4cm size, a minimum size limit may not be applicable. Will the Border Force officers be successful in identifying these species in order to reduce the chance of mistaken identity of juveniles with other similar looking fish species at the border? Can the proponent suggest and appropriate size limit to allow positive identification, with supporting evidence?	The applicant agreed that a minimum size of 2cm SL should be applied and contend that these species are identifiable at that size.
Health status Appropriate certification of health status (i.e. free from disease, viral agents) of the originating facility prior to importation of this species, and adherence to all other Australian import conditions including post arrival quarantine, should be ensured.	Any fish imported into Australia for ornamental purposes are subject to being listed on the EPBC Act as an allowable import species and must have appropriate health certification then be subject to quarantine protocols in place at the time. They will come through licensed premises with appropriate quarantine processes.

4.5 Risk Mitigation

In response to the comments received during the consultation rounds, the applicant provided the following risk mitigation measures:

1) It is recommended that any importation of these fish should be a minimum length of 2 cm SL for ease of identification.

2) The applicant has stated that all stocks would come initially from German breeders and then from commercial facilities to which these captive-bred stocks are distributed to ensure no pressure is placed upon wild populations.

3) Imported specimens will be subject to health certification requirements for freshwater ornamental (aquarium) fish, including inspection by a competent authority within 7 days prior to export; and undergo post-import quarantine.

4) Retailers or other traders should be encouraged to engage in "best practice" and to provide relevant information brochures to buyers of this species.

The department acknowledges the applicant's suggestions and agrees with measures 1 and 2. Due to the already low risk that these species pose to the Australian environment, the first proposed mitigation measure outlined above can be imposed as an import condition to further reduce the risk posed to an acceptable level.

For mitigation measure 2, the department suggests that sourcing from "captive-bred sources only" be imposed as an import condition to ensure no pressure is placed upon wild populations.

The measure at point 3 would mitigate the risk of disease transmission to a minimal level.

5 Discussion

The global aquarium trade is arguably the greatest biosecurity threat to freshwater ecosystems (Ebner et al. 2020). 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 & McNee 2010). A 2020 report by Ebner et al. 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).

Propagule pressure may be used as an indicator of establishment success for invasive species. Successful invasive species are introduced more times than unsuccessful species. Commercial production of ornamental species may increase the intensity of introductions (Moyle & Marchetti 2006, Ebner et al. 2020). This risk can be minimised in Australia by regulating species being imported, limiting the number of collections containing species, limiting the number of specimens in each collection and increasing the housing security when species are kept (Bomford 2008). Arthington et al. (1999) considered that there is a low or residual probability that New Guinea rainbowfishes would establish feral populations in Australia.

The species under assessment have highly restricted distributions, and relatively little is known about their biology and ecology in their natural habitats (Tappin 2015). For almost all species, information of spawning, egg and larval development in the wild is lacking, as is general information on habitat preference and water quality tolerances (Tappin 2015). However, research has shown that temperature is critical for spawning and egg survival, with eggs requiring temperatures above 23°C to survive to hatching (Semple 1991). The rivers in tropical northern Australia have average

surface water temperatures of 30°C but may range from 25-38°C (Tappin 2011) and would likely provide suitable conditions for self-sustaining populations to become established.

Results from the FISK Model show that all 6 *Pseudomugil* species are low risk, and the impacts assessment suggest minor potential impacts on the environment if they were to establish. There is no evidence of *Pseudomugil* species successfully establishing elsewhere, nor is there evidence for any of the 96 species in the family Melanotaeniidae. *Pseudomugil* are tolerant of temperatures ranging from 12-36°C and have similar preferred temperature and pH ranges as native rainbowfish species in northern Australia, suggesting that the rivers and floodplains of northern Australia could provide suitable habitat for *Pseudomugil* species.

Under ss 391(1) of the EPBC Act, the Minister must take account of the precautionary principle in making decisions. The precautionary principle is triggered by two threshold conditions: (1) a threat of serious or irreversible environmental damage (direct or indirect); and (2) scientific uncertainty as to the environmental damage. In the absence of any history of invasiveness and establishment, and a low climate match, results from the FISK Model show that all 6 *Pseudomugil* species pose a low risk to the Australian environment and would have minor potential impacts should they establish. Therefore, the department has determined that the 6 *Pseudomugil* species do not pose a threat of serious irreversible damage.

The current scale of biodiversity loss in freshwater ecosystems is rapid and immense (Reid et al. 2019), and conservation of freshwater fishes and their habitats is of major concern. Subsection 303EN(3) of the EPBC Act states that the Minister must not issue a permit 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. Australia also 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.

New Guinea is one of the most threatened biological hotspots, with human activities increasingly disturbing and destroying freshwater habitats (White et al. 2021). Ongoing declines in habitat quality and area, impacts of logging activities and invasive species are listed as threats to the 6 *Pseudomugil* species under assessment (Allen & Kadarusman 2020a, 2020b, Allen, Kadarusman & Unmack 2020, Hammer & Allen 2020, Palmer-Newton 2020a, 2020b). Adding species already under threat to Australia's approved list may further compound their conservation status by creating an incentive to harvest from the wild, resulting in populations declines (Tlusty 2002).

Section 303EB(2) allows the Minister to impose conditions or restrictions to specimens in Part 2, including a restriction or condition relating to the source of the specimen (303EB(2)(b)). With 5 of these species listed as Critically Endangered or Endangered, and 1 species listed as Data Deficient, consideration must be given to the potential impact that listing these species in the Live Import List could have on wild stocks. Listing these species as regulated specimens with a condition imposed to ensure imports are from captive-bred sources only would ensure no pressure is placed upon wild populations. It is likely that *P. paskai* is not available from captive-bred sources and imports may rely on wild-caught specimens.

