# A report to address the “Terms of Reference” for an application to include *Glossolepis dorityi* on the allowable live imports list under the provisions of Section 303 EB, Environment Protection Biodiversity Conservation Act, 1999.

Photographer - Ian Robertson, permission to use image obtained 17 March 2021

## Introduction

The keeping of tropical fish species in aquaria is growing in popularity and has been booming during the lock down period attributed to the Covid19 Pandemic. Studies into mental health have proven that an aquarium can produce a soothing effect on the human mind that tends toward anxiety. This trend to worry about the future seems to be increasing in recent times. Studies have demonstrated stress reduction from viewing aquatic life in an aquarium, lower heart rates and decrease in blood pressure. (Clements 2019 and Cracknell 2016)

The ornamental aquatic life, fish, invertebrates and aquatic plants industry is not like industries that produce food and shelter it is more like the Fashion Industry that relies on new products to excite customers to buy the latest trend. The rise of Social Media and other instant news forums has produced an intense interest in owning possessing the latest trend. This has happened recently with the smuggling of the small Mexican red crayfish and the Indonesian Assassin Snail. Neither of those are on the allowable import list. There is also a large Australia wide trade in red cherry shrimps and other small colourful crustaceans, all of which are smuggled except the native species from tropical NT and Qld.

The Authors of this report will determine that Dan Dority's Grime Rainbowfish *Glossolepis dorityi* does not possess any of the aspects of an organism that will cause problems should it escape effective human control. These aspects are reproduced from a statement prepared for a Court Case in the NT when an aquarium shop bought unassessed imported aquatic life to a Darwin Aquarium Shop. The statement was to be presented in the witness box by the author of this report, however the accused offender pleaded guilty.

### Disease

Introduced unassessed aquatic life entering Australia without appropriate quarantine or a risk assessment of the exporting country can carry exotic parasites and disease that may negatively impact on native species and aquaculture enterprises.

### Competition with native species

Introduced unassessed aquatic life that escapes human control may breed into very large numbers out competing native species for food and space possibly causing local extinctions of native species.

### Destruction of aquatic habitat

Introduced unassessed aquatic life that escapes human control may damage waterways by digging and moving substrate causing water to be clouded with silt, smothering plants and contributing to erosion.

### Dangerous species

Introduced unassessed aquatic life that escapes human control may have features that are a danger to humans, large venomous spines, very sharp teeth, even high voltage electrical discharge and could pose a danger to recreational and commercial activities in natural waterways.

### Impacts associated with Genetic Changes

Introduced unassessed aquatic life that escapes human control may be closely related to native aquatic life and be able to hybridise causing the loss of genetic diversity.

#### References

**Clements, Valentin, Rankin, Baker, Gee, Snellgrove, Sloman** (2019) "*The effects of interacting with fish in aquariums on human health and well-being: A systematic review*" published by Institute of Biomedical and Environmental Health Research, School of Health and Life Sciences, University of the West of Scotland, Paisley, United Kingdom.

**Cracknell, White, Pahl, Nichols & Depledge**. 2016 "*Marine Biota and Psychological Well-Being: A Preliminary Examination of Dose–Response Effects in an Aquarium Setting*" published by Environment and Behavior2016, Vol. 48(10) 1242 –1269© 2015 SAGE Publications

**Allen, G.R.**, 2001. A new species of rainbowfish (*Glossolepis*: Melanotaeniidae) from Irian Jaya, Indonesia. Fish. Sahul 15(3):766-775. (Ref. 44111)

https://www.fishbase.in/summary/Glossolepis-dorityi.html
**Froese, R. and D. Pauly**. Editors. 2020. FishBase.
World Wide Web electronic publication.
www.fishbase.org, version (12/2020).

## Terms of Reference

1. Provide information on the taxonomy of the species.

**Overview:** The rainbowfish genus *Glossolepis* consists of nine species occurring only in the northern half of New Guinea. The name *Glossolepis* consists of two words from the greek language: "glossa" = tongue "lepis" = scale and refers to the tongue-shaped scale margins.

Characteristic differences to the closely related Rainbowfish genera *Melanotaenia* and *Chilatherina* are:

- tongue-shaped scales,
- increased number of gill rakers,
- first spine of the second dorsal fin stronger than the first spine of the first dorsal fin and
- relatively elongated pectoral fins and enlarged teeth in the lateral wing of the remaxillary.

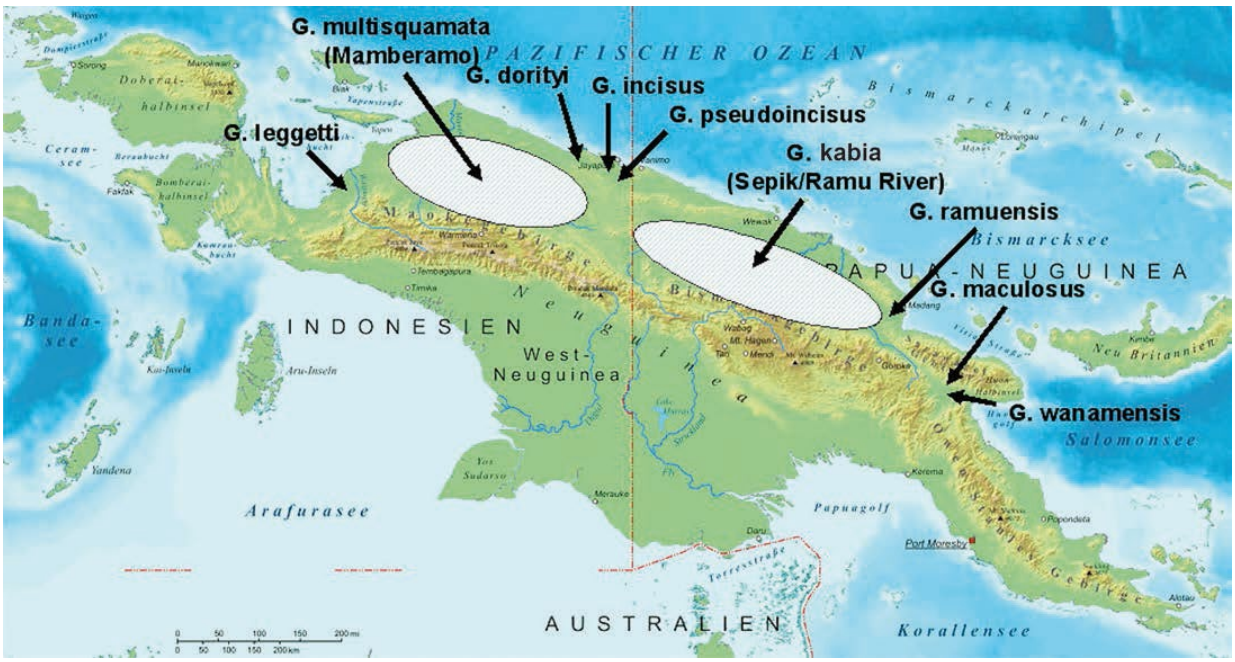

Fig. 1: Distribution of the genus *Glossolepis*. Map: Creative commons, modified.

