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***Sewellia lineolata*:** 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)



October 2022 (Updated May 2023)

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 hill stream loach (*Sewellia lineolata*) indicates the risk of allowing the importation of the species would pose minimal biosecurity risk to Australia. The species has not been reported as having established in the wild outside its natural range despite being traded internationally for over 20 years.

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 largely because not considered invasive or otherwise ecologically harmful, nor associated with diseases exotic to Australia. It is a relatively small, benign species similar in many respects to fish already deemed appropriate to be imported into Australia.

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

A structured risk assessment based on the methodology of Bomford (2008) estimated a 'low' risk, *S. lineolata* also received a SARDI method 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. *S. lineolata* should be considered a lower risk than many if not most of the species currently permitted live importation to Australia. It is recommended that *S. lineolata* is added to the Live Import List.

DAWE terms of reference

1. Provide information on the taxonomy of the species.

- *Sewellia lineolata* (Valenciennes 1846).
- Actinopterygii (ray-finned fishes), Cypriniformes (Carp), Gastromyzontidae (suckers or hillstream loaches).
- *Synonyms*: *Balitora lineolata* Valenciennes 1846; *Sewellia songboensis* Nguyen and Nguyen 2005.
- *Common names*: Hill stream loach, Tiger hill stream loach, Reticulated hill stream loach, Gold Ring Butterfly Sucker.

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.

- *Sewellia lineolata* is not CITES listed.
- The species is listed on the IUCN Red List as Vulnerable because it has a limited distribution and experienced population declines in the early 2000s (Huckstorf and Freyhof 2011), although, Fishbase, considered less accurate than the more current IUCN analysis, suggests a broader distribution.
- *S. lineolata* is found in central Vietnam in rivers that feed into the Mekong (Huckstorf and Freyhof 2011), in Thua Thien-Hue Province (Huong river drainage), Quang Nam Province (Thu Bon river), Quang Ngai Province (Tra Khuc and Ve rivers) and Binh Dinh Province (An Lao river) (Seriously Fish n.d.).
- The species is readily spawned in aquaria and is not hard to raise. Most commercially traded fish are farm produced (Tankarium n.d.).

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. lineolata* 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 (Aqua-Fish.Net n.d., Seriously Fish n.d., Tank Facts n.d. and Tankarium n.d.).

- *Lifespan of the species*: 8-10 years in aquaria if maintained properly (Tankarium n.d.).
- *Size and weight range*: The fish grow to a maximum of 55-65 mm length (Seriously Fish n.d.).

- *Natural geographic range*: The IUCN reports *S. lineolata* range to be is found in central Vietnam, although, Fishbase, considered less accurate and current than the IUCN analysis, suggests a broader distribution.
- *Habitat*: Habitat requirements are well documented. The species requires cooler waters than many tropical fish (20-24°C, pH 6.5-7.5, water hardness 71.43-178.57ppm), and may die if water temperatures are consistently above 24°C (Tankarium n.d.). It inhabits fast moving waters in mountain streams and requires highly oxygenated water (Theone 2008a).
- *Diet, including potential to feed on agricultural plants*: Observed to be active during daytime searching in the periphyton on both horizontal and vertical surfaces of stones probably searching for aquatic invertebrates (Freyhof and Serov 2000). Aquarium websites all identify the species as a benthic scraping feeder, requiring algae and build-up of biofilm to survive well in aquaria, with no indication of feeding on significant terrestrial plant material (Seriously Fish n.d., Tankarium n.d., Theone 2008a)
- *Social behaviour and groupings*: In the wild fish are in small groups (4-7) amongst the rocks and on flat bare rock surfaces in mountain streams (Theone 2008a, Theone 2008b). In aquaria they are very peaceful and perform better in small groups and there may be a hierarchy within groups (Tank Facts n.d.).
- *Territorial and aggressive behaviours*: None recorded. There may be some interaction within the species (Seriously Fish n.d) but the species is generally regarded as peaceful.
- *Natural predators*: Not reported but piscivorous birds, mammals or fish in their habitat would likely prey on them.
- *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. FishBase reports the species as harmless to humans (Froese and Pauly n.d.—a).

3. Provide information on the reproductive biology of the species.

The reproductive biology of *S. lineolata* is fairly well understood.

