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

Submitted by the Aquarium Industry Association of Australia



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Executive Summary

Consideration of the Department of Agriculture, Water and the Environment (DAWE) terms of reference for proposed amendments to the List of Specimens taken to be Suitable for Live Import (Live Import List) against information available for the Torpedo barb (*Sahyadria denisonii*) indicates the risk of allowing the importation of the species would pose minimal biosecurity risk to Australia. Notably, *S. denisonii* is not reported to have established breeding populations outside its natural range overseas despite being traded internationally for over 30 years and similar species such as *Dawkinsia filamentosa* have not established self-maintaining wild populations in Australia despite decades of importation. Furthermore, captive breeding populations of *S. denisonii* currently exist in the Australian hobby supplying a limited domestic trade ─ these populations have not led to the establishment of feral populations in Australia.

Importantly, most of the information available about this species is from the ornamental fish hobby literature; there is little information in the scientific literature, especially as it relates to establishment risks. The absence of such reports despite the many decades of worldwide trade is precisely because of the benign nature of the species since scientific study (and associated literature) focuses almost exclusively on species found to be invasive. Indeed, three of the five criteria used in the Bomford methodology (Bomford 2008) for determining establishment success (as used in the Department's own assessments) pertain to the presence or absence of reported historical establishment – the other two criteria being the species' climatic and geographical range. The absence of published scientific literature about the species should not therefore be the sole basis of decision making, especially when there is a long history of trade to draw on – to do so is considered outside the intended applicability of the Environment Protection and Biodiversity Conservation Act's precautionary principle.

Of the many species that would add value to the ornamental fish hobby sector in Australia, this species has been selected for application to add to the Live Import List taking into account the fact that the species has not been reported to be invasive or otherwise ecologically harmful, nor associated with diseases exotic to Australia. It is a relatively small, benign species similar in many respects to fish already deemed appropriate to be imported into Australia.

S. denisonii would be a welcome addition to the species permitted live importation, especially given the growing popularity of the hobby in Australia and the significant economic and social benefits of the aquarium fish trade to Australia. The addition of *S. denisonii* would be consistent with current import policy given that the species is present in Australia and given that it is closely related to and shares a similar environmental risk profile with other species currently permitted live importation to Australia.

This TOR report should be read together with the 'Frequently Asked Questions' (Appendix 1) document that forms part of the package of information submitted to the DEWA in support of the Aquarium Industry Association of Australia's application to add *S. denisonii* to the Live Import List.

A structured risk assessment of *S. denisonii* based on the methodology of Bomford (2008) estimated a 'moderate' risk, generally consistent with the risk that would likely be posed by the vast majority of the species currently permitted live importation to Australia.

S. denisonni also received a SARDI risk score of 0 which is considered low risk. These results further support and reinforce the data already presented using the Bomford model and will enable high level of confidence in the data presented.

It is recommended that *S. denisonii* is added to the Live Import List.

DAWE terms of reference

1. *Provide information on the taxonomy of the species.*

   - Denison barb or Torpedo barb *Sahyadria denisonii* Day 1865.
   - Actinopterygii (ray-finned fishes); Cypriniformes (Carps); Cyprinidae (Minnows or carps); Sub-family Barbinae.
   - Synonyms: *Labeo denisonii*; *Puntius denisonii* (Day 1865).
   - Common names: Denison Barb, Torpedo Barb, Red Line Torpedo Barb, Miss Kerala, Red Comet Barb, Redline Barb, Roseline Shark, Denison's Flying Fox and Bleeding Eye Barb (Page 2020).

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

   - *S. denisonii* is not CITES listed.
   - The species is listed on the International Union for Conservation of Nature's Red List of Threatened Species (Endangered category) and has some conservation value in the wild (Ali *et al.* 2015).
   - The species is native to southern India (Western Ghats) where wild populations have previously been under pressure from collection to supply the aquarium trade. The low abundance, gregarious and aggregating nature, easy location of habitats and/or aggregating locations, together with an increasing market demand and popularity, made *S. denisonii* vulnerable to overfishing and possible endangerment (Raghavan *et al.* 2009). Since this time captive breeding throughout south east Asia is now reasonable for almost all international trade in S. *denisonii.*
   - Mercy *et al.* (2015) noted that 'measures to minimise the likelihood of imported specimens being source from the wild, i.e. ensuring that imports are captive bred, would negate this risk to conservation value. Indeed, encouraging the trade in captive Red List fish will reduce the risk of fish being sourced internationally from the wild'.
   - Mercy *et al.* (2015) documented the first success of captive breeding and early developmental studies of *S. denisonii*. Over recent years captive breeding methods have been developed and commercial numbers of captive bred specimens are sold internationally.
   - The species has been traded internationally as an aquarium species for 30 years (Jared Patrick, Premier Pet.).
   - Given the species is listed on the International Union for Conservation of Nature's Red List of Threatened Species in the endangered category may present a concern, the applicant is willing to have discussions, if required, establishing import conditions ensuring S. *denisonii* sourced are captive bred, noting that no certification process has been implemented to date.

3. Provide information about the ecology of the species.

As with most aquarium species, much of the information about the ecology, including environmental requirements, of *S. denisonii* is not available in the peer reviewed scientific literature. Where such information is lacking, this assessment relies on hobbyist information websites so, applies largely to aquarium behaviour and requirements (Page 2020, Sharpe 2020, Wikipedia n.d.—a, Wikipedia n.d.—b).

- *Lifespan of the species*: 5 years (Sharpe 2020).
- *Size and weight range*: Sizes in the wild populations range from 33mm up to a maximum of 162 mm in total length, with the most common length being 50-60 mm (Sajan *et al.* 2015). Studies of the species in different river systems indicate stock-specific variation in population structure (Sajan *et al.* 2015).
- *Natural geographic range*: The species is a stenotherm (18-26 ºC) endemic to Kerala and south Karnataka in southern India (Malabar Coast) (Sharpe 2020). The species has an estimated range of less than 9,000 km^2 and a fragmented area of actual occupancy of less than 300km^2 (Ali *et al*. 2015).
- *Habitat*: *S. denisonii* is a stream dwelling fish with an affinity towards rocky pools and stream edges with thick overhanging vegetation along banks (Ali *et al*. 2015). However, the species has also been observed from riverine habitats including run, glide and riffles with sand, gravel, cobble and boulder substrates (Ali *et al*. 2015).
- *Diet, including potential to feed on agricultural plants*: *S. denisonii* is a herbivore feeding on filamentous algae, diatoms and plant matter (Raghavan *et al.* 2009). There are no reports of the species posing a threat to agricultural crops.
- *Social behaviour and groupings*: *S. denisonii* is a gregarious species, often appearing in shoals. The species is known to spawn during the North East Monsoon in the months of November-January (Ali *et al*. 2015).
- *Territorial and aggressive behaviours*: There are no reports of territorial or aggressive behaviours in this species.
- *Natural predators*: Not reported in the scientific literature but the species would likely be prey to piscivorous birds, mammals or fish in their natural habitat. As a relatively small species with conspicuous patterning and coloration, the young and adults of the species would be prone to predation by many Australian predatory freshwater fish species such as such as barramundi, grunters, tarpon, Eleotrids, Apogonids and gudgeons.
- *Characteristics that may cause harm to humans and other species*: No characteristics that may cause harm to human or other species have been reported in this species.

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

Mercy *et al.* (2015) classified the life history of *S. denisonii* into embryonic, larval, juvenile, subadult and adult stages with fecundity varying depending on the size and age of breeding pairs. Under laboratory conditions hatching takes place 36 h after fertilisation at a water temperature of 27.5±0.5ºC. At hatching, mean larval length was approximately 3.5 mm with the yolk sac remaining up to 3-4 days. Organogenesis of larvae was completed 15-20 days after hatching. The fertilised eggs of *S. denisonii* are heavily yolked, transparent, spherical and yellow

in colour. The eggs are adhesive similar to other *Puntius* species, the genus in which the species was historically classified.

The spawning season of *S. denisonii* is reported to correspond more or less with the regional monsoon (June–August) and associated seasonal cues, since mature specimens have been observed in the wild from May, with peak maturity seen in June and continuing until July (Raghavan *et al.* 2009). The sex ratio in aggregations of mature fish is highly skewed favouring males (1:25) (Raghavan *et al.* 2009).

- *Age at maturity (first breeding)*: Solomon *et al.* (2011) reported size at first maturity to be 95 mm for females and 85 mm for males, approximating to 1+ year class fish (12-18 months old).

- *How frequently breeding occurs*: Mercy *et al.* 2015 observed spawning season of the species in the wild is from November to March ─ others have reported a narrower season from November-January, more closely aligned to India's North East Monsoon (Ali *et al.* 2015)

- *Can the female store sperm*: Females are not reported to store sperm. Fertilisation is external ─ all fish in this family are egg-layers and like most cyprinids this species does not build nests or guard the eggs.

- *How many eggs or live-born young are produced at each breeding event*:
  Mercy *et al.* (2015) reported absolute fecundity of *S. denisonii* ranging from 293 to 967ova per female, while Solomon *et al.* (2011) recorded a range of 76 to 1098; extremely low when compared to other cyprinids such as *Systomus* (*Puntius*) *sarana* (Chandrasoma and de Silva 1981) and *Rasbora daniconius* (Nagendran *et al.* 1981). Similar to this species, three endemic cyprinids threatened by aquarium collections in Sri Lanka, *Pethia* (*Puntius*) *nigrofasciatus*, *Pethia* (*Puntius*) *cumingi* and *Systomus* (*Puntius*) *pleurotaenia* are also known to have a low absolute fecundity (151–638 for 46–64 mm TL) (Solomon *et al.* (2011).

- *Has the species hybridised with other species (both in the wild and in captivity) or has it the potential to hybridise with any other species*: the species is not reported to have hybridised with any other species.

- *If the species can hybridise, are the progeny fertile*: Not applicable.

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

   The species has not been reported as having established feral population outside of their natural geographic distribution, despite being traded internationally for the aquarium trade for the past 30 years in volumes in the order of 3 million per year (Jared Patrick, Premier Pet, pers. com.).

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

   A search of the scientific literature did not identify any previous environmental risk assessment of this species. The species is not on the BRS 'grey list' of ornamental fish species, i.e. non-native species that are present in Australia through historical imports that are not on the Live Import List, nor is it one of the species of non-native freshwater fish that are reported to have

established self-sustaining populations in the wild in Australia (Corfield et al. 2008).