**Information on the taxonomy of the species.**

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii (ray-finned Fishes)
Order: Atheriniformes (Silversides)
Family: Melanotaeniidae (Rainbowfishes)
Genus: *Glossolepis* (origin - *Glossolepis*: Greek, "glossa" = tongue, and "lepis" = scale which refers to the tongue shaped scale margins
Species: *Glossolepis dorityi* (Allen 2001), Dority's Rainbowfish, Zig-Zag rainbowfish

**Etymology:** *Glossolepis:* Greek, glossa = tongue + Greek, lepis = scale,
This species is named dorityi in honour of **Dan Dority** for his efforts in collecting the type specimens.

**Reference:**
**Allen, Gerald R.** (2001) A new species of rainbowfish (*Glossolepis*: Melanotaeniidae) from Irian Jaya, Fishes of Sahul, Journal of the Australia New Guinea fishes association, Volume 15, Number 3, PP766-775

*Glossolepis dorityi* from Lake Nenggwambu. © Johannes Graf

*Glossolepis dorityi mature male* from Lake Nenggwambu. © J. Felix


Creative commons. Distribution range of Glossolepis dorityi. © Johannes Graf

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.

A search of Convention for International Trade in Endangered Species (CITES) checklist with the search terms “Rainbowfish” and “Glossolepis” revealed no results for those entities. (accessed 21 April 2021).

A search of the International Union for the Conservation Red List web site indicated the Grime Rainbowfish, *Glossolepis dorityi* as critically endangered. It has listed the threatening process as residential and commercial development, aquaculture and agriculture and invasive species introductions. (Accessed 23 March 2021). The use of local trees for poisons to catch fish for food was also mentioned as a threatening process. Any specimens imported if the application is improved will be from aquaculture in the USA or Germany. No wild collections will be made.

A search of the International Union for the Conservation of Nature (IUCN) Red List indicated there are 9 species of Glossolepis listed.

*Glossolepis dorityi* listed as critically endangered
https://www.iucnredlist.org/species/161080437/161080455

*Glossolepis incisus* listed as endangered
https://www.iucnredlist.org/species/9268/147681075

*Glossolepis leggetti* listed as least concern
https://www.iucnredlist.org/species/161080708/161080713

*Glossolepis kabia* listed as least concern
https://www.iucnredlist.org/species/161080469/161080528

*Glossolepis maculosus* listed as endangered
https://www.iucnredlist.org/species/9269/147681182

*Glossolepis multisquamata* listed as least concern
https://www.iucnredlist.org/species/169502/147681206

*Glossolepis ramuensis* listed as vulnerable
https://www.iucnredlist.org/species/9271/147681464

*Glossolepis pseudoincisus* listed as vulnerable
https://www.iucnredlist.org/species/9270/147681435

*Glossolepis wanamensis* listed as critically endangered
https://www.iucnredlist.org/species/9272/147681490

**References:**

The Cites Species website with lists and search facility URL
http://www.cites.org/eng/disc/species.php

The IUCN Red List search facility locate at URL http://www.iucnredlist.org/search

**3. Provide information about the ecology of the species. Include, but do not restrict your response to:**

**3.a Lifespan of the species.**

Rainbowfishes, *Melanotaenia, Glossolepis* and *Chilatherina* are treated as one entity in regard to lifespan by Allen and Cross, they are said to live approximately 4 years in the natural location but can live up to 8 years when in captivity. (Allen and Cross 1982). Tappin 2011 suggested rainbowfishes from temperate waters have a longer life span than rainbowfishes from warm tropical areas.

**References:**
**Allen, G.R. & Cross, N.J.** (1982) "*Rainbowfishes of Australia and Papua New Guinea"*. Published by Angus and Robertson

**Tappin, A.R.,** (2011) "*Rainbowfishes, their care and keeping in captivity*" available on the world wide web as a portable document format (PDF) at universal resource locator http://www.mediafire.com/download/g7qzn85uqde8v8o/Rainbowfishes.2011.pdf

**3.b Size and weight range.**

**Allen,** (2001), records the Holotype of the species as being 88.0 mm standard length, and 14 paratypes as being between 77.4 and 115.0 mm standard length, which is also reflected by **Tappin, A.R.,** (2011)

**References:**
**Allen, Gerald R. (2001)** A new species of rainbowfish (*Glossolepis*: Melanotaeniidae) from Irian Jaya, Fishes of Sahul, Journal of the Australia New Guinea fishes association, Volume 15, Number 3, PP766-775

**Tappin, A.R.,** (2011) "*Rainbowfishes, their care and keeping in captivity*" available on the world wide web as a portable document format (PDF) at universal resource locator http://www.mediafire.com/download/g7qzn85uqde8v8o/Rainbowfishes.2011.pdf

**3.c The natural geographic range.**

*Glossolepis dorityi* is currently known only from the Grimé River region of northern West Papua. The area was formerly known by the Dutch administrators as the Nimboran (Grimé) Plain, was described by Boeseman (1963), although no reference was made to the floodplain lakes. The type locality consists of a small (estimated area of 4-5 hectares) round lake (Lake Nenggwambu). It is located roughly 50 kilometres west of Lake Sentani.

**References:**
**Allen, Gerald R. (2001)** A new species of rainbowfish (*Glossolepis*: Melanotaeniidae) from Irian Jaya, Fishes of Sahul, Journal of the Australia New Guinea fishes association, Volume 15, Number 3, PP766-775

**Boeseman, M. (1963)** Notes on the fishes of western New Guinea 1. Zool. Mededelingen, 38(14); 221-242.

**3.d Habitat.**

There is a vigorously flowing outlet stream, but no apparent inlet, indicative of a subterranean connection with neighbouring lakes via the limestone substratum. Water was relatively clear and maximum depth was estimated to be at least 10–15 m. The lake is surrounded by secondary forest and aquatic plants were abundant, but relatively few species were evident.

Fishes were most strongly congregated around the outlet, where vegetation was very dense. *G. dorityi* was the most abundant fish species and a second rainbowfish, *C. fasciata* was also common. The body colouration of this *C. fasciata* variety is mostly an orange to mauve and shows a golden luminescent nuptial stripe on their forehead which is switched on and off during spawning.

**Reference:**
**Allen, Gerald R.** (2001) A new species of rainbowfish (*Glossolepis*: Melanotaeniidae) from Irian Jaya, Fishes of Sahul, Journal of the Australia New Guinea fishes association, Volume 15, Number 3, PP766-775

**Graf, Johannes.** (2010) The genus *Glossolepis* International Rainbowfish Association (IRG) Special Edition no 1. of the "Rainbowfish" ISBN 978-3-936616-64-4

Lake Nenggwambu, habitat of *Glossolepis dorityi*. © Johannes Graf

### 3.e Diet, including potential to feed on agricultural plants

The specific diet of *Glossolepis dorityi* was not recorded by Allen (2001) but the diet of other members of the *Glossolepis* genus are well recorded. All rainbowfishes of the family Melanotaeniidae are reasonably similar in their dietary preferences. They are omnivores, eating a variety of small aquatic and terrestrial creatures and plant matter. Rainbowfishes have villiform teeth that extend outside their mouth around their lips to enable them to scrape algae from submerged hard surfaces. The diet includes algae, ants, aquatic insect larvae and small crustaceans. (Allen 1991)

