Synodontis eupterus: 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 featherfin synodontis (*Synodontis eupterus*) 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 40 years. Related species such as *Synodontis nigriventris* have not established self-maintaining wild populations in Australia despite decades of importation. Small numbers of *S. eupterus* already exist in the domestic hobby having been regularly bred & traded in Australia over the last 40 years ─ although these are not large commercial numbers of fish, 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.

S. eupterus 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. eupterus* would be consistent with current import policy given it is closely related to and likely 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 *S. eupterus* is added to the Live Import List.

DAWE terms of reference

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

    - Featherfin synodontis, *Synodontis eupterus* Boulenger 1901
    - Actinopterygii (ray-finned fishes); Siluriformes (Catfish), Mochokidae (Squeakers or upside-down catfishes).
    - *Synonyms: S. euptera, S. macrepipterus, S. ornatipinnis*
    - *Common names*: featherfin squeaker, upside down catfish, featherfin catfish

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.*

    - *Synodontis eupterus* is not CITES evaluated.

    - This species is listed on the IUCN Red List as Least Concern (LC) as this species has a wide distribution, with no known major widespread threats (Awaïss *et al*. 2020).

    - *S. eupterus* is found in western Africa in several large river basins, including the Chad, Niger and Volta River basins as well as unconfirmed reports from the White Nile very distant to these other river basins (Awaïss *et al*. 2020). The species is considered abundant in some parts of its range being a favoured food fish for artisanal fishers and making up most of their catch (Shinkafi and Daneji 2011).

    - The species is readily spawned in with the aid of hormones (Shinkafi and Mamman 2012; Sipos *et al.* 2019) in commercial fish farms (Seriously Fish n.d.). Some are harvested from the wild for the aquarium trade (Awaïs *et al*. 2020).

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

    - *Lifespan of the species:* 15 years in aquaria if maintained properly (Seriously Fish n.d.). *S. eupterus* is a relatively long-lived species, living for 8-10 years but with one report up to 25 years (Brough *et al.* n.d.).

    - *Size and weight range:* The fish grow to a maximum of 30 cm length, but are usually about 20cm long (Shinkafi and Daneji 2011).

    - *Natural geographic range*: *S. eupterus* is found in western Africa in serval large river basins, including the Chad, Niger and Volta River basins as well as unconfirmed reports from the White Nile very distant to these other river basins (Awaïss *et al*. 2020).

    - *Habitat*: Habitat requirements or fishing methods are not well documented, except that it is found in moderately flowing water over muddy bottoms but can also be found in some rocky areas (Awaïss *et al.* 2020). It is a tropical fish with optimal water temperatures of 22-26°C, but a single specimen likely released by an aquarist was found in Croatia in 13.7°C water (Dulčić *et al.* 2018). If not discovered, it is unlikely this single specimen would have survived long at such a low temperature.

    - *Diet, including potential to feed on agricultural plants*: Diet in wild fish includes phytoplankton, zooplankton, detritus, plant tissues, insects, crustaceans and insect parts (Shinkafi *et al.* 2010). Gut content studies of wild fish indicate they are bottom dwelling and bottom feeders, ingesting detritus with other foods such as insect larvae (Shinkafi *et al.* 2010). The food types indicate benthic feeding without ingestion of significant terrestrial plant material. A closely related species *S. nigrita* is an omnivore with a gut three times the length of the body, and feeds on phytoplankton,

zooplankton, detritus, plant tissues, insects, crustaceans and insect parts (Shinkafi *et al*. 2010).

- *Social behaviour and groupings*: Details of social behaviours have not been reported, although they do pair up prior to spawning and make audible noises during spawning and when encountering predators (Awaïss *et al.* 2020; Brough *et al*. n.d.).

- *Territorial and aggressive behaviours*: None recorded. Some aquarist websites promote them as a community tank species.

- *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).

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

   The reproductive biology of *S. eupterus* is fairly well understood as it is routinely bred using hormone induced spawning techniques.

   - *Age at maturity (first breeding)*: 2-3 years (Seriously fish n.d)

   - *How frequently breeding occurs*: The species is bred commercially for the ornamental fish trade. Females spawn about eight time per year

   - *Can the female store sperm*: External fertilisation; broadcast spawners.

