National Environmental Science Program

Threats, risk assessment and recovery action planning for rare and threatened freshwater fish in Queensland's Wet Tropics region

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Acknowledgement of Country

We acknowledge the Traditional Owners of Country throughout Australia and their continuing connection to and stewardship of land, sea and community. We pay our respects to them and their cultures and to their Ancestors, Elders and future leaders. Our Indigenous research partnerships are a valued and respected component of National Environmental Science Program research.

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EXECUTIVE SUMMARY

This report presents a comprehensive desktop review, risk assessment and list of potential recovery actions for 22 rare and threatened freshwater fish species in Queensland's Wet Tropics region. Threats to these species in the Wet Tropics include climate change, land use alteration, invasive species, fire regimes, natural disasters, water resource management and infrastructure, residential development and recreational use, hybridization with sister species, and overharvesting and illicit collection. The risk assessment was conducted during a workshop attended by experts from a range of organisations including government, universities, consultancies and local management.

The risk assessment identified several species at very high risk to some threats. Changes in the flow regime and occurrence of extreme events such as cyclones, drought and landslides were rated as very high risk to Daintree and Cairns rainbowfishes and cling gobies (except *Sicyopterus* spp.). Remaining populations of *Melanotaenia* rainbowfishes (Malanda, Utchee Creek and Lake Eacham) are at very high risk of hybridization with eastern rainbowfish, the spread of which is accelerated by habitat degradation that leads to warmer water temperatures. Bloomfield River cod are at very high risk of impacts associated with invasive and translocated fish due to their restricted range and overlapping diet and habitat preferences with introduced species.

Several other threats were identified as high risk across most of the species, including climate change (changes in temperature, rainfall, flow), invasive species (fish, weeds, pigs), habitat and water quality degradation, natural disasters (catastrophic cyclones, floods, droughts) and water resource development and infrastructure. Threats that were generally rated low to moderate risk to the assessed species included overharvesting and illicit collection and altered fire regimes.

The prioritised recovery action planning identified a suite of potential high-priority, feasible, and cost-effective actions to mitigate key threats and support species recovery. These include:

- Research to fill critical knowledge gaps: understanding the biology and ecology of species for which there is still little information available.
- Conservation translocations and captive breeding: establishment of insurance populations for easily reared species at imminent risk, such as Malanda and Daintree rainbowfishes. Investigating the feasibility of captive breeding Bloomfield River cod.
- Habitat restoration: riparian revegetation, erosion control, and instream habitat enhancement in priority catchments.
- Invasive species management: targeted control of non-native fish and weeds, and exclusion of feral animals from sensitive habitats.
- Community and stakeholder engagement: strengthening partnerships with First Nations groups, local landholders, and community groups to support on-ground actions and stewardship.

This report provides detailed information that can be used to develop a multi-species Recovery Action Plan for rare and threatened freshwater fish of the Wet Tropics. The desktop review of available information on each species highlighted knowledge gaps on key aspects of the biology and ecology of some species that is critical to developing targeted management actions. Taxonomic resolution and description of rare or threatened species not included in this risk assessment is also urgently needed. The risk assessment should be updated in the future to include these species, and as new data and emerging threats arise.

1. INTRODUCTION

Wet Tropics region

The Wet Tropics bioregion is located along the coastline of the northeastern part of the Australian continent, stretching 450 km from Cooktown in the north to Townsville in the south (Figure 1). Contained within the bioregion is the Wet Tropics World Heritage Area (WTWHA), which is comprised of 894,420 hectares of mostly tropical rainforests (UNESCO, 2025). The combination of the tropical monsoonal climate and mountainous geography result in high rainfall during the Australian summer and a distinctively high dry season rainfall as a result of cloud capture and orographic forcing (BOM, 2019). The climate is hot and humid, with average annual rainfall around 1980 mm (but up to 12,000 mm in the high-altitude areas) and an average of 86 days per year with temperatures above 30°C (BOM, 2019). The terrain is dominated by rugged mountain ranges, tablelands and lowland coastal plains, with elevations ranging from sea level to around 1700 m asl (Pearson, 2016). Granite is the major geology, with some basaltic intrusions (Pearson et al., 2015). The region exhibits a variety of freshwater systems including rivers, streams, crater lakes and floodplain wetlands. The Wet Tropics bioregion, defined by the mapping of major vegetation communities, is used to delineate the extent of the Wet Tropics (Thackway & Cresswell, 1995). It includes streams in the upper reaches of some western-draining catchments, such as the Mitchell and certain headwater tributaries of the Burdekin (Figure 2). However, the bioregionalization of freshwater fish in these western draining catchments is different from the eastern draining rivers and streams within the Wet Tropics (Shelley et al., 2019). The eastern draining streams are generally shorter, with higher gradients and reduced floodplains compared to those flowing westward (Pearson et al., 2015).

Eastern draining streams of the Wet Tropics flow through tropical rainforest into the Coral Sea. These tropical rainforests are relicts of the Gondwanan forest that once covered Australia and Antarctica 50 to 100 million years ago and contain a high biodiversity, with the region covering less than 0.2% of the Australian continent but containing around half of the nation's species (UNESCO, 2025). A high proportion of these species have a small population size and restricted distribution due to the unique biogeographical processes that shaped the region's biodiversity and the legacy of past clearing in the region, resulting in a high number of rare and vulnerable species, despite legislative protection (DES, 2019; Wet Tropics Management Authority, 2024). These species are evolutionary records of rainforest plant and vertebrate fauna from which many of the fauna that inhabit the surrounding continent have evolved (UNESCO, 2025). Among these vertebrates are a diverse and distinctive freshwater fish assemblage (41% of Australia's fish species), with 131 native and at least nine non-native species recorded in the Wet Tropics (B. Pusey et al., 2008; Wet Tropics Management Authority, 2013, 2024). Of the 131 native species, approximately 65% rely on freshwater habitats and the remainder are marine species that may occasionally visit freshwater (B. Pusey et al., 2008; Wet Tropics Management Authority, 2013). The number of endemic freshwater fish in the wet tropics is low compared to terrestrial vertebrates, and many of these endemic species are listed as threatened, endangered or critically endangered due to human induced threats and their high vulnerability to these threats due to small population size. Further, the habitat of these species mostly exists outside of protected areas, where 89% of fish species in the region have less than 20% of their total Wet Tropics distribution within International Union for Conservation of Nature (IUCN) category II protected areas (Januchowski-Hartley et al., 2011).

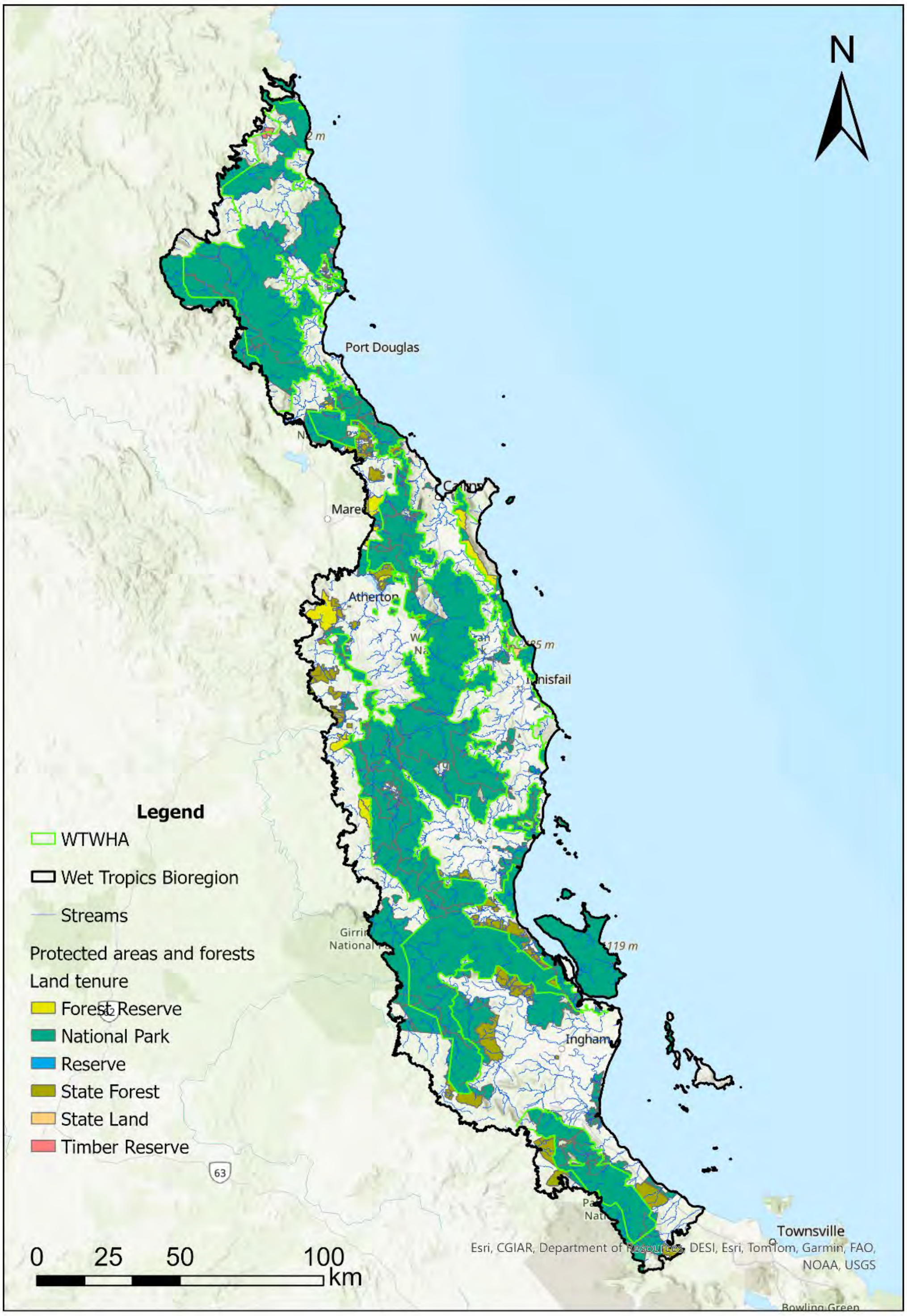

Figure 12. Protected areas and significant wetlands in the Wet Tropics bioregion (Protected areas and forests of Queensland lot, State of Queensland Department of Environment, Science, and Innovation, 2025). WTWHA = Wet Tropics World Heritage Area (State of Queensland Department of Environment and Science, 2011).