### 3.f Social behaviour and groupings

Their founder described them as very abundant around the margins of Lake Nenggwambu. They were not schooling but in loose aggregations swimming at all levels in water half to one and a half meters deep. Allen (1991) describes the general behaviour of rainbowfishes as

small schooling fishes generally less than 12 cm in length and common in most habitats below 1500m elevation. The habits of other members of *Glossolepis* genus in captivity are well documented. Behavioural observations for *Glossolepis* are typical for most rainbowfishes and may be considered indicative of the behaviour of *Glossolepis Dorityi*. Tappin (2005) gives the following general descriptions of rainbowfish behaviour in the aquarium; “Rainbowfishes have very similar breeding habits, their food requirements are similar, and water that suits one particular species will suit all. All are of good-natured temperament and will live harmoniously, more or less, with one another. Rainbowfishes are a schooling fish, living in the midwater to the surface zone, often adjacent aquatic and emergent vegetation or snags in deeper water and in the quieter parts of streams at the head and bottom of riffles and rapids. From first light to mid morning dominant males will intensify in colour, select a feature such as a prominent piece of aquatic vegetation or small snag then attempt to lure and chase females into the area at the same time displaying erect fins to other nearby males trying to attract the same females. Males with close areas will sometime circle each other flaring their fins. This rarely causes any damage and as it is mostly stylized display to establish male dominance. Females generally select the male they mate with and the pair quiver side by side for a few seconds near the chosen feature before a simultaneous release of eggs and sperm. The pair split apart in a rapid burst, scattering the fertilized eggs into the vegetation. The eggs have sticky filaments and are generally caught in the vegetation where they remain for 5 to 11 days before hatching into well formed larvae with very small yolk sac.”

**Reference:**
Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson. (pp9-16)

3.g territorial and aggressive behaviours

Males with close areas will sometime circle each other flaring their fins. This rarely causes any damage and as it is mostly stylized display to establish male dominance. Rainbowfishes are peaceful towards each other and other species except for the male displays mentioned earlier. Keepers of aggressive species such as some cichlids use rainbowfishes as “dither fish” to diffuse aggressive behaviour because the are able to keep out of the way and distract the aggressive species from hurting each other.

Reference:
Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson. (pp9-16)

3.h natural predators

Rainbowfishes will form the diet of many predatory species of fish, water birds, aquatic reptiles and humans. The fish markets in Jayapura have dried Glossolepis for sale and they are eaten like biscuits. Some of the predatory fish families that eat rainbowfishes that occur in Australia and West Papua are; Ambassidae, Anguillidae, Apogonidae, Ariidae, Belonidae, Butidae, Carcharhinidae, Dasyatidae, Eleotridae, Gobiidae, Kuhliidae, Latidae, Lutjanidae, Megalopidae, Muraenidae, Osteoglossidae, Plotosidae, Sciaenidae, Synbranchidae, Terapontidae and Toxotidae. List compiled from Fishbase April 2021.

https://www.fishbase.se/country/CountryChecklist.php?resultPage=8&what=list&trpp=50&c_code=598&cpresence=Reported&sortby=alpha&ext_CL=on&ext_pic=on&vhabitat=fresh

3.i characteristics that may cause harm to humans and other species.

There are no really sharp spines or any toxins or venom in any member of the Melanotaeniidae family.

**Reference:**
Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson. (pp9-16)

Fishbase: https://www.fishbase.de/summary/Glossolepis-maculosa.html

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

There are no scientific records of any work done on the reproductive biology of *Glossolepis dorityi* but the description of the *Glossolepis dorityi* by Allan G.R (2001) states that it is closely related to *Glossolepis leggetti* and *Glossolepis multisquamatus. Glossolepis multisquamatus* is a species that is well known in the aquarium trade and has been kept and bred by the authors since 1983 from stock obtained from Melbourne. Four other *Glossolepis* species are well known in Australia; *Glossolepis maculosus, Glossolepis incisus, Glossolepis ramuensis* and *Glossolepis wanamensis*. The members of this genus were imported by various individuals from wild New Guinea populations up until 1986 when further import controls were placed on live ornamental fish importations.

**4.a The age at maturity (first breeding)**

The authors could find no record of this information for *Glossolepis dorityi* but generally Rainbowfishes start to breed about 6 months of age and are reported to live for about 4 years in their natural habitat and up to 8 years in captivity.

**Reference:**
Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson. (pp9-16)

**4.b how frequently breeding occurs**

The authors could find no record or observation for *Glossolepis dorityi* but closely related *Glossolepis* species will produce about 40 to 100 viable eggs a day for several consecutive days in a two week period. This amount of egg production will continue during times of good water quality and abundant foods which would occur for several months before, during and shortly after the wet season.

**Reference:**
Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson. (pp9-16)

**4.c if the female can store sperm**

The authors could find no record in any Rainbowfish books or papers examined of this family being able to store sperm. Rainbow fish are egg scatterers with eggs and sperm ejected simultaneously requiring both sexes for a successful fertile egg laying.

References
Tappin, A.R., (2011) “Rainbowfishes, their care and keeping in captivity” available on the world wide web as a portable document format (PDF) at universal resource locator http://www.mediafire.com/download/g7qzn85uqde8v8o/Rainbowfishes.2011.pdf

**4.d how many eggs or live-born young are produced at each breeding event**

The authors could find no record or observation for *Glossolepis dorityi* but closely related *Glossolepis* species will produce about 40 to 100 viable eggs a day for several consecutive

days in a two week period. This amount of egg production will continue during times of good water quality and abundant foods which would occur for several months before, during and shortly after the wet season.

**Reference:**
Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson. (pp9-16)

**4.e if the species has hybridised with other species (both in the wild and in captivity) or has the potential to hybridise with any other species**

Reports of naturally occurring rainbowfish hybrids in the wild are extremely rare. A report of naturally occurring hybrids between the genera *Melanotaenia* and *Chilatherina* can be found in Allen & Cross (1992) but there are no known naturally occurring hybrids between *Glossolepis* sp. and *Melanotaenia* sp.. There are no naturally occurring *Glossoplepis* species in Australia. Despite the fact that some species of *Glossolepis* have been kept as aquarium fish in Australia for several decades this genus has never established feral populations in Australia.

Based on Allen (1989) and other works, the species in this genus have evolved in isolation from each other and almost certainly differences in courtship and spawning behaviour would have evolved at the same time (indeed, such isolating mechanisms must be available in this one habitat for two or more taxa to have evolved to the level of genus!). Distinct species as we know them have evolved as separate breeding units because of physicochemical, behavioural and recognition cues. These are complex and species-specific and effectively restrict hybridization. That many species of rainbowfish are being raised in ponds adjacent to each other by breeders in Asia and elsewhere (and it is so unlikely that the tanks would always be uncontaminated), negates the likelihood of easy hybridisation between this and other rainbowfish taxa. There are reports, both published and anecdotal, of hybridisation between the various species of *Melanotaenia, Glossolepis, Chilatherina* and *Rhadinocentrus* as well as between genera. Virtually all of these have taken place either accidentally or on purpose under the artificial conditions within captivity.

There was no record or mention from Dr Allen of any hybrids of this species in its natural location. Hybridisation in rainbowfishes, although rarely occurring in nature, can be forced in the aquarium by providing only one sex of two different species. A closely related species, *Glossolepis incisus* was hybridized with a *Melanotaenia praecox* by Jarred Patrick of Bay Tropical Fish of Brisbane in an attempt to create appealing aquarium subject for commercial purposes. The resulting offspring were infertile. Overseas ( Europe and USA) some attempts have been made to establish “aquarium” strains of hybrids between various *Melanotaenia* species and none of these have become established in the trade, mainly because of hobby , club and market resistance to such crosses . The hobby groups overseas such as the RSG (Rainbowfish Study Group, in the USA) and the IRG (in Europe) and ANGFA here in Australia regularly advise hobbyists against buying or perpetuating such hybrids even when they are disguised under “pseudo-scientific” names such as *Melanotaenia marcii* etc. Hobbyists engage in continuous dialogue on various aspects of husbandry and conservation of rainbowfishes (as well as other species) on the Internet, social media and various discussion forums in several languages. The members of the Australia and New Guinea Rainbowfishes Association have a “Code of Conduct” that encourages enthusiasts to stay away from hybrid fish.