   - *How many eggs or live-born young are produced at each breeding event*: Absolute fecundity ranges from about 100 eggs to over 20,000 (Shinakfi and Mamman 2012). Different stages of eggs in the ovaries indicate an extended spawning period, from June to August in Minna, Nigeria (Shinkafi and Mamman 2012). Hormone induced spawning has resulted in a wide ovulation range of 18190 ±15 181 eggs (Sipos *et al*. 2019).

   - *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.

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 (Froese and Pauly n.d.─a), despite being traded internationally for the aquarium trade for over 40 years in volumes in the order of 1.5 million fish per year. Dulčić *et al.* (2018) reported finding a single specimen of *S. eupterus* in Croatia, indicating the fish can survive cooler (13.7°C) waters. The authors

speculate the fish may have been released from a home aquarium after growing too large (19.3 cm) to maintain. The species is unlikely to breed and form self-sustaining populations so far outside its optimal water temperature range of 22-26°C.

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. 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 40 years.

   The addition of *S. eupterus* 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 species such as *Synodontis nigriventris* 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 '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 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: S. eupterus* is not a schooling species which means that it 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 – it is unlikely to happen at random (DAWE 2020a).
  As the species lives in tropical flowing rivers on a muddy substrate there would be opportunities to establish in the few perennial rivers in northern monsoonal Australia. However, it does breed in areas with seasonal flooding (Seriously Fish n.d.), so there would be suitable environments in northern Australia.

- *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 areas in Western Africa (Chad, Niger (including Benue) and Volta river basins) where the species is confirmed present as well as some areas in Northeast Africa from where the species has been reported but not confirmed (Awaïss *et al.* 2020). 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 682, 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 recently released 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.

- *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). Dulčić et al. (2018) has however reported finding a single specimen of *S. eupterus* in Croatia, indicating the fish can survive cooler (13.7°C) waters. The authors speculate the fish may have been released from a home aquarium after growing too large (19.3 cm) to maintain. The species is unlikely to breed and form self-sustaining populations so far outside its optimal water temperature range of 22-26°C. The absence of established populations outside its natural range is despite being actively traded internationally as an aquarium species for many years.

- *Overseas range*: The species is endemic to Western Africa in serval large river basins, including the Chad, Niger and Volta River basins as well as unconfirmed reports from the White Nile very distant to these other river basins (Awaïss *et al*. 2020). The confirmed area in Western Africa were used to determine a total overseas range of 76, 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, noting the finding of a single specimen in Croatia likely released by an aquarist (Dulčić *et al.* 2018). However, it can be assumed that the species has been released into non-native areas on many occasions over the 40+ 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: S. eupterus* belongs to the family Mochokidae (Squeakers or upside-down catfishes). FishBase recognises 133 species of *Synodontis.* Of these, three have been reported in the wild outside their natural range (although unknown if established as a feral population); the finding of a single specimen of *S. eupterus* in Croatia (Dulčić *et al.* 2018) and the 1996 report of *S. angelicus* and *S. nigriventris* found in a Philippine waterway (Froese and Pauly n.d.─b). Of a total 130+ species, 15 are reported in FishBase as traded internationally as commercial aquarium species and of these 15, there are, if we take worst case conservative approach, potentially 3 reported populations (representing three species) have been found potentially established outside the countries to which they are native. As internationally traded aquarium species, it is reasonable to assume that there would have been many instances of inadvertent or deliberate introductions of these 15 species around the world over the last few decades – conservatively assumed to be 50 introductions (likely more in reality) for the purposes of this risk assessment – and this level of introductions has resulted in 3 potentially established populations of three species.

  If the Bomford (2008) methodology is applied to the genus *Synodontis*, where the genus success rate % = 100(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 3/50 (6%). Notably, the related *S. nigriventris* is on the current list of specimens taken to be suitable for live import and has been imported to Australia for over 40 years without wild populations being established. Furthermore, *S. eupterus* already exist in the domestic hobby having been bred & traded in Australia over for more than 40 years ─ although these are not large commercial numbers of fish, these populations have not led to the establishment of feral populations in Australia.

