Yasuhikotakia morleti: Application 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)

September 2021

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 Skunk loach (*Yasuhikotakia morleti*) indicates the risk of allowing the importation of the species would pose minimal biosecurity risk to Australia. There is only a single report of *Y. morleti* being found in the wild outside its natural range despite being traded internationally for over 40 years and similar species such as *Botia lohachata* have not established self-maintaining wild populations in Australia despite over 16 years of importation. Populations of *Y. morleti* likely exist in the domestic hobby having been intermittently traded in Australia over the last 40 years ─ 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 is an indication of the benign nature of the species since scientific study (and associated literature) focuses almost exclusively on invasive species that have some ecological impact. 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.

Y. morleti 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 *Y. morleti* would be consistent with current import policy given it is closely related to and shares a similar environmental risk profile to other species currently permitted live importation to Australia.

A structured risk assessment based on the methodology of Bomford (2008) estimated a ‘moderate’ risk, generally consistent with the risk that would be posed by most of the species currently permitted live importation to Australia. It is recommended that *Y. morleti* is added to the Live Import List.

DAWE terms of reference

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

    - Skunk loach, *Yasuhikotakia morleti* Tirant 1885.
    - Actinopterygii (ray-finned fishes); Cypriniformes (Carps); Botiidae (loaches); Sub-family Botiinae (Froese and Pauly n.d.─a).
    - Synonyms: *Botia morleti* Tirant (1885); *Botia horae* Smith (1931) (Froese and Pauly n.d.─a).
    - Common names: Hora's Loach, Skunk Botia Loach, Mouse Loach, and Cream Loach (Brough and Roche n.d.).

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.

- *Y. morleti* is not CITES listed.
- The species is listed on the IUCN Red List as 'Least Concern' because although it is found in the aquarium trade, impact from wild harvesting or other threats have not been identified (Allen 2013).
- *Y. morleti* is native to Cambodia, Laos and Thailand (Froese and Pauly n.d.─a).

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

- *Lifespan of the species*: Typically 6-8 years, but has been reported to live up to 12 years (Brough and Roche n.d.).
- *Size and weight range*: 8-10cm (Aqua-Fish.Net n.d., Froese and Pauly n.d.─a).
- *Natural geographic range*: *Y. morleti* is recorded from Thailand, Laos and Cambodia in the Mekong River System (Froese and Pauly n.d.─a).
- *Habitat*: The species is typically found in standing and flowing waters of the Mekong River system in medium and large-sized rivers where it is found in rock crevices or burrowed under rocks and sunken logs (Tropical Fish Keeping 2013, Froese and Pauly n.d.─a). Although the Mekong is quite turbid, water quality requirements under aquarium conditions are for very pure water at 24-30°C, with low dissolved organics and nitrates (Tropical Fish Keeping 2013).
- *Diet, including potential to feed on agricultural plants: Y. morleti* is primarily carnivorous, eating molluscs and crustaceans, insects, snails and other benthic invertebrates, but will occasionally feed on soft aquatic vegetation (Brough and Roche n.d.). The species probably moves into temporarily flooded areas when water levels are high. The young of the year return to rivers in November and December in the lower Mekong (Froese and Pauly n.d.─a). All Botiids are recommended as snail control in aquaria.
- *Social behaviour and groupings*: *Y. morleti* is gregarious in aquaria, suggesting they likely live in small groups in the wild. In aquaria the species must be maintained in groups of five or more to reduce aggression and allow the fish to form a natural hierarchy (Thoene 2006).
- *Territorial and aggressive behaviours*: The species is aggressive towards other fish and is not recommended for mixed aquaria except with much larger tank mates (Tropical Fish Keeping 2013).
- *Natural predators*: Not reported but piscivorous birds, mammals or fish in their habitat would likely eat 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, although they have sub-ocular spines which could cause a small injury if carelessly handled.

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

   - *Age at maturity (first breeding)*: Not reported in the scientific literature but estimated to be about 3 years under captive bred conditions.