There are wild places that have many species of Rainbowfish living together, if hybridisation was common or easy there would only be one species with the features of the original 4 or 5 species at that location. The Mary River NT, at the southern end entry to Kakadu National Park has 4 species of Rainbowfish, *Melanotaenia trifasciata, M.exquisita, M.nigrans and M.splendida inornata*. No hybrids have been found there during many collections by Author 1.

References

**Tappin, A.R.,** (2011) "*Rainbowfishes, their care and keeping in captivity*" available on the world wide web as a portable document format (PDF) at universal resource locator http://www.mediafire.com/download/g7qzn85uqde8v8o/Rainbowfishes.2011.pdf

ANGFA "Code of Conduct"
https://www.angfa.org.au/about-constitution/206-angfa-code-of-conduct.html

ANGFA "Code of Conduct"
https://www.angfa.org.au/about-constitution/206-angfa-code-of-conduct.html

### 4.f Fertility of Hybrid Progeny

There is no record of *Glossolepis dorityi* being hybridized in captivity nor any observations of hybrids in their natural habitat. Hybrids of other *Glossolepis* with *Melanotaenia* produce infertile offspring. Recent Scientific Genetic studies are inconclusive regarding the possible fertility of hybrid offspring. Bay Tropical Fish in Qld, Jarrod Patrick tried to make a more colourful hybrid between Melanotaenia praecox and Glossolepis incisus, they produced an hybris but were unable to breed further fish from the hybrid, concluding it was infertile.

Majtánová and all, 2020, concluded that their DNA in the family Melanotaeniidae was sufficiently close for them all to hybridise. Author 1 called Dr Peter Unmack for clarification and was reminded that Rainbowfishes have been imported into Australia for many decades and none have caused any trouble from introductions to natural waterways, However there has been an hybridisation event in Running River a tributary of Barnett River Qld where a different Rainbowfish *Melanotaenia splendida splendida* has been introduced to a different Rainbowfish *Melanotaenia splendida* known as Running River Rainbowfish. Researchers for Australian National University have taken steps to preserve that over run species. However these are both in the *Melanotaenia splendida* group, very closely related.

Majtánová, Unmack, Prasongmaneerut, Shams, Srikulnath, Ráb and Ezaz (2020) "*Evidence of Interspecific ChromosomalDiversification in Rainbowfishes(Melanotaeniidae, Teleostei)*" published Genes2020,11, 818; doi:10.3390/genes11070818

### 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.

There are no records of this fish being translocated to another place. Despite the fact that some species of *Glossolepis* have been kept as aquarium fish in Australia for several decades this genus has never established feral populations here. *Glossolepis dorityi* has been introduced to Europe and North America and has not established feral populations.

**References:**

http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/new-legislation/submission/terrestrial-ecosystems.pdf

**Francis, Robert A.** (2012) A Handbook of Global Freshwater Invasive Species ISBN 978-1-84971-228-6

https://www.fishbase.de/summary/Glossolepis-dorityi.html
Froese, R. and D. Pauly. Editors. 2020. FishBase.
World Wide Web electronic publication.
www.fishbase.org, version (12/2020). Accessed 04 Apr 2021

**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 by Biosecurity Australia.**

*Glossolepis incisus,* has been assessed by Patricia Kialola for and on behalf of the Pet Industry Association of Australia. *Glossolepis leggetti* has been assessed by author 1 and was advised by email on 8th October 2020 that the fish has been approved and has been added to the allowable import list as created by S.303EB of the Environment Protection Biodiversity Conservation Act of 1999.

Panaquatic Health Solutions Pty Ltd conducted a review of the health risks associated with the importation of Rainbowfish for ornamental purposes.

**Reference:**

Amendment - List of Specimens Taken to be Suitable for Live Import (11/04/2005)
**https://www.legislation.gov.au/Details/F2005L00922/Explanatory%20Statement/Text**

**Panaquatic® Health Solutions Pty Ltd, 2009**, "*Scientific review of the Biosecurity risks associated with the importation of rainbowfish for ornamental purposes*", available as an electronic publication on World Wide Web Universal Resource Locator;
https://www.baphiq.gov.tw/public/Data/910614193571.pdf
, or
http://www.agriculture.gov.au/SiteCollectionDocuments/ba/animal/horsesubmissions/2009-24a-1_red_rainbowfish_attachment.pdf

**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. Include at least the following factors:

Bomford and Glover 2004 risk assessment process for estimating the ability of a fish species establishing within the Australian environment was prepared by Mary Bomford in 2004 Using the provisions in "Risk assessment model for import and keeping of exotic freshwater and Estuarine Fish" A report produced for the Department of the Environment and Heritage, Commonwealth of Australia 2004

Using the copy of Climex for PC provided to the Author by Mary Bomford the following calculations were done to provide a score against the provisions in the assessment process.

BOMFORD ASSESSMENT

SPECIES: *Glossolepis dorityi*

| **Score A, Climate Match** | | NT | Aus |
|---|---|---|---|
| Number of squares within 60% of the mean: | (No. 5) | 2 | 94 |
| Number of squares within 50% of the mean: | (No. 6) | 7 | 19 |
| Number of squares within 40% of the mean: | (No. 7) | 3 | 2 |
| Number of squares within 30% of the mean: | (No. 8) | 0 | |
| Number of squares within 20% of the mean: | (No. 9) | 0 | |
| Number of squares within 10% of the mean: | (No. 10) | 0 | |

| | NT | Aus |
|---|---|---|
| Total = | 12 | 115 |
| **Score:** | **2** | **3**(Ref: fishbase.org, PC CLIMATE) |

**Score B, Overseas Range**

Number of 1° x 1° grids in which species occures overseas.

No. of squares : <4

**Score:** **0** (Ref: fishbase.org, googleearth.com)

**Score C, Establishment**

Locations of establishment incidence: Nil

**Score:** **1** (Ref: fishbase.org)

**Score D, Introduction Success**

Percentage of Introduction events that have been successful

Introductions: nil

Successful:

**Score:** **2** (Ref: fishbase.org)

**Score E, Taxa risk**

**Genus:**

Introductions: 0

Successful: 0

**Score:** (Ref: fishbase.org / M. Bomford)

**Family:**

Introductions: 5

Successful: 5 unknown

**Score:** **2** (Ref: fishbase.org / M. Bomford)

AUS

**Total:** **7**

The score of 7 according to the assessment model gives the fish a moderate chance of establishment.

| Establishment Risk Rank | Establishment Risk Score |
|---|---|
| Extreme | 13 |
| Very High | 11–12 |
| High | 9–10 |
| Moderate | 6–8 |
| Low | 4–5 |
| Very Low | ≤ 3 |

## 7a. ability to find food sources

Glossolepis dorityi is a small forage species that lives at the margins of its natural habitat, from near the surface to the bottom in 1 to 1.5 meters of clear water. It will have a similar diet to all other Melanotaeniidae that is an omnivorous consisting of small terrestrial insects fallen in the water, aquatic insects, small aquatic crustaceans and algae. The whole family has small villiform teeth designed to scrape periphyton form hard submerged surfaces. The species will be ok in any environment with suitable water quality along with other small forage fishes with a similar diet.