However, the species is known to be captive bred and traded domestically in Australia (Jared Patrick, Premier Pet.). It is unknown how the first individuals arrived in Australia ─ it is plausible that they may have been shipped to Australia inadvertently as they resemble some closely related species on the current Live Import List (Anthony Ramsey, Pet Industry Association of Australia.).

The addition of *S. denisonii* to the Live Import List would be generally consistent with Australia's biosecurity arrangements for live fish given that the species is present in Australia and given that it is closely related to and likely shares a similar environmental risk profile with several species currently permitted live importation to Australia.

Having a species recognised on the EPBC Act list as being approved is the only practical mechanism available to recognise the legal status of the fish species in Australia. Specifically, some jurisdictions require approval under the EPBC Act in order for the species to be kept and traded, regardless of the existing status of the species. As such, approving a species already here is still important. There is no valid argument rejecting consideration of the application due the fish being here when various jurisdictions actually require it.

Additionally, *S. denisonnii* has been further risk assessed by Michael Sierp (2022) of Aquatic Biosecurity Pty Ltd using the SARDI method contained in the report Deveney, M. (2018) Assessing the risks associated with the Australian Trade in live ornamental fish species: development of a risk assessment tool. Importantly the SARDI methodology also considers the already existing risk associated with the trade of species already present in Australia, something overlooked by other models. The SARDI methodology compiles risk scores from responses to 40 separate risk queries covering three separate categories, the likelihood of release, likelihood of invasion, and consequences of invasion. It must also be recognized that the SARDI risk assessment was developed with funding from environment and invasive committee (EIC) and endorsed by all federal, state and industry stakeholders and participants in the EIC, as well as the aquatic vertebrate and invertebrate working group. as a suitable method to determine risk associated with the trade of ornamental fish already in Australia. The report prepared by M Sierp has been attached as appendix B. It is further noted that trade value and volume data used for these assessments were set using expected figures should the species be approved for live import, ensuring any increase to propagule pressure and likelihood of release is accounted.

S. denisonni received a SARDI risk score of 0 which is considered low risk with the level of data deficiency not exceeding the no confidence threshold of 30%. It is also noted that the individual scores for likelihood of release, likelihood of invasion, and consequences of invasion were also all low with raw scores of 9, 0 and 4 respectively (Sierp 2022). These results further support and reinforce the data already presented using the Bomford model and will enable high level of confidence in the data presented.

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

Assessing the risk of the potential of introducing a new organism into the environment involves assessing the risk of it becoming established and spreading and the likely impacts if establishment occurred. The risk assessment method 'Exotic Freshwater Fish Model 1' developed by Mary Bomford has been adopted by DAWE for its freshwater fish risk

assessments (Bomford 2008). The following considers each of the risk factors considered by Bomford to be applicable to freshwater fish and is guided by the recent Australian Government risk assessment of glass catfish (DAWE 2020a). The specific criteria in the DAWE template terms of reference are also covered. The potential impacts of established feral populations are addressed in the next term of reference (#8). A structured risk assessment based on the Bomford methodology is at Appendix A.

Importantly, much of the information available about this species is from the ornamental fish hobby; information in the scientific literature, especially as it relates to establishment risks is limited. The absence of such reports despite the many decades of worldwide trade is precisely because of the benign nature of the species, since scientific study (and associated literature) focuses almost exclusively on species found to be invasive. Indeed, three of the five criteria used in the Bomford methodology (Bomford 2008) for determining the likelihood of establishment success (as used in the Department's own assessments) pertain to the presence or absence of reported historical establishment – the other two criteria being climatic and geographical range. The absence of published scientific literature about the species should not in itself be the basis of decision making, especially when there is a long history of international trade on which to draw on – to do so is considered outside the intended applicability of the Environment Protection and Biodiversity Conservation Act's precautionary principle.

Of the many species that would add value to the ornamental fish hobby sector in Australia, this species has been selected for application to add to the Live Import List taking into account the fact that the species has not been reported to be invasive or otherwise ecologically harmful, nor associated with diseases exotic to Australia. It is a relatively small, benign species similar in many respects to fish already deemed appropriate to be imported into Australia.

- *Propagule pressure*—the release of large numbers of animals at different times and places enhances the chance of successful establishment: As a schooling species S. denisonii has a higher likelihood of establishing than non-schooling species. However, the species is not territorial, and any inadvertent or deliberate releases into water ways would likely disperse. The possible locations where establishment may occur are generally remote from populated areas; this includes areas in Arnhem Land and far Northern Australia (Brett Herbert, Freshwater Ecologist. pers. com.). It is highly unlikely that enough fish would be accidently or deliberately released into a suitable receiving environment to establish a breeding population. There are examples of tropical aquarium species such as *Poecilia reticulata* that have established small populations in disturbed habitats in urban and peri-urban areas like those found in Darwin, Cairns or Brisbane (Arthington et al. 1999). *S. denisonii* is not known to have established in the any such habitats overseas despite the trade in this species for decades. A moderate to high probability of establishing a self-sustaining population would require deliberate release into very specific waterways – it is unlikely therefore to happen at random; a risk similar to that noted for the glass catfish (*Kryptopterus vitreolus*) in a recent Departmental risk assessment (DAWE 2020a).

- *Climate match*—introduction to an area with a climate that closely matches that of the species' original range: Climatch (original v1.0) was run with the source region set to circumscribe nine stations in the Western Ghats ranges of India including the location of sampling sites (in and around 75ºE, 12ºN) used by Solomon *et al.* (2011) and the broader 'extant and probably extant' geographical range described in the IUCN species assessment (Ali *et al.* 2015). A climate match prediction was generated using the Euclidian algorithm applied to the 'world stations' data set. Climatch calculated a 'value X' (Climate Euclidian

Sum Level 5) of 655, equating to a climate match score of 5, increased to 6 because there were less than 12 meteorological stations used in the prediction. DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements. The new upgraded version of Climatch (v2.0) was not used in this assessment because at the time of conducting this assessment, it had yet to be calibrated for purposes of applying the Bomford methodology.

- *Overseas range:* The species is a stenotherm (18-26ºC) endemic to Kerala and south Karnataka in southern India (Malabar Coast) (Sharpe 2020). It has an estimated range of 8,805 km^2 and is conservatively estimated to occupy a total 6, 1^o latitude x 1^o longitude grid squares (Bomford 2008).

- *History of establishment elsewhere—previous successful establishment:* There have been no recorded establishment of wild populations of *S. denisonii* outside its natural range, despite likely inadvertent or deliberate introductions as an internationally traded aquarium species. The species is considered to have been "introduce but never established" (Bomford 2008).

- *Introduction success:* The species is not known to have been released or established. However, after decades of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction success rate is conservatively considered to be less than 0.25 or 25%.

- *Taxonomic group—belonging to a family or genus which has a high establishment success rate: S. denisonii* belongs to the family Cyprinidae (freshwater fish that includes the carps, the true minnows, and their relatives such as barbs and barbels) and the subfamily Barbinae — the taxonomy of the Barbinae is uncertain as some genera historically considered within it are still considered *incertae sedis* (Wikipedia n.d.—a). There are four ornamental cyprinid species that are reported to have established self-maintaining populations in Australian waters; namely goldfish (*Carassius auratus*), rosy barb (*Puntius conchonius*), Sumatra barb (*Puntius tetrazona*) and white cloud mountain minnow (*Tanichthys albonubes*) (Corfield *et al.* 2008). However, there is limited value in assigning a level of invasiveness risk to the family as a whole because the Cyprinidae is the largest and most diverse fish family and the largest vertebrate animal family in general, with about 1750 valid species, representing about 150 genera (Fricke *et al*. 2020) (Froese and Pauly n.d.—a)

  At a genus level, since there are only two species in the genus *Sahyadria*, all species currently in the genus *Puntius* (to which the species previously belonged) plus the two species of *Sahyadria* may be considered as a single group for risk assessment purposes. According to FishBase (Froese and Pauly n.d.—b), of a total 52 species (50 *Puntius* and 2 *Sahyadria*), 11 (10 *Puntius* and 1 *Sahyadria*) are traded as ornamental species, and of these 11, there are seven records (representing only two species) on FishBase of *Puntius* species being found to have established wild populations outside the countries to which they are native. As internationally traded species, it is reasonable to assume that there would have been many past instances (perhaps in the hundreds) that these 11 species would have been introduced to non-native environments over the past several decades of international trade – an introduction being a release event where one or more individuals of these species are directly or indirectly released into natural waters outside their natural range. A conservative 50 past introductions is assumed for the purposes of this risk assessment. (If a much smaller number of release events are deemed to have occurred over the last many decades of

international trade, this would mean that release events are very rare and that the overall risk is commensurately minute.) This assumed level of introductions has resulted in 7 established populations of two species. The 'genus level' taxa risk is therefore 7/50 (14%).

- *Ability to find food sources*: As a herbivore feeding on filamentous algae and plant matter, the species is expected to find food sources in the unlikely event it is introduced into the wild.

- *Ability to survive and adapt to different climatic conditions (e.g. temperatures, rainfall patterns)*: *S. denisonii* is a benthopelagic stenotherm endemic to the Achenkovil, Pamba and Chaliyar rivers; specifically in four locations — Cheenkannipuzha (a major tributary of Valapattanam River), the Achankovil river, the Chaliyar river and near Mundakayam town (Wikipedia n.d.—b). The species thrives in a subtropical climate in water with a 6.8-7.8 pH, a water hardness of 5-25 dGH and a temperature range of 18 to 26°C. This climatic range together with its stream habitat requirements limits the potential geographical range where the species could theoretically establish (Wikipedia 2020b).

- *Ability to find shelter*: As a stream dwelling fish with an affinity towards rocky pools, edges with thick overhanging vegetation along its banks (Wikipedia n.d.—b), opportunity to find shelter in the event of deliberate or inadvertent release into the wild would be limited.