6 Conclusion

The department has reviewed the application to amend the *List of Specimens Taken to be Suitable for Live Import* (Live Import List) to include 6 *Pseudomugil* species and undertaken a risk assessment. During this process, the department independently reviewed all available information on the species and sought consultation from Commonwealth, state and territory agencies, the public and other experts, as is required under the *Environment Protection and Biodiversity Conservation Act 1999.*

Recommendation: In consideration of their conservation status, the department recommends listing *Pseudomugil connieae, Pseudomugil furcatus, Pseudomugil ivantsoffi, Pseudomugil luminatus* and *Pseudomugil reticulatus* in Part 2 of the Live Import List with the condition:

- Captive-bred specimens only, of minimum length 2cm SL.

In consideration of its status as Critically Endangered and the likelihood that imported specimens will be collected from the wild, the department **does not recommend** adding *Pseudomugil paskai* to the Live Import List.

Appendix A: FISK Model results for 6 *Pseudomugil* species

Question	Response	Certainty	Comments and references
Biogeography/Historical			
Domestication/Cultivation			
Is the species highly domesticated or widely cultivated for commercial, angling or ornamental purposes?	N	4	Not reported to be highly domesticated or as being captive bred for at least 20 generations.
Has the species established self-sustaining populations where introduced?	N	4	Never introduced
Does the species have invasive races/varieties/sub-species?	N	4	No subpsecies or varierties recorded
Climate and Distribution			
What is the level of matching between the species' reproductive tolerances (native and introduced range) and the climate of the RA area?	3	3	High
What is the quality of the climate match data?	2	4	Quality of climate match data is considered Medium as climate matching was based on terrestrial climate data (Climatch v 2.0) and water temperature data (Warnakula, Parsons & Mitchell 2023).
Does the species have self-sustaining populations in three or more (Köppen-Geiger) climate zones?	N	4	Distribution covers 1 Koppen-Geiger zones (Af)
Is the species native to, or has established self-sustaining populations in, regions with similar climates to the RA area?	Y	3	1 Af zone in Australia in highly restricted area just south of Cairns. Areas of northern Australia likely conducive environments. Many rivers are floodplain rivers, which are important for rainbowfishes
Does the species have a history of being introduced outside its natural range?	N	4	No reference to any established, introduced populations.
Invasive elsewhere			
Has the species established one or more self-sustaining populations beyond its native range?	N	4	No reference to any established, introduced populations.
In the species' introduced range, are there impacts to wild stocks of angling or commercial species?	N	4	n/a
In the species' introduced range, are there impacts to aquacultural, aquarium or ornamental species?	N	4	n/a
In the species' introduced range, are there impacts to rivers, lakes or amenity values?	N	4	n/a
Does the species have invasive congeners?	N	4	No invasive members in this genus

Question	Response	Certainty	Comments and references
Biology/Ecology			
Undesirable traits			
Is the species poisonous/venomous, or poses other risks to human health?	N	4	Fishbase status: Harmless. Species in the genus Pseudomugil are not poisonous or venomous, nor do they pose a risk to human health
Does the species out-compete with native species?	N	4	No reference to any established, introduced populations.
Is the species parasitic of other species?	N	4	There is no information to suggest that any member of this genus is parasitic of other species
Is the species unpalatable to, or lacking, natural predators?	N	4	Not unpalatable to predators. Predatory fish families known to eat rainbowfishes include Ambassidae, Anguillidae, Apogonidae, Ariidae, Belonidae, Butidae, Carcharhinidae, Dasyatidae, Eleotridae, Gobiidae, Kuhliidae, Latidae, Lutjanidae, Megalopidae, Muraenidae, Osteoglossidae, Plotosidae, Sciaenidae, Synbranchidae, Terapontidae and Toxotidae (Froese & Pauly 2022).
Does the species prey on a native species previously subjected to low (or no) predation?	N	4	Pseudomugil would not prey on any native species previously subjected to low (or no) predation. Native predatory fishes occur in virtually every water body where their listed prey items are found.
Does the species host, and/or is it a vector, for one or more recognised non-native infectious agents?	N	3	A review of diseases associated with rainbowfish did not identify any pests or diseases associated with the family Melanotaeniidae that were not already identified in Australia (Hardy-Smith, Jones & Kailola 2007).
Does the species achieve a large ultimate body size (i.e. >15 cm total length) (more likely to be abandoned)?	N	4	All of the Pseudomugil species in this assessment are less than 15cm TL.
Does the species have a wide salinity tolerance or is euryhaline at some stage of its life cycle?	N	4	Has been reported from brackish areas but this does not constitute euryhaline
Is the species able to withstand being out of water for extended periods (e.g. minimum of one or more hours)?	N	4	Rainbowfishes can also perform aquatic surface respiration to survive low oxygen concentrations for short periods (Tappin 2011). However, they are not dessication tolerant and cannot survive out of water.
Is the species tolerant of a range of water velocity conditions (e.g., versatile in habitat use)	?	3	No information suggests they are versatile in their habitat use and habitat use suggests not tolerant of water velocity changes, but this species has a highly restricted geographic distribution and water velocity tolerances are not known.
Does feeding or other behaviours of the species reduce habitat quality for native species?	N	4	Mid water feeders, no evidence of bioengineering behaviour.
Does the species require minimum population size to maintain a viable population?	?	4	No references found.
Feeding guild			