**7b. ability to survive and adapt to different climatic conditions (e.g. temperatures, rainfall patterns)**

There is very little climate match between West Irian and the Australian continent. See Bomford risk assessment. There are few places where a large population is near a suitable aquatic environment for this species. Perhaps near Townville, Cairns and Darwin there maybe waters that will enable this fish to survive. There are people in these places putting tropical exotic species in ponds that are in flood prone areas. 72 species of exotic aquarium fish were released into the Katherine River in the 1999 floods that put nearly 4 meters of water through the main street emptying the aquariums in the local pet shop. Personal communication with proprietor, Cornelius Johansen. There have been no reports of ferals establishing in that river.

**7c. ability to find shelter**

The founder of the species describes the fish as swimming in loose groups near the edge not at the surface nor near the bottom but all levels of mid water in 1 to 1.5 meters depth. This to me indicates that its habits are similar to all other members of the Melanotaeniidae family. They are relaxed, spread out and swim in loose groups during a normal day, form schools if attacked by predators or when travelling. A personal observation from Author 1, at night most rainbowfishes are hard against the bank in very shallow water away from noctournal hunters in the deep water. This makes them an easy meal for Night Herron

7d. rate of reproducing

Glossolepis dorityi is assumed to be similar to other members of that genus, producing between 40 and 200 eggs several days in a row during a two week period in a time of good conditions. Fry survival would depend on the availability of small natural foods such as plankton, both zooplankton and phytoplankton.

**Reference:**
Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson. (pp9-16)

**7e. any characteristics that the species has which could increase its chance of survival in the Australian environment.**

Arthington et al. (1999) considered that there is a low or residual probability that New Guinea rainbowfishes would establish feral populations in Australia. Indeed, G. incisus has been here, and popular, for more than 25 years (and other New Guinea rainbowfishes are cultivated here also).

The risk assessment process for estimating the ability of a fish species establishing within the Australian environment was prepared by Mary Bomford in 2004 Using the provisions in “Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models” A report produced for the Department of the Environment and Heritage, Commonwealth of Australia 2004. Using the copy of Climex for PC provided to the Author by Bomford process indicates a score of 7 for *Glossolepis dorityi*, a moderate chance of survival in Australian water ways.

*Glossolepis dorityi* has a small distribution in North Western Irian Jaya restricted to the Grime River system and its tributaries. The natural spread of this species would occur similar to other rainbowfishes. Some of the spread mechanisms for rainbowfishes are upstream and downstream migrations especially in times of greater flow during wet season floods. Barriers such as waterfalls will prevent upstream migrations of rainbowfishes and the marine

environment is devoid of rainbowfishes so the estuaries of rivers prevent rainbowfishes from moving to new rivers via the sea (Allen 1995).

This species is a lake species only known from two lakes, the lake where it was collected is blue clear water, there are chunks of limestone in the channel where the water exits and the area is limestone base. This would indicate the water is most likely hard and alkaline with a pH over 7.5 and hardness 300 ppm or higher, alkalinity 150 ppm or higher based on Author 1 measurements of other limestone influenced water ways and from ANGFA Database records.

If Glossolepis dorityi were to escape effective control the area where the fish may establish is where the suitable climate is adjacent areas of more dense population, where the likelihood of accidental or intentional release is greater. Possible areas may include areas such as Townsville to Cairns, Queensland and the areas adjacent Darwin in the Northern Territory. The likelihood of escaping effective human control in the Kimberley region of WA is reduced because of the low population density. Since the most likely scenario for release into the wild will be by aquarium escape into the disturbed habitats surrounding major centres of population the survival of this species is extremely unlikely.

Even if somebody was prepared to transport expensive broodstock (plastic bags, oxygen, styrofoam boxes etc) to one of the possible suitable natural habitats (e.g. Lake Argyle in W.A. or Lawn Hill Gorge National Park in Queensland) and these conspicuous red and blue fish were to avoid the formidable spectrum of natural predators (an array of waterbirds, an even larger array of predatory fish such as barramundi, grunters etc, file snakes, and so on) and the species became established it is most likely that it would peacefully co-exist with the other small forage species, just as several species of native rainbowfishes, glassfishes, hardyheads and small gudgeons peacefully co-exist in many other habitats in Northern Australia. The naturally small restricted habitat of *Glossolepis dorityi* tends to suggest its behaviour is that of low invasiveness because it is not already widespread despite suitable habitat surrounding its natural distribution. It is also possible that locally predators in that area are efficient in controlling its numbers and reducing its spread into adjacent habitats. *Glossolepis* have no demonstrated salt tolerance therefore no tendency to invade other drainages via estuary migration (Allen and Cross 1982, Allen 1989, Allen 1991, Allen 1995, Allen et al 2002, Herbert and Peeters 1995, Lake 1978, Larson and Martin 1990, Leggett and Merrick 1987, Lever 1996, Merrick and Schmida 1984). IUCN suggest the species may be extinct in the wild.

**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:**

It would appear from conversations with the founder of the species that this species is only found in a few small areas in West Papua. The IUCN list it as possibly extinct in the wild due to introductions of feral species such as tilapia and channa. It was also mentioned there is a local practise of using crushed root compounds to poison fish. In the NT local use roots of *Derris trifoliata* and Freshwater Mangrove, *Barrintonia acutangular*, both these plants occur in New Guinea and through SE Asia, many of these species that have bark and roots that are used to kill fish are common in North Australia and New Guinea.

Reference ;

Brock ( 1998 ) "*Top End Native Plants*" published by John Brock.

Cowie, Short, Osterkamp-Madsen (2000) "*Floodplain Flora*" published by Environment Australia and NT Parks and Wildlife

IUCN red list of Threatened Species URL - https://www.iucnredlist.org/

**8.a similar niche species (ie. competition with other species for food, shelter etc.)**

If *Glossolepis dorityi* were to establish in natural waterways, it would mix with the similar forage fishes and most likely school with local rainbowfishes, glassfishes, hardyheads, gudgeons and other similar species. It would be competing with the other small omnivores that eat small crustaceans, aquatic insects, terrestrial insects and algae. In some river systems in Australia, up to four species of rainbowfish coexist without either obvious competition or inter-breeding (e.g. Mary River, N.T., Jardine River, Qld.). It can be assumed that because *Glossolepis dorityi* is similar to and is most closely related to *Glossolepis leggetti,* and *G.multisquamatus* and other members of the *Glossolepis* genus the behaviour will be similar. Aquarium observations worldwide of *Glossolepis dorityi* have been recorded to be similar to other related fish from this genera are mid to surface dwellers, exhibiting little aggression toward other fish except from breeding males and this aggression is stylized display that is harmless and generally ignored by fishes of other species and mostly ignored by their own species except other males trying to attract available females.

Reference:
Aqua-fish.net – since 2005 - https://en.aqua-fish.net/fish/doritys-rainbowfish

**8.b probable prey/food sources**

Generally rainbowfishes are omnivorous eating mainly algae which they scrape from harder surfaces with their villiform teeth that extend to the outside of the jaws. They will also take advantage of small crustaceans, aquatic and terrestrial insects when available. Grime Rainbowfish, *Glossolepis dorityi* is a small omnivore, a second order consumer that itself would form part of the diet of larger predatory fishes. It is a species with a maximum recorded length of 104 mm (Allan 2001). The predators in the Grime River System are similar but less in number than the predators in the undisturbed habitats in the North of Australia.