- *Rate of reproducing*: Solomon *et al.* 2011 reported absolute fecundity of *S. denisonii* to be extremely low, compared to other cyprinids such as *Systomus* (*Puntius*) *sarana* and *Rasbora daniconius*. Similar to this species, three endemic cyprinids threatened by aquarium collections in Sri Lanka, *Pethia* (*Puntius*) *nigrofasciatus*, *Pethia* (*Puntius*) *cumingi* and *Systomus* (*Puntius*) *pleurotaenia* are known to have a low absolute fecundity (151–638 for 46–64 mm TL). The net reproductive rate (the number of offspring that a female produces during its lifetime) is therefore considered relatively low compared to other cyprinids considered to be invasive.

- *Any characteristics that the species has which could increase its chance of survival in the Australian environment*: The species is not considered to have any characteristics that would increase its likelihood of survival in the wild in Australia.

In summary, *S. denisonii* is considered unlikely to establish, in main because the species is not reported to have established breeding populations outside its natural range despite being traded internationally as an ornamental species for the last 30 years, and because there are few areas in Australia expected to have habitat suitable for the species to establish. This conclusion can be ground-truthed to an extent by comparing *S. denisonii* with similar species such as *Dawkinsia filamentosa* that have not established self-maintaining wild populations despite decades of importation to Australia for the aquarium trade. Furthermore, there currently exists breeding populations of *S. denisonii* in the Australian hobby – these have not led to the establishment of feral populations in Australia.

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

8. *Provide a comprehensive assessment of the potential impact of the species should it establish feral population/s in Australia. Include, but do not restrict your assessment to the impact of this species on:*

- *Similar niche species (i.e. competition with other species for food, shelter etc.)*: In the unlikely event this species establishes in the wild in Australia, it may compete for benthic algae and plant matter with other small herbivores and omnivores in tropical waters (17-28°C), typically in pebble, rock or boulder-substrate running water habitats. These niche species could include bottom feeders such as rainbowfishes (*Melanotaenia* spp.), *Pseudomugil* spp. and other small omnivores. *S. denisonii* is unlikely to compete with species that feed in the water column such as glassfishes/Agassiz's perchlet (*Ambassis agassizii*) (AKA Agassiz's glass fish), flyspecked hardyheads (*Craterocephalus stercusmuscarum*), unspecked hardyhead (*Craterocephalus fulvusgudgeons*) and other similar species (Brett Herbert, Freshwater Ecologist. pers. com.). There are no reports in the scientific literature of any ecological impacts as a result of the species establishing outside its natural range in other countries. As noted in TOR 7 above, the absence of such reports is an indication of the benign nature of the species since scientific literature focuses almost exclusively on species that have some ecological impact.

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

- *Probable prey/food sources, including agricultural crops*: *S. denisonii* has not been reported to pose any threat to agricultural crops or pose a threat as a predator — it is a herbivore.

- *Habitat and local environmental conditions*: *S. denisonii* has not been reported to change its environment or habitat. It is a stream dwelling fish with an affinity towards rocky pools, edges with thick overhanging vegetation along its banks (Ali *et al*. 2015). It does not build nests and lays adhesive eggs that attach to the pebbly substrate of stream bottoms.

- *Control/eradication programs that could be applied in Australia if the species was released or escaped*: Potential control measures include listing as a noxious species; eradication or containment programs (including movement controls) or broader education/awareness building campaigns such as the NAQS program for labelling fish bags in aquarium shops in northern Australia.

- *Characteristic or behaviour of the species which may cause land degradation i.e. soil erosion from hooves, digging*: There are no reports of this species exhibiting behaviours that my cause habitat degradation.

- *Potential threat to humans*: The species is not reported as posing any threat to humans.

Using the SARDI method, specifically risk queries 25 to 40, show little to no consequences of invasion should *S. denisonnii* establish feral populations in Australia. A thorough review of all available literature showed that *S. densonnii* has no recorded impacts on any wild or farmed aquatic species outside its natural range. It is not a parasitic or migratory species, causes no harm to humans and has no record of altering the function of ecosystems, nor does it outcompete or prey on any fish species, beyond its natural range. It also cannot hybridise with any Australian native fish. Furthermore, there is no evidence in any literature, worldwide, that the species has ever caused any deleterious environmental, social or economic impacts. (Sierp 2022).

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

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

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

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

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

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

- *Potential trade in the species*: The species is routinely traded internationally (and to a much smaller extent, domestically) and would be a welcome addition to the species permitted importation. In the order of 3 million fish of the species are traded internationally and given the growing popularity of the hobby in Australia, the likely market demand in Australia for imported *S. denisonii* stock would represent about one percent of this (Jared Patrick, Premier Pet.).

- *Why this species has been chosen*: Internationally, the species is in high demand by hobbyists because aquacultured specimens are very affordable to the average hobbyist. *S. denisonii* is prohibitively priced in Australia due to unavailability of imported stock and as a result, beyond the reach of most hobbyists. Permitting importation will mean that the species could be offered at a more affordable price, with associated benefits to the trade and the hobby. The species is not aggressive and compatible to keep in aquaria with other tropical species.

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

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

    - *The disposal options for surplus specimens*: Fish will be imported for purposes of supplying the aquarium fish trade and as such no surplus specimens are expected. In the event of mortality, animals will be disposed as per the provisions of the *BICON Import Conditions for Freshwater Aquarium Fish: Effective 18 July 2020* (DAWE 2020b) and in accordance with the Aquarium Industry Association of Australia (AIAA) National Code of Practice (AIAA 2008).

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

    - *The species' current quarantine status*: The species is not currently on the permitted species list.

    - *Pest or noxious status*: The species is not list on any state or federal pest or noxious species list.

    - *Whether it is prohibited or controlled by permit or licence in any state or territory*: The species is not prohibited or controlled by permit or licence in any state or territory.

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Appendix A: Bomford model risk assessment: *Sahyadria denisonii*

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

Bomford (2008) identified a range of factors that determined establishment success of freshwater fish, including propagule pressure, climate match, history of establishment elsewhere, geographic range and taxonomic group. These risk factors together with potential impacts should *Sahyadria denisonii* (Day 1865) establish wild populations in Australia are discussed below, as are the outputs of applying the Bomford (2008) methodology. These findings should be considered together with information addressing the DAWE terms of reference for proposed amendments to the *List of Specimens taken to be Suitable for Live Import (Live Import List)* in the body of this submission.

Establishment success

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

As a schooling species *S. denisonii* has a higher likelihood of establishing than non-schooling species. However, the species is not territorial, and any inadvertent or deliberate releases into water ways would likely disperse. The possible locations where establishment may occur are generally remote from populated areas; this includes areas in Arnhem Land and far Northern Australia (Brett Herbert, Freshwater Ecologist. pers. com.). There are examples of tropical aquarium species with known invasive characteristics such as *Poecilia reticulata* that have established small populations in disturbed habitats in urban and peri-urban areas such as those that exist in Darwin, Cairns or Brisbane (Arthington et al. 1999). *S. denisonii* is not known to have established in the many such habitats overseas despite the trade in this species for decades. A moderate to high probability of establishing a self-sustaining population would require deliberate release into very specific waterways – it is unlikely therefore to happen at random, similar in risk to glass catfish (*Kryptopterus vitreolus)* as noted in a recent Departmental risk assessment (DAWE 2020a). It is highly unlikely that enough fish would be accidently or deliberately released into a suitable receiving environment to establish a breeding population.

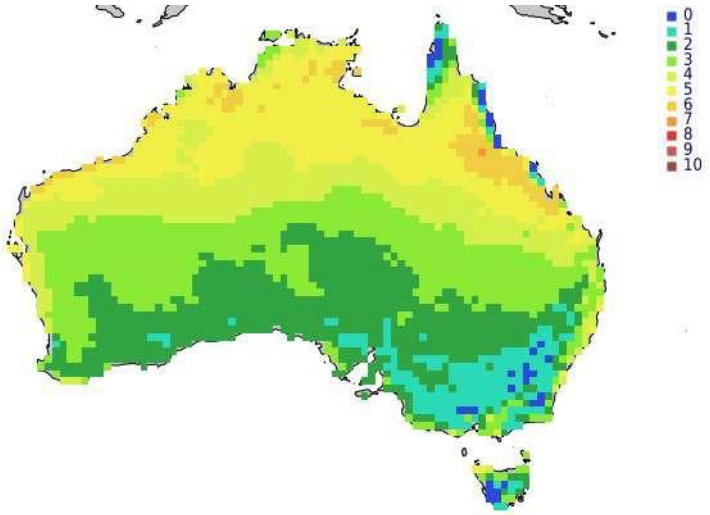
If permitted importation *Sahyadria denisonii* would be freely available in Australia through aquarium stores and retail at about $10-20 per fish. The species would be common enough in Australia that theft due to lack of availability is unlikely.

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

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

Map coordinates of collection sites provided in Solomon *et al.* (2011) provides fairly precise data for climate matching purposes. Climatch (v1.0) was run with the source region set conservatively to circumscribe weather stations in the Western Ghats ranges of India including the location of sampling sites (in and around 75ºE, 12ºN) used by Solomon *et al.* (2011) and

the broader 'extant and probably extant' geographical range described in the IUCN species assessment (Ali *et al.* 2015). A climate match prediction was generated using the Euclidian algorithm applied to the 'world stations' data set (Figure 1). Climatch calculated a 'value X' (Climate Euclidian Sum Level 5) of 655, equating to a climate match score of 5, increased to 6 because there were less than 12 meteorological stations used in the prediction. DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements. The recently released upgraded version of Climatch (v2.0) was not used in this assessment because at the time of conducting this assessment, it had yet to be calibrated for purposes of applying the Bomford methodology.



Score	0	1	2	3	4	5	6	7	8	9	10
Count	33	195	699	721	482	551	103	1	0	0	0

Figure 1 Climatch output for *Sahyadria denisonii*

History of establishment elsewhere—previous successful establishment:

There have been no recorded establishment of wild populations of *S. denisonii* outside its natural range, despite likely inadvertent or deliberate introductions as an internationally traded aquarium species. The species is considered to have been "introduce but never established" (Bomford 2008).

Overseas range:

The species is a stenotherm (18-26ºC) endemic to Kerala and south Karnataka in southern India (Malabar Coast) (Sharpe 2020). It has an estimated range of 8,805 km2 and is conservatively estimated to occupy a total 6, 1º latitude x 1º longitude grid squares (Bomford 2008).

Introduction success:

The species is not known to have been released or established. However, after decades of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction success rate is conservatively considered to be less than 0.25 or 25%.