   - *How frequently breeding occurs*: Breeding frequency in the wild has not been reported. About three spawns a year are expected from a female under aquaculture conditions.

   - *Can the female store sperm*: Not known but unlikely as there is no intromittent organ. They are egg layers so fertilisation is external.

   - *How many eggs or live-born young are produced at each breeding event*:
     There is no published information on the fecundity of this species in the wild. Under aquaculture conditions, the fecundity is estimated to be in the order of 200 eggs per spawn. Joshi and Pathani (2009) reported a mountain species, *Botia almorhae* producing 908-3616 eggs depending on size. Another species, *Botia dario* produced 5245 to 53754 eggs averaging 31833 (Hossain *et al*., 2007).

   - *Has the species hybridised with other species (both in the wild and in captivity) or has it the potential to hybridise with any other species*: There are no reports of hybridisation.

   - *If the species can hybridise, are the progeny fertile*: N/A.

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

   The species has not been reported as having established feral populations outside of their natural geographic distribution, despite being traded internationally for the aquarium trade for over 40 years in volumes in the order of 1.0 million fish per year.

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 establish self-sustaining populations in the wild in Australia (Corfield *et al.* 2008). It is however noted that the BRS grey list is currently under review by a technical working group of the Vertebrate Pest Committee and is being amended to better reflect the ornamental fish species historically present and traded in Australia. It is further noted that small numbers of this species are known to have existed in Australia in the past and likely persist in the Australian hobby.

   The addition of *Y. morleti* to the Live Import List would be generally consistent with Australia’s biosecurity arrangements for live fish given that the species is closely related to and shares a similar environmental risk profile with the clown loach (*Chromobotia macracanthus*), the dwarf chain loach *(Ambastaia sidthimunki)* and the yoyo loach (*Botia lohachata*), all of which are currently permitted live importation to Australia.

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

   Assessing the risk of the potential of introducing a new organism into the environment involves assessing the risk of it becoming established and spreading and the likely impacts if establishment occurred. The risk assessment method put forward by Bomford (2008) has been adopted by DAWE for its risk assessments. The following considers each of the risk factors considered in Bomford (2008) to be applicable to freshwater fish and is guided by the recent DAWE 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).

   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 is an indication of the benign nature of the species since scientific study and associated literature focuses almost exclusively on invasive species that have some ecological impact. 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.

   - *Propagule pressure—the release of large numbers of animals at different times and places enhances the chance of successful establishment: Y. morleti* is reported from Thailand, Laos and Cambodia in the Mekong River system (Allen 2013), typically in standing and flowing turbid waters of the Mekong river system in medium and large-sized rivers where it is found in rock crevices or burrows under rocks and sunken logs (Tropical Fish Keeping 2013, Froese and Pauly n.d.─a). As a stream dwelling tropical fish with opportunity to find shelter in the event of deliberate or inadvertent release into the wild would be limited to a few perennial rivers in northern Australia. It is unlikely 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 a populated area. 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 (DAWE 2020a). It is unlikely that enough fish would be accidently 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 was used to assist in identifying possible habitats in Australia that the species could inhabit if released (Bomford 2008). *Y. morleti* is endemic to the Mekong and Chao Phraya basins, and Mae Khlong basin (Thailand Laos and Cambodia) *Y. morleti* is endemic to Thailand, Laos and Cambodia in the Mekong River System (Allen 2013). Climatch (original v1.0) was run with the source region set to circumscribe an area across Thailand, Laos and Cambodia consistent with the probable distribution described in Allen (2013). 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 746, equating to a climate match score of 5. DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements. The new upgraded version of Climatch (v2.0) was

not used in this assessment because its improved mapping resolution results in higher output values that are yet to be calibrated for purposes of applying the Bomford methodology.

- *Overseas range: Y. morleti* is endemic to the Mekong and Chao Phraya basins, and Mae Khlong basin (Thailand Laos and Cambodia) *Y. morleti* is endemic to Thailand, Laos and Cambodia in the Mekong River System (Froese and Pauly n.d.─a). Based on the species distribution in Allen (2013), the species is estimated using 'mapcoordinates.net' to occupy a total of 40, 1^{o} latitude x 1^{o} longitude grid squares (Bomford 2008).