**8.c habitat and local environmental conditions**

*Glossolepis dorityi* are mid water swimmer and thus cause no disturbance to the substrate or cause water turbidity. Their dietary components (algae and aquatic organisms) are abundant in any healthy ecosystem. This species breeds by laying eggs on aquatic vegetation or debris and does not damage the habitat doing so. They exhibit no parental care so have no extra biological advantage over other rainbowfish or other egg laying species.

The introduction of disease from the introduction of a *Glossolepis* sp. into the natural environment is unlikely to pose any further risk than other endemic freshwater fish species as there are no known fish diseases or strains specific to Melanotaeniids. Any diseases that are carried into native waters by escaped *G. dorityi* (Fishbase records diseases in other *Glossolepis* species such as fin rot, flukes and general bacterial infections) are unlikely to be more lethal to Australian rainbowfishes than would diseases they may already by carrying. In particular, with Mycobacteriosis, a common captive disease of rainbowfish worldwide, there is no *Mycobacterium* species specific to melanotaeniids (ANGFA, 2002). Kahn et al. (1999) stated that mycobacteriosis equally affects a wide range of freshwater and marine aquarium fish in Australia.
There is no firm evidence, from all of the areas where other *Glossolepis*, e.g. *G. incisus,* are raised, that it has formed or will form feral populations. In the unlikely event that it would in northern Australia, those populations would be more likely to be under pressure from native Australian aquatic predators than would populations of other small exotic fishes (such as those of guppies and swordtails which are a permitted import to Australia and have formed feral populations) because their habits would be more 'familiar' to predators. There is no information that describes any control or eradication of this genus.

A disease import risk assessment report was prepared by Panaquatic Health Solutions for Biosecurity Australia concluded there were 4 diseases of concern but revealed that all these diseases also occur in Australian waters.

Reference :

Hardy-Smith P., Jones R. and Kailola P. (2007) *"Scientific review of the biosecurity risks associated with the importation of rainbowfish for ornamental purposes"* - Prepared for Biosecurity Australia by Panaquatic® Health Solutions Pty Ltd

IUCN red list of Threatened Species URL - https://www.iucnredlist.org/

**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).**

Arthington et al. (1999) considered that there is a low or residual probability that New Guinea rainbowfishes would establish feral populations in Australia. Indeed, *Glossolepis incisus, maculosus, ramuensis, multisquamatus,* and *wanamensiss* have been here, and popular, for more than 35 years (and other New Guinea rainbowfishes are cultivated here also). Permitting *Glossolepis dorityi* into Australia would not create undue pressure on the populations in the Grime River system as all stocks would come initially from German breeders and then from commercial facilities to which these captive bred stocks are distributed. Further demand from the Grime River system would be unnecessary once captive stocks are established as ease of supply would be greater from these sources (as it would be very difficult to form an aquarium fish exporting business in West Papua).

*G. dorityi* poses no greater threat to Australian aquatic biodiversity than does the other *Glossolepis* sp*. (Glossolepis. incisus,* and *soon glossolepis leggetti)* currently permitted for import. The distinctive colouration of this species, likely popularity of this species among hobbyists, and expectant relatively high price should together mitigate against any likelihood of accidental establishment of feral populations. It is unknown whether this species has any distinctive features that would make it readily identifiable at a small size, rainbowfish fry at 10 millimetres are relatively difficult to differentiate to a species level. It is therefore recommended that any importation of these fish should be a minimum length of 4 centimetres for ease of identification.

As it is planned that species is to be imported via a commercial facility in Europe and then distributed via commercial facilities in Australia it may be difficult to control the distribution and abundance of the species once established in Australia. The establishment of a permit system would not be feasible on an individual fish basis as it would require coordination of permits from the wholesaler, to the individual retailer and then on to the individual purchaser, certainly crossing state boundaries in the process.

Retailers/traders should be encouraged to engage in "best practice" and to provide relevant information brochures to buyers of this species. At present, there are numerous Melanotaeniidae species being kept in Australia that have been derived from very small numbers of fish, imported pre-1986 and surviving despite very narrow genetic variability. The genetic basis of this species will be considerably wider and thus the need for "fresh" wild stock imports at a later date will be unlikely. Importation of single sex or reproductively altered individuals would not be of any value to the recipient aquaculture business.

**10. Provide a summary of the proposed activity, including the intended use of the species (e.g. pet, commercial, scientific).**

If accepted for import, *Glossolepis dorityi* will be used in the live fish ornamental aquarium display trade. *Glossolepis dorityi* are to be added to the live import list to legitimise the use of the species within Australia as an ornamental aquarium fish. Five of the nine species of *Glossolepis* have been in Australia prior to 1983, G*lossolepis incisus* and Glossolepis *leggetti* appear on the 'List of Specimens Suitable for Live Import' under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act. Rainbowfish of the genus *Glossolepis* have been used as an ornamental species within the aquarium hobby and aquarium trade in Australia ever since their introduction in the 1960's.

If *Glossolepis dorityi* is added to the allowable import list it is logical that aquarium fish importers will most likely import this species as part of the normal numbers of species imported from the usual foreign sources of ornamental aquarium fishes that are acceptable to the conditions imposed by the Biosecurity Act 1915.

**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. You must include:**

The fish will be transported as per the conditions set down by the International Air Transport Association (IATA) guidelines and the provisions of AQIS policy document 99/2750a (AQIS 1999). The importation of the species will adhere to provisions of Biosecurity Australia advice 2009/24 issued 02 October 2009. Keeping in captivity, husbandry information is well documented by Tappin 2005.

Reference:
Tappin, Adrian. (2005) "*Rainbowfishes ~ Their Care & Keeping in Captivity Second Edition - 2011"* available on World Wide Web electronic publication at URL http://www.mediafire.com/file/g7qzn85uqde8v8o/Rainbowfishes.2011.pdf

**11. a 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 specimens if approved for import will be imported under the same provisions and disease protocols as used for other ornamental fishes imported by Aquarium Importers and the current quarantine practices as outlined by Biosecurity Australia Advice 2009/24 of 2 October 2009. They will be kept in aquariums with lids inside buildings.

**11.b the disposal options for surplus specimens**

The species will be kept under the same conditions as any other members of the same genus would be kept in Aquaria. The Aquarium trade will treat this fish in a similar to other members of the genus *Glossolepis* which have been bred and traded in Australia since the 1970's when they were first imported legally by Barry Crockford of Melbourne, and continuously imported until 1986 when the importation of New Guinea rainbowfishes ceased. The importers of this fish will comply with provisions under conditions as outlined in advice 2009/24 issued by Biosecurity Australia 02 October 2009. *Glossolepis dorityi* will be kept under conditions that mimic the water quality and diet that are as close as possible to the limited knowledge of its natural habitat.

There is a process in place under the provisions of the new Biosecurity Act 2015 for importing Ornamental Fishes and the disease protocols to prevent fish carrying disease into Australia. The proponents do not intend to import any *Glossolepis dorityi* into Australia but realise that other importers may do so. Any importer will have to follow the quarantine protocols put in place by the Department of Agriculture Water, and the Environment. Australian Government

Department of Agriculture Water, and the Environment, conditions for importing live ornamental fish into Australia available on the world wide web at universal resource locator - http://www.agriculture.gov.au/import/goods/live-animals/importing-live-fish-aus

If application is successful and Author 1 is able to farm this species any surplus production will be handled as any other excess fish. Unwanted fish are euthanised by overdose of anaesthetic and used as aquatic plant fertiliser.