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

S. denisonii belongs to the family Cyprinidae (freshwater fish that includes the carps, the true minnows, and their relatives such as barbs and barbels) and the subfamily Barbinae ─ the taxonomy of the Barbinae is uncertain as some genera historically considered within it are still considered *incertae sedis* (Wikipedia n.d.─a). There are four ornamental cyprinid species that are reported to have established self-maintaining populations in Australian waters; namely goldfish (*Carassius auratus*), rosy barb (*Puntius conchonius*), Sumatra barb (*Puntius tetrazona*) and white cloud mountain minnow (*Tanichthys albonubes*) (Corfield *et al.* 2008). However, there is limited value in assigning a level of invasiveness risk to the family as a whole because the Cyprinidae is the largest and most diverse fish family and the largest vertebrate animal family in general, with about 1750 valid species, representing about 150 genera (Fricke *et al*. 2020) (Froese and Pauly n.d.─a)

At a genus level, since there are only two species in the genus *Sahyadria*, all species currently in the genus *Puntius* (to which the species previously belonged) plus the two species of *Sahyadria* may be considered as a single group for risk assessment purposes. According to FishBase (Froese and Pauly n.d.─b), of a total 52 species (50 *Puntius* and 2 *Sahyadria*), 11 (10 *Puntius* and 1 *Sahyadria*) are traded as ornamental species, and of these 11, there are seven records (representing only two species) on FishBase of Puntius species being found to have established wild populations outside the countries to which they are native. As internationally traded species, it is reasonable to assume that there would have been instances (perhaps in the hundreds) that these 11 species would have been introduced to non-native environments over the past several decades of international trade – an introduction being a release event where one or more individuals of these species are directly or indirectly released into natural waters outside their natural range. A conservative 50 past introductions is assumed for the purposes of this risk assessment. (If a much smaller number of release events are deemed to have occurred over the last many decades of international trade, this would mean that release events are rare and that

the overall risk is commensurately low.) This assumed level of introductions has resulted in 7 established populations of two species. The 'genus level' taxa risk is therefore 7/50 (14%).

Potential impacts of established feral populations

Sahyadria denisonii is a schooling nonaggressive fish that is not reported to be territorial or to change its habitat. If a population did manage to become established in the wild in Australia it may compete for food resources with native fish, this would include small invertebrates and zooplankton (Brett Herbert, Freshwater Ecologist. pers. com.). As there are no reports of any *Sahyadria* species establishing feral populations direct impacts are not certain but unlikely.

S. denisonii poses a minor impact risk to the Australian environment as they have been freely traded internationally for many years, with no evidence of establishment of feral populations or any detrimental impact in any other country.

Disease transmission to Australian fish and aquarium fish populations

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

Bomford 2008 Exotic Freshwater Fish Risk Assessment Model

Common name	Torpedo barb
Scientific name	*Sahyadria denisonii* Day 1865
Date assessed	10 October 2020
Literature Search Type and Date:	FishBase October 2020

Risk criterion	Value	Explanation
A. Climate Match Score (1–8)	6	Climatch (v1.0) Euclidian Sum Level 5 (Value X) = 655. This value equates to a climate match score of 5, which is increased to 6 because there were less than 12 meteorological stations used in the prediction.
B. Overseas Range Score (0–4)	1	Applying a conservative estimate of 6, 1-degree grid squares.
C. Establishment Score (0–3)	0	The species is considered to have been "introduce but never established", representing an establishment score of 0.
D. Introduction Success Score (0–4)	<1	Never known to be released or established. However, after decades of trade worldwide it can be assumed the species has been released into non-native areas. The introduction success rate is conservatively considered to be <0.25, representing an introduction success score of <1.
E. Taxa Risk Score 1(0–5)	1	As an internationally traded aquarium species, it is reasonable to assume that there would have been many instances of inadvertent or deliberate introduction around

		the world of the 11 ornamental fish species currently or formerly belonging to the genus *Puntius.* Conservatively, 50 past introductions are assumed for the purposes of this risk assessment. There are only seven records (representing only two species) on FishBase of *Puntius* species being found to have established wild populations outside the countries to which they are native. The 'genus level' taxa risk is therefore 7/50 (14%). Notably, there are several species of barbs such as *Puntius vittatus* that are on the current Live Import List.

Summary	*Score*	*Rank*
Establishment Risk	9	Moderate

Conclusion

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

APPENDIX 1 – FAQ

ISSUE	REQUEST FOR INFORMATION	RESPONSE BY APPLICANT
A minimum size limit should be applied to the importation to reduce the chance of mistaken identity of juveniles with other similar looking fish species at the border	Please suggest and justify a suitable size limit to allow positive identification, with supporting evidence (Such as photos of fish at differing life stages – showing their similarities and differences to other similar fish).	This issue is outside of the terms of reference for the application. Under the current import conditions, fish specimens that cannot be identified as the species stated in import documentation (including health certification) are not released on inspection by DAWE. Size and sex limits have never been the responsibility of the applicant, but rather something that DAWE operations would usually handle. Over the years industry have worked with DAWE on mechanisms to ensure identification is easy, but size and sex should not impact an 'environmental' review as to whether the species can be added to the list. We will be happy to work with the relevant department when this species is approved on implementation of an appropriate size limit should it be deemed necessary. It is also noted that the fish species most likely to be confused with *S.denisonii* are already approved for live import into Australia.
This species on not on either the white or grey list, suggesting it could be from illegal imports, therefore on principle it should not be included on the Live Import list. To include it now, diminishes the intent of the list as it may be seen by others that you can get around the legalities by applying after the fact.		The Grey List is not and was never designed as a comprehensive list of all ornamental species that were present and traded in Australia. This is directly acknowledged in the 2006 report that published the grey list "A strategic approach to Ornamental fish management in Australia" (Appendix 2, Grey List, pg29). In any case regardless of how a species already present in Australia may have arrived in the past, does not (and should not) change or influence the process of a formal risk assessment when considering approval for addition to the allowable import list. There are some species on the grey list that were once allowable imports.
The applicant only presents an assessment of establishment		With respect to risks associated with pathogens/diseases that may be carried in imported ornamental fish,

likelihood, not biosecurity risk, as they have not considered the consequence to the environment, economy or socio-cultural values if this species were to establish.		a review of the scientific literature did not identify any hazards beyond those identified in the DEWA IRA (1999) and subsequent reviews (see TOR #8). These risks would be managed under the baseline import conditions that currently apply to all imported ornamental fish, which includes consideration of likely environmental, economic and social consequences of disease establishment, consistent with the Biosecurity Act (2015). Furthermore, it is our understanding based on DEWA advice that each species proposed for addition to the Live Import List is additionally reviewed by DEWA against its import risk analyses as part of the Live Import List approval process. If the intent of the stakeholder comment relates to the environmental, social and economic consequences of the fish species establishing in the wild in Australia, this is a core element of the TORs set out by DEWA and which the applicant has addressed (see TOR# 8), noting that there are no reports in the scientific literature of any ecological impacts as a result of the species establishing outside its natural range in other countries and that the absence of such reports is an indication of the benign nature of the species since scientific literature focuses almost exclusively on species that have some ecological impact. Additionally, SARDI risk assessments were also commissioned to provide even greater support of the above claims.
Many species in the aquarium industry often have very little in the scientific literature particularly on tolerances (etc) and much of the information is garnished from industry and hobbyist websites. Consequently, it must be assumed that		This is not a fair or reasonable assumption, however, it is reasonable to suggest aquarium industry and hobby literature have thoroughly explored the tolerances of species commonly kept and traded. It is unreasonable to exclude or deem invalid the wealth of specific industry and hobbyist knowledge of a given species simply because it didn't come from a scientific journal, particularly when

tolerances are likely to be greater than what is often just an ideal range.		such information is not available in scientific journals. Most importantly, any judgement in this regard must be based on a sound understanding of the drivers for scientific research. Scientific research is typically undertaken on species that are considered to be problematic. The species that have been submitted for consideration for adding to the permitted species list have been chosen on the basis that these are not considered ecologically problematic despite years of international trade. Thus, the harmless nature of these species is precisely and logically the reason they have not been the subject of scientific research.
This species in not allowed into our state or territory (e.g. NT) – it is not an allowable import. Allowing a species in and therefore making it more affordable is not a valid reason for listing.		This issue is outside of the terms of reference for the application and is not relevant. Philosophical objections to adding more species to the permitted import list are not valid and need to be disregarded in any assessment. It is further noted that the only mechanism for Industry to have the keeping of new species recognised in Jurisdictions such as NT, WAS & TAS is to have them listed as suitable for live import in the EPBC act.
Several members of Cyprinidae are highly invasive and established around the globe.	Please provide details including scientific references for diseases that are found in Cyprinidae species.	The purpose of the EPBC process and the associated Bomford assessment to ascertain the invasiveness of individual species. This process takes into account the number of recognised invasive species in broader taxa, which has been done for the species proposed for addition to the Permitted Species list. Furthermore, disease risk is assessed by Biosecurity Australia (BA), Independent of this process. The Import risk assessment for ornamental finfish (1999) adequately addresses these risks. Industry will continue to work with BA as required to ensure Australia maintains its appropriate level of protection.
This species may have been determined to have an establishment		The fact that 'moderate risk' species are already present on the current list of species suitable for allowable

risk greater than low (i.e. moderate). Whilst there may be other species of moderate risk on the list this should not set a precedent for inclusion.		import does indeed set the standard and expectation for what Australia views as appropriate in terms as an appropriate and acceptable level of risk. These include species that have gone through the formal EPBC ToRs and associated Bomford assessment process, including Bomford assessments undertaken by the Australian Government. Some of the existing species that are imported and traded that are deemed 'medium' have been imported with 100,000's and have posed no risk to the environment, and as such this history of NO establishment suggests they are of LOW risk.
Currently there are x number of fish on the Live Import List.	What evidence is there that one new species will have significant economic benefit or should be added?	This issue is outside of the terms of reference for the application and is not relevant. Philosophical objections to adding more species to the permitted import list are not valid and need to be disregarded in any assessment. This notwithstanding, it must be understood that fundamental to all hobbies of this nature, is the importance of variety and new species. It is this variety and availability of new species that sustains the ornamental fish hobby and the industries that support the hobby. Any new consumer item creates greater interest in those products, which is why the fashion industry is constantly releasing new colours in clothes and shoes. With a digital global economy, Australians are seeing new emerging international trends, which includes new varieties of fish as techniques allow species that had not been able to be bred, now available. Furthermore, it is good policy to permit the legal import of species that meet the required criteria addressed within the TOR. To reject them simply continues to provide an environment where smugglers are allowed to profit as they satisfy the consumer demand in these species in place of the legitimate industry.
Potential impact of this species, if it were to	Provide evidence of what would happen if	This matter is directly and clearly addressed in the Department's

establish a feral population in Australia	the fish become established in Australian waters.	TORs. There are no known diseases specific to this species that are exotic to Australia. The species is not reported to be invasive. In any case, this species is relatively benign, relatively small and similar in many respects to fish already deemed appropriate to be imported into Australia. The absence of information in formal scientific literature is not an adequate reason to suggest the species could be harmful in some respects. If there were problems with the species, then scientific studies would have been undertaken. Scientific research is typically undertaken on species that are considered to be problematic. The species that have been submitted for consideration for adding to the permitted species list have been chosen precisely because they are not considered ecologically problematic despite years of international trade. Additionally, SARDI risk assessments were also commissioned to provide even greater support of the above claims.