Question	Response	Certainty	Comments and references
If the species is mainly herbivorous or piscivorous/carnivorous (e.g., amphibia), then is its foraging likely to have an adverse impact in the RA area?			n/a
If the species is an omnivore (or a generalist predator), then is its foraging likely to have an adverse impact in the RA area	N	3	All rainbowfish species are omnivores, eating a variety of small aquatic and terrestrial creatures and plant matter. Rainbowfish have villiform teeth that extend outside their mouth around their lips to enable them to scrape algae from submerged hard surfaces. The diet of rainbowfishes includes algae, ants, aquatic insect larvae and small crustaceans. Their foraging activity is unlikely to negatively impact the area
If the species is mainly planktivorous or detritivorous or algivorous, then is its foraging likely to have an adverse impact in the RA area?			n/a
If the species is mainly benthivorous, then is its foraging likely to have an adverse impact in the RA area?			n/a
Reproduction			
Does the species exhibit parental care and/or is it known to reduce age-at-maturity in response to environment?	N	4	Rainbowfish are egg scatterers with viable eggs and sperm ejected simultaneously requiring both sexes for fertile offspring to be produced (Tappin 2011). Eggs adhere on submerged aquatic and riparian vegetation for 5-15 days before hatching into fry (Tappin 2011).
Does the species produce viable gametes?	Y	4	Viable gametes in wild populations
Is the species likely to hybridize with native species (or use males of native species to activate eggs) in the RA area?	N	3	No evidence of hybridisation in this genus
Is the species hermaphroditic?	?	3	Hermaphroditism has been reported in rainbowfish and may be relatively widespread (Tappin 2011).
Is the species dependent on the presence of another species (or specific habitat features) to complete its life cycle?	Y	3	Without sites to deposit eggs and allow fertilisation and development, rainbowfish populations will not survive. Important breeding sitse include submerged aquatic and riparian vegetation
Is the species highly fecund (>10,000 eggs/kg), iteropatric or has an extended spawning season relative to native species?	N	3	Produce about 5 to 15 viable eggs a day for several consecutive days in a two-week period (Tappin 2011). A total of 42-125 eggs can be released over that period.
What is the species' known minimum generation time (in years)?	1	3	Generally, rainbowfishes start to breed about 6 months of age and are reported to live for about 4 years in their natural habitat and up to 8 years in captivity
Dispersal mechanisms			
Are life stages likely to be dispersed unintentionally?	N	3	Not a bait species
Are life stages likely to be dispersed intentionally by humans (and suitable habitats abundant nearby)?	Y	2	Potential discards from people who abandon aquariums
Are life stages likely to be dispersed as a contaminant of commodities?	N	3	Would be very unlikely to be sold with other fishes; very low probability as contaminant of non-fish commodities.

Question	Response	Certainty	Comments and references
Does natural dispersal occur as a function of egg dispersal?	N	3	Eggs adhere on submerged aquatic and riparian vegetation for 5-15 days before hatching into fry (Tappin 2011).
Does natural dispersal occur as a function of dispersal of larvae (along linear and/or 'stepping stone' habitats)?	?	3	Little is known about the specifics of reproduction, no literature or references found that address this.
Are juveniles or adults of the species known to migrate (spawning, smolting, feeding)?	N	3	All species have a restricted geographic range, and do not migrate for spawning.
Are eggs of the species known to be dispersed by other animals (externally)?	?	3	There is no proof, but it is possible if highly unlikely, that the eggs of rainbowfish have filaments that are mildly sticky and cause the eggs to catch in aquatic plants. It has been suggested they can attach to the legs of wading birds but this cannot be verified.
Is dispersal of the species density dependent?	?	1	No references found that address stock densities in the wild.
Persistence attributes			
Are any life stages likely to survive out of water transport?	N	3	No references mention desiccation tolerance
Does the species tolerate a wide range of water quality conditions, especially oxygen depletion and temperature extremes?	Y	3	Pseudomugil species are subjected to seasonal variations in temperatures from 12 – 36'C, pH (5.0-9.2) and hardness levels (Tappin 2011). Rainbowfishes can also perform aquatic surface respiration to survive low oxygen concentrations for short periods (Tappin 2011).
Is the species readily susceptible to piscicides at the doses legally permitted for use in the risk assessment area?	Y	3	No evidence to suggest it would be immune to piscicides
Does the species tolerate or benefit from environmental disturbance?	Y	3	Species survival would be enhanced by floods, with spawning known to peak in floodplain areas during the wet season. Floodplain and temporary wetland habitats are important for rainbowfish, and extensive floodplains lie adjacent to some of the largest northern rivers.
Are there effective natural enemies of the species present in the risk assessment area?	Y	3	Species does not exhibit unusual morphology or defensive behaviours. Would be subject to native predators.

Outcome:	Low (-1.0)
Mean certainty	3.4
Certainty Factor:	0.81
Sectors affected	
Aquacultural	-1
Environmental	3
Nuisance	0

Total questions	Answered	? Responses
A. Biogeography/Historical	**13**	**0**
1. Domestication/Cultivation	3	0
2. Climate and Distribution	5	0
3. Invasive elsewhere	5	0
B. Biology/Ecology	**33**	**6**
4. Undesirable traits	12	2
5. Feeding guild	1	0
6. Reproduction	7	1
7. Dispersal mechanisms	8	3
8. Persistence attributes	5	1
Total number of 'don't know' responses		**6**
% of 'don't know' responses		12%

Appendix B: Impacts assessment scoring criteria

Table 13 Impacts assessment scoring criteria

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	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 hybridization 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.
Infrastructure	Damage to human infrastructure, roads, buildings, dams, docks, fences,	None or biological traits and lifestyle	Occasional damage with minor economic	Damage to fences and/or plantations,	Considerable damage to property and	Considerable damage to flood defence

Impact	Description	Minimal	Minor	Moderate	Major	Critical
	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.	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.	losses, e.g., damage to fences, impact through pollution, accumulations of droppings, minor increases in soil erosion.	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.	infrastructure, with considerable economic costs, damage through burrowing or nesting in buildings. Major obstruction of waterway.	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 C: Comments received on the proposal to include 6 *Pseudomugil* species in the Live Import List

Round 1

Consultation with the general public, stakeholders and state and territory government agencies on the applicants' report was undertaken from 14 October to 24 November 2022. Submissions containing comments to be addressed were received from 3 stakeholders (Table 14). No other responses were received.