- *Age at maturity (first breeding)*: Approximately 2 years ([REDACTED])
- *How frequently breeding occurs*: Seasonal in the wild although can breed multiple times a year in a good season, 2 to 3 times per year in captivity ([REDACTED])
- *Can the female store sperm*: No. External fertilisation; broadcast spawners.
- *How many eggs or live-born young are produced at each breeding event*: Adhesive egg layer, smaller batch sizes of between 20-50 eggs per spawn ([REDACTED]).

- *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:* Hybridisation has not been reported in this species.
 - *If the species can hybridise, are the progeny fertile:* N/A.
4. *Provide information on whether this species has established feral populations, and if so, where those populations are. Include information on whether this species has been introduced to other countries, even if it has not established feral populations.*

The species has not been reported as having established feral population outside of their natural geographic distribution (Froese and Pauly n.d.—a), despite being traded internationally for the aquarium trade for over 20 years. The species is unlikely to breed and form self-sustaining populations outside its optimal water temperature range of 20-24°C and highly oxygenated, fast flowing hillstream habitat.

5. *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 identified a recent risk assessment of the species by Millington M, Sierp M, Gaylard S (2022). This assessment used 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 pest vertebrate and invertebrate working group, as a suitable method to determine risk associated with the trade of ornamental fish already in Australia. *S. lineolata* received a SARDI risk score of 0 (page 20) 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.

The species is not on the BRS 'grey list' of likely high biosecurity risk ornamental fish species, i.e. non-native species that are present in Australia through historical imports that are not on the Live Import List, noting, the grey list is not extensive and does not cover all ornamental species that are historically present in Australia. It is also not 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, albeit in small numbers (). 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. It is further noted that the species has been present in Australia for at least 20 years (Jared Patrick, Premier Pet).

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

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

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

Importantly, most of the information available about this species is from the ornamental fish hobby literature; there is little information in the scientific literature, especially as it relates to establishment risks.

The absence of such reports 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.

- *Propagule pressure—the release of large numbers of animals at different times and places enhances the chance of successful establishment: S. lineolata* is not a schooling species which means that it might be less likely to establish than schooling species. As the species lives in mountain, tropical flowing streams on a rocky substrate there would be perennial streams in the mountains of the wet tropics in Queensland potentially suitable for establishment ([REDACTED]

[REDACTED]). It is unlikely therefore that enough fish would be released into a suitable receiving environment to establish a breeding population as a result of an accident or being deliberately released into the local waterways in or near populated areas. It is unlikely therefore that enough fish would be released into a suitable receiving environment to establish a breeding population as a result of an accident or being deliberately released into the local waterways in or near populated areas. 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. lineolata* 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 (v2.0) was run with the source region set to circumscribe areas in drainages in central Viet Nam: Huong River (Thua Thien Hue Province), Thu Bon River (Quang Nam Da Nang Province), Trac Khuc River and Ve River (Quang Ngai Province) and An Lao River (Binh Dinh Province) and some streams in between (Freyhof and Serov 2000, Serov et al. 2006). A climate match prediction was generated using the Euclidian algorithm applied to the 'world stations' data set. Climatch calculated a 'value 5' (Climate Euclidian Sum Level 5) of 1258, equating to a climate match score of 4 using recalibrated 'value 5' ranges for Climatch v2.0 provided by ABARES¹. DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements.
- *History of establishment elsewhere—previous successful establishment:* There are no reports on FishBase of introductions or establishment of this species outside its known natural range (Froese and Pauly n.d.—a). The species is unlikely to breed and form self-sustaining populations so far outside its optimal water temperature range of 20-24°C. The absence of established populations outside its natural range is despite being actively traded internationally as an aquarium species for many years is likely due to its specialist habitat requirements ([REDACTED]).
- *Overseas range: The species is endemic to central Vietnam.* The range described by (Huckstorf and Freyhof 2011) was used to determine a total overseas range of approximately 3, 1° latitude x 1° longitude grid squares for purposes of the Bomford (2008) assessment.
- *Introduction success:* The species is not known to have established outside its native range. However, it can be assumed that the species has been released into non-native areas on many occasions over the 30 plus years of trade worldwide as an

¹ Recalibrated Climatch v2 'value 5' ranges corresponding to climate match scores 1-8: 1(0), 2 (1-276), 3(277-1036), 4(1037-2763), 5(2764-6907), 6(6908-10361), 7(10362-17268), 8 (>17268)

aquarium species. The introduction success rate is conservatively considered to be less than 0.25 (Bomford 2008).