Torpedo barb

S. denisonii is IUCN listed (Endangered Category) and has a limited distribution. DPIRD is not satisfied there are robust checks and balances in place to ensure the species would not be sourced from the wild for import into Australia and would not support the addition of this species to the list.	Lyer (2016) outlines how trade in listed species (and specifically mentions wild harvest of torpedo barbs Sahyahadria spp.) can be counterproductive to protection and compromise conservation efforts due to increased harvesting. Please detail how you can assure that only captive bred fish will be imported and that listing would not impact the wild populations?	IUCN listed status does not prevent or preclude international trade in a species; while it should always be a consideration it is not in itself a justification to not support approval. It is not industry's intent to import or trade in wild caught *S. denisonni.* S. *denisonni* is commercially farmed in large numbers throughout Indonesia and Malaysia, more than capable of satisfying international aquarium trade demand. There is currently little to no wild harvest remaining in this species as it has become cost prohibitive when compared to aquaculture produced specimens (wild caught fish are 20 times more expensive than

		farmed fish). The importation of wild caught specimens would simply not be commercially viable. Furthermore, India from where the species originates is not an approved country to export of freshwater ornamental fish to Australia.
Given the species is listed on the International Union for Conservation of Nature's Red List of Threatened Species in the endangered category, how can the applicant ensure that importation of this species will not deplete wild stocks?		Given the species is listed on the International Union for Conservation of Nature's Red List of Threatened Species in the endangered category may present a concern, the applicant is willing to have discussions on the implementation of a captive only import conditions. Noting that no such certification process has been implemented to date for other freshwater species currently approved for live import.

Aquatic Biosecurity Pty Ltd

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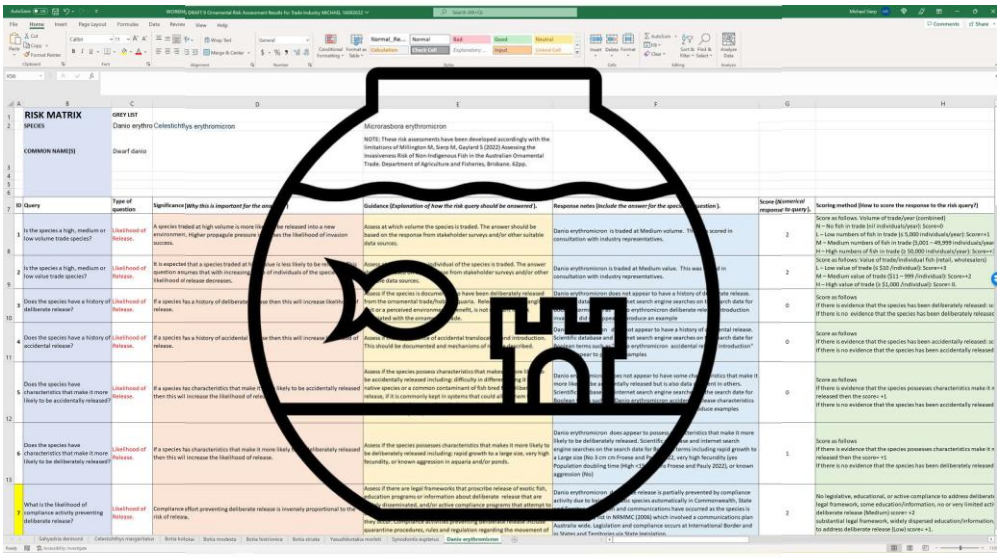
Client Reference : Aquarium Industry Association of Australia AIAA

Our Reference : R0590

Date : 09/09/2022

ASSESSMENT OF NINE ORNAMENTAL FISH RISK SPECIES USING THE SARDI METHOD FOR THE AIAA

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1. COPYRIGHT STATEMENT, PURPOSE, DISCLAIMER, STATUTE OF LIMITATIONS

1.1 COPYRIGHT

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1.2 PURPOSE

This Report is the introduction to nine ornamental fish risk assessments conducted in August 2022 with respect to Australian waters. The opinions expressed are given in good faith. This Report is issued without prejudice. In the opinion of the author the report constitutes a statement of the conditions at the time the work was carried out.

It is to be clearly understood that the condition/state of items hereafter reported upon are strictly the opinion of the undersigned and that opinion reflects the data found in August 2022 only, not exhaustively.

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This publication may be cited as:
Sierp M (2022) Assessing the Invasiveness Risk of Nine Non-Indigenous Fish in the Australian Ornamental Trade. Aquatic Biosecurity Pty Ltd

2. SUMMARY

This technical report illustrates the results of processing nine ornamental fish species using the SARDI method contained in the report Deveney, M. (2018) Assessing the risks associated with the Australian Trade in live ornamental fish species: development of a risk assessment tool. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2018/000280-1. SARDI Research Report Series No.991. 85pp.

The results are given in excel spreadsheets as an appendix with point scores and % data omissions.

Trade value and Trade volume data were provided by industry members.

The species progressed through the model included:

SCIENTIFIC NAME	COMMON NAME
Sahyadria denisonii	RED LINE TORPEDO BARB
Celestichthys marginatus	CELESTIAL PEARL DANIO
Botia kubotai	KUBOTAI LOACH
Botia modesta	REDTAIL LOACH
Botia histronica	HISTRONICA LOACH
Botia striata	BOTIA STRIATED LOACH
Yasushikotakia morleti	SKUNK LOACH
Synodontis eupterus	FEATHER FIN SYNODONTIS
Danio erythromicron	EMERALD TIGER RASBORA

The SARDI method results for these species appeared to be Low Risk noting some data was absent.

3. PROJECT DETAILS AND METHODS

Table 1. Background details

	Details
Principal	Dr Michael Sierp Relevant Qualifications: BSc.(Hons).PhD. MBA. Dip. Marine Surveying, CertIVOcc. Div. CertIII Transport and Logistics Master <24m

Dr Sierp is an experienced environmental scientist in the field of aquatic biosecurity, fresh and marine waters. He co-authored the report Millington M, Sierp M, Gaylard S (2022) Assessing the Invasiveness Risk of Non-Indigenous Fish in the Australian Ornamental Trade. Department of Agriculture and Fisheries, Brisbane. 62pp.

4. INTRODUCTION

Aquatic Biosecurity Pty Ltd was approached by the Aquarium Industry Association of Australia (AIAA) to process nine ornamental fish species through the SARDI risk assessment Deveney 2018. This was to be a complimentary study to Millington et al 2018 where 447 species were assessed.

Through the use of a series of scores based on the presence or absence of specific parameters that encompass different contributions to risk posed by each parameter, species are categorised as:

1. “high risk” (>150)
2. “moderate risk” (51 – 149)
3. “low risk” (<50)

4. METHODS

A series of reference websites were used in the collation of the data required which lead to individual papers and abstracts. This information was then added to the templates and scores given accordingly. The data was taken from but not limited to the following sources:

Table 1. Key websites and the type of information they typically provided that were used to complete the rapid risk assessments (from Millington et al 2022).

Website name	Habitat	Range	Biology	Reproduction	Parasites	Disease	Disturbance	Invasive records	Native family
Fishbase[1]	Y	Y	Y	Y	Y	Y			
Climatch[2]	Y								
Google scholar search engine[3]	Y	Y	Y	Y	Y	Y	Y	Y	
Centre for Agriculture and Bioscience International[4]			Y					Y	
Explore United States Geographical Survey Invasive Species Research[5]	Y	Y	Y	Y	Y	Y	Y	Y	Y
Food and Agricultural Organization[6]								Y	
Encyclopedia of Life[7]	Y		Y		Y				
Animal Diversity Web[8]			Y	Y					
Seriously Fish[9]			Y						
Native Fish Australia[10]									Y
Fishes of Australia[11]									Y
World Organisation for Animal Health[13]					Y	Y			
Victorian Fisheries Authority[14]					Y	Y			
Department of Health[15]					Y	Y			
The International Union for Conservation of Nature Red List of Threatened Species[17]	Y	Y	Y				Y		
Koppen-Geiger[18]	Y								
Planet Catfish[19]	Y	Y	Y	Y					
ProQuest Journal Access[21]	Y	Y	Y	Y	Y	Y	Y	Y	Y
Research Gate[22]	Y	Y	Y	Y	Y	Y	Y	Y	Y

The SARDI excel template was filled out sequentially for each species accordingly with Deveney 2018 and where data deficiencies existed they were noted.

Queries ID14, ID16, ID28 and ID32 were updated after seeking qualification from Dr M.Deveney (SARDI) in his email on 25/10/2022 and are indicated by **.

The excel templates are attached as an excel file appendix to this report.

5.0 RESULTS – APPENDIX A RISK ASSESSMENT CRITERA RESULTS

[SEE APPENDIX FOR TEMPLATES]

Table 2. Results

SCIENTIFIC NAME	COMMON NAME	Score	Category	Data Deficiency %
Sahyadria denisonii	Red line torpedo barb	0	Low	27.5
Celestichthys marginatus	Celestial pearl danio	0	Low	22.5
Botia kubotai	Kubotai loach	-162	Low	27.5
Botia modesta	Redtail loach	-200	Low	30
Botia histronica	Histronica loach	0	Low	30
Botia striata	Botia striated loach	0	Low	27.5
Yasushikotakia morleti	Skunk loach	0	Low	30
Synodontis eupterus	Feather fin synodontis	-70	Low	27.5
Danio erythromicron	Emerald tiger rasbora	-27	Low	22.5

The results are significantly lower fromV1 to V2 after qualifying ID 14,16,28 and 32 with Dr M.Deveney's new interpretation from 25/10/2022.