Table 14 Comments received during public consultation and response from applicant

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
WA Department of Primary Industries and Regional Development	In general, the Department of Primary Industries and Regional Development considers the suite of 6 Blue eye applications being considered for addition to the Federal permitted import list to be relatively low risk to the Western Australian environment. However, DPIRD WA does not support the addition of any of these fish due to sustainability concerns in their native environment. All but *Pseudomugil furcatus* are IUCN listed as endangered (EN) or critically endangered (CR) and should therefore not be added to the permitted import list. *Pseudomugil furcatus* is listed as data deficient but has a very limited distribution, consequently it is likely to be vulnerable to overfishing and it would be prudent to use the precautionary principle and not add it to the import list. Lyer (2016) outlines how trade in listed species can be counterproductive to protection and compromise conservation efforts due to increased harvesting. Certification in developing countries is problematic and poorly managed. As a signatory to the Convention on Biological Diversity, Australia has the responsibility to ensure that activities within	No further information required	The applicant provided information from the IUCN for each species, highlighting information that some species are captive bred with commercial quantities available. ***Pseudomugil connieae*** This species has been in Australia since 1982 and is still being kept and bred by numerous aquarists. It regularly shows up on Australian internet sites. In 2020, the IUCN indicates this species is assessed as Endangered. It has an extent of occurrence (EOO) of 2,500 km2. There are between one and three locations based on threats related to development, which have resulted in a loss of the specific rainforest habitat of this species. Research into the population and distribution is urgently required, especially as this area is relatively unsurveyed and heavily developed. There have been 3 previous assessments: 2009 – where the species was classified as Vulnerable (VU), 1996 – where the species was classified as Lower Risk/least concern (LR/LC), and 1994 – where the species was classified as Rare (R). Allen (1981) reports: The type specimens were collected within a 25 km radius of Popondetta. This area is situated a short distance inland from the Solomon Sea and is primarily a low river plain dissected by a number

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
	our jurisdiction do not cause damage to the environment of other states or areas. If the species being considered are already under threat, adding the species to Australia's approved list, may further compound this issue by creating an incentive to harvest from the wild.		of meandering streams. Much of the area is virgin rainforest, but there are also large patches of cleared grassland. Most specimens were taken from small, relatively swift tributary streams in very clear water. Temperature and pH in these streams ranged from 24°-27°C and 7.7-7.9 respectively. The stomach contents of several paratypes indicate a diet consisting primarily of minute crustaceans and insect larvae with a small amount of algal matter. There are no other species of rainbowfishes in the streams occupied by P. connieae. The recent assessment of 2020 located at: https://www.iucnredlist.org/species/18544/147757093 details: **Population:** This species was abundant in several streams of the Popondetta district in the 1970s and early 1980s, but its current status is unknown (G.R. Allen pers. comm. 2019). The habitat has undergone large changes recently and there is very little natural rainforest left in the known distribution area of this species, which suggests the population will have declined since collection in the 1980s. **Habitat and Ecology:** This is a pelagic species that is generally found in clear, moderate to fairly rapid flowing streams and creeks in both shaded rainforest or sunlit, exposed sections such as cleared grassland, below an elevation of about 150 m. It can commonly be found in rocky pools situated in well-shaded positions, and is an egg laying omnivore that normally congregates in schools (G.R. Allen pers. comm. 2019). **Use and Trade:** This species is much sought after in the aquarium trade. **Threats:** This species is threatened by habitat conversion due to settlements, logging, oil palm plantations, and alluvial gold mining and associated pollution. There is very little natural rainforest left in the known distribution area of this species, which suggests the population will have declined since collection in the 1980s. Invasive species are likely to be present but there has been a lack of surveys to confirm this (U. Kolkolo pers. comm. 2019). **Conservation Actions:** There are no conservation actions in place for this species. Research into the population and distribution is urgently required, especially as this area is relatively unsurveyed and heavily developed.

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			This is a very colourful fish and is being commercially and sustainably farmed and available from various fish farms in USA, Europe, and by Maju Aquarium in Indonesia. The author accessed various sites on the internet on 24/01/2023. Being available overseas suggests that there should not be any wild harvesting of this fish, as collecting this fish would be very expensive. Therefore we ask that this species be accepted onto the allowable fish import list. ***Pseudomugil furcatus*** This species has been in Australia since 1982, and is still being kept and bred by numerous aquarists. It regularly shows up on Australian internet sites. In 2020, the IUCN indicates this species is assessed as Data Deficient, reporting the following. **Justification:** This species is known only from two localities in eastern Papua New Guinea, in the Kwagila and Musa river basins. The population in the Musa river basin around Safia is probably threatened by logging, while threats to the population in the Kwagila basin are unknown. Given its restricted distribution and the limited information available on its population status and overall threats, it is assessed as Data Deficient. Previously Published Red List Assessments: 1996 – Lower Risk/least concern (LR/LC), and, 1994 – Rare (R) **Geographic Range Description**: This species occurs in the lowlands of the Northern Province in eastern Papua New Guinea, between Dyke Ackland and Collingwood bays. It has only been recorded from near Pumani Village, about 15 km inland from Collingwood Bay in the Kwagila river basin, and at Safia in the Musa River Valley about 56 km inland from Dyke Ackland Bay (G.R. Allen pers. comm. 2019) **Population**: This species was first collected in 1953 near Pumani Village and was abundant in rainforest streams near Safia in 1982. Its current status is unknown (G.R. Allen pers. comm. 2019). **Current Population Trend:** Unknown