Historically, human induced threats to the Wet Tropics were dominated by impacts associated with intensive land use change from natural to agricultural, grazing or forestry, including clearing of native vegetation and increased levels of pollutants in the soils and waterways (Lewis et al., 2021). Lowland rainforests were cleared for sugar cane production and highland rainforests (e.g. Atherton

Tablelands) were cleared for cultivation and grazing (Lewis et al., 2021). Over the past two decades, the predominant threats shifted as the rate of land use change slowed and other threats intensified (Lewis et al., 2021; Wet Tropics Management Authority, 2024). These intensified threats include invasive species, climate change, changes to the fire and hydrological regimes, and occurrence of catastrophic weather events such as large floods (Wet Tropics Management Authority, 2024). Freshwater fish species endemic to the Wet Tropics are exposed to one or more of these threats and a risk assessment of these threats is critical to informing management actions that aim to conserve freshwater biodiversity in the Wet Tropics (B. Pusey et al., 2008). Conservation targets for vulnerable, threatened, endangered, or critically endangered freshwater fish are focused on the downlisting of these species to future proof populations against intensifying and interacting threats (Lintermans et al., 2020). Understanding the risks of threats to these species is imperative for identifying knowledge gaps and setting priority goals for species management.

Figure 23. Hydrological features of the Wet Tropics bioregion. Layers include management areas of wetlands of high ecological significance (HES) and general ecological significance (GES) (State of Queensland Department of Environment and Science, 2011); A Directory of Important Wetlands in Australia, 3rd Edition (Environment Australia Wetland Inventory Team, Northern Region, DEHP, 2001); major catchment boundaries and rivers and streams.

Objectives and approach to threat and risk assessment

The objective of this report is to deliver key information that can be used to develop a Recovery Action Plan for species where it is deemed necessary to conserve their populations into the future. A Recovery Action Plan provides a strategic framework to support the conservation and recovery of threatened species in Queensland. Key information required to develop a Recovery Action Plan includes an assessment of key threats and this report aims to provide that assessment for endemic, rare, and threatened freshwater fish species of the Wet Tropics region. Firstly, publicly available existing information on the conservation status, biology and ecology, distribution and key threats to each priority rare and threatened species is presented. Historical, current, and future threats to freshwater ecosystems of the Wet Tropics are then discussed, as well as any management actions taken to mitigate the impacts of these threats to freshwater ecosystems. This information was reviewed by a suite of experts prior to attending a workshop to assess the risks of each threat to these species. During the expert workshop, threats to each species were assessed in terms of the timing of the threat (i.e., past, ongoing or future), its scope (i.e., the proportion of the total population affected) and severity (i.e., the overall declines caused by the threat). This information was considered by experts when assessing risks from each threat (in terms of likelihood and consequence). The likelihood and consequence assessments were used to assign risk ratings for each species and threat, which were then used to guide a set of goals for recovery actions for these species. The purpose of these goals is to highlight knowledge gaps to prioritise future research and identify critical populations requiring on-ground management action.

2. CONTEXT

2.1. Priority rare and threatened freshwater fish species

The diverse and distinctive freshwater fish assemblage of the Wet Tropics region is contained within 37 families, with almost half within six families: Eleotridae (gudgeons), Gobiidae (gobies), Ambassidae (glassfishes), Mugilidae (mullets), Terapontidae (grunters) and Plotosidae (eel-tailed catfish) (B. Pusey et al., 2008). The Russell/Mulgrave, Johnstone and Daintree River catchments are among the most species rich catchments in the region, which is thought to be due to the year-round reliability of flow, resulting in fewer extinctions (B. J. Pusey & Kennard, 1996). Flow perenniality in these catchments is mostly attributed to the Great Dividing Range reaching its northeastern Australian maximum (>1750 m asl) in their headwaters, resulting in dry season orographic forcing of rainfall due to wind interception and cloud capture (B. Pusey et al., 2008).

Latitudinal gradients and profile changes along river gradients also appear to influence freshwater fish assemblages in the wet tropics (B. J. Pusey & Kennard, 1996). The river profiles change dramatically from headwaters to estuary due to the mountainous terrain of the Wet Tropics and the resulting fish assemblages are determined in part by species' life history and dispersal ability (B. J. Pusey & Kennard, 1996). The Wet Tropics contains both large rivers and small coastal streams draining high mountain ranges, referred to as short, steep, coastal streams. The aquatic habitat and fish assemblages differ between these distinct drainage types (B. C. Ebner et al., 2014; B. J. Pusey & Kennard, 1996; P. A. Thuesen et al., 2011). Further, large river systems in the Wet Tropics contain several distinct habitat types that vary with altitude, gradient and stream order, including upland rainforest streams along the mountain tops and plateaus (e.g. Atherton Tablelands), high gradient main channels abundant with waterfalls, riffles, rapids, and cascades, lowland river channels, and lowland floodplains adjacent to river channels (Godfrey et al., 2022; B. Pusey et al., 2008).

The Wet Tropics region contains more endemic freshwater fish species than any other region of north-eastern Australia (Unmack 2001), several of which are listed as Critically Endangered (Daintree rainbowfish, Malanda rainbowfish), Endangered (Cairns rainbowfish, Lake Eacham rainbowfish, Utchee Creek rainbowfish, Mulgrave goby), and Vulnerable (Bloomfield River cod) on the IUCN Red List of Threatened Species. There are also several endemic species for which little is known about their biology and ecology, highlighting the potential for these species to be vulnerable to threat impacts. Therefore, this threat assessment and recovery action plan report focuses on a suite of 22 rare and/or threatened fish species in the Wet Tropics (Table 1). A set of criteria was used for identifying species to be included in this study. Species were chosen if they exist exclusively or primarily within the Wet Tropics and are reliant on or spend most of their lives in freshwater. There must also be knowledge available on their taxonomy, biology and ecology to enable the risk assessment to be undertaken. The unresolved taxonomy of several species in the Wet Tropics indicates that there are likely to be further endemic species that should be included in a risk assessment but first require taxonomic description and research to fill knowledge gaps on their biology and ecology that would inform a future assessment. An example of these species is the *Mogurnda* genus complex, which recent genetic study has revealed to likely be composed of seven distinct species (Amini et al., 2025), and several rainbowfish species that are yet to have their taxonomy resolved (*Pers Comms.*, P. Unmack). These include; 1) a group referred to as "Tully rainbowfish", which are found above Tully Falls and in the North Beatrice River (a tributary of the North Johnstone River); 2) "Misty Mountain rainbowfish" which are only found in a single tributary (Downey Creek) of the South Johnstone River; 3) "Hilda Creek rainbowfish" which is a sister species to *Melanotaenia utcheensis* and is only known from a single creek in the Daintree River (*Pers Comms.*, P. Unmack).

The 22 reviewed species are contained within six families, including Gobiidae (gobies, 12 spp.), Melanotaeniidae (rainbowfishes, 5 spp.), Plotosidae (eel-tailed catfishes, 1 spp.), Percichthyidae (cods and basses, 1 spp.), Terapontidae (grunters, 1 spp.), Muraenidae (moray eel, 1 spp.) and Soleidae (freshwater sole, 1 spp). Many of these species are restricted to single river basins and distinct habitat types, making them vulnerable to threat impacts (B. Pusey et al., 2008). The freshwater moray and most of the cling goby species are found in short, steep coastal streams (B. C. Ebner, Fulton, et al., 2016; B. C. Ebner & Thuesen, 2011), while the red-tailed cling goby, and the ocellated and Mulgrave River gobies are found in both main channels and smaller streams. Most of the endemic rainbowfish species are found in smaller rainforest tributaries, whereas the Wet Tropics tandan, Bloomfield River cod and khaki grunter are found mostly in main channel environments (B. Pusey et al., 2004; Welsh et al., 2014). The distribution of Hogan's freshwater sole is poorly understood but appears restricted to the tidal lower freshwater reaches of larger rivers. A more detailed review of the conservation status, biology and ecology, distribution and key threats to each species is provided in Appendix 1. This information is critical to ensuring the vulnerability of each species to key threats is well understood prior to undertaking the risk assessment. This information was gathered from global and Australian grey and published literature, including the IUCN assessment for each species and Conservation Advice documents for species listed under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999. Distribution maps were generated for most species using only publicly available data from the Queensland Government Species Profiles, WildNet and ALA databases and are therefore not a comprehensive representation of species distributions.

Table 1. List of priority endemic, rare, and/or threatened freshwater fish species of the Wet Tropics Australia. EPBC Act (1999) categories for listed species include Critically Endangered (CE) and Endangered (E). Queensland Nature Conservation Act 1992 (QLD NCA 1992) categories for listed species include Critically Endangered (CE), Endangered (E), and Vulnerable (V). IUCN Red Listed of Threatened Species (IUCN) assessment categories for listed species include Critically Endangered (CR), Endangered (EN), Vulnerable (V), Data Deficient (DD) and Least Concern (LC). Species names are linked to Fishes of Australia web pages for each species.