- *History of establishment elsewhere—previous successful establishment:* There is a single report of *Y. morleti* being found in the Philippines, although it is unknown if this represents an established feral population (Froese and Pauly n.d.─a). This single possible case is despite the species being traded internationally as an aquarium species for over 40 years and likely inadvertent or deliberate introductions on many occasions as an internationally traded aquarium species. The species is categorised as having "only established exotic population(s) on island(s)" (Bomford 2008).

- *Introduction success:* There is a single report of *Y. morleti* being found in the Philippines, although it is unknown if this represents an established feral population (Froese and Pauly n.d.─a). After many decades of trade worldwide it can be assumed the species has been released into non-native areas on many occasions. The introduction success rate is conservatively considered (that is erring on the side of overestimation) to be less than 0.25 (Bomford 2008).

- *Taxonomic group—belonging to a family or genus which has a high establishment success rate:*
  At a taxa level, of the nine species of valid *Yasuhikotakia* species recognised on FishBase, five are traded as ornamental species (Froese and Pauly n.d.─b). As internationally traded aquarium species, it is reasonable to assume that there would have been many instances of inadvertent or deliberate introduction of these five species around the world – conservatively (erring on the side of overestimation) 25 past introductions are assumed for the purposes of this risk assessment. There are only three records (representing three species) on FishBase of *Yasuhikotakia* species being found to have been introduced into the wild outside the countries to which they are native, although it is unknown if these introductions have led to establishment of wild populations (Froese and Pauly n.d.─b). The 'genus level' taxa risk is therefore <3/25 (12%). Notably, several loaches including *Botia lohachata* and *Chromobotia macracanthus* are on the current list of specimens taken to be suitable for live import, have been imported to Australia for many decades and have not established wild populations.

- *Ability to find food sources*: As a carnivore feeding primarily on benthic invertebrates, 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)*: *Yasuhikotakia morleti* lives in still and moving water and migrates from rivers into tributaries to spawn (Brough and Roche n.d.). The species requires a tropical climate in soft water at 24 to 30°C. This climatic range together with its (perennial)

stream habitat requirements limit the geographical range where the species could theoretically establish in Australia.

- *Ability to find shelter*: As a stream dwelling tropical fish with opportunity to find shelter in the event of deliberate or inadvertent release into the wild would be limited to a few rivers in northern Australia.

- *Rate of reproducing*: Reproductive rate (the number of offspring that a female produces during its lifetime) data in wild population have not been reported. Under aquaculture conditions, females are productive for about 3 years and produce in the order of 200 eggs per spawning. The net reproductive rate is considered low compared to most recognised invasive species.

- *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, *Y. morleti* is considered unlikely to establish, in main because the species is not reported to have established breeding populations outside its natural range despite being traded internationally as an ornamental species for over 40 years and there are few areas in Australia expected to have habitat suitable for the species to establish. This conclusion can be ground-truthed to an extent by comparing *Y. morleti* with similar species such as *Botia lohachata*, which have not established self-maintaining wild populations despite excess of 16 years of importation to Australia for the aquarium trade. Furthermore, captive aquarium populations of *Y. morleti* likely persist in the domestic hobby – these have not led to the establishment of feral populations in Australia.

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 invertebrates with other small tropical benthic fish typically in habitats with sandy or gravel substrates. These niche species could include bottom feeders such as ell tailed catfishes (*Neosilurus* spp., *Porochilus* spp.) or juvenile eels (*Anguilla reinhardtii*). As it digs into sand and burrows it may displace species in similar habitats (i.e. eel tailed catfish, some gobiids). 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, although Botiids are susceptible to white spot of fish (*Ichthyophthirius multifiliis*) as are most fish with small or no scales (including Neosilurids). Another disease (called skinny disease) is relatively common in imported loaches and is thought to be caused by the flagellate parasite *Spironucleus* sp. (Seriously Fish n.d.). This parasite is found throughout the world in most vertebrates but is poorly characterised although they may be reasonably species specific (Williams *et al*. 2011).