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			Habitat and Ecology: This species is common in clear rocky pools in slow-flowing rainforest streams with abundant aquatic vegetation. It can reach a maximum size of 4 cm SL (G.R. Allen pers. comm. 2019). **Use and Trade:** This species occurs in the international aquarium trade, but the majority of specimens are commercially bred. The level of take from wild stocks is unknown. **Threats:** It is likely that this species is threatened by habitat conversion due to logging around Safia. Other potential threats that occur within that area include oil palm plantations and alluvial gold mining with its associated pollution. Invasive species are also probably present, but there has been a lack of surveys to confirm this (U. Kolkolo pers. comm. 2019). Threats to the population of this species in the Kwagila river basin are unknown. **Conservation Actions:** There are no known conservation actions in place for this species. Research is needed into its distribution, population status and potential threats. The full report can be accessed at: Palmer-Newton, A. 2020. Pseudomugil furcatus.: https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T18545A162322140.en This fish is being commercially and sustainably farmed and available from various fish farms in USA, Europe, and by Maju Aquarium in Indonesia. The author accessed various sites on the internet on 24/01/2023. Being widely available overseas suggests that there should not be any wild harvesting of this fish, as collecting this fish would be very expensive. Therefore we ask that this species be accepted onto the allowable fish import list. ***Pseudomugil ivantsoffi*** This species is in Australia. The author accessed various sites on the internet on 24/01/2023, and found this species available on an Australian Wholesaler/Importers list, suggesting that there are commercial quantities available.

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			In 2020, the IUCN indicates this species is assessed as Endangered, reporting the following. **Justification:** This species is assessed as Endangered. It has an extent of occurrence (EOO) of 2,000 km^2, occurs in two locations (one in the forest tributaries and one in the peat swamps and associated main channel), and there is continuing decline in habitat. **Geographic Range Description:** This species is known only from the Timika region of Papua Province, Indonesia. It was previously confused with Pseudomugil reticulatus, a species restricted to the Ayamaru Lakes district of the Bird's Head Peninsula (Ivantsoff et al. 1996). **Population:** This species was formerly common in rainforest streams in the Kuala Kencana-Kopi River areas of the Freeport Mining Company concession area, but is apparently now rare (G.R. Allen pers. comm. 2019). **Habitat and Ecology**: This species occurs in shallow, clear, slow-flowing streams in dense lowland rainforest, and can also be found in sago-Pandanus swamps. It often occurs with Pseudomugil pellucidus, and is a good indicator of pristine forest conditions, although it can sometimes be found in altered habitats. It can grow to a maximum size of about 3.1 cm SL (G.R. Allen pers. comm. 2019). **Use and Trade**: This species is found in the aquarium trade, but individuals are from captive bred populations (P. Unmack pers. comm. 2019). **Threats:** The Timika region has had large increases in the human population in recent decades due to migration for mining. Related threats to this species include land clearance for housing. There is a mining concession in the region, within which housing is not built. The impacts of mining (e.g. sedimentation) are primarily on the main stream of the river, and so this species is largely unaffected as it is found in the tributaries, rather than the main channel. However, this species also occurs in peat swamps, which would be affected by sedimentation (G.R. Allen pers. comm. 2019). Oil palm plantations are also a threat to the west of Timika (Kadarusman pers. comm. 2019). There are also invasive species in the region (G.R. Allen and Kadarusman pers. comm. 2019).

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			Conservation Actions: This species may occur in the Lorentz National Park but there are no confirmed records. There are no conservation actions in place for this species. Research into the population and distribution is recommended. The full report can be accessed at: Allen, G.R. & Kadarusman. 2020. Pseudomugil ivantsoffi, found at: . https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161077334A161077338.en This fish is being commercially and sustainably farmed and available from various fish farms in USA, Europe, and by Maju Aquarium in Indonesia. The author accessed various sites on the internet on 24/01/2023. Being widely available overseas suggests that there should not be any wild harvesting of this fish, as collecting this fish would be very expensive. Therefore we ask that this species be accepted onto the allowable fish import list. ***Pseudomugil luminatus*** This species is in Australia. The author accessed various sites on the internet on 24/01/2023, and found this species available on an Australian Wholesaler/Importers list., suggesting that there are commercial quantities available. In 2020, the IUCN indicates this species is assessed as Endangered, reporting the following. **Justification:** This species is assessed as Endangered. It has an extent of occurrence (EOO) of 2,000 km^2, occurs in two locations (one in the forest tributaries and one in the main channel and associated peat swamps, in which the species may now be extinct), and there is continuing decline in habitat. **Geographic Range Description**: This species is currently known only from south-central New Guinea in the vicinity of Timika, Papua Province, Indonesia (G.R. Allen pers. comm. 2019). **Population:** The type locality, which lies about 20–25 km upstream of the Aikwa River estuary, was severely altered by sediment tailings from the

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			Freeport gold and copper mine in the late 1990s and this species and other swamp-associated fauna are presumed to no longer be present (G.R. Allen pers. comm. 2019). **Habitat and Ecology**: This species was previously locally common in sago-Pandanus swamp habitat with clear but darkly stained, slow-flowing water. However, it is now primarily found in streams in forests. Most of the paratypes of this species were taken from two sites in the Iweka River system at elevations of 45–60 m above sea level, with a water temperature of 26–28°C a pH of 4.8–7.2 and a conductivity of 7–126 µS/cm. The maximum size of this species is 2.2 cm SL (G.R. Allen pers. comm. 2019). **Use and Trade**: This species is found in the aquarium trade, but individuals are from captive bred populations (G.R. Allen pers. comm. 2019). **Threats:** The Timika region has had large increases in the human population in recent decades due to migration for mining. Related threats to this species include land clearance for housing. There is a mining concession in the region, within which housing is not built. The impacts of mining (e.g. sedimentation) are primarily on the main stream of the river, and so this species is largely unaffected as it is found in the tributaries, rather than the main channel. However, this species previously also occurred in peat swamps, which have been severely reduced by sedimentation (G.R. Allen pers. comm. 2019). Oil palm plantations are also a threat to the west of Timika (Kadarusman pers. comm. 2019). There are also invasive species in the region (G.R. Allen and Kadarusman pers. comm. 2019). **Conservation Actions:** This species may occur in the Lorentz National Park but there are no confirmed records. There are no conservation actions in place for this species. Research into the population and distribution is recommended. The full report can be accessed at: Allen, G.R. & Kadarusman. 2020. Pseudomugil luminatus. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161077353A161077357.en