- *Ability to find food sources*: As an omnivore 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)*: Temperature range is 22-27°C, pH 5.6-7.5 and hardness 8-20 dGH (Brough *et al.* n.d., Seriously Fish n.d.).

- *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 that have the required temperature range in Northern Australia.

- *Rate of reproducing*: Overall rate is unknown but experimental spawning has produced up to over 30 000 eggs (Sipos *et al*. 2019). However, ovary observations suggests several spawnings over the wet season are more likely (Shinkafi and Mamman, 2012). In commercial breeding conditions, females produce around 200 eggs about 8 times a year.

- *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. eupterus 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 many decades 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 the species with the related S. nigriventris, which has not established self-maintaining wild populations despite several decades of importation to Australia for the aquarium trade. Furthermore, S. eupterus already exists in the domestic hobby having been bred traded in Australia over the last 40 years ─ although these are not large commercial numbers of fish, these populations 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 muddy or rocky substrates. These niche species could include bottom feeders such as eel tailed catfishes (*Neosilurus* spp., *Porochilus* spp.). Some juvenile fish such as golden perch and grunters may feed on benthic invertebrates. 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 *Synodontis eupterus*, although the cosmocercoid nematode *Raillietnema synodontisi* was found in aquarium fish in Czechoslovakia (Moravec and Řehulka 1987). No disease was recoded as the paper was primarily taxonomic.

- Probable *prey/food sources, including agricultural crops*: *S. eupterus* feeds on benthic invertebrates. It does not feed on any agricultural crops.

- *Habitat and local environmental conditions*: *S. eupterus* 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 my cause habitat degradation.

- *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 *S. eupterus*, 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 *S. eupterus* would represent about one percent of this.

  Why this species has been chosen: Internationally, the species is in high demand by hobbyists. New catfish species would be popular in Australia, adding variety to the species available to Australian hobbyists. This species has the added peculiarity along with others in the genus of sometimes swimming upside down, hence the name. The species is not aggressive and compatible to keep in aquaria with other most other tropical species. Two other Synodontis catfishes, *S. multipunctatus* and S. *nigriventris* are currently permitted for import to Australia; *S. eupterus* has the added attraction of feathery fins.

  Although small numbers of this species are known to 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 morphs) needed to meet Australian hobby demand.

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 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 (closely 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.

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Appendix A: Bomford model risk assessment: *Synodontis eupterus*

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. eupterus* (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.

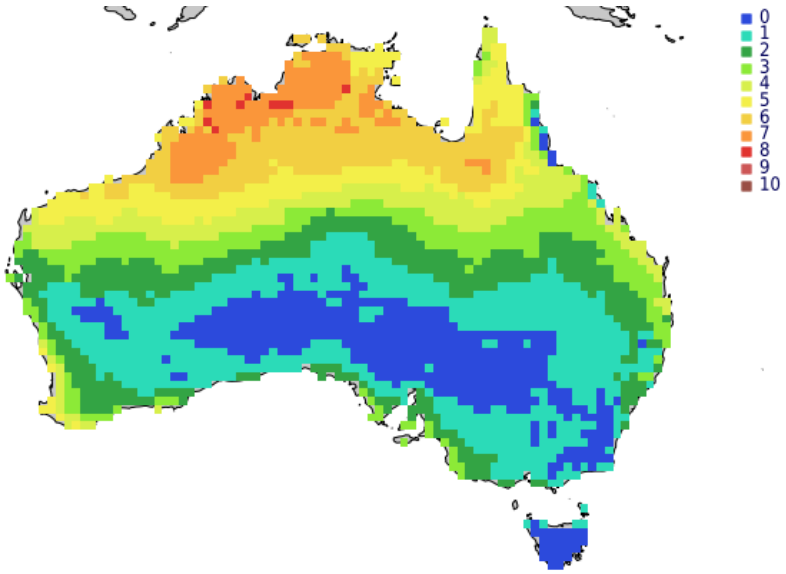
Establishment success

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

S. eupterus is not a schooling species which means that it 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 – it is unlikely to happen at random (DAWE 2020a). As the species lives in tropical flowing rivers on a muddy substrate there would be opportunities to establish in the few perennial rivers in northern monsoonal Australia. However, it does breed in areas with seasonal flooding (Seriously Fish n.d.), so there would be suitable environments in northern Australia. 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 (original v1.0) was run with the source region set to circumscribe areas in Western Africa (Chad, Niger (including Benue) and Volta river basins) where the species is confirmed present as well as some areas in Northeast Africa from where the species has been reported but not confirmed (Awaïss *et al.* 2020). 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 682, 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 recently released 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	458	697	409	300	239	229	291	153	9	0	0