- *Probable prey/food sources, including agricultural crops*: *Y. morleti* is primarily carnivorous, eating molluscs and crustaceans, insects, snails and other benthic invertebrates, but will occasionally feed on soft aquatic vegetation. It does not feed on any agricultural crops.

- *Habitat and local environmental conditions*: *Yasuhikotakia morleti* has not been reported to change its environment or habitat. The species is typically found in standing and flowing waters of the Mekong River system in medium and large-sized rivers where it is found in rock crevices or burrowed under rocks and sunken logs.

- *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*: This species does reportedly dig into sand and may dig burrows, but is not reported to cause habitat degradation (Aqua-Fish.Net n.d.).

- *Potential threat to humans*: The species is not reported as posing any threat to humans (Froese and Pauly n.d.─a).

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

   Potential environmental impacts from importation of live animals into Australia can take the form of direct pest risks or indirect risks associated with the introduction of new diseases that may be carried in imported stock. In the case of *Y. morleti*, 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).

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 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 1.0 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 *Y. morleti* stock would represent about one percent of this.

- *Why this species has been chosen*: Internationally, the species is in high demand by hobbyists and would be extremely popular in Australia. Similar loach species currently permitted importation such as *Chromobotia macrocanthus*, *Ambastaia sidthimunki* and *Botia lohachata* are very popular in Australia. The species is not aggressive and compatible to keep in aquaria with most 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 2020)

    - *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 2020) and in accordance with the Pet Industry Association of Australia (PIAA) National Code of Practice (PIAA 2008).

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

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

    - *Pest or noxious status*: The species is not 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

Allen DJ (2013) *Yasuhikotakia morleti*. The IUCN Red List of Threatened Species 2013: e.T187878A8637898. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T187878A8637898.en

Aqua-Fish.Net (n.d.) "Skunk botia - *Yasuhikotakia morleti*" [online] Available at: https://en.aqua-fish.net/fish/skunk-botia [Accessed 20 October 2020]

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]

Brough C and Roche J (n.d.) "Skunk Loach" [online] Available at: https://animal-world.com/encyclo/fresh/loaches/SkunkLoach.php [Accessed 20 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. Available online: https://www.environment.gov.au/system/files/resources/fb1584f5-1d57-4b3c-9a0f-b1d5beff76a4/files/ornamental-fish.pdf [Downloaded 1 November 2020]

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. Available online: https://environment.gov.au/system/files/consultations/1b591465-8486-450a-b12f-2f824fd925ca/files/glass-catfish-risk-assessment.pdf [Downloaded 1 November 2020].

DAWE (2020b) "Import conditions for freshwater aquarium fish: Effective 18 July 2020. Department of Agriculture, Water and the Environment" [online] Available at: https://bicon.agriculture.gov.au/BiconWeb4.0/ImportConditions/Conditions?EvaluatableElementId=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]

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]

Froese R and Pauly D Editors (n.d.─a) "*Yasuhikotakia morleti* (Tirant, 1885)" [online] Available at: https://www.fishbase.de/summary/11321 [Accessed 1 November 2020]

Froese R and Pauly D Editors (n.d.─b) "Scientific Names where Genus Equals *Yasuhikotakia*": FishBase search results for species belonging to the genus Yasuhikotakia [online] Available at: https://www.fishbase.se/search.php [Accessed 1 November 2020]

Hossain MA, Khatum MR and Hussain MA (2007) On the fecundity and sex-ratio of *Botia dario* (Hamilton) (Cypriniformes: Cobitidae). Univ. J. Zool. Rajshahi Univ, 26:27-29

Joshi S and Pathani S. (2009). Spawning biology of a hill stream fish, *Botia almorhae* Day of Kumaun Himalaya, Uttarakhand. Indian J. Fish. 56.

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]

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.) "Botia kubotai" [online] Available at: https://www.seriouslyfish.com/species/botia-kubotai/) [Accessed 12 November 2020].