6.0 BIBLIOGRAPHY COMPLIMENTARY WITH THE BIBLIOGRAPHY FROM *MILLINGTON M, SIERP M & GAYLARD S (2022)*

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APPENDIX 2

RISK MATRIX **GREY LIST**

SPECIES Sahydria denisonii

NOTE: These risk assessments have been developed accordingly with the limitations of Millington M, Sierp M, Gaylard S (2022) Assessing the Invasiveness Risk of Non-Indigenous Fish in the Australian Ornamental Trade. Department of Agriculture and Fisheries, Brisbane. 62pp.

COMMON NAME(S) Redline Torpedo Barb

**Point score is taken from email M.Deveney Tue 25/10/2022 1:09 PM

ID	Query	Type of question	Significance (*Why this is important for the analysis?*)	Guidance (*Explanation of how the risk query should be answered*).	Response notes (*Include the answer for the species in question*).	Score (*Numerical response to query*).	Scoring method (How to score the response to the risk query?)	Max Score	Data deficient
1	Is the species a high, medium or low volume trade species?	Likelihood of Release.	A species traded at high volume is more likelyto be released into a new environment. Higher propagule pressure increases the likelihood of invasion success.	Assess at which volume the species is traded.The answer should be based on the response from stakeholder surveys and/or other suitable data sources.	Sahyadria denisonii is traded at Medium volume. This was scored in consultationwith industry representatives.	2	Score as follows. Volume of trade/year (combined)N – No fish in trade (nil individuals/year): Score=0L – Low numbers of fish in trade (≤ 5,000 individuals/year): Score=+1 M – Medium numbers of fish in trade (5,001 – 49,999 individuals/year): Score=+2 H – High numbers of fish in trade (≥ 50,000 individuals/year): Score=+3.	3	
2	Is the species a high, medium or low value trade species?	Likelihood of Release.	It is expected that a species traded at high value is less likely to be released. This question assumes that with increasing valueof individuals of the species the likelihood ofrelease decreases.	Assess at which value an individual of the species is traded. The answer should be basedon the response from stakeholder surveys and/or other suitable data sources.	Sahyadria denisonii is traded at Medium value. This was scored in consultation withindustry representatives.	2	Score as follows: Value of trade/individual fish (retail, wholesalers) L – Low value of trade (≤ $10 /individual): Score=+3M – Medium value of trade ($11 – 999 /individual): Score=+2 H – High value of trade (≥ $1,000 /individual): Score= 0.	3	
3	Does the species have a history of deliberate release?	Likelihood of Release.	If a species has a history of deliberate releasethen this will increase likelihood of release.	Assess if the species is documented to have been deliberately released from the ornamental trade/hobby/aquaria. Release for food or angling, bait or a perceived environmental benefit, is not relevant for risk associated withthe ornamental trade.	Sahyadria denisonii does not appear tohave a history of deliberate release. Scientific database and internet search engine searches on the search date for Boolean terms such as "Sahyadria denisoniideliberate release introduction invasion" didnot appear to produce examples	0	Score as follows If there is evidence that the species has been deliberately released: score= +1 If there is no evidence that the species has been deliberately released: score= 0.	1	
4	Does the species have a history of accidental release?	Likelihood of Release.	If a species has a history of accidental release then this will increase likelihood ofrelease.	Assess if there is evidence of accidental translocation and introduction. This should be documented and mechanisms of release described.	Sahyadria denisonii does not appear to have a history of accidental release through.Scientific database and internet search engine searches on the search date for Boolean terms such as "Sahyadria denisoniiaccidental release introduction" did not appear to produce examples	0	Score as follows If there is evidence that the species has been accidentally released: score= +1 If there is no evidence that the species has been accidentally released: score= 0.	1	
5	Does the species have characteristics that make it morelikely to be accidentally released?	Likelihood of Release.	If a species has characteristics that make itmore likely to be accidentally released then this will increase the likelihood of release.	Assess if the species possess characteristicsthat makes it more likely to be accidentally released including: difficulty in differentiating it from native species or a common contaminantof fish bred for deliberate release, if it is commonly kept in systems that could allow them to escape, and attachment and survival on equipment likely to be translocated to opensystems.	Sahyadria denisonii does not appear to havesome characteristics that make it more likelyto be accidentally released but is also data deficient in others. Scientific database and internet search engine searches on the search date for Boolean terms such as "Sahyadria denisonii accidental release characteristics resemble similar equipment systems survival" did not produce examples	0	Score as follows If there is evidence that the species possesses characteristics make it more likely to be accidentallyreleased then the score= +1 If there is no evidence that the species has been accidentally released then the score= 0.	1	1
6	Does the species have characteristics that make it morelikely to be deliberately released?	Likelihood of Release.	If a species has characteristics that make itmore likely to be deliberately released then this will increase the likelihood of release.	Assess if the species possesses characteristics that makes it more likely to be deliberately released including: rapid growth toa large size, very high fecundity, or known aggression in aquaria and/or ponds.	Sahyadria denisonii does appear to possess characteristics that make it more likely to be deliberately released. Scientific database and internet search engine searches on thesearch date for Boolean terms including rapid growth to a Large size (No 90-110mm (seriously fish) 15cm Froese and Pauly 2022), very high fecundity (No) Population doubling time (high <15months Froese and Pauly 2022), or known aggression (No, peaceful) https://www.seriouslyfish.com/species/Sahya dria-denisonii/	1	Score as follows If there is evidence that the species possesses characteristics make it more likely to be deliberatelyreleased then the score= +1 If there is no evidence that the species has been deliberately released then the score= 0.	1	

APPENDIX 2

ID	Query	Type of question	Significance (*Why this is important for the analysis?*)	Guidance (*Explanation of how the risk query should be answered*).	Response notes (*Include the answer for the species in question*).	Score (*Numerical response to query*).	Scoring method (How to score the response to the risk query?)	Max Score	Data deficient	
7	What is the likelihood of compliance activity preventing deliberate release?	Likelihood of Release.	Compliance effort preventing deliberate release is inversely proportional to the risk of release.	Assess if there are legal frameworks that proscribe release of exotic fish, education programs or information about deliberate release that are widely disseminated, and/or active compliance programs that attempt to detect deliberate releases when they occur or as soon as possible after they occur. Compliance activities preventing deliberate release include quarantine procedures, rules and regulation regarding the movement of fish.	Sahyadria denisonii deliberate release is partially prevented by compliance activity due to being an exotic species automatically in Commonwealth, State and Territory legislation and communications have occurred as the species is listed in the grey list in NRMMC (2006) which involved a communications plan Australia wide. Legislation and compliance occurs at International Border and in States and Territories via State legislation.	2	No legislative, educational, or active compliance to address deliberate release (High) score=+3 legal framework, some education/information, no or very limited active compliance to address deliberate release (Medium) score= +2 substantial legal framework, widely dispersed education/information, active compliance program to address deliberate release (Low) score= +1.	3		Fisheries Management and Biosecurity Act(s); NRMMC (2006) A STRATEGIC APPROACH TO THE MANAGEMENT OF ORNAMENTAL FISH IN AUSTRALIA. Department of Agriculture, Fisheries and Forestry. Accessed 15/7/2021 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.150.1666&rep=rep1&type=pdf 40pp; Release of Aquatic Organisms Policy
8	What is the likelihood of compliance activity preventing accidental release?	Likelihood of Release.	Compliance effort preventing accidental release is inversely proportional to the risk of release.	Assess if there are legal frameworks that proscribe activities that can inadvertently release exotic fish (controls on the location of fish farms and ponds, licensing or registration processes), education programs or information to aid in preventing accidental release that are widely disseminated, and/or active compliance programs that attempt to detect inadvertent releases when they occur or as soon as possible after they occur. Compliance activities preventing accidental release include improvement of identification expertise, public awareness.	Sahyadria denisonii accidental release is partially prevented by compliance activity due to being an exotic species automatically in Commonwealth, State and Territory legislation and communications have occurred as the species is listed in the grey list in NRMMC (2006) which involved a communications plan Australia wide. Legislation and compliance occurs at International Border and in States and Territories via State legislation	2	No legislative, educational, or active compliance to address accidental release (High) score=+3 legal framework, some education/information, no or very limited active compliance to address accidental release (Medium) score=+2 substantial legal framework, widely dispersed education/information, active compliance program to address accidental release (Low) score= +1.	3		Fisheries Management and Biosecurity Act(s); NRMMC (2006) A STRATEGIC APPROACH TO THE MANAGEMENT OF ORNAMENTAL FISH IN AUSTRALIA. Department of Agriculture, Fisheries and Forestry. Accessed 15/7/2021 http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.150.1666&rep=rep1&type=pdf 40pp
9	Is the species domesticated or reared in a way that makes it more or less likely to survive if released?	Likelihood of invasion.	Domestication has the potential to enhance fitness (in terms of growth rate, mating success and/or fecundity) in domesticated strains (including transgenic strains) over wild strains (e.g. Muir and Howard, 1999). Domestication or rearing in a way that makes it more likely to survive if released increases the likelihood of invasion.	Assess if the taxon has been selectively bred for traits of benefit to humans (domesticated) or subjected to other selection or genetic modification.	Sahyadria denisonii does appear to have a history of domestication, selective breeding and inherited negative or deleterious traits according to Sajan 2016. Scientific database and internet search engine searches on the search date for Boolean terms such as "Sahyadria denisonii domestication selective breeding genetic modification inherited negative deleterious" did appear to provide an example Sajan 2016	-1	Score as follows: If a species domesticated or reared in a way that makes it less likely to survive if released score= -1 If the species is not domesticated or reared in a way that makes it neither more nor less likely to survive if released score= 0 If a species is domesticated or reared in a way that makes it more likely to survive if released score= +1.	1		
10	Has the species established populations outside their native range?	Likelihood of invasion.	If a species has successfully established self-sustaining populations outside their native range then this will increase the likelihood of invasion.	Assess if there are records of established populations of the species in question outside their native range.	Sahyadria denisonii does not appear to have established invasive populations outside its native range according to Froese and Pauly 2022 and IUCN Redlist (Chaudry 2020)	0	Score as follows no invasive populations score= 0 species has established non-native population(s) with defined limited range score= 1 species has established numerous populations but is limited to one continent score= 3 species has become broadly invasive on two or more continents score= 5.	5		
11	Is species reproductive tolerance suited to climates in the risk assessment area?	Likelihood of invasion.	The likelihood of invasion increases as the number of climate zones in the species' native range matching with Australian climate zones increases.	Using Climatch http://data.daff.gov.au:8080/Climatch/climatch.jsp assess how the climate in the species' native range matches the climate zone in Australia.	Highest Climatch score = 2 Score = 0	0	Climatch score 0-4.9 score= 0 Climatch score 5-7.9 score= 3 Climatch score 8-10 score= 5.	5		
12	What is the quality of the climate match?	Likelihood of Invasion.	The likelihood of invasions rises as the quality of climate match data improves.	Using Koppen-Geiger climate types (http://koeppen-geiger.vu-wien.ac.at/present.htm), estimate of the quality of the data used to generate the climate match, and if specific climatic requirements are present in the species' native environment that do not occur in Australia.	Sahyadria denisonii area Aw, Am, BSh Australia has Af, Am, Aw, Bwh, Bsk, Bwk,Bsh Cfa, Cfb, Csa,Cwa, Csb Corresponding Australian area Aw, Am, BSh	-1	Match quality high or species climatically tolerant score= 0 some climatic differences present that decrease likelihood of establishment score= -1 climate match poor, specific climatic features occur in native range that are not present in receiving habitat score= -3.	0		