				Conservation status					
Family	**Species**	**Author**	**Common name**	**EPBC Act**	**QLD NCA 1992**	**IUCN**	**Qld Fisheries Act**	**Distribution (sourced from Fishes of Australia)**	**Endemic to Wet Tropics**
Plotosidae	*Tandanus tropicanus*	Welsh, Jerry & Burrows 2014	Wet Tropics Tandan			LC		Endemic to coastal rivers of the Wet Tropics region of northeast Queensland, including the Daintree, Mulgrave-Russell, Johnstone, Tully, and Five Mile drainage basins.	1
Melanotaeniidae	*Cairnsichthys bitaeniatus*	Allen, Hammer & Raadik 2018	Daintree rainbowfish	CE	CE	CR	-	Endemic to small tributary streams of the Cooper Creek and nearby Hutchinson Creek systems of the Daintree region, north-eastern Queensland.	1
Melanotaeniidae	*Melanotaenia* sp. nov. 'Malanda'	-	Malanda rainbowfish	CE	CE	CR	-	Endemic to the Malanda district of the southern Atherton Tablelands, north Queensland - in four small isolated upper tributaries of the North Johnstone River.	1
Melanotaeniidae	*Cairnsichthys rhombosomoides*	(Nichols & Raven 1928)	Cairns rainbowfish	E	E	EN	-	Endemic to the Wet Tropics in northern Queensland, from the Daintree - Cape Tribulation area, 120 km north of Cairns to the Innisfail region.	1
Melanotaeniidae	*Melanotaenia eachamensis*	Allen & Cross 1982	Lake Eacham rainbowfish	E	-	EN	-	Endemic to the upper reaches of the Barron, North Johnstone and South Johnstone River catchments at altitudes above 500 m above sea level; also in Koombooloomba Dam on the Tully River, Atherton Tablelands, Queensland.	1
Melanotaeniidae	*Melanotaenia utcheensis*	McGuigan 2001	Utchee Creek rainbowfish	-	-	EN	-	Known only from lowland tributaries of the North and South Johnstone Rivers, Queensland - including the Utchee, Fisher, Rankin and Short Creeks in the North and South Johnstone River catchments.	1
Percichthyidae	*Guyu wujalwujalensis*	Pusey & Kennard 2001	Bloomfield River cod	-	-	V	No take	Endemic to the Bloomfield River, upstream of Bloomfield Falls.	1
Terapontidae	*Hephaestus tulliensis*	De Vis 1884	Khaki grunter	-	-	LC	-	Known only from easterly flowing drainages between the Daintree River and the Herbert River, in the Wet Tropics region of northeast Queensland.	1

Family	Species	Author	Common name	Conservation status				Distribution (sourced from Fishes of Australia)	Endemic to Wet Tropics
				EPBC Act	QLD NCA 1992	IUCN	Qld Fisheries Act		
Gobiidae	Awaous ocellaris	(Broussonet 1782)	Ocellated river goby	-	-	LC	-	Occurs in coastal streams in northeast Queensland. Elsewhere, the species is widespread in the Indo-west-central Pacific.	0
Gobiidae	Glossogobius bellendenensis	Hoese & Allen 2009	Mulgrave goby	-	-	EN	-	Occurs in the Russell, Mulgrave and Mossman rivers and creeks near Cairns in north-eastern Queensland.	1
Gobiidae	Schismatogobius hoesei	(Keith, Lord & Larson 2017)	Scaleless goby	-	-	LC		Endemic to the Wet Tropics region of Queensland and recorded from the Endeavour River to Liverpool Creek.	1
Gobiidae	Sicyopterus cynocephalus	(Valenciennes 1837)	Cleft-lipped goby	-	-	LC	No take (as "cling goby")	Queensland Wet Tropics, south of Cairns. Elsewhere the species occurs in the tropical, west Pacific, from the Philippines and Indonesia, eastwards to the Solomon Islands.	0
Gobiidae	Sicyopterus lagocephalus	(Pallas 1770)	Red-tailed goby, Blue stream goby	-	-	LC	No take (as "cling goby")	Occurs in the Wet Tropics, Queensland, from the Bloomfield River to the Nyleta Creek, south of Cairns. Elsewhere, the species occurs in the Indo-west-central Pacific.	0
Gobiidae	Sicyopus discordipinnis	Watson 1995	Red-bum goby	-	-	LC	No take (as "cling goby")	Queensland Wet Tropics, in the Noah Creek catchment and Paul's Pocket Creek, Queensland, at altitudes between 100 and 191 m above sea level, and in the Cedar Bay, Cape Tribulation and Malbon-Thompson area. Elsewhere, the species occurs in Indonesia (Sulawesi and West Papua), Papua New Guinea and the Solomon Islands.	0
Gobiidae	Smilosicyopus fehlmanni	(Parenti & Maciolek 1993)	Fehlmann's Sicyopus	-	-	LC	No take (as "cling goby")	Occurs upstream of waterfalls in a number of short steep coastal streams in the Wet Tropics. Elsewhere the species is found in the tropical, west-central Pacific, Palau to New Caledonia.	0
Gobiidae	Smilosicyopus leprurus	(Sakai & Nakamura 1979)	Frog goby, Scaled tail Sicyopus	-	-	LC	No take (as "cling goby")	Pauls Pocket Creek, east side Malbon-Thompson Range, QLD; tropical, west Pacific (Japan and Palau to Australia).	0
Gobiidae	Stiphodon pelewensis (formerly S. atratus)	Herre 1936	Black Stiphodon	-	V	LC	No take (as "cling goby")	North of Cooktown to south of Cairns, Queensland. Elsewhere the species occurs in the west Pacific: Palau, New Guinea, Indonesia, Solomon Islands, Vanuatu and New Caledonia.	0

Family	Species	Author	Common name	Conservation status				Distribution (sourced from Fishes of Australia)	Endemic to Wet Tropics
				EPBC Act	QLD NCA 1992	IUCN	Qld Fisheries Act		
Gobiidae	*Stiphodon rutilaureus*	Watson 1996	Golden-red Stiphodon, Orange cling goby	-	V	LC	No take (as "cling goby")	Queensland Wet Tropics, from north of the Daintree River to south of Cairns. Elsewhere the species occurs in the West-Pacific - Indonesia (Irian Jaya), Papua New Guinea, Solomon Islands, Vanuatu, Fiji and New Caledonia.	0
Gobiidae	*Stiphodon semoni*	Weber 1895	Opal cling goby	CE	-	LC	No take (as "cling goby")	Wet Tropics of north Queensland from north of the Daintree River to south of Cairns. Elsewhere the species is widespread in streams throughout Australasia, the Indo-Malaya Archipelago, and Oceania. This species occurs in 9 of 18 catchments within the Wet Tropics.	0
Gobiidae	*Stiphodon surrufus (formerly S. birdsong)*	Watson & Kottelat 1995	Emerald cling goby	-	E	LC	No take (as "cling goby")	South of Cairns, QLD, and elsewhere in Papua New Guinea, Indonesia (West Papua) and the Solomon Islands.	0
Muraenidae	*Gymnothorax polyuranodon*	(Bleeker 1853)	Freshwater moray	-	-	LC		Wet Tropics region of northeast Queensland. Elsewhere the species occurs in the tropical Indo-West Pacific: Sri Lanka, Indonesia, Borneo, New Guinea, Philippines, New Caledonia and Fiji.	0
Soleidae	*Synclidopus hogani*	Johnson & Randall 2008	Hogan's sole			DD		Known only from the tidal lower freshwater reaches of the Daintree River, upstream from Daintree, Queensland. May also occur in Arnot Creek in the Herbert River (Wet Tropics Report Card 2022).	1

2.2. Desktop review of threats to freshwater fish species of the Wet Tropics

There are several threats to the priority rare and threatened freshwater fish of the Wet Tropics listed in Table 1. These threats and their mechanism for impact are described briefly in Table 2 and in more detail in Sections 2.2.1 - 2.2.9.

Table 2. Key threat categories to freshwater fish in the Wet Tropics and their mechanisms for impact. The associated IUCN threat classification level is also given.

Threat	IUCN threat class level 1	IUCN threat class level 2	Primary mechanisms for impact in the Wet Tropics
Saline intrusion and sea level rise	11. Climate Change	11.1 Changes in Physical & Chemical Regimes	• Sea level rise may push the freshwater-estuarine interface westward, further reducing already limited lengths of large lowland river that are preferred by some species. • Inundation of floodplain wetlands due to sea level rise and saline intrusion of groundwater may induce loss of these wetlands as they transition to saline systems, making them uninhabitable for fish.
Changes in equatorial currents		11.1 Changes in Physical & Chemical Regimes	• Amphidromous fish larvae rely on predictable ocean currents to remain within reach of suitable freshwater habitats. • Shifts in current direction or strength can carry larvae too far from shore or into unsuitable areas. • If currents carry larvae away from river mouths, their chances of successful recruitment are sharply reduced. • Currents often synchronize with larval development periods and any changes in seasonal or interannual patterns can cause mismatches between larval release and favourable transport conditions.
Rising temperatures		11.2 Changes in Temperature Regimes	• Impacts of increased air and water temperatures will depend on species' optimal thermal range, outside of which growth and reproduction may be negatively affected. • Fish assemblages will change as species move to new areas. Impacts of this will likely be greatest in cooler highland streams as eastern rainbowfish move into the habitat of and hybridize with other *Melanotaenia* rainbowfishes.

Changes in rainfall, runoff, flow regimes		11.3 Changes in Precipitation & Hydrological Regimes	• Predicted vegetation changes from rainforest to vine forest may cause habitat changes in the surrounding aquatic environment (e.g. change in stream shading or bank stability and shape), impacting the assemblage composition of invertebrates and fish. • The effects of a higher cloud and humidity layer are expected to be most significant in the dry season via more pronounced seasonality, threatening the perennial status of rivers. This will have pronounced impacts on the invertebrate and fish assemblages due to the preference of several species for flowing habitat.
Clearing, fragmentation, and land use change	2. Agriculture & Aquaculture, 5. Biological Resource Use & Control	2.1 Annual & Perennial Non-Timber Crops, 2.2 Wood & Pulp Plantations, 2.3 Terrestrial Animal Farming, Ranching & Herding, 5.3 Logging, Harvesting & Controlling Trees	• The health of the aquatic ecosystems adjacent to agricultural land uses depends on the buffer width and condition of the riparian forests. • Riparian vegetation clearing that leads to bank instability and increased erosion degrades freshwater habitat via changes to waterway morphology, habitat complexity, water quality, and food availability. • Riparian clearing increases water temperatures and may alter the instream light environment (from red dominated to blue dominated) which may influence spawning display and the ability of females to assess male fitness, possibly increasing the risk of hybridization.
Water quality degradation	9. Pollution	9.1 Water-Borne & Other Effluent Pollution	• Water quality impacts associated with agricultural land uses include the input of nutrients, sediments, organic material, and pesticides into waterways. • Excess nutrients build up as fertilizers enter the waterways, causing eutrophication and excessive growth of aquatic plants, including invasive weeds. • Major pesticides reaching waterways in the Wet Tropics include herbicides such as ametryn, atrazine, and diuron and the insecticide imidacloprid which are likely to have toxicity impacts. • Organic pollution severely deoxygenates waterways via bacterial respiration, causing fish kills. • Discharge from sugar mills is heavily loaded with sugars and leads to proliferation of microbial film that heavily impacts macroinvertebrate communities, a key food source for fish.