- *Taxonomic group—belonging to a family or genus which has a high establishment success rate:* *S. lineolata* belongs to the family Gastromyzontidae (hill stream loaches). FishBase recognises 13 species of *Sewellia* (Froese and Pauly n.d.—b). Of these, none have been reported in the wild outside their natural range and only one (*S. lineolata*) is listed as being traded commercially as an aquarium species. If the Bomford (2008) methodology is applied to the genus *Sewellia*, then of a total 14 species, one is traded as ornamental species and none have been reported outside the countries to which they are native. As internationally traded aquarium species, it is reasonable to assume that there would have been many past instances (perhaps in the hundreds) of inadvertent or deliberate introduction of these three species around the world over the many decades that they have been traded – 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 are assumed for the purposes of this risk assessment. (If a much smaller number of release events are deemed to have occurred world over during the last many decades of international trade, this would mean that release events are very rare and that the overall risk is commensurately minute.). The ‘genus level’ taxa risk is therefore 0/50 (0%).

Notably, loaches are on the current list of specimens taken to be suitable for live import and have been imported to Australia for over 40 years without wild populations being established.

- *Ability to find food sources:* As a benthic grazer and biofilm feeder, 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):* Temperature range is 20-24°C, pH 6.0-7.5 and hardness 71-178 ppm (Aqua-Fish.Net n.d.) The species has a narrow range and requirement for well oxygenated, fast flowing water, so would not be expected to survive outside of its stated requirements.
- *Ability to find shelter:* As a stream dwelling tropical fish with an affinity for flowing streams, there would be limited habitat in the type of rivers having the required temperature range in Australia.
- *Rate of reproducing:* Females mature at about 2 years, breeding seasonally in the wild (2-3 times a year in captivity) and producing 20-50 eggs per spawn ([REDACTED]).
- *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. lineolata* 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 three decades and because

there are few areas in Australia expected to have habitat suitable for the species to establish.

7. *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, its specialised feeding habits mean it would be unlikely to compete with native fish species. Mountain streams with suitable temperatures are habitats for few fish species in Australia, and none of these live at the bottom of streams with strong currents. No competition would be expected with mid-water or surface feeding fish. 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 by DAWE for importation of ornamental fish to Australia. No specific diseases have been associated with *Sewellia lineolata*.
- *Probable prey/food sources, including agricultural crops:* *S. lineolata* feeds on biofilm. It does not feed on any agricultural crops.
- *Habitat and local environmental conditions:* *S. lineolata* has not been reported to change its environment or habitat. It is a stream dwelling fish with an affinity towards a narrow temperature range.
- *Control/eradication programs that could be applied in Australia if the species was released or escaped:* Potential controls measures include listing as a noxious species; eradication or containment programs (including movement controls) or broader education/awareness building campaigns such as labelling aquarium fish bags with messaging.
- *Characteristic or behaviour of the species which may cause land degradation i.e. soil erosion from hooves, digging:* There are no reports of this species exhibiting any behaviours that may cause habitat degradation.
- *Potential threat to humans:* The species is not reported as posing any threat to humans (Froese and Pauly n.d.—a).

Using the SARDI method, specifically risk queries 25 to 40, show little to no consequences of invasion should *S. lineolata* establish feral populations in Australia (Millington M, Sierp M, Gaylard S 2022). The SARDI risk assessment included a thorough review of all available literature showed that *S. lineolata* has no recorded impacts on any wild or farmed aquatic species outside its natural range. It is not a parasitic species, nor is there any novel or notifiable diseases in the literature. It is not a

migratory species, causes no harm to humans and has no records 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. (Millington M, Sierp M, Gaylard S 2022).

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

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

9. *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 creating employment and contributing to the economy of all states and Territories, it has become especially important during the CoViD pandemic where individuals subject to movement restrictions are turning increasingly to the hobby for recreation – the hobby therefore plays a significant part in helping alleviate the stressors associated with the pandemic and post-CoViD recovery, both from economic and social perspectives.

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

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

- *Potential trade in the species:* The species is routinely traded internationally and would be a welcome addition to the species permitted importation. In the order of 50,000 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 *Sewellia lineolata* would represent about one percent of this (Jared Patrick, Premier Pet, pers. com.).

- *Why this species has been chosen:* Internationally, the species is in high demand by hobbyists. New loach species would be popular in Australia, adding variety to the species available to Australian hobbyists. This species particularly attractively patterned, peaceful and relatively small making it an ideal aquarium fish.