Reference :
Aquagreen Aquarium and Pond Keepers Code of Conduct – available at URL - https://www.aquagreen.com.au/files/Code_of_Conduct_V5.pdf

**12. Provide information on all other Commonwealth, state and territory legislative controls on the species, including:**
- **the species' current quarantine status, or**
- **pest or noxious status, or**
- **whether it is prohibited or controlled by permit or licence in any state or territory.**

In the book by Robert Francis (2012) A Handbook of Global Freshwater Invasive Species, there are no references or instances of any *Glossolepis* spp. being an invasive or noxious species, anywhere in the world.

### 12.a The Commonwealth Government

Regulation of fish imports is in two parts, biosecurity and possible risk to the environment. Environmental risk is controlled and assessed under provisions the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The list of allowable species of fishes for importation into Australia and *Glossolepis dorityi* is not included on the current list. The current list of fishes allowed for importation occurs in section 303 EB of the Environment Protection and Biodiversity Conservation Act 1999 Information about importation of fishes is available on Department of The Environment and Energy web site accessed through universal resource locator accessed 24 March 2021 - https://www.legislation.gov.au/Series/F2006B01053

The disease risk assessment used to be controlled by the provisions of the Quarantine Act 1908. The current legislation is the Biosecurity Act 2015 as in force 25 march 2020 available on the Federal Register of Legislation at Universal Resource Locator https://www.legislation.gov.au/Details/C2020C00127 and accessed 24 march 2021. The Federal Department that changes its name regularly and is responsible for the administration of these acts this week is The Department of Agriculture, Water and the Environment which was established on 1 February 2020.

### 12.b The Northern Territory Government

The Northern Territory Fisheries Division Department of Industry, Tourism and Trade will not allow *Glossolepis dorityi* across its border unless it has passed the Commonwealth guidelines for acceptance into Australia. The list of species of fishes allowed into the Northern Territory for ornamental fishes is the same as Commonwealth list under the provisions of the EPBC Act 1999 or native to Australia but with the possibility of having the species rejected if it is deemed unsuitable by the NT. Minister for Fisheries as outlined in section 26 of the Northern Territory Fisheries Regulations 2017. The most current version of the Northern Territory Fisheries Regulations is available on line at universal resource locator accessed 24/03/2021 - https://nt.gov.au/marine/for-all-harbour-and-boat-users/aquatic-pests-marine-and-

freshwater/list-of-noxious-fish and shows no *glossolepis* on that list that was last updated 16 March 2018.

### 12.c The Queensland Government

The Queensland legislation to control possession of noxious fish called “Restricted Matter” comes under the provisions of the Biosecurity Act 2014, Schedule 2 lists Noxious Fish in the Restricted matter schedule. Part 6 of the Act lists further Noxious Fish. *Glossolepis dorityi* is not listed on this schedule as noxious fish or listed in the restricted matter schedule. The most current version of Queensland Biosecurity Act 2014 can be accessed on the world wide web at universal resource locator -
https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/B/BiosecurityA14.pdf
and there are no glossolepis on the list. Accessed 05 April 2021

### 12.d The Western Australian Government

Under Regulation 176 of the Fish Resources Management Regulations 1995, a person must not bring into the State a species of fish not endemic to the State without the written approval, or written authority, of the Executive Director of the Department of Fisheries. Species listed as noxious under Schedule 5 of the Fish Resources Management Regulations 1995 and prohibited to be imported into the State. *Glossolepis dorityi* is not listed as noxious or restricted in Western Australia. West Australian Government Fish Resources Management Regulations 1995 current at 9 Dec 2016 accessed 14 March 2017, available on world wide web universal resource locator -
https://www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_1458_homepage.html The West Australian Government of noxious fish list accessed 24/11/2017, is available on the world wide web at universal resource locator -
http://www.fish.wa.gov.au/Documents/biosecurity/noxious_fish_list.pdf and shows no glossolepis on that list.

### 12.e The South Australian Government

The South Australian Fisheries legislation relating to exotic aquarium is a “Noxious Fish List” created under the provisions of the Fisheries Management Act 2007.

The Fisheries Management Act is available here -
https://www.legislation.sa.gov.au/LZ/C/A/FISHERIES%20MANAGEMENT%20ACT%202007.aspx and was accessed 05 April 2021.

The noxious fish list is available on SA Gov web site available here -
https://pir.sa.gov.au/biosecurity/aquatics/aquatic_pests/noxious_fish_list - accessed on 05 April 2021.

A search of that list did not locate any listing of *Glossolepis dorityi*.

### 12.f The New South Wales Government

*NSW Government* implemented the Biosecurity Act 2015 (the Act). ... Under Section 18 of the *Regulation* it is illegal to possess, buy, sell or move notifiable aquatic pests in *NSW*. It is also an offence to possess any prohibited matter. *Glossolepis dorityi* is not listed as a pest fish. Schedule 2 of that act lists “Prohibited Matter” that includes freshwater fish species. A check of the prohibited matter list failed to locate any record of Glossolepis dorityi

That act and schedule can be located here - https://www.legislation.nsw.gov.au/view/html/inforce/current/act-2015-024#sch.2 – accessed 05 April 2021

### 12.g The Victorian Government

Section 75 of the Victorian Fisheries Act 1995, allows the declaration of certain species as "Noxious Aquatic Species". The Victorian Government publishes the Noxious Aquatic Species List on their web site. *Glossolepis dorityi* does not appear on this list. The list of Victorian Government declared noxious species is available on the World Wide Web at universal resource The Victorian Fisheries Act accessed 07/04/2021 is available on the World Wide Web at universal resource locator - https://vfa.vic.gov.au/operational-policy/pests-and-diseases/noxious-aquatic-species-in-victoria

### 12.h Tasmania

To import freshwater aquarium or pond fish into Tasmania the Inland Fisheries Service lists allowable species. The list is created under the provisions of the Animal Health Act 1995, a list of allowable species is created under the provisions of that act and published on Tasmanian Government URL - https://dpipwe.tas.gov.au/Documents/IFS%20Permissible%20Fish%20List.pdf
A number of apecies are declared pest species and Controlled Species and Noxious Fish must not be imported.
Glossolepis dorityi is not a listed noxious fish. Glossolepis dorityi is not listed as an allowable species.

### References


Allen, G.R. (1989). "*Freshwater Fishes of Australia*", TFH Publications, New Jersey.

Allen, Gerald R., (1991) "*Freshwater Fishes of New Guinea"* Christensen Research Institute Publication no. 9, Madang, PNG

Allen, Gerald .R. (1995) "*Rainbowfishes in Nature and in the Aquarium*" Tetra Press, Germany.

Allen, G.R. and N.J. Cross (1982). Rainbowfishes of Australia and Papua New Guinea. Angus & Robertson.

Allen, G.R., S.H. Midgley and M. Allen (2002). Field Guide to the Freshwater Fishes of Australia, Western Australian Museum.

Allen, Gerald R. and Renyaan, Samuel J. ( 1998 ) "*Three New Species of Rainbowfish (Melanotaeniidae) from Irian Jaya, Indonesia*", Aqua Journal of Ichthyology and Aquatic Biology, Vol. 3 (2), September 1998.