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			This fish is being commercially and sustainably farmed and available from various fish farms in USA, Europe, and by Maju Aquarium in Indonesia. The author accessed various sites on the internet on 24/01/2023. Being widely available overseas suggests that there should not be any wild harvesting of this fish, as collecting this fish would be very expensive. Therefore we ask that this species be accepted onto the allowable fish import list. ***Pseudomugil paskai*** The author accessed various sites on the internet on 24/01/2023, and found this species available on a few Wholesaler/Importers list. In 2020, the IUCN indicates this species is assessed as Critically Endangered, reporting the following. **Justification**: This species is known only from small creeks around Kiunga, with an area of occupancy (AOO) and extent of occurrence (EOO) both with best estimates of 4 km^2 (and not thought to exceed 200 km2). It was formerly common in the 1980s but is now considered rare, with recent attempts to find it being unsuccessful. This decline may be due to the threats of surrounding human settlements and resulting pollution, which are likely causing ongoing declines in habitat quality and area. This species is therefore assessed as Critically Endangered, and surveys are needed to determine its population status. Previously Published Red List Assessments 1996 – Data Deficient (DD) and 1994 – Vulnerable (V) **Geographic Range Description**: This species is known only from the Upper Fly River system of Papua New Guinea from a few small creeks along the Kiunga-Tabubil road, approximately 830-850 km upstream from the sea. Previous records from the Timika area of Papua Province, Indonesia were based on misidentifications of Pseudomugil luminatus. Photographs from the Aru Islands indicate the presence of a very similar fish, which is possibly P. paskai (G.R. Allen pers. comm. 2019). **Population:** This species was formerly common in the 1980s in the vicinity of Kiunga, but is now considered rare. Recent attempts to find

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			this species were unsuccessful (G.R. Allen pers. comm. 2019), and the population is assumed to be declining. **Current Population Trend:** Decreasing Habitat and Ecology This species occurs in rainforest habitat in low-hill terrain at elevations of about 100-150 m. Its streams are slow-flowing and either turbid or tea-coloured with abundant aquatic vegetation and pH and temperature ranges of 6.1-6.5 and 25-26°C. It can grow to a maximum size of about 2.5 cm SL (G.R. Allen pers. comm. 2019). **Use and Trade:** This species is rarely found in the aquarium trade. **Threats:** This species has declined since the 1980s when it was described as common, and recent attempts to find it were unsuccessful. The cause of this decline is not certain, although a number of threats occur in the surrounding area. These include run off from the Kiunga-Tabubil main road and from surrounding settlements and resulting pollution. Introduced species are also a potential threat. The Ok Tedi River is impacted by the effects of mining, including sedimentation, fragmentation and habitat change, although the creek habitat of this species is likely to be less impacted. **Conservation Actions**: There are no known conservation actions in place for this species. As recent attempts to find this species were unsuccessful, surveys are urgently needed to determine its current population status and distribution. Habitat restoration and protection may also be needed. The full report can be accessed at: Palmer-Newton, A. 2020. Pseudomugil paskai. https://dx.doi.org/10.2305/IUCN.UK.2020- 3.RLTS.T18547A147757519.en It is uncertain if this fish is being commercially bred in large volumes at this stage. However, we are hopeful that it is, or that expeditions are planned to acquire this species. Therefore we ask that this species be accepted onto the allowable fish import list.

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			Pseudomugil reticulatus The author accessed various sites on the internet on 24/01/2023, and found this species available on various wholesalers price lists in Europe, USA, and Indonesia. In 2020, the IUCN indicates this species is assessed as Critically Endangered, reporting the following. **Justification**: This species is assessed as Critically Endangered. It is a poorly known species with only a few specimens available. Collections in 1982 and 1999 found the species, but only following extensive searches for the species was it found again in 2019 in a single locality. It has a restricted extent of occurrence (EOO) of 20 km2 , is known only from one location based on the primary threat of predation by invasive species, and is experiencing continuing decline in the number of mature individuals due to this threat. **Geographic Range Description**: This species is known only from tributary streams flowing into Lake Ayamaru in the central Bird's Head Peninsula of West Papua Province, Indonesia. Aside from the holotype collected in 1982, the species was known only from 15 other specimens deposited at the Western Australian Museum collected in 1999 (G.R. Allen pers. comm. 2019). After extensive searches, a few individuals were also found at a single site in 2019 (P. Unmack pers. comm. 2019). It was erroneously reported from the Timika region of southern Papua Province, Indonesia by Ivantsoff et al. (1997) based on specimens of Pseudomugil ivantsoffi (G.R. Allen pers. comm. 2019). **Population:** There is no information on the population size or trend. **Current Population Trend**: Unknown **Habitat and Ecology:** This species is known only from tributary streams flowing into Lake Ayamaru. These are small, clearwater streams running through secondary forest with a sand/mud bottom and minimal aquatic vegetation. It can grow to a maximum size of about 2.8 cm SL (G.R. Allen pers. comm. 2019).