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

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

- *The containment (e.g. cage, enclosure) and management standards for this species to prevent escape or release. This should also talk about the security standards for this specimen:* The fish will be transported as per the International Air Transport Association (IATA) guidelines and the provisions of the *BICON Import Conditions for Freshwater Aquarium Fish: Effective 18 July 2020* (DAWE 2020b)
- *The disposal options for surplus specimens:* Fish will be imported for purposes of supplying the aquarium fish trade and as such no surplus specimens are expected. In the event of mortality, animals will be disposed as per the provisions of the *BICON Import Conditions for Freshwater Aquarium Fish: Effective 18 July 2020* (DAWE 2020b) and in accordance with the Pet Industry Association of Australia (PIAA) National Code of Practice (PIAA 2008).

11. 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 (related species are).
- *Pest or noxious status:* The species is not listed 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.

REFERENCES

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

Aqua-Fish.Net (n.d.) "Tiger hillstream loach - *Sewellia lineolata*" [online] Available at: <https://en.aqua-fish.net/fish/tiger-hillstream-loach> [Accessed 1 November 2021]

Bomford M (2008) Risk assessment models for the establishment of exotic vertebrates in Australia and New Zealand: validating and refining risk assessment models. Invasive Animals Cooperative Research Centre, Canberra. Available online: https://pestsmart.org.au/wp-content/uploads/sites/3/2020/06/Risk_Assess_Models_2008_FINAL.pdf [Downloaded 1 November 2020]

Corfield J, Diggles B, Jubb C, McDowall RM, Moore A, Richards A and Rowe DK (2008) Review of the impacts of introduced ornamental fish species that have established wild populations in Australia'. Prepared for the Australian Government Department of the Environment, Water, Heritage and the Arts. [<https://www.environment.gov.au/system/files/resources/fb1584f5-1d57-4b3c-9a0f-b1d5beff76a4/files/ornamental-fish.pdf>]

DAWE (2020a) Risk Assessment to add *Kryptopterus vitreolus* to, and remove *Kryptopterus bicirrhis* from, the Environment Protection and Biodiversity Conservation Act 1999 List of Specimens taken to be Suitable for Live Import August 2020. Department of Agriculture, Water and the Environment. [online] <https://environment.gov.au/system/files/consultations/1b591465-8486-450a-b12f-2f824fd925ca/files/glass-catfish-risk-assessment.pdf> [Accessed 1 November 2020].

DAWE (2020b) Import conditions for freshwater aquarium fish: Effective 18 July 2020. Department of Agriculture, Water and the Environment. Available at: <https://bicon.agriculture.gov.au/BiconWeb4.0/ImportConditions/Conditions?EvaluableElementId=482052&Path=UNDEFINED&UserContext=External&EvaluationStateId=7f1ea5c5-8bef-4b34-a789-2987549620ff&CaseElementPk=1354044&EvaluationPhase=ImportDefinition&HasAlerts=False&HasChangeNotices=False&IsAEP=False> Accessed 12 October 2020.

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

DOA (2014) Importation of freshwater ornamental fish: review of biosecurity risks associated with gourami iridovirus and related viruses—Final import risk analysis report, Department of Agriculture, Canberra. Available online: https://www.agriculture.gov.au/sites/default/files/style%20library/images/daff/___data/assets/pdf_file/0004/2404309/gourami-ira.pdf [Downloaded 1 November 2020]

Freyhof J and Serov DV (2000) Review of the genus *Sewellia* with description of two new species from Vietnam (Cypriniformes: Balitoridae). *Ichthyol. Explor. Freshwat.* 11(3):217-240

Froese R and Pauly D Editors (n.d.—a) “*Sewellia lineolata*” [online] Available at: <https://www.fishbase.se/summary/Sewellia-lineolata.html> [Accessed 2 October 2021]

Froese R and Pauly D Editors (n.d.—b) “Fish Identification: Find Species” [online] <https://www.fishbase.se/identification/SpeciesList.php?genus=Sewellia> [Accessed 2 Oct 2021]

Huckstorf V and Freyhof J (2011) *Sewellia lineolata*. *The IUCN Red List of Threatened Species* 2011: e.T188088A8641242. <https://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T188088A8641242.en> [Downloaded on 02 October 2021]

Kahn SA, Wilson DW, Perera RP, Hayder H and Gerritty SE (1999). *Import Risk Analysis on Live Ornamental Finfish*. Canberra: Australian Quarantine and Inspection Service. 187 pages. Available online: <https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/ba/animal/horsesubmissions/finalornamental.pdf> [Downloaded 1 November 2020]

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.