Thoene M (2006) "Loaches online: Skunk Loach (Yasuhikotakia morleti)" [online] available at: https://www.loaches.com/species-index/yasuhikotakia-morleti [accessed 20 November 2020]

Tropical Fish Keeping (2013) "*Yasuhikotakia morleti*" [online] Available at: https://www.tropicalfishkeeping.com/threads/yasuhikotakia-morleti.193865/ [Accessed 20 November 2020]

Williams CF, Lloyd D, Poynton SL, Jorgensen A, Millet COM and Cable J (2011) *Spironucleus* species: Economically-Important Fish Pathogens and Enigmatic Single-Celled Eukaryotes. J Aquac Res Development S2:002. doi:10.4172/2155-9546.S2-002. Available at: https://animal-world.com/encyclo/fresh/loaches/BurmeseBorderLoach.php [Accessed October 2020]

Appendix A: Bomford model risk assessment: *Yasuhikotakia morleti*

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 *Yasuhikotakia morleti* (Tirant 1885) 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

Y. morleti is reported from Thailand, Laos and Cambodia in the Mekong River System (Allen 2013), typically in standing and flowing turbid waters of the Mekong river system in medium and large-sized rivers where it is found in rock crevices or burrows under rocks and sunken logs (Tropical Fish Keeping 2013, Froese and Pauly n.d.─a). As a stream dwelling tropical fish with opportunity to find shelter in the event of deliberate or inadvertent release into the wild would be limited to a few rivers in northern Australia. It is unlikely 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 a populated area. 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 (DAWE 2020a). It is unlikely that enough fish would be accidently or deliberately released into a suitable receiving environment to establish a breeding population.

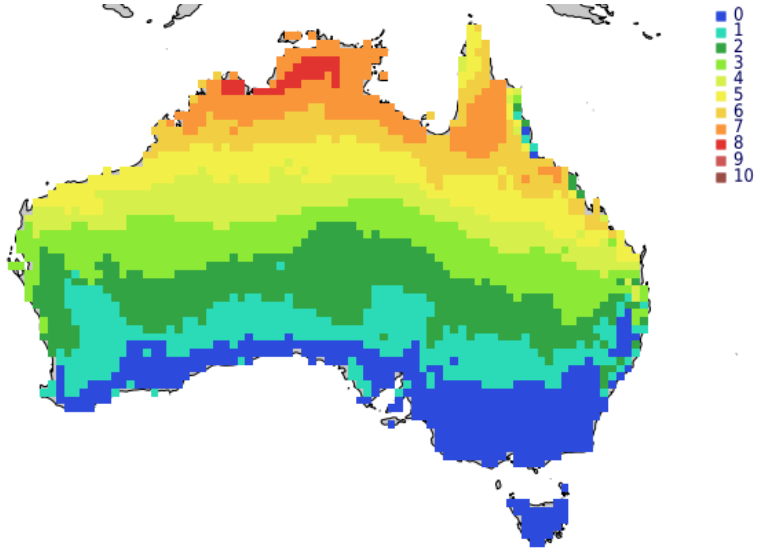
If permitted importation *Y. morleti* would be freely available in Australia through aquarium stores. The species would be common enough in Australia that theft due to lack of availability is unlikely.

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

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

Climatch was used to assist in identifying possible habitats in Australia that the species could inhabit if released (Bomford 2008). *Y. morleti* is endemic to the Mekong and Chao Phraya basins, and Mae Khlong basin (Thailand Laos and Cambodia) *Y. morleti* is endemic to Thailand, Laos and Cambodia in the Mekong River System (Froese and Pauly n.d.─a). Climatch (original v1.0) was run with the source region set to circumscribe an area across Thailand, Laos and Cambodia consistent with the probable distribution described in Allen

(2013). 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 746, equating to a climate match score of 5. DAWE (2020a) suggested the need for some caution in predicting climate suitability for freshwater aquatic species because Climatch is based on terrestrial climate measurements. The new upgraded version of Climatch (v2.0) was not used in this assessment because its improved mapping resolution results in higher output values that are yet to be calibrated for purposes of applying the Bomford methodology.