ANGFA. 2002. *Response to the Thorogood report on Glossolepis incisus*. Australia New Guinea Fishes Association. 15 p.

ANGFA Database available on the world wide web at URL http://db.angfa.org.au
If reviewers require further information contact Author 1 for password access.

ANGFA "Code of Conduct" available on the world wide web at URL https://angfa.org.au/index.php?option=com_attachments&task=download&id=64

Arnold, K.E. (2000). Kin recognition in rainbowfish (*Melanotaenia eachamensis*): sex, sibs and shoaling. PHD thesis, University of QLD.

**Arthington, A.H., Milton, D.A. and McKay, R.J.** (1983) "*Effects of urban development And habitat alterations on the distribution and abundance of native exotic freshwater fish in the Brisbane region, Queensland*". Australian Journal of Ecology, 8: 87-101.

**Arthington, A. H.; Kailola, P. J.; Woodland, D. J.; Zaluki, J. M.** (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

Bioisecurity Act 2015 as in force 25 march 2020, available on Federal Register of Legislation at Universal Resource Locator https://www.legislation.gov.au/Details/C2020C00127 Accessed 24 march 2021

**Bomford, Mary** (2006) "Risk assessment for the establishment of exotic vertebrates in Australia: recalibration and refinement of models" A report produced for the Department of the Environment and Heritage, Commonwealth of Australia

**Bomford, Mary and Glover, Julie** (June 2004) "*Risk assessment model for the import and keeping of exotic freshwater and estuarine finfish*", A report produced by the Bureau of Rural Sciences for The Department of Environment and Heritage.

**Briggs, Glen.** (2021) Personal communication in his capacity as part time international fish buyer for Aquarium Industries, Melbourne, Australia. Telephone: 03 9409 930

**Brock**, **John** ( 1998 ) "*Top End Native Plants*" published by John Brock.

**Clements, Valentin, Rankin, Baker, Gee, Snellgrove, Sloman** (2019) "*The effects of interacting with fish in aquariums on human health and well-being: A systematic review*" published by Institute of Biomedical and Environmental Health Research, School of Health and Life Sciences, University of the West of Scotland, Paisley, United Kingdom.

Convention on International Trade of Endangered Species threatened species database available on the universal resource locator http://www.cites.org/eng/resources/species.html Accessed on 24 March 2021

**Cowie, Short, Osterkamp-Madsen** (2000) "*Floodplain Flora*" published by Environment Australia and NT Parks and Wildlife

**Cracknell, White, Pahl, Nichols & Depledge**. 2016 "*Marine Biota and Psychological Well-Being: A Preliminary Examination of Dose–Response Effects in an Aquarium Setting*" published by Environment and Behavior2016, Vol. 48(10) 1242 –1269© 2015 SAGE Publications

Environment Protection Biodiversity Conservation Act 1999 Australian Commonwealth Legislation available as an electronic publication from the world wide web at universal resource locator https://www.legislation.gov.au/Details/C2021C00081 as in force 16 December 2020, accessed 24 march 2021

**Dority, Dan**, personal communication with Author number 1 March 2021, phone 0499 913 712 Dan now lives in Darwin.

**Flanney, Tim** (1994) "*The Future Eaters: An Ecological History of the Australasian Lands and People"*, ISBN 0-8021-3943-4 ISBN 0-7301-0422-2

**Francis, Robert A**., (2012) "A Handbook of Global Freshwater Invasive Species" Published by Taylor and Francis

**Froese, R. and D. Pauly**. Editors. 2020. FishBase.
World Wide Web electronic publication.
www.fishbase.org, version (12/2020). Accessed 24 march 2020

Hardy-Smith, Jones, Kailola (2009) "*Scientific review of the biosecurity risks associated with the importation of rainbowfish for ornamental purposes*" prepared for Biosecurity Australia by Panaquatic Health Solutions Pty Ltd.

Herbert, B. and J. Peters (1995). Freshwater Fishes of Far North Queensland Department of Primary Industries, Queensland.

International International Union for Conservation of Nature and Natural Resources red list. http://www.redlist.org/search/search-basic accessed March 2021

Jarred Patrick, Bay Tropical Fish, Brisbane, personal communication to Author.

Kahn, S.A., Wilson, P.W., Pereira, R.P., Hayder, H. and Gerrity, S.E. 1999. *Import Risk analysis on live ornamental finfish*. Canberra: Australian Quarantine and Inspection Service. 172 p.

Kailola, P.J. 2004 "Risk assessment of ten species of ornamental fish under the *Environment Protection and Biodiversity Conservation Act 1999"*

Lake J.S., (1978). Australian Freshwater Fishes – an Illustrated Field Guide. Nelson, Australia.

Larson, H.K. and K.C. Martin (1990). Freshwater Fishes of the Northern Territory. Northern Territory Museum, Darwin.

Lawson, David (1997) The Northern Territory Government policy "Strategy for Conservation through Sustainable Use of Wildlife"
http://www.nretas.nt.gov.au/__data/assets/pdf_file/0018/11187/sustainable_utilisation_wildlife.pdf

Leggett, R. and J.R. Merrick (1987). Australian Native Fishes for Aquariums, Griffin Press.

Lever, C. (1996). Naturalised Fishes of the World Academic Press. ISBN 0-12-444745-725

McCosker, J. (1998). Mate choice and sexual selection in two species of Australian rainbowfish (*M. duboulayi and M. splendida splendida*): implication for speciation. Honours thesis, University of Queensland.

McNee, Alex ( no date on publication ) "A national approach to the management of exotic fish species in the aquarium trade: An inventory of exotic freshwater species" Published by Bureau of Rural Sciences, Canberra

Merrick, J.R. and G.E. Schmida (1984). Australian Freshwater Fishes, Biology and Management. Griffin Press.

Northern Territory of Australia Fisheries Act 1988 as in force 20 June 2018 and Northern Territory of Australia Fisheries Regulations 1992 as in force from 31 July 2020. Northern Territory Government Legislation available as an electronic publication from world wide web universal resource locator - http://www.nt.gov.au/dcm/legislation/current.html accessed 24 March 2021

Phelong, P.C. (1996) "Climex: a system to predict the distribution of an organism based on climate preferences". Available as a download from West Australian Government universal resource locator http://www.agric.wa.gov.au

Queensland Fisheries Act 1994. Available as a download from universal resource locator - http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/F/FisherA94

Queensland Fisheries Regulation 1995. Available as a download from universal resource locator - www.legislation.qld.gov.au/LEGISLTN/CURRENT/F/FisherR95

Schmida, G.E. (2000) "*Rainbowfish, A Complete Pet Owners Manual*"

Tappin, Adrian. (2005) "Home of the rainbowfish" available on World Wide Web electronic publication at URL http://members.optushome.com.au/chelmon/index.htm

Tappin, Adrian. (2005) "*Rainbowfishes ~ Their Care & Keeping in Captivity Second Edition - 2011"* available on World Wide Web electronic publication at URL http://www.mediafire.com/file/g7qzn85uqde8v8o/Rainbowfishes.2011.pdf

University of Queensland (1998). Rainbowfish Workshop. Proceedings of workshop discussing various student projects – UQ and Griffith Universities.

Wilson, D.N. & Biggs, C (2004) "Aquarium and Pond Keepers Code of Conduct" available as a download from World Wide Web electronic publication at URL http://www.aquagreen.com.au/files/Code_of_Conduct_V5.pdf