PIAA (2008) Pet Industry Association of Australia (PIAA) National Code of Practice (PIAA 2008) [online] Available at: <http://piaa.net.au/wp-content/uploads/2015/03/PIAA-CodeofPractice.pdf> [Accessed 12 October 2020].

Seriously Fish (n.d.) “*Sewellia lineolata*” [online] Available at: <https://www.seriouslyfish.com/species/sewellia-lineolata/> [Accessed 1 November 2021]

Serov DV, Nezdolij VK and Pavlov DS (2006) *The Freshwater Fishes of Central Vietnam*. KMK Scientific Press, Moscow and Nha Trang, 363 pp.

Tank Facts (n.d.) “Tank Facts” [online] Available at: https://www.tankfacts.com/fish/freshwater/loaches/reticulated-hillstream-loach_436 [Accessed 1 November 2021]

Tankarium (n.d.) “Reticulated Hillstream Loach (*Sewellia Lineolata*) – Care Guide” [online] Available at: <https://www.tankarium.com/hillstream-loach/> [Accessed 1 November 2021]

Thoene M (2008a) “*Sewellia Lineolata*” [online] Available at: <https://www.loaches.com/species-index/sewellia-lineolata> [Accessed 1 November 2021]

Thoene M (2008b) “*Sewellia lineolata* - Natural habitat and How They Get To Our Aquariums” [online] Available at: <https://www.loaches.com/articles/sewellia-lineolata-natural-habitat-and-how-they-get-to-our-aquariums> [Accessed 1 November 2021]

Appendix A: Bomford model risk assessment: *Sewellia lineolata*

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 *S. lineolata* (Boulenger 1901) 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

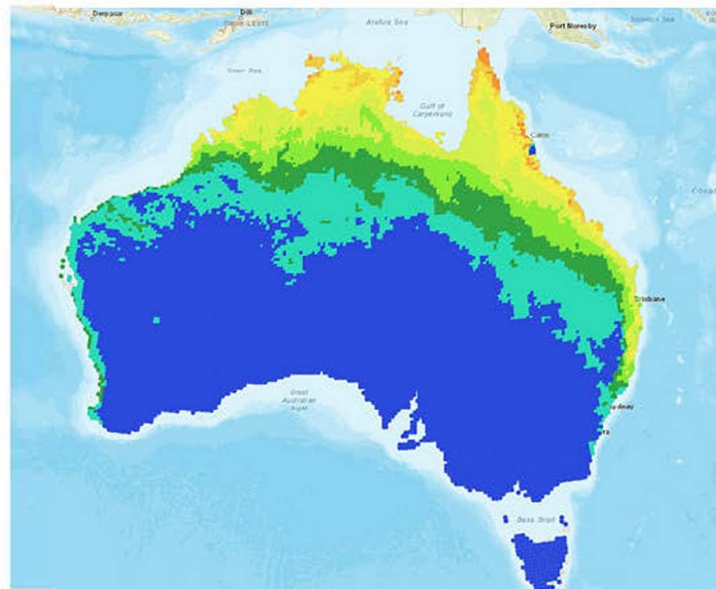
Propagule pressure—the release of large numbers of animals at different times and places

S. lineolata is not a schooling species which means that it might be less likely to establish than schooling species. A moderate to high probability of establishing a self-sustaining population would require deliberate actions by a knowledgeable individual to introduce a large number of fish into very specific aquatic habitats. As the species lives in mountain, tropical flowing streams on a rocky substrate there would be opportunities to establish in the few perennial mountain streams in north-eastern Australia ([REDACTED]). 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. lineolata* 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 unlikely that enough fish would be accidentally or deliberately released into a suitable receiving environment to establish a breeding population.

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

Climatch (v2.0) was run with the source region set to circumscribe areas in drainages in central Viet Nam: Huong River (Thua Thien Hue Province), Thu Bon River (Quang Nam Da Nang Province), Trac Khuc River and Ve River (Quang Ngai Province) and An Lao River (Binh Dinh Province) and some streams in between (Freyhof and Serov 2000, Serov et al. 2006). A climate match prediction was generated using the Euclidian algorithm applied to the 'world stations' data set. Climatch calculated a 'value 5' (Climate Euclidian Sum Level 5) of 1258, equating to a climate match score of 4 using recalibrated 'value 5' ranges for

Climatch v2.0 provided by ABARES². DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements.