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			Use and Trade: This species is found in the aquarium trade, but individuals are from captive bred populations. **Threats:** The habitat of this species is subject to broad fluctuations in water levels. It is thought that these fluctuations became more severe in the 1990s, and are probably exacerbated by climate change. The primary threats are predation by birds and invasive species (including snakehead, tilapia, carp and goldfish). **Conservation Actions:** There are no conservation actions in place for this species. Research into the population and distribution is recommended because this species is poorly known, as it was difficult to catch even when the habitat was in good condition (G.R. Allen pers. comm. 2019). The full report can be accessed at: Allen, G.R., Kadarusman & Unmack, P. 2020. Pseudomugil reticulatus. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T161077487A161077492.en This fish is being commercially and sustainably farmed and available from various fish farms in USA, Europe, and by Maju Aquarium in Indonesia. The author accessed various sites on the internet on 24/01/2023. Being widely available overseas suggests that there should not be any wild harvesting of this fish, as collecting this fish would be very expensive. Therefore we ask that this species be accepted onto the allowable fish import list.
NSW DPI	NSW DPI supports the amendment to add these species to the Live Import List provided the following concerns are considered: 1. As the maximum length of these species is generally no greater to 2cm to 4cm size, a minimum size limit may not be applicable. Will the Border Force officers be successful in identifying these species in order to reduce the chance of mistaken identity of juveniles with other similar looking fish species at the border? Can the proponent suggest and appropriate size limit to	• Describe method(s) to identify the 6 species of *Pseudomugil* in order to reduce misidentification of specimens, especially juveniles, with other similar looking species. • Propose appropriate body sizes for these species to allow their positive	It is suggested that the minimum size for the blue eyes should be 20mm. They are identifiable at that size. The author has been in contact with importers here in Australia, and exporters from other countries. Overseas exporters list species available that are captive bred. Any fish imported into Australia for ornamental purposes are subject to being listed on the EPBC Act as an allowable import species and must have appropriate health certification then be subject to quarantine protocols in place at the time. They will come through licensed premises with appropriate quarantine process to allow fish in good health at the

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
	allow positive identification, with supporting evidence? 2. 5 out of 6 of these species are classified as either endangered or critically endangered, with the remainder being data deficient. Can the proponent provide evidence that these species will harvested in a sustainable manner? 3. That appropriate certification of health status (i.e., free from disease, viral agents) of the originating facility prior to importation of this species, and adherence to all other Australian import conditions including post arrival quarantine is ensured. NSW DPI further notes that all other identified biosecurity risks are acceptable and Popondetta Rainbowfish (*Pseudomugil connieae*), Forktail Rainbowfish (*Pseudomugil furcatus*), Ivantsoff's Blue-eye *(Pseudomugil ivanstoffi*), Red Neon Blue-eye (*Pseudomugil luminatus*), Paska's Blue-eye It is noted that in Section 12.f in providing information on NSW legislative controls on the species the proponent has incorrectly referenced the Fisheries Management Act 1994 in a number of these applications. Control of aquatic species was transferred in 2017 to the Biosecurity Act 2015 which declares some fish, aquatic invertebrates and plants as prohibited matter under Schedule 2; and the Biosecurity Regulation 2017 which declares notifiable aquatic species under Schedule 1 Part 2. No species of Pseudomugil are declared as prohibited or notifiable matter under NSW legislation.	identification, with supporting evidence. • Provide evidence that these species will be harvested in a sustainable manner. • Provide method(s) and further information/evidence to ensure that appropriate certification of health status (i.e., free from disease, viral agents) of the export facility prior to importation of these species. • Correctly revise any reference to the Fisheries Management Act 1994.	other end of the process. Anyone importing allowable species into Australia will also have to comply with any state legislation in place at the time of importation. If Commonwealth Legislation allows a species to be imported then any attempt by the state to make those species noxious will be in contravention to the Constitution. Only certain countries are approved to export freshwater aquarium fish to Australia. they are: China, French Polynesia, Germany, Hong Kong, Indonesia, Malaysia, New Zealand, Singapore, Sri Lanka, Thailand, and The USA. They are listed as Effective 26 October 2012, by BICON Australian Biosecurity Import Conditions - available at: https://bicon.agriculture.gov.au/BiconWeb4.0/ViewElement/Element/Index?elementPk=1659368&caseElementPk=1752962 Health certification for freshwater* ornamental finfish exported to Australia * including all approved freshwater species other than goldfish, gouramis, bettas, paradise fish, cichlids and poeciliids. The model health certificate has been updated to reflect a departmental name change and re-formatted for consistency (Appendix 6). Updated model health certificates for imported ornamental (aquarium) finfish – Valid from 1 March 2016 - available at: https://www.agriculture.gov.au/biosecurity-trade/import/industry-advice/2016/02-2016 states that: Only fish listed in the list of permitted live freshwater fish suitable for import are included in this consignment and are documented on the attached invoice. The fish in the consignment have been inspected within seven (7) days prior to export and show no clinical signs of infectious disease or pests. The export premises are currently approved for export to Australia as meeting standards under the Department of Agriculture, Water and the Environment. All fish being held at the export premises exhibit no clinical signs of significant infectious disease or pests and are sourced from populations not associated with any significant disease or pests within the 6 months prior to certification.