			• Drains and levees on the floodplain can allow saltwater intrusion and expose acid-sulfate soils, causing high levels of acidity that degrade water quality, leading to reduced biodiversity and increased exposure to diseases (e.g. epizootic ulcerative syndrome).
Aquatic habitat degradation		5.3 Logging, Harvesting & Controlling Trees	• Fish diversity is directly affected by the health of riparian systems due to the influence of riparian health on stream habitat structure, with a higher abundance of alien species found in degraded streams. • Habitat complexity and riparian cover directly affect the diversity and composition of macroinvertebrate assemblages, a key prey item for fish.
Invasive weeds	8. Invasive / Other Problematic Species, Genes & Pathogens	8.1 Invasive Non-Native / Alien Species	• Fish will be impacted by habitat changes caused by weeds, including channelisation of flow, increased velocities and stream incision. • Weeds reduce water quality, causing hypoxic conditions that render the habitat unsuitable for fish. • The proliferation of aquatic weeds is exacerbated by reduced canopy cover associated with riparian vegetation clearing, severely depleting dissolved oxygen and impeding fish movement, making the waterway uninhabitable for many species. • The proliferation of weeds limits the growth of native macrophytes, thereby placing bottom-up food web restrictions on food availability for fish because weeds are not consumed by fish. • Weeds also facilitate the invasion of invasive fish species.
Invasive terrestrial animals and stock		8.1 Invasive Non-Native / Alien Species	• Feral pigs and stocked animals (e.g. cattle) cause extensive damage to riparian and riverine habitats when accessing waterways to drink. Pigs also cause damage to habitat when feeding (rooting) or wallowing. • Trampling of vegetation exacerbates soil and bank erosion and repeated walking into waterways severely disturbs sediment and aquatic vegetation and fauna.
Invasive fish		8.1 Invasive Non-Native / Alien Species	• The primary species of invasive fish in the Wet Tropics are two species of tilapia and four species of Poeciliidae. • While tilapia consume mostly plant material, competition with native fish occurs indirectly through shared food resources and directly via predation of fish eggs and aggressive behaviour exhibited by reproducing individuals.

			• Tilapia can thrive in, and contribute to, poor water quality due to their high tolerance for saline and low oxygen conditions and feeding and nesting behaviour that damages substrate. • Impacts of the Poeciliidae species include mosquitofish displaying aggression towards natives (e.g. fin nipping), mosquitofish and guppy predation on native eggs and fry, and overlap of their diet with natives. • Guppies and mosquitofish are also known vectors of diseases and parasites.
Translocated fish – hybridization		8.2 Problematic Native Species	• Hybridization with translocated native fish can result in genetic introgression, which can lead to loss of a unique lineage. • Hybrid offspring may have reduced fitness if the introduced genes disrupt adaptations to the local environment, making them less suited to survive in their natural habitat. • Hybrids may exhibit lower survival, reproduction, or overall performance compared to pure individuals due to incompatible gene combinations or breakdown of co-adapted gene complexes.
Translocated fish – ecological impacts		8.2 Problematic Native Species	• Several fish species that are native to other Australian waterways have been intentionally released (illegally and legally through Fisheries stocking programs, referred to here as translocated) into Wet Tropics waterways that do not naturally contain these species. • The ecological impacts of these introductions can rival or exceed those of invasive fish species and have led to local extinctions of endemic species in some locations in the Wet Tropics. • The primary documented mechanism for this impact is predation by translocated species, particularly predation on small-bodied endemic species.
Altered fire regimes (increased severity)	7. Natural System Management & Modifications	7.1 Fire & Fire Management	• Waterway contamination with ash causes deoxygenation and declines in water quality. Deoxygenation can cause physiological stress and fish kills. Threatened freshwater fish that have a restricted range or a single population remaining are highly vulnerable fire due to possible deoxygenation of water across the entire population. • Habitat changes can occur if riparian vegetation is burnt, including changes to hydrology resulting from fallen debris, reduced shading, and increased erosion.

Increased frequency/severity of cyclones extreme rainfall, and extreme floods	10. Natural Disasters	10.2 Severe Weather Events	• Large floods can cause major disturbance to the terrestrial and aquatic habitat and severe degradation of water quality. • These disturbances can lead to continued degradation of water quality, loss of connectivity due to hydrological changes associated with flood damage and debris transport, and changes to food availability for fish due to habitat changes. • Fish species with a restricted range or few, small remaining populations are particularly vulnerable to these water quality and habitat changes because their entire habitat can be damaged.
Landslides		10.2 Severe Weather Events	• Landslides can destroy riparian habitat and cause extreme increases in sediment loads, resulting in long periods of turbidity, changes to mesohabitat (e.g. reduction in pools) and potential barriers to fish movement as sediment slugs form in river channels. • Fish that nest in the substrate may be impacted by unfavourable nesting conditions as increased sediment can suffocate eggs and larvae. • Mobilised soils increase elemental chemical transfer to streams. Bacteria that oxidise iron form persistent red slime biofilms that covers aquatic habitat for months or years following landslides. • This slime causes severe food web and nesting site disruptions. Algal grazing fish are left without food supply, and invertivores are also impacted by changes to algal grazing invertebrates. Loss of plant cover may also reduce allochthonous input (leaf litter, insects).
Heatwaves		10.2 Severe Weather Events	• Heatwaves can increase water temperatures and highland cool refugia species will be most impacted by this if water temperatures exceed their preferred thermal range. • The impact of heatwaves will be exacerbated during droughts when waters are flowing slower and therefore experience more severe temperature rises.
Drought		10.2 Severe Weather Events	• Droughts reduce river flow and extreme droughts in the Wet Tropics may cause perennial rivers to cease flow in the dry season, resulting in changes to the invertebrate and fish assemblages due to the preference of some species for flowing habitat.

Altered hydrology	7. Natural System Management & Modifications	7.2 Dams & Water Management / Use	• Water extraction via impoundments, aquifers, and directly from streams alters hydrology in the Wet Tropics. • Hydrological alterations can impact the area of available preferred habitat that is required by fish of various life stages during specific seasons, resulting in reduced survival or spawning and recruitment success. • Water extraction can reduce connectivity, impacting fish movement through reduced movement opportunity. Reduced connectivity also interrupts the drift of amphidromous fish larvae from fresh to marine waters and mortality of larvae may occur when they do not reach waters of required higher salinity in time to develop.
Impoundment of riverine habitat		7.2 Dams & Water Management / Use	• Impoundments cause a change in habitat from shallower, flowing habitat to open, deeper pools that promote a higher richness of invasive weed and fish species.
Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)			• Dams, weirs, bridges, culverts, and causeways can be barriers to fish movement.
Over-harvesting/illicit collection	5. Biological Resource Use & Control	5.4 Fishing, Harvesting & Controlling Aquatic Species	• Small populations are especially vulnerable to even low levels of harvest. • Over-harvesting can reduce population size below viable thresholds, making recovery difficult or impossible. • Highly endemic species or those with unique coloration or morphology are targeted for the aquarium trade and are at high risk of illicit collection.
Increased human (and pet) visitor usage and modification of riparian zones and instream areas			• Human and animal faeces cause increased nutrient and bacterial loads in streams, resulting in poor water quality and facilitating algal blooms. • Humans move rocks to create small spas for swimming, altering the water flow and displacing habitat for periphyton, fish and macroinvertebrates. Building of rock cairns causes similar impacts.

2.2.1. Climate change

Climate change poses a major threat to the unique biogeography of the Wet Tropics and adjacent Great Barrier Reef due to the mountainous terrain and the integral role that temperature plays in cloud height and precipitation in this region (Hilbert et al., 2014). Recognising the major threat that climate change poses to the biodiversity of the region, the Wet Tropics Management Authority has implemented the '*Climate Adaptation Plan for the Wet Tropics: 2020-2030'* that aims to improve landscape resilience and facilitate transition to adaptive communities and Industries (Wet Tropics Management Authority, 2019). Understanding projected changes to the climate is key to preparing mitigation measures but can be difficult when the projections show low confidence for some aspects of the climate (McInnes et al., 2015).

Air temperatures in the Wet Tropics have been increasing since national observations began in 1910, with a 1.1 °C mean surface air temperature increase between 1910 and 2013 (McInnes et al., 2015). Climate projections predict with high confidence that there is likely to be a substantial increase in the temperature on the hottest days, the frequency of hot days, and the duration of warm spells (McInnes et al., 2015). The Shared Socioeconomic Pathways second scenario (SSP2: where trends broadly follow their historical patterns) predicts continued air temperature rises across the Wet Tropics, with the largest mean temperature rise (~1.6 °C by 2070) predicted for the winter months (June-August) (Queensland Future Climate Dashboard - CMIP6: Queensland Government, 2025). There is less clarity in the effects of climate change on rainfall, with rainfall changes possible, but uncertainty around whether these will mean a wetter or drier climate for the Wet Tropics (McInnes et al., 2015). The intensity of heavy rainfall events is likely to increase, and tropical cyclones are expected to be more intense but less frequent (McInnes et al., 2015). The SSP2 scenario predicts decreased wet season rainfall and small increases in dry season rainfall in the Wet Tropics (Queensland Future Climate Dashboard - CMIP6: Queensland Government, 2025). On the landscape, evapotranspiration is expected to increase and soil moisture decrease (McInnes et al., 2015). Little change is projected for fire frequency but fires are expected to be more extreme (McInnes et al., 2015). Sea level has been steadily rising since 1966 and is expected to continue to rise, although the rate of rise throughout the 21st century is highly dependent on future emissions (McInnes et al., 2015). These projected changes are a significant threat to the long-term preservation of ecosystems in the Wet Tropics and are expected to cause numerous impacts on the region's vegetation and biota (Hilbert et al., 2014). Impacts will vary between highland and lowland areas due to the reliance on cloud formation and height in highland areas and proximity to marine waters in lowland areas.

In the highlands, the mountain tops and tablelands are refugia 'islands' of cool temperatures surrounded by warm air in the valleys and savannah. These islands form a scattered archipelago of habitat for organisms that are unable to survive and reproduce in warmer climates, including several endemic freshwater fish that prefer cooler high elevation streams (B. Pusey et al., 2008; Wet Tropics Management Authority, 2024). Movement between these islands is not possible for these fish due to the disconnection of streams by mountains (B. Pusey et al., 2008). The low cloud layer that is integral to lower temperatures and higher precipitation in these highland areas is expected to rise as the air temperature rises, with a possible lift from 600–900m by 2050 (DES, 2019; Wet Tropics Management Authority, 2014). Scenarios with a high degree of warming predict a decrease in suitable environment for highland rainforests and coastal complexes, and an increase in suitable environment for various types of vine forest (Hilbert, 2010). These vegetation changes may cause habitat changes in the surrounding aquatic environment (e.g. change in stream shading or bank stability and shape). The effects of a higher cloud and humidity layer are expected to be most significant in the dry season, which is when these forests and streams are most reliant on the moisture from cloud contact

(Hilbert, 2010). More pronounced seasonality of precipitation threatens the perennial status that most of the rivers in the Wet Tropics currently hold (M. J. Kennard et al., 2010; Pearson et al., 2015). The ecology of streams is closely related to stream intermittency and changes from a perennial to intermittent flow regime will have pronounced impacts on the invertebrate and fish assemblages in the affected waterways (Pearson et al., 2015). Endemic highland species inhabiting the cool refugia streams may face the highest risk of extinction as the rising temperatures force them to the upper limits of highland streams, though there is little empirical evidence to support this speculation (Pearson et al., 2015; Wet Tropics Management Authority, 2024).