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ID	Query	Type of question	Significance (*Why this is important for the analysis?*)	Guidance (*Explanation of how the risk query should be answered*).	Response notes (*Include the answer for the species in question*).	Score (*Numerical response to query*).	Scoring method (How to score the response to the risk query?)	Max Score	Data deficient
13	Is the species environmentally versatile?	Likelihood of Invasion.	Environmental versatility is directly proportional to the species' likelihood of invasion.	Assess if the following traits apply: euryhaline, desiccation tolerant, takes wide range of food items, tolerates a wide range of water quality conditions, habitat variability, oxygen depletion tolerance and high temperature tolerance.	Scientific data base and internet search engine searches on the search for Boolean terms including : "euryhaline (No) omnivorous (Yes https://www.seriouslyfish.com/species/sahya dria-denisonii/) water quality tolerant (No) habitat variability (Yes) oxygen depletion tolerance (No) temperature tolerance (No) https://www.seriouslyfish.com/species/Sahya dria-denisonii/ Did not appear to find 3 examples	-1	If more than three traits apply score= +2If fewer than three traits score= -1.	2	1
14	Is the species' native range well defined?	Likelihood of Invasion.	If a species' native range is well defined thenthis increases the certainty that invasive records are accurate, and provides improvedcertainty of climate match.	Assess if the species' native range is uncertain. Uncertainty can be confirmed if thenative range is not well documented and/or unclear.	IUCN redlist and https://www.seriouslyfish.com/species/Sahya dria-denisonii/ list native range of this species. The species well defined though **	-1	If populations that have been categorised as invasiveare in the native range: Score= -3 If the native range is not well defined: Score= -1If the native range is well defined and/or invasive populations are known to be introduced score= +1.	1	1
15	Does the species have invasive relatives?	Likelihood of Invasion.	The status as a member of an invasive genusadds to the likelihood of invasion. Invasive history of a species and its congeners and confamilials is deemed to be a good predictorof invasiveness potential (Ruesink et al., 1995; Reichard 2001).	Assess if the species is related to invasive species.	Sahyadria denisonii is not listed on the Global Invasive Species Database (ISSG) itdoes appear to be a member of an invasivefamily Cyprinidae from a review of available literature	1	If the species is a member of an invasive Genus score= +3 If the species is a member of an invasive Family score= +1 If the species is not a member of an invasive genus orfamily score= 0.	3	1
16	Is the species likely to avoid predation?	Likelihood of Invasion.	Avoidance of predation increases the likelihood that an introduced species will survive, establish and breed.	Assess if the species has characteristics that are likely to decrease predation including if it is unpalatable to predators, spiny or armored, toxic to fish, unusually cryptic or burrowing or likely to inhabit in systems devoid of predators.	Sahyadria denisonii is reported as a ray finned fish by Froese and Pauly 2022 with spines ** (yes https://www.seriouslyfish.com/species/Sahya dria-denisonii/), unpalatable (?), armoured (no), toxic (No), unusually cryptic (Yes stripes) burrowing (no) and likely to inhabit in systems with predators (yes)	1	If the species is unpalatable to predators in the receiving environment score= 1 If the species is palatable to predators in the receiving environment or there are no predators in the receiving environment score= 0.	1	
17	Are predators absent from waters where the species is likely tobecome invasive?	Likelihood of Invasion.	If predators are absent then the likelihood of invasion is increased.	Assess if the species is suited to and likely to be introduced to environments with no natural predators.	Using climatch and the Koppen-Geiger climate types it does not appear that predators would not be present	0	If predators are likely to be absent in suitable environments score= +1 If predators are likely to be present in suitable environments score= 0.	1	
18	Does the species exhibit parental care, is it a livebearer or Caquetaia kraussii?	Likelihood of Invasion.	If a species expresses parental care, mouth-brooding and/or live-bearing behavior, this will increase its likelihood of successful establishment.	Assess if the species uses parental care, mouth-brooding and/or live-bearing. Parental care in fish includes the protection of the clutchafter spawning. Mouth-brooding fish hold eggsor newly hatched young in their mouths. Live- bearing fish bear live young rather than depositing eggs.	No evidence of mouthbrooding and parentalcare	0	If a species displays parental care, is a livebearer or mouth-brooder score= +1 If a species does not display parental care, is not a livebearer or mouth-brooder score= 0.	1	
19	Is the species known to reduce age-at-maturity in response to environment?	Likelihood of Invasion.	If the species displays decreased age-at- maturity in response to environmental stressors then this will increase the likelihoodof invasion.	Assess if the species can adapt its age-at-maturity in response to environmental pressures.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"age at maturity plasticity" did not appear to provide examples and is data deficient (Froese and Pauly 2022)	0	If the species is known to reduce age-at-maturity in response to environment score= +2 If the species does not reduce age-at-maturity in response to environment score= 0.	2	1
20	Is the species hermaphroditic?	Likelihood of Invasion.	Hermaphroditism is expected to facilitate successful establishment, thus the likelihood of invasion increases. Some fish that exhibit this characteristic are simultaneous hermaphrodites, which means that they can be both genders at the same time and are able to mate with any individual in their species if present. Other fish species are sequential hermaphrodites, which means thatthey can change sex once or even multiple times in their lifetime.	Assess if the species is hermaphroditic, reproduces asexually or is parthenogenesis:this occurs where both male and female reproductive organs are present in the sameindividual.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"hermaphroditic" and "hermaphrodite" did not appear to provide examples which suggest it is a hermaphrodite.	0	If the species is hermaphroditic score= +3; if the species is not hermaphroditic score= 0.	3	1

APPENDIX 2

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21	Is the species dependent on the presence of a specific habitat feature to complete its life cycle, and is this particular habitat feature present inthe areas susceptible to invasions?	Likelihood of Invasion.	The presence of a habitat feature required bythe species to complete its life cycle is expected to increase the species' likelihood ofinvasion.	Assess if the species requires a specific habitat feature to complete its life cycle. Some species require specific habitat features (e.g. fast- flowing water, particular species of plant or types of substrata) in order to reproduce successfully.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisoniibreeding habitat did present particular examples of slow oxygen rich creeks and streams https://www.seriouslyfish.com/species/Sahya dria-denisonii/	1	If the species is dependent on the presence of specifichabitat features to establish, and this particular habitat feature is present in the areas susceptible to invasionsscore= +1 If the species is dependent on the presence of habitat features to complete its life cycle, and this particular habitat feature is not present in the areas susceptible toinvasions score= -1 If the species is not dependent on the presence of a specific habitat features to complete its life cycle score=0.	1	
22	Does the species have reproductive characteristics other than parental care thatincrease its likelihood of beinginvasive?	Likelihood of Invasion.	If a species possesses such reproductivetraits then this will increase its likelihood ofinvasion.	Assess if the species has reproductive characteristics that increase its likelihood ofbeing invasive including high fecundity (>10,000 eggs/kg), batch spawning, serial (multiple) spawning, extended spawning, embryos that can resist environmental extremes or enter diapause.	Scientific database and internet search engine searches on the search date for Boolean terms including high fecundity (Resilience is <15 months), (Froese and Pauly 2022) batch spawning (Yeso), extended spawning (?), embryos that can resist environmental extremes or enter diapause" did not provide examples.	1	If the species has reproductive characteristics that increase its likelihood of being invasive score= +1 If the species has no reproductive characteristics that increase its likelihood of being invasive: score= -1.	1	
23	Is the species' generation time facilitative of invasions?	Likelihood of Invasion.	Generation time is directly proportional to the species' likelihood of invasion.	Assess the species' average time from hatching to maturity in years.	Sahyadria denisonii's minimum population doubling time is <15 months	1	Minimum population doubling time <1.4 years score= +11.4-4.4 years score= 0 ≥4.4 years score= -1.	1	1
24	Does the species tolerate or benefit from environmental disturbance?	Likelihood of Invasion.	If the species tolerates or benefits from environmental disturbance then the likelihoodof establishment is increased.	Assess if there is evidence that the species benefits from temporary changes in the average environmental conditions or unusualevents, particularly human impacts.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"habitat disturbance environmental disturbance" did not appear to provide an example to support this	-1	If the species tolerates or benefits from environmental disturbance score= +1 If the species does not tolerate or benefit from environmental disturbance score= -1.	1	1
25	Where the species occurs outside its nativerange are there impacts on wild aquatic species?	Consequence.	History of impacts on wild aquatic species outside its native range is expected to increase the probable consequence (furtherimpact).	Assess if there is evidence of impacts on wild aquatic species such as the decline, endangerment or extinction of native species, including correlational evidence.	Scientific database and internet search engine searches for Boolean terms includingSahyadria denisonii "introduction species impacts" did not appear to find examples ofinvasion. Any invasion will impact on an ecosystem through predation or competition.	0	No impacts on wild aquatic species recorded score= 0 Species has had impacts on wild aquatic species outside its native range but this impact is found over alimited range score = +1 Species has had impacts on wild aquatic species outside its native range in more than one natural ecosystem on one continent score= +3 Species has had impacts on wild aquatic species outside its native range on two or more continents score= +5.	5	
26	Where the species occurs outside its native range are there impacts on farmedaquatic species?	Consequence.	History of impacts on farmed aquatic species outside its native range is expected to increase the probable consequence (further impact).	Assess if there is evidence of impacts on farmed species such as costs from control ofthe species or productivity losses.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"introduction aquaculture impacts" did not appear to provide examples to support this.	0	No impacts on farmed aquatic species score= 0 Species has impacts on farmed aquatic species outsideits native range but this impact is found in a natural ecosystem with limited range score= +1 Species has had impacts on farmed aquatic species outside its native range in more than one natural ecosystem on one continent score= +3 Species has had impacts on farmed aquatic species outside its native range on two or more continents score= +5.	5	
27	In the species' non native range is there evidence that the species has altered the structure or function of a natural ecosystem?	Consequence.	If the species in question has altered the structure or function of a natural ecosystemthen this increases the probable consequence.	Is there evidence that the species has caused changes in the structure or function of a natural ecosystem in its invasive range.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"introduction ecosystem engineer" did not appear to provide examples to support this.	0	No evidence of structural change score= 0 Species has altered the structure or function of a natural ecosystem in a limited range score= +1; specieshas altered the structure or function of more than one natural ecosystem in one continent score= +3 Species has altered the structure or function of natural ecosystems in two or more continents score= +5.	5	