Figure 1 Climatch output for *Synodontis eupterus*

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). Dulčić et al. (2018) has however reported finding a single specimen of *S. eupterus* in Croatia, indicating the fish can survive cooler (13.7°C) waters. The authors speculate the fish may have been released from a home aquarium after growing too large (19.3 cm) to maintain. The species is unlikely to breed and form self-sustaining populations so far outside its optimal water temperature range of 22-26°C. The absence of established populations outside its natural range is despite being actively traded internationally as an aquarium species for many years.

Overseas range:

The species is endemic to Western Africa in several large river basins, including the Chad, Niger and Volta River basins as well as unconfirmed reports from the White Nile very distant to these other river basins (Awaïss *et al*. 2020). The confirmed areas in Western Africa were used to determine a total overseas range of 76, 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, noting the finding of a single specimen in Croatia likely released by an aquarist (Dulčić *et al.* 2018). However, it can be assumed that the species has been released into non-native areas on many occasions over the 40+ 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:

S. eupterus belongs to the family Mochokidae (Squeakers or upside-down catfishes). FishBase recognises over 130 species of *Synodontis.* Of these, three have been reported in the wild outside their natural range (although unknown if established as a feral population); the finding of a single specimen of *S. eupterus* in Croatia (Dulčić *et al.* 2018) and the 1996 report of *S. angelicus* and *S. nigriventris* found in a Philippine waterway (Froese and Pauly n.d–b). Of the over 130 *Synodontis* species, 15 are reported in FishBase as traded internationally as commercial aquarium species and of these 15, there are, if we take worst case conservative approach, potentially 3 reported populations (representing three species) have been found potentially established outside the countries to which they are native. As internationally traded aquarium species, it is reasonable to assume that there would have been many instances of inadvertent or deliberate introductions of these 15 species around the world over the last few decades – conservatively assumed to be 50 introductions (likely more in reality) for the purposes of this risk assessment – and this level of introductions has resulted in 3 potentially established populations of three species.

If the Bomford (2008) methodology is applied to the genus *Synodontis*, where the genus success rate % = 100(Number of successful introductions to all countries of species in the genus/Total number of introductions to all countries of species in the genus), then the 'genus level' taxa risk is 3/50 (6%).

Notably, the related *S. nigriventris* is on the current list of specimens taken to be suitable for live import and has been imported to Australia for over 40 years without wild populations being established. Furthermore, small numbers of *S. eupterus* likely exist in the domestic hobby having been intermittently traded in Australia over the last 40 years – although these are not large commercial numbers of fish, these populations have not led to the establishment of feral populations in Australia.

Potential impacts of established feral populations

There is a single report of a single specimen of *S. eupterus* being found outside its natural range, likely released by an aquarist (Dulčić *et al.* 2018), despite being traded internationally as an aquarium species 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 muddy or rocky substrates. These niche species could include bottom feeders such as eel tailed catfishes (*Neosilurus* spp., *Porochilus* spp.). Some juvenile fish such as golden perch and grunters may feed on benthic invertebrates. 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	Featherfin synodontis
Scientific name	Synodontis eupterus Boulenger 1901
Date assessed	16 March 2021
Literature Search Type and Date:	FishBase March 2021

Risk criterion	**Value**	**Explanation**
A. Climate Match Score (1–8)	5	Climatch (v1.0) Euclidian Sum Level 5 (Value X) = 682. This value equates to a climate match score of 5.
B. Overseas Range Score (0–4)	4	*S. eupterus* is estimated to occupy a total range of 76, 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)	1	Conservatively, 50 past introductions of the 15 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 *Synodontis* species being found to have been potentially established outside the countries to which they are native. The 'genus level' taxa risk is therefore 3/50 (6%).

Summary	*Score*	*Rank*
Establishment Risk	11	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 *Synodontis eupterus* is added to the Live Import List.