Reduced availability of preferred habitat is also a likely consequence for lowland fish species as saline intrusion due to sea level rise pushes the freshwater-estuarine interface westward, further reducing already limited lengths of large lowland river which are abutted by steep streams with waterfall barriers at the base of the mountains (Pearson et al., 2015). Extensive areas of the Wet Tropics coastal plain which are currently under sugar cane cultivation are at risk of groundwater salination (Wet Tropics Management Authority, 2024). Floodplain wetlands are unique and critical environments for lowland species and are already degraded across much of the Wet Tropics floodplain due to sugar cane production (Arthington et al., 2015). Inundation due to sea level rise and saline intrusion of groundwater may induce loss of these wetlands as they transition to saline systems, making them uninhabitable for freshwater fish (Bellard et al., 2016; Wet Tropics Management Authority, 2024).

Further impacts of climate change on freshwater fish of the Wet Tropics may arise in response to changes to the intensity of extreme events such as cyclones and fires. These are discussed in more detail in Sections 3.4 & 3.5. While the confidence is low for rainfall projections in the Wet Tropics, both increased and decreased rainfall will have significant impacts on ecosystems. Droughts will decrease the extent and connectivity of wetlands, and reduce flushing of degraded wetlands and streams, compounding impacts of invasive weed growth and elevated nutrient concentrations (Wet Tropics Management Authority, 2024). Heavy rains also affect degradation due to greater soil erosion and agricultural chemical runoff (Wet Tropics Management Authority, 2024).

2.2.2. Clearing, fragmentation, habitat and water quality degradation

The threat of clearing in the Wet Tropics is highly dependent on location, with only 41–49 % of native vegetation remaining in the lowlands and the Atherton Tableland area of the highlands, compared to 81–98 % remaining in the sub-regions dominated by mountains (Accad et al., . Species with habitat within the WTWHA may have experienced improved habitat quality over the past two decades following significant revegetation of previously cleared areas within the WTWHA (Wet Tropics Management Authority, 2024). However, areas outside of the WTWHA have seen continued clearing due to urban expansion in response to increasing human population size, timber harvesting, and agricultural production in the region (Wet Tropics Management Authority, 2024). The impacts of land clearing and associated land uses remain as some of the highest impacts to the freshwaters of the Wet Tropics (Pearson, 2016). These impacts are most severe for highland freshwater streams surrounding cultivation areas and lowland wetlands surrounding sugar cane plantations due to the high intensity of agriculture in these areas (Pearson, 2016). According to the *State of the Wet Tropics 2012-2013 report*, up to 80% of lowland wetlands have been lost and the remainder are in urgent need of rehabilitation (Wet Tropics Management Authority, 2013). The health of the aquatic ecosystems adjacent to these land uses depends on the buffer width and condition of the riparian forests (Arthington et al., 2007; Mackay et al., 2010). Impacts associated with these agricultural land uses include the input of nutrients, sediments, organic material, and pesticides into waterways.

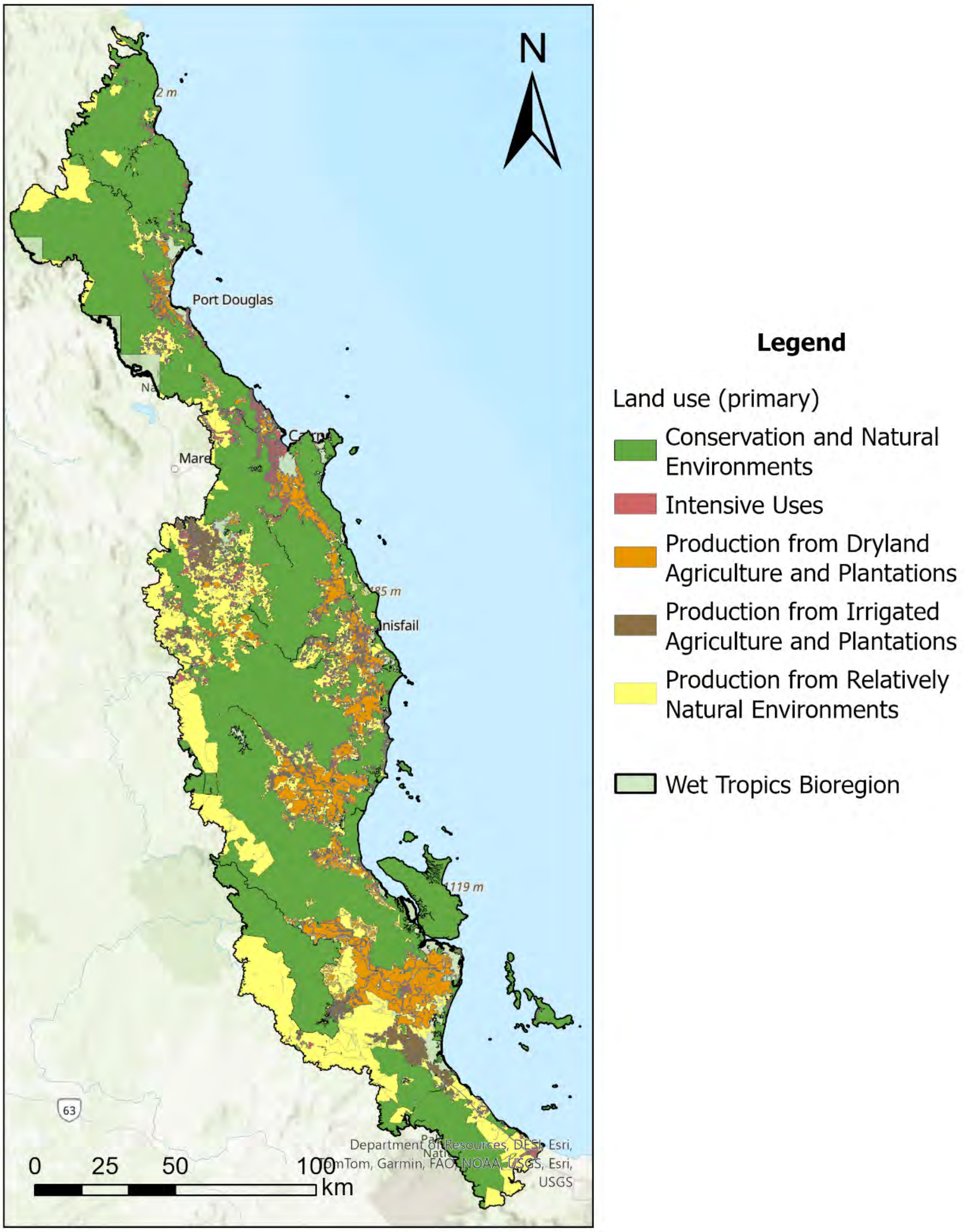

Figure 34. Primary land uses in the Wet Tropics (derived from the GBR land use spatial layer)

Fertilizers are widely applied in the Wet Tropics, and large quantities end up in waterways via surface runoff or infiltration (Tsatsaros et al., 2013). Excess nutrients build up as these fertilizers enter the waterways, causing eutrophication and excessive growth of aquatic plants, including invasive weeds (Tsatsaros et al., 2013). The proliferation of these plants is exacerbated by reduced canopy cover associated with riparian vegetation clearing, severely depleting dissolved oxygen and impeding fish movement (Arthington et al., 2007), making the waterway uninhabitable for many species (Bunn et al., 1997; Mackay et al., 2010; Pearson & Stork, 2008). Major pesticides reaching waterways in the Wet Tropics include herbicides such as ametryn, atrazine, and diuron and the insecticide imidacloprid which are likely to have toxicity impacts in Australia's tropical freshwater ecosystems (Pathiratne & Kroon, 2016). These herbicides impact primary producers by inhibiting photosynthesis and the insecticide imidacloprid disrupts neural processes and aquatic insects, ostracods, and amphipods are likely to be most sensitive to its toxicity (LeBaron, 2011; Pathiratne & Kroon, 2016; Tomizawa & Casida, 2005). Organic inputs in the Wet Tropics are derived from several sources, including effluents from sewage works and sugar mills and in situ sources such as decaying vegetation (e.g. sugar cane trash or aquatic plants) (A. Mitchell et al., 2008; Pearson, 2016). These sources of organic pollution severely deoxygenate waterways via bacterial respiration, causing fish kills (Pearson & Penridge, 1987; Wet Tropics Waterways, 2024a). Macroinvertebrates are also heavily impacted by microbial activity associated with sugar mill effluent (Pearson & Penridge, 1987). The impacts of these organic pollutants are exacerbated in warm, slow moving waters and are therefore greatest in lowland wetlands (Pearson, 2016).

Grazing and cropping areas (particularly sugar cane and bananas) are the greatest source of sediment pollution in the Wet Tropics region, where fine sediment comes from soil that is lost through hillslope, streambank, and gully erosion (Brodie et al., 2008; Terrain NRM, 2015). The clearing of native, deep rooted vegetation and replacement with shallow-rooted pastures, reduction in surface biomass through grazing, and soil compaction by animal treading are among the main factors causing increased erosion rates (Ludwig & Tongway, 2002; McIvor et al., 1995). These activities reduce soil cohesion, soil infiltration capacity, and surface roughness, leading to accelerated runoff and erosion, causing higher sediment and nutrient loads in waterways (Gifford & Hawkins, 1978). The riparian vegetation clearing that leads to bank instability and increased erosion also degrades freshwater habitat via changes to waterway morphology, habitat complexity, water quality, and food availability (Brodie et al., 2008).