Score	0	1	2	3	4	5	6	7	8	9	10
Count	10616	3182	1530	1227	1423	931	273	54	0	0	0

Figure 1 Climatch output for *Sewellia lineolata*

History of establishment elsewhere-previous successful establishment:

There are no reports on FishBase of introductions or establishment of this species outside its known natural range (Froese and Pauly n.d.-a). The species is unlikely to breed and form self-sustaining populations so far outside its optimal water temperature range of 20-24 °C. The absence of established populations outside its natural range is despite being actively traded internationally as an aquarium species for 30 years (Jared Patrick, Premier Pet, pers. corn.).

Overseas range:

The range described by (Huckstorf and Freyhof 2011) was used to determine a total overseas range of approximately 3, 1° latitude x 1° longitude grid squares for purposes of the Bomford (2008) assessment.

Introduction success:

² Recalibrated Climatch v2 'value 5' ranges corresponding to climate match scores 1-8: 1(0), 2 (1-276), 3(277-1036), 4(1037-2763), 5(2764-6907), 6(6908-10361), 7(10362-17268), 8 (>17268)

The species is not known to have established outside its native range. However, it can be assumed that the species has been released into non-native areas on occasions over the 20 years of trade worldwide as an aquarium species. The introduction success rate is conservatively considered to be less than 0.25 (Bomford 2008).

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

FishBase recognises 13 species of *Sewellia* (Froese and Pauly n.d.—b). Of these, none have been reported in the wild outside their natural range and only one (*S. lineolata*) is listed as being traded commercially as an aquarium species. As internationally traded aquarium species, it is reasonable to assume (in the absence of published scientific data) that there would have been many past instances (perhaps in the hundreds) of inadvertent or deliberate introduction of these four species around the world over the many decades that these species have been traded – 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 are 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.)

If the Bomford (2008) methodology is applied to the genus *Sewellia*, where the genus success rate % = 100 x (Number of successful introductions to all countries of species in the genus/Total number of introductions to all countries of species in the genus), the 'genus level' taxa risk is 0/50 (0%). Notably, loaches are on the current list of specimens taken to be suitable for live import and have been imported to Australia for over 40 years without wild populations being established.

Potential impacts of established feral populations

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. In the unlikely event this species establishes in the wild in Australia, its specialised feeding habits mean it would be unlikely to compete with native fish species. Mountain streams with suitable temperatures are habitats for few fish species in Australia, and none of these fish dwell at the bottom of the strong current areas of streams. No competition would be expected with mid-water or surface feeding fish.

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. Loaches 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	Hill stream loach
Scientific name	<i>Sewellia lineolata</i> (Valenciennes 1846)
Date assessed	2 December 2021
Literature Search Type and Date:	FishBase November 2021

Risk criterion	Value	Explanation
A. Climate Match Score (1-8)	4	Climatch (v2.0) Euclidian Sum Level 5 (Value X) = 1258. This value equates to a climate match score of 4.
B. Overseas Range Score (0-4)	0	<i>S. lineolata</i> is estimated to occupy a total range of 3, 1° latitude x 1° longitude grid squares.
C. Establishment Score (0-3)	0	The species is considered to have been "introduced but never established", representing an establishment score of 0.
D. Introduction Success Score (0-4)	1	The species is not known to have established outside its native range. However, after many decades of trade worldwide it can be assumed it has been released into non-native areas on many occasions. The introduction rate is conservatively considered (that is erring on the side of overestimation) to be <0.25, representing an introduction success score of 1.
E. Taxa Risk Score (0-5)	0	Conservatively, 50 past introductions of the 15 internationally traded species of the genus are assumed for the purposes of this risk assessment. There are no records on FishBase of <i>Sewellia</i> species being found to have been potentially established outside the countries to which they are native. The 'genus level' taxa risk is therefore 0/50 (0%).

Summary	Score	Rank
Establishment Risk	5	Low

Conclusion

The estimated risk of 'low' using the Bomford (2008) methodology is generally much lower than the risk that would be posed by most of the species currently permitted live importation to Australia. It is recommended that *Sewellia lineolata* is added to the Live Import List.