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			All fish in the consignment have been in approved export premises for 14 days prior to export. The fish have not been kept in water in common with farmed foodfish (fish farmed for human consumption including recreational fishing) or koi carp. Adequate quarantine safeguards are in place to maintain the health status of the certified fish until export. The fish are effectively isolated in holding systems that prevent infection by direct contact with other fish or indirect contact via water, equipment or any other means. The current model health certificate is located at: Model health certificate form 1st March 2016 The author erroneously recorded in Section 12.f that Fisheries Management Act 1994. As pointed out above, The Biosecurity Act 2015 No. 24, which declares some fish, aquatic invertebrates and plants as prohibited matter under Schedule 2; and the Biosecurity Regulation 2017 which declares notifiable aquatic species under Schedule 1 Part 2. No species of Pseudomugil or Kiunga are declared as prohibited or notifiable matter under NSW legislation. The ACT can be found at: https://legislation.nsw.gov.au/view/pdf/asmade/act-2015-24
De-identified	The applications indicate: • should these species be added to the Live Import List, imported stock would be sourced from captive-bred populations overseas (e.g., "German breeders") which meet relevant provisions under the Biosecurity Act 2015 • a high demand and associated high prices for these species as aquarium fish in Australia • despite a limited genetic pool within currently held captive populations of these species "the need for fresh wild stock imports at a later date will be unlikely" - noting this possibility is not excluded	Propose import conditions to limit the potential for wild populations to be harvested.	It is suggested that the minimum size for the blue eyes should be 20mm. They are identifiable at that size. The author has been in contact with importers here in Australia, and exporters from other countries. Overseas exporters list species available that are captive bred. Any fish imported into Australia for ornamental purposes are subject to being listed on the EPBC Act as an allowable import species and must have appropriate health certification then be subject to quarantine protocols in place at the time. They will come through licensed premises with appropriate quarantine process to allow fish in good health at the other end of the process. Anyone importing allowable species into Australia will also have to comply with any state legislation in place at the time of importation. If Commonwealth Legislation allows a species to be imported then any attempt by the state to make those species noxious will be in contravention to the Constitution.

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
	• should these species be added to the Live Import List, importers other than the applicant may also seek to bring some of these species into Australia e.g., *Pseudomugil ivantsoffi* • in their native habitats these species are listed on the IUCN red list as endangered, except for *P. furcatus* (data deficient) and *P. paskai* (critically endangered) Given these factors and the relative proximity of the native range of these species (Papua New Guinea) to Australian borders, consideration should be given to applying conditions which limit the potential for wild populations to be harvested for import as aquarium fish e.g., fish can only be sourced from established, captive-bred sources.		Only certain countries are approved to export freshwater aquarium fish to Australia. they are: China, French Polynesia, Germany, Hong Kong, Indonesia, Malaysia, New Zealand, Singapore, Sri Lanka, Thailand, and The USA. They are listed as Effective 26 October 2012, by BICON Australian Biosecurity Import Conditions - available at: https://bicon.agriculture.gov.au/BiconWeb4.0/ViewElement/Element/Index?elementPk=1659368&caseElementPk=1752962 02-2016 - Updated model health certificates for imported ornamental (aquarium) finfish – Valid from 1 March 2016 - available at : https://www.awe.gov.au/biosecurity-trade/import/industry-advice/2016/02-2016 states that: Only fish listed in the list of permitted live freshwater fish suitable for import are included in this consignment, and are documented on the attached invoice. The fish in the consignment have been inspected within seven (7) days prior to export and show no clinical signs of infectious disease or pests. The export premises are currently approved for export to Australia as meeting standards under the Department of Agriculture, Water and the Environment. All fish being held at the export premises exhibit no clinical signs of significant infectious disease or pests and are sourced from populations not associated with any significant disease or pests within the 6 months prior to certification. All fish in the consignment have been in approved export premises for 14 days prior to export. The fish have not been kept in water in common with farmed foodfish (fish farmed for human consumption including recreational fishing) or koi carp. Adequate quarantine safeguards are in place to maintain the health status of the certified fish until export. The fish are effectively isolated in holding systems that prevent infection by direct contact with other fish or indirect contact via water, equipment or any other means.

Respondent	Major comments	Further information requested	Applicant response (yellow highlights by applicant)
			The current model health certificate is located at: Model health certificate form 1st March 2016

Round 2

Consultation with state and territory government agencies on the department's risk assessment report was undertaken from 10 May to 17 June 2023. Submissions containing comments to be addressed were received from the Northern Territory, South Australian and Western Australian Governments (Table 15Table 14).

Table 15 Comments received during consultation Round 2 with states and territory governments.

Respondent	Major comments	Department's response
NT Government	The NT has no issues with allowing import of this cohort of fishes into Australia under the normal conditions for import of aquarium fish and the additional condition for these two genera that they be captive bred.	N/A
SA Government	Based on the overall risk rating of low, but noting uncertainties in the assessment, the listing of the 8 species in Part 2 of the Live Import List which comprises specimens that require a permit under the EPBC Act to be imported is not opposed, with support for the recommended conditions. Ornamental fish can carry infections of serious pathogens. It is suggested that a health certification be a requirement for exemptions to the import list to provide adequate protection from disease introduction.	As per BICON Australian Biosecurity Import Conditions, imported specimens will be subject to health certification requirements for freshwater ornamental (aquarium) fish, including inspection by a competent authority within 7 days prior to export; and undergo post-import quarantine.
WA Department of Primary Industries and Regional Development	DPIRD supports the inclusion of the condition as an attempt to manage this risk. However, it should be acknowledged that the inclusion of that condition does not mitigate that risk entirely and its effectiveness is heavily reliant on others doing the right thing outside of Australia's legal reach. There remains the risk that the source of the captive-bred populations is from the wild and that the captive-bred gene pool will likely need some "refreshing" at some stage which may come from the wild stock. It is concerning that in the applicant's response to previous concerns they are unsure if it is available commercially from breeding facilities and they are planning collecting expeditions. This would imply that this species will be collected from the wild and imported to Australia or the overseas facilities and then imported to Australia, either way a critically endangered species will be collected from the wild, which does not align with our international obligations.	The recommendations have been updated to reflect WA's comments, with *P. paskai* now not recommended to be listed due to conservation concerns.

Glossary

Term	Definition
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species
DCCEEW	Department of Climate Change, Energy, the Environment and Water
EPBC	Environment Protection and Biodiversity Conservation Act 1999
FISK	Fish Invasiveness Screening Kit
GISD	Global Invasive Species Database
IUCN	International Union for Conservation of Nature
mm	Millimetres
ppm	Parts per million
SL	Standard length
spp	Species
TL	Total length

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