Effects of fertilizer, pesticide, organic material, and sediment pollution associated with land use on freshwater fish are complex and interactive, compounded by habitat degradation due to increased invasive weeds and fauna, clearing of riparian vegetation, and damage of riverbanks and riverbed by cattle (Pearson, 2016). These water quality and habitat changes associated with land use alter the area of available suitable habitat and cause changes to food availability (Pearson et al., 2015). Riparian vegetation cover affects the amount of coarse particulate organic matter (CPOM) available in streams, leading to differences in macroinvertebrate assemblages (Arthington et al., 2007). Aquatic macroinvertebrates, a key prey item for fish, have higher species richness in areas with greater forest coverage (Pearson et al., 2018). Some fish species also directly consume terrestrial vegetation (e.g. consumption of terrestrial fruits by khaki grunter (*Hephaestus tulliensis*)) and changes to the type and quantity of vegetation falling into the stream may therefore have both bottom-up and top-down food web impacts (A. M. Davis et al., 2011; B. J. Pusey & Arthington, 2003). Fish diversity is directly affected by the health of riparian systems due to the influence of riparian health on stream habitat structure, with a higher abundance of alien species found in degraded streams (Arthington et al., 2007). Changes to light quality, quantity and shade in streams may directly impact fish metabolic rates, disease resistance, body morphology and mortality (B. J. Pusey & Arthington, 2003). Increased UV B radiation could caused increased mortality of eggs and larvae and impact sexual selection, leading to higher rates of hybridization (B. J. Pusey & Arthington, 2003).

2.2.3. Invasive, translocated, and stocked non-native species

The threat of invasive species to the Wet Tropics region was rated as high to very high in the State of Wet Tropics 2023–24 report (Wet Tropics Management Authority, 2024) and many of the impacts associated with these invasive species apply to freshwater fish. Freshwater fish will be impacted by invasive weeds, feral terrestrial and stocked animals that damage riparian and riverine habitat, and invasive aquatic species that are competitive with native fish. These may include exotic (native to other continents) or translocated native species originating from elsewhere within Australia.

Invasive weeds

Riparian vegetation has been dramatically altered in parts of the Wet Tropics, with large trees replaced by herbaceous vegetation such as Singapore daisy (*Sphagneticola tribobata*) and para grass (*Brachiaria mutica*), as well as large stands of bamboo (*Bambusa* spp and *Phyllostachys* spp) and other weeds such as water hyacinth (*Eichhornia crassipes*) which forms a thick mat over slow-flowing waterways (Arthington et al., 2007; Pearson & Stork, 2008). Riparian disturbance directly impacts macrophyte species composition including presence of invasive weeds (Mackay et al., 2010), and introduced para grass and Singapore daisy are particularly abundant where there is poor riparian canopy cover (Arthington et al., 2007; Bunn et al., 1998). The replacement of native vegetation with these weeds has numerous impacts on both physical and water quality components of freshwater habitats. Studies in the Wet Tropics have shown that invasion by weeds such as para grass and Singapore daisy has caused channelisation of flow, increased velocities and stream incision (Arthington et al., 2007). A major water quality issue frequently caused by invasive aquatic weeds is water deoxygenation, causing hypoxic conditions that render the habitat unsuitable for fish (Perna & Burrows, 2005). These physical and water quality changes caused by invasive weeds impact fish communities, with lower fish species richness in floodplain wetlands of the Wet Tropics with para grass and *Hymenachne* than those with submerged macrophytes (Arthington et al., 2015). Low fish and macroinvertebrate diversity has been observed in association with extensive areas of camphor laurel along the Little Mulgrave River (*Pers comms.,* B. Pusey). Additionally, C4 plants (e.g. para grass) are not a primary carbon source for fish in lowland habitats (Bunn et al., 1997), and their proliferation limits the growth of native macrophytes, thereby placing bottom-up food web restrictions on food availability for fish. The proliferation of weeds can also facilitate the invasion of invasive fish species, particularly those from the Poeciliidae family (Arthington et al., 1983; B. Pusey et al., 2000).

Invasive terrestrial animals and stock

Invasive terrestrial animals in the Wet Tropics include cats (*Felis catus*), feral pigs (*Sus scrofa*), and invertebrates (including several species of ants), among others (Wet Tropics Management Authority, 2024). Pigs and stocked animals (e.g. cattle) pose the highest threat to freshwater fish due to the extensive damage they cause to riparian and riverine habitats when accessing waterways to drink (Pearson, 2016). Trampling of vegetation exacerbates soil and bank erosion and repeated walking into waterways severely disturbs sediment and aquatic fauna (J. Mitchell & Mayer, 1997; Pearson, 2016). Additionally, digging by pigs causes extensive damage and is widespread throughout the WTWHA (J. Mitchell & Mayer, 1997). Pig related impacts are likely to be most severe in natural areas (including protected areas) which contrasts many of the other discussed threats that are more common in streams surrounded by agricultural or urban land uses.

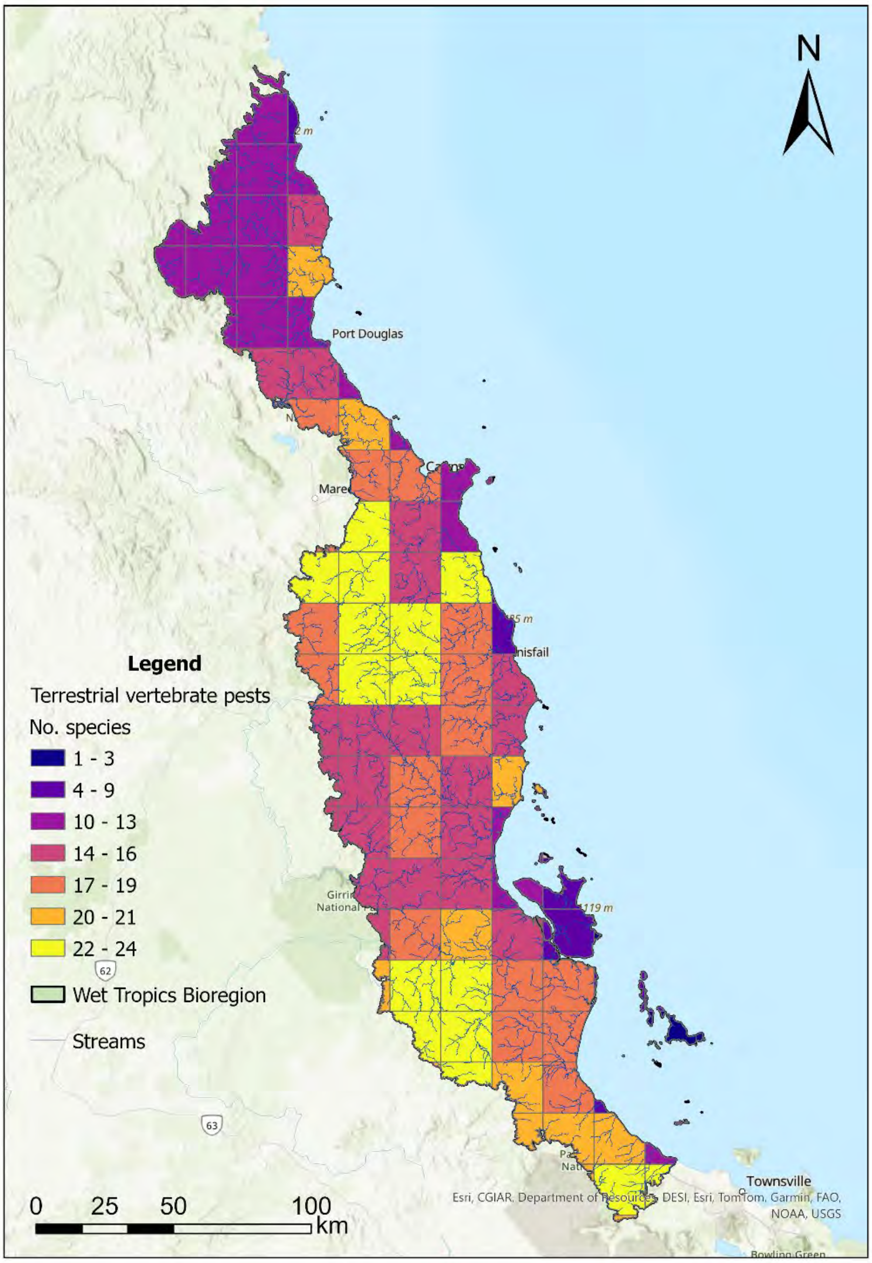

Figure 45. Gridded polygon showing the number of terrestrial vertebrate pest species (e.g. feral pigs, deer) using the QLD pest distribution survey series layer (11/03/2024).

Invasive and translocated fish

The introduction of non-native fish species is a continual and increasing threat as the number of introduced species increases in waterways throughout the Wet Tropics (Wet Tropics Management Authority, 2024).

The Wet Tropics provides ideal conditions for the establishment of self-sustaining populations of invasive (not native to Australia) tropical freshwater fish commonly sold through the aquarium trade and several of these species are established in Wet Tropics waterways. These include spotted tilapia (*Pelmatolapia mariae*), Mozambique tilapia (*Oreochromis mossambicus*), and four species of Poeciliidae (guppy – *Poecilia reticulata*, mosquitofish – *Gambusia holbrooki*, swordtail – *Xiphophorus* *helleri,* and platy – *Xiphophorus maculatus*) (F. J. Kroon et al., 2015). Recent surveys have also found populations of three spot gourami (*Trichopodus trichopterus*) near Cairns (Ebner and Collins, *unpub. data*). Mozambique and spotted tilapia established in some Australian waterways in the 1970's and early 1990's, respectively (Russell et al., 2012). Despite strict regulations, heavy penalties and expensive education and eradication efforts (mostly by government), tilapia continue to spread to new river systems in Australia (O'Mara et al., 2025; Russell et al., 2012). While tilapia consume mostly plant material (O'Mara, Venarsky, et al., 2023; Rayner et al., 2009), competition with native fish occurs indirectly through shared food resources and directly via predation of fish eggs (O'Mara, Venarsky, et al., 2023) and aggressive behaviour exhibited by reproducing individuals (Webb et al., 2007b, 2007a). Additionally, tilapia are tolerant to a range of environmental conditions, including a wide range of salinity and low dissolved oxygen saturation, giving them an advantage over natives in degraded waterways (Arthington & Blühdorn, 1994). They can also contribute to poor water quality and eutrophication via excretion of waste, damage to macrophyte habitat during feeding, and substrate disturbance during nest building (Arthington & Blühdorn, 1994; Greiner & Gregg, 2008). Impacts of the Poeciliidae species include mosquitofish displaying aggression towards natives (e.g. fin nipping), mosquitofish and guppy predation on native eggs and fry, and overlap of their diet with natives (Arthington, 1991; Pyke, 2008). Poecilids (e.g. guppies, platys) are known to feed on aquatic and terrestrial invertebrates in Australia (Arthington, 1989), with guppies also feeding on benthic algae (Dussault & Kramer, 1981). They are likely to compete with the Mulgrave River goby (*G. bellendenensis*), an aquatic invertivore, the Cairns rainbowfish (*C. rhombosomoides*), a terrestrial invertivore, and possibly also juvenile Wet Tropics tandan (*T. tropicanus*) (F. Kroon et al., 2011; B. Pusey et al., 2004). Guppies and mosquitofish are also known vectors of diseases and parasites (Arthington, 1991). The presence of Poeciliidae species in Wet Tropics rivers has been associated with a decrease in the abundance of some native fish species (F. J. Kroon et al., 2015).