Score	0	1	2	3	4	5	6	7	8	9	10
Count	437	403	507	401	291	293	214	208	31	0	0

Figure 1 Climatch output for *Yasuhikotakia morleti*

History of establishment elsewhere—previous successful establishment:

There is a single report of *Y. morleti* being found in the Philippines, although it is unknown if this represents an established feral population (Froese and Pauly n.d.–a). This single case is despite the species being traded internationally as an aquarium species for over 40 years and likely inadvertent or deliberate introductions as an internationally traded aquarium species. The species is categorised as having "only established exotic population(s) on island(s)" (Bomford 2008).

Overseas range:

Y. morleti is endemic to the Mekong and Chao Phraya basins, and Mae Khlong basin (Thailand Laos and Cambodia) *Y. morleti* is endemic to Thailand, Laos and Cambodia in the Mekong River System (Froese and Pauly n.d.–a). Based on the species distribution in Allen (2013), the species is estimated using 'mapcoordinates.net' to occupy a total 40, 1° latitude x 1° longitude grid squares (Bomford 2008).

Introduction success:

There is a single report of *Y. morleti* being found in the Philippines, although it is unknown if this represents an established feral population (Froese and Pauly n.d.–a). After many decades

of trade worldwide it can be assumed the species has been released into non-native areas on many occasions. The introduction success rate is conservatively considered (that is erring on the side of overestimation) to be less than 0.25 (Bomford 2008).

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

At a taxa level, of the nine species of valid *Yasuhikotakia* species recognised on FishBase, five are traded as ornamental species (Froese and Pauly n.d.─b). As internationally traded aquarium species, it is reasonable to assume that there would have been many instances of inadvertent or deliberate introduction of these five species around the world – conservatively (erring on the side of overestimation) 25 past introductions are assumed for the purposes of this risk assessment. There are only three records (representing three species) on FishBase of *Yasuhikotakia* species being found to have been introduced into the wild outside the countries to which they are native, although it is unknown if these introductions have led to establishment of wild populations (Froese and Pauly n.d.─b). The 'genus level' taxa risk is therefore <3/25 (12%). Notably, several loaches including *Botia lohachata* and *Chromobotia macracanthus* are on the current list of specimens taken to be suitable for live import, have been imported to Australia for many decades and have not established wild populations.

Potential impacts of established feral populations

There is only a single report of *Y. morleti* outside its natural range despite being traded internationally for over 40 years. There is no evidence of any detrimental impact caused by the establishment of the species. In the unlikely event this species establishes in the wild in Australia, it may compete for benthic invertebrates with other small tropical benthic fish typically in habitats with sandy or gravel substrates. These niche species could include bottom feeders such as ell tailed catfishes (*Neosilurus* spp., *Porochilus* spp.) or juvenile eels (*Anguilla reinhardtii*). As it digs into sand and burrows it may displace species in similar habitats (i.e. eel tailed catfish, some gobiids). 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. Botiid fishes 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	Redtail Botia
Scientific name	*Yasuhikotakia morleti* Tirant 1885
Date assessed	17 January 2021
Literature Search Type and Date:	FishBase January 2021

Risk criterion	Value	Explanation
A. Climate Match Score (1–8)	5	Climatch (v1.0) Euclidian Sum Level 5 (Value X) = 746. This value equates to a climate match score of 5.

B. Overseas Range Score (0–4)	4	*Y. morleti* is estimated to occupy a total 40, 1° latitude x 1° longitude grid squares (Bomford 2008).
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 been released or established. 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)	2	Conservatively, 25 past introductions of the 5 internationally traded species of the genus are assumed for the purposes of this risk assessment. There are three records (representing three species) on FishBase of *Yasuhikotakia* species being found to have been potentially established outside the countries to which they are native. The 'genus level' taxa risk is therefore 3/25 (12%).

Summary	*Score*	*Rank*
Establishment Risk	12	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 *Yasuhikotakia morleti* is added to the Live Import List.