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28	Does establishment of the species posea risk to human health?	Consequence.	If a species is known to cause harm to humans, e.g. poison, venom this will increasethe probable consequence.	Assess if the species is harmful to humans including poisonous, venomous, or traumatogenic.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"harmful harmless threat" did not appear to provide examples to support this. Froese and Pauly 2022 suggest harmless **	0	If the species is known to pose a risk to human health score= +2 If the species does not pose a risk to human health score= 0.	2	
29	Where established outside its native range does the species out compete native species?	Consequence.	If a species has a record of outcompeting native species where it has established outside its native range then this will increasethe probable consequence.	Assess if there is evidence where the specieshas established outside its native range if interactions occur that which decrease the fitness of native species.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"range extension outcompete" did not appear to provide examples	0	If the species out competes native species where it has established outside its native range score= +1 If the species does not out compete native specieswhere it has established outside its native range: Score= 0.	1	
30	Is the species parasitic or micro predatory?	Consequence.	Invasions of parasitic fish have a history of high consequence, particularly where those species were not present prior to the invasion.	Assess if the species is a parasite which is obligately or facultatively dependent on a non-mutual relationship with another species, or whether the species is a micropredator, consuming parts of other species without killingthem, and if suitable hosts or prey are availablein the receiving environment.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"parasitic micropredatory" did not appear to provide examples to support this.	0	If the species is parasitic and suitable hosts are presentscore= +1; if the species is not parasitic or no hosts arepresent score= 0.	1	
31	Does the species prey on a native species, particularly those previously subjected to low (or no) predation?	Consequence.	Invaders that feed on native species with poor resilience to predation is expected to result in an increase of the probable consequence.	Assess if the species is likely to prey on native species and if the species is likely to establish in hydrosystems normally devoid of predatory fish (generally remote systems with low speciesrichness).	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"predator native species" did not appear to provide examples but it is primarily a omnivore feedin on worms, insects, crustaceans, plant material, and other organic debris. https://www.seriouslyfish.com/species/Sahya dria-denisonii	0	If the species has a history of preying on native species score= +1 If the species has no history of preying on native species score= 0.	1	
32	Does the species host, and/or is it a vector, for recognised pests and pathogens, especially non-native?	Consequence.	If a species is the host, and/or a vector, for recognised pests and pathogens, especially non-native ones, this will increase the risk for consequence.	Assess if the species is a recorded host of serious with non-native pathogens and parasites, with the host either being the originalintroduction vector of the disease or as a hostof the disease brought in by another species.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii "pathogens parasites pests disease" did notappear to provide specific examples. Biotidsare susceptible to itchthyophthirius multifiliis and skinny disease https://www.seriouslyfish.com/species/Sahya dria-denisonii **	1	Species is not described as carrying a disease/pathogen score= 0 Species hosts a pathogen/parasite of low significance or which is not recorded as causing disease score=+1Species hosts a disease of moderate significance butwhich is not notifiable score= +2 Species hosts a notifiable and/or environmentallysignificant disease score= +3.	3	1
33	Does the species feed on a broad range of diet items?	Consequence.	If a species feeds on a broad range of diet items, the probable consequence is increased.	Assess if the species feeds on a wide range ofboth plant and animal taxa. Assess if the species is an opportunistic, general feeder thatis not specifically adapted to consuming eitheranimal or plant material.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"diet" did provide the example from https://www.seriouslyfish.com/species/Sahya dria-denisonii/ that the species is omnivorous and will accept a varied diet primarily a omnivore feedin on worms, insects, crustaceans, plant material, and other organic debris. https://www.seriouslyfish.com/species/Sahya dria-denisonii	2	Species is known to feed on a broad range of diet items score= +2 Species is not known to feed on a broad range of dietitems score= 0.	2	
34	Can the species hybridize naturally with native species?	Consequence.	Interspecific hybridization with native speciesunder natural conditions increases the probable consequence.	Asses if interspecific hybridization with nativespecies in the area likely to be invaded is recorded under natural conditions.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"hybridization" does not appear to provide anexamples	0	Species is known to hybridize naturally with speciesnative to the recipient area score= +2 No data of hybridization but native species in sameFamily present score=1 Species is known not to hybridize with native species,or there are no native species in the same family: score= 0.	2	1

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35	Does the species generally inhabit environments that are facilitative of dispersal?	Consequence.	If the species prefers environments that are facilitative of dispersal the probable consequence is increased.	Assess if the species generally inhabits environments where natural dispersal of eggsor larvae will occur (fluvial) , or if the speciesprefers environments that are closed water bodies (lacustrine) where natural dispersal isless likely.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii" dispersal" does appear to provide examples as it is found in fast flowing hill streams and rocky pools with thick riparian vegetation (Froese and Pauly 2022)	1	If the environment in which the species is likely to establish is facilitative of species dispersal score= +1 If the receiving environment is not facilitative of species dispersal score= 0.	1	
36	Is the species migratory?	Consequence.	If there is evidence of migratory behavior thiswill increase the probable consequence.	Assess if the species move from one region orhabitat to another according to the seasons.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"migratory " did not appear to provide examples to support this https://www.seriouslyfish.com/species/Sahya dria-denisonii	0	If the species is migratory: Score=+1 If the species is not migratory: Score=0.	1	1
37	Is the species susceptible to control measures?	Consequence.	Susceptible to control measures is inversely proportional to the species' probable consequence.	Assess if there the species is documented tobe resistant to control agents including piscicides or if there are no control options available.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"control measures eradication pest" does notappear to provide examples including	0	If the species is susceptible to control measures (canbe eradicated) score=0 If the species possess some resistance to control measures (can be controlled with additional or particulareffort) score= +1 If the species possess high resistance to control measures (very difficult to control or can not be controlled) score= +3.	3	
38	Is there a history of economic loss caused by the fish species within its invasive range?	Consequence.	History of economic loss increases the probable consequence.	Assess if the species has caused economic impacts including reduced productivity, costs ofmitigation, remediation and eradication, research costs, reduced earnings, impacts to export markets, banning of sale of commercially popular species, interruption of commercial aquatic activities, increased requirements for biosecurity/management in aquaculture or irrigation or decreased quality of commercially valuable water.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"economic loss" does not appear to provideexamples to support this	0	No history of economic loss score= 0 Some economic loss over limited geographic range score= +1 Substantial economic loss on one continent score= +2 Substantial economic loss on more than one continent score= +5.	5	
39	Are there any icon species, high value environmental assets, or other environmentally significant values in Australia placedat risk by the establishment of this species?	Consequence.	If the species places any icon species, high value environmental assets, or other environmentally significant values in Australiaat risk will increase the probable consequence.	Assess if there are native species which havepublic appeal, promotional and publicity value, or which have been used to harness conservation for that species and other taxa that may be affected by establishment of the species. Assess if the species has a history of impacts that could affect these icon species. Impacts include predation, competition, reduced habitat quality, genetic effects such ashybridization or introgression, introduction of parasites or pathogens, changes in disturbance regimes, resource pools and supply rates, predation etc. Icon species, highvalue asset include for example threatened species, habitats or ecosystem types that are likely to be exposed to the pest species duringthe invasion process.	Scientific database and internet search engine searches on the search date for Boolean terms including Sahyadria denisonii"environmental loss" does not appear to provide examples to support this.	0	Impacts on icon species, high value environmental assets, or other environmentally significant values inAustralia unlikely score= 0 Some impact on icon species, high value environmentalassets, or other environmentally significant values in Australia likely score= +2 Substantial impacts on icon species, high value environmental assets, or other environmentally significant values in Australia likely score= +5.	5	
40	Are there any socially significant assets or amenities (not related to human health) threatenedby the establishment of this species?	Consequence.	If the species threatens any socially significant assets or amenities (not related tohuman health) in Australia this will increase the probable consequence of invasion.	Assess if the species has a history of impactsthat affect the way humans use the invaded environment, with particular relevance to industry, notable environmental features or lifestyle that have social value.	Scientific database and internet search engine searches on the search date for Boolean terms including Botia sp."social loss" does not appear to provide examplesto support this	0	Impacts on socially significant assets or amenities (notrelated to human health) in Australia unlikely score= 0 Direct or indirect impacts on socially significant assetsor amenities (not related to human health) in Australialikely score= +2 Substantial impacts on socially significant assets or amenities (not related to human health) in Australialikely score= +4.	4	

Likelihood of:	*Raw score*	*Raw max*	*Score*	*Deficiency%*
Release	**9**	**16**	**6**	**27.50**
Invasion	**0**	**29**	**0**	
Consequence	**4**	**46**	**1**	
Total	**0**	**21344**	**0**	

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