. Several other fish species that are native to other Australian waterways have been intentionally released (illegally and legally through Fisheries stocking programs, referred to here as translocated) into Wet Tropics waterways that do not naturally contain these species (Burrows, 2004; Hollaway & Hamlyn, 1998). Barramundi (*Lates calcarifer*) and grunters (*Hephaestus* species; sooty and khaki/Tully grunters) are commonly translocated predatory native fish species that are now found extensively in river reaches throughout the Wet Tropics that did not naturally contain these species (Burrows, 2004). Other species translocated into Wet Tropics rivers include mouth almighty (*Glossamia aprion*), eel-tail catfish (*Tandanus tandanus*), and mangrove jack (*Lutjanus argentimaculatus*), among others (Burrows, 2004; Hollaway & Hamlyn, 1998). Red claw crayfish (*Cherax quadricarinatus*) have also been released into Liverpool Creek/Maria Creek, Koombooloomba Dam, and Tinaroo Dam (Burrows, 2004). Some of these introductions have resulted in severe impacts to endemic rare and threatened fish species, rivalling or exceeding impacts caused by invasive exotic fish (Burrows, 2004). Perhaps the most well-known devastating impact of these translocations was the introduction of mouth almighty to Lake Eacham in the 1980's (Burrows, 2004). The illegal translocation of mouth almighty, along with barred grunter (*Amniataba percoides*), seven-spot archerfish (*Toxotes chatareus*)*,* and bony bream (*Nematalosa erebi*) resulted in the local extinction of Lake Eacham rainbowfish (*Melanotaenia eachamensis*) from the lake by 1987 (Barlow et al., 1987). This was attributed to predation by mouth almighty, and possibly also by barred grunter and seven-spot archerfish (Barlow et al., 1987; Burrows, 2004; B. Pusey et al., 2004).

Translocated native fish also pose a high risk to genetically similar native species through hybridization. Hybridization is known to occur between the eastern rainbowfish (*Melanotaenia splendida*) and other *Melanotaenia* species in the Wet Tropics, including the Lake Eacham and

Malanda (*Melanotaenia* sp. nov. 'Malanda') rainbowfishes (Tims et al., 2024; Unmack et al., 2016; Zhu et al., 1998). It is unknown whether hybridization occurs between Wet Tropics endemic grunter and catfish and their widespread sister taxon (*Hephaestus tulliensis* and *Hephaestus fuliginosus*, *Tandanus tropicanus* and *Tandanus tandanus*). The risk of the threat of hybridization to these two species is therefore unable to be properly assessed until these knowledge gaps are filled.

2.2.4. Fire

The fire regime is a major factor shaping vegetation types in the Wet Tropics, with tropical rainforests dominating areas that remain unburnt (Stanton et al., 2014). Human-lit fires were once common due to First Nations, agricultural, and grazing practices but all of these burning practices are now rarely performed in the Wet Tropics (Stanton et al., 2014). While many of the region's endemic species are contained within rainforests, the more fire-prone open wet sclerophyll forests on the fringes of the rainforest also contain significant numbers of ancient, threatened, and endemic species (Wet Tropics Management Authority, 2024). Rainforest is likely to become more vulnerable to fire as climate change raises air temperatures and increases drought and heat wave intensity (McInnes et al., 2015). Fire during drought can be catastrophic in drying wetlands because the peat soils can burn for weeks, killing even fire-adapted vegetation (Wet Tropics Management Authority, 2024). One of the major impacts of fire on waterways is contamination with ash, and subsequent deoxygenation and declines in water quality (Terrain NRM, 2024b). These water quality changes impacts occur not only in the burnt areas but also for significant distances downstream. Habitat changes may also occur if riparian vegetation is burnt, including changes to hydrology resulting from fallen debris, reduced shading, and increased erosion (Terrain NRM, 2024b). Already degraded waterways in areas with agricultural or grazing land uses may be most at risk due to their higher likelihood of burning and exacerbation of existing water quality issues with contamination by ash runoff (Terrain NRM, 2024b). Threatened freshwater fish that have a restricted range or a single population remaining are highly vulnerable fire due to possible deoxygenation of water across the entire population (Lintermans et al., 2020; Terrain NRM, 2024b).

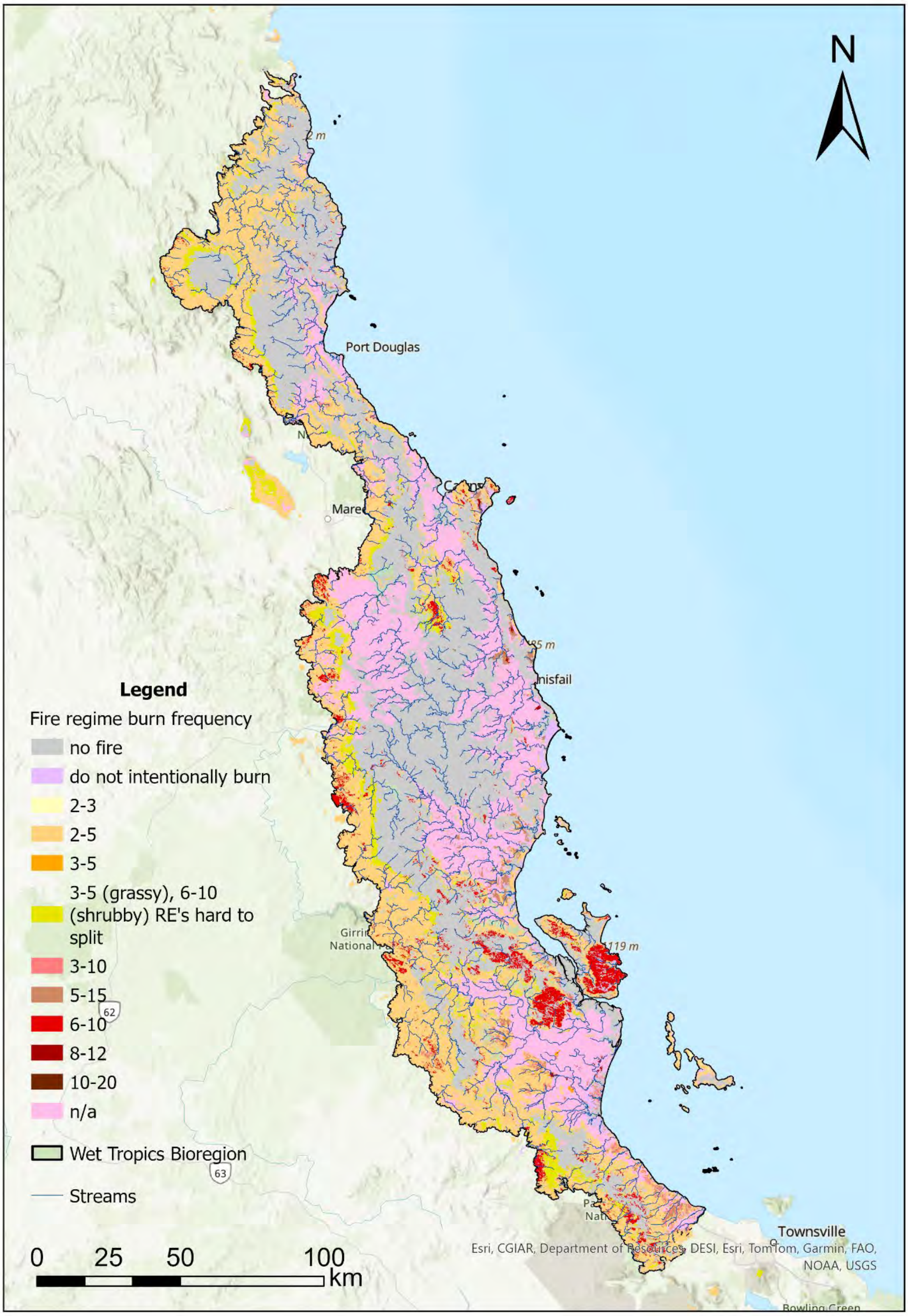

Figure 56. Fire regime layer showing burn frequency categories (Department of Environment and Science and Queensland Parks and Wildlife Service Fire Management System).

2.2.5. Floods and other extreme events

Cyclones, large floods, heatwaves and droughts are natural events experienced in the Wet Tropics (Wet Tropics Management Authority, 2024). Evolution of the native vegetation and stream biota has resulted in biological communities that are somewhat adapted to these extreme events, with the exception of extreme catastrophic events (Pearson et al., 2015; Wet Tropics Management Authority, 2014). Tropical Cyclone Jasper that made landfall in December 2023 is a recent example of a catastrophic weather event impacting the Wet Tropics and was one of the most extreme recorded in Australian history (Prasad 2024). This extreme event resulted in widespread geomorphic change, including severe riparian erosion, slumping, and potential loss of instream habitat complexity (Howley et al. 2024). With the intensity of extreme events expected to increase due to climate change (McInnes et al., 2015), ecosystems will be under stress and their resilience will depend on their capacity to recover before the next damaging event (Terrain NRM, 2024b). Stream fauna are resilient to moderate natural disturbance (Rosser & Pearson, 2018) but sensitive to major flood or drought (Pearson, 2014). This is likely due to the major disturbance that is caused by large flood events on the terrestrial and aquatic habitat, and the severe degradation of water quality (Wet Tropics Management Authority, 2024). In the aquatic habitat this includes changes to hydrology resulting from fallen debris, reduction of canopy cover where riparian vegetation is damaged, and contamination of waterways and soils with debris and pollutants (Terrain NRM, 2024b). These immediate impacts can lead to long-term changes such as continued degradation of water quality, loss of connectivity due to hydrological changes associated with flood damage and debris transport, and changes to food availability for fish due to habitat changes (Terrain NRM, 2024b).

Weeds readily invade areas where riparian zones have been flood-scoured, and forest that has been damaged by cyclones is more vulnerable to high-intensity fires and weed invasion than intact forest (Camarero, 2019; Murphy & Metcalfe, 2016). Areas that undergo repeated cycles of cyclone-fire-weed invasion are likely to experience biodiversity loss (DES, 2019). Extreme cyclones and flooding, such as experienced in the Wet Tropics in 2024 during Tropical Cyclone Jasper, cause widespread landslides that significantly damage the landscape, including large scale loss of tropical rainforest and runoff of fine sediment into waterways (Wet Tropics Management Authority, 2024). These damaging events, along with first wet season flushing rains, are responsible for the bulk of particulate nitrogen input into Wet Tropics streams (Brodie & Mitchell, 2006). A single, large flood event can be responsible for most of the annual sediment and nutrient export from Wet Tropics catchments (Furnas, 2003). Fish species with a restricted range or few, small remaining populations are particularly vulnerable to these water quality and habitat changes because their entire habitat can be damaged (Terrain NRM, 2024b). Fish may be forced to move to find new suitable habitat, possibly causing further fragmentation of populations (Terrain NRM, 2024b). Damaged habitat may not fully recover, or may be in poorer condition due to the colonisation of invasive plants and animals, many of which are dispersed via winds and floods during large storms (Terrain NRM, 2024b).

2.2.6. Altered hydrology and service infrastructure

In the Wet Tropics, water is extracted from aquifers, streams, and major impoundments for agricultural, industrial, domestic, and community use (Pearson, 2016). Major impoundments include Tinaroo Dam which alters flows to the Barron River and the Koombooloomba, Copperlode, and Paluma Dams, which are located within the WTWHA (Wet Tropics Management Authority, n.d.). The Koombooloomba dam has a small scale (7.3 MW) hydro power station that generates electricity from the flows released from the dam. Small scale hydro power stations often release water at variable rates over the day to match electricity demand, which can significantly alter the hydrology of the river system (Figueiredo et al., 2021). Water extraction through any of the methods used in the Wet Tropics can alter hydrology and the water infrastructure itself causes numerous ecological impacts (Pearson, 2016). These impacts were assessed for the Barron River (Queensland Government, 2023). The Wet Tropics Water Plan is used to manage water across the region and is updated periodically to include emerging flow-ecology research and is reviewed every five years (Queensland Government, 2016). The 2024 Minister's Performance Assessment Report of the Wet Tropics Water Plan stated a low risk for most ecological outcomes (including fish) but the plan does not include unregulated water take (e.g. for stock and domestic purposes) (Queensland Government, 2024).

Research from across northern Australia more broadly indicates that freshwater fish can be impacted by water resource development in a number of ways, with impacts dependent on the number and scale of developments, as well as the timing, magnitude and duration of water take (O'Mara, Beesley, et al., 2023). Alterations to the natural flow regime can impact the area of available preferred habitat that is required by fish of various life stages during specific seasons, resulting in reduced survival or spawning and recruitment success (Keller et al., 2019; Stewart-Koster et al., 2011). Impoundments present additional impacts, including a direct barrier effect to migrating organisms and change in habitat to open, deeper pools that promote a higher richness of invasive weed and fish species (Gehrke et al., 2002; F. J. Kroon et al., 2015; O'Mara, Venarsky, et al., 2023). However, impoundments are not the only barriers to fish movement, with over 3700 bridges, culverts, and causeways in the Wet Tropics identified as potential barriers to fish movement (F. J. Kroon & Phillips, 2015). To mitigate barrier impacts of water and service infrastructure, fishways have been installed in some locations within the Wet Tropics, particularly in the Herbert and Murray River catchments between Ingham and Tully (Wet Tropics Waterways, 2024b). However, the cost vs. benefit of fishways needs to be considered as their function to facilitate the movement of mobile fish species may be detrimental to the rare and threatened freshwater fish species of the Wet Tropics. Several of the threatened species included in this risk assessment are impacted by hybridization with natives expanding their range (e.g. rainbowfish of the *Melanotaenia* genus hybridising with eastern rainbowfish (*Melanotaenia splendida*)) and by the ecological impacts caused by invasive fish species (F. J. Kroon et al., 2015; Tims et al., 2024). In these cases, a lack of connectivity due to barriers may actually benefit these priority species by keeping parts of their distribution free from invasive or hybridising native fish (Jones et al., 2021).

Canals and drainage networks are also a prominent feature in agricultural areas and can severely impact water quality, particularly in lowland areas (Wet Tropics Management Authority, n.d.). On the floodplain, drains and levees can allow saltwater intrusion and expose acid-sulfate soils, causing high levels of acidity that degrade water quality in aquatic habitats, leading to increased susceptibility to diseases and reduced biodiversity (Pearson, 2016; Powell & Martens, 2005). In the 1990's, concerns were raised about links between acid sulfate soils and outbreaks of epizootic ulcerative syndrome (Callinan et al., 1993). First wet season flows release acidified water stored behind floodgates, greatly reducing the pH of the receiving water which causes severe damage to fish skin and gills that can lead to fish kills and increased susceptibility of fish to infection by *Aphanomyces invadans* (epizootic ulcerative syndrome) due to acid-induced skin damage (Callinan, 1997; Sammut et al., 1995).

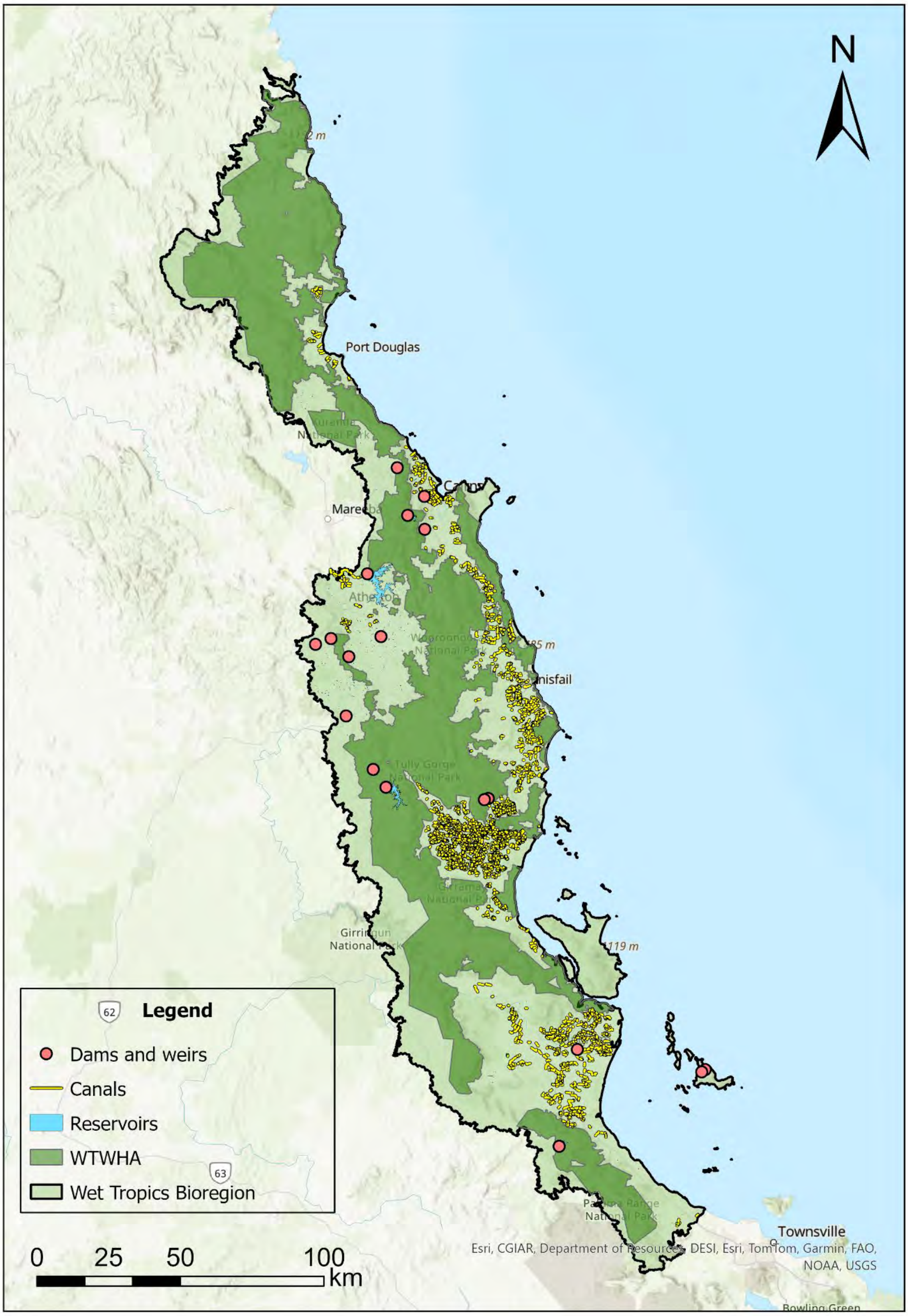

Figure 67. Reservoirs, dams, weirs and canals (Queensland Department of Regional Development Manufacturing and Water, Queensland Department of Resources). Data last updated 21/10/2024.

Some rivers in the Wet Tropics, particularly those with major storages, have altered hydrology due to water extraction, while other remain mostly unmodified in terms of flow (Wet Tropics Management Authority, 2024). However, demands for water use in the region continue to rise due to increased diversification and intensification of agriculture, regional population growth and expansion of urban areas (Wet Tropics Management Authority, 2024). Groundwater extraction on the Atherton Tablelands is increasing which is of concern because of the importance of the aquifers for recharging highland streams (Wet Tropics Management Authority, 2024). Several rare and threatened fish have few, limited populations remaining in this area and the hydrology of the streams they inhabit is critical for their survival (DCCEEW, 2014, 2022). Further, impacts of groundwater extraction are not well studied, making it difficult to assess the risk of this type of extraction to freshwater ecosystems in the Wet Tropics.

2.2.7. Residential areas and recreational use

The human population of the Wet Tropics region is expected to increase from 494,448 people in 2021 to 603,007 in 2046, placing increased demands for road corridor construction, more recreational spaces, and increased use of freshwater (Wet Tropics Management Authority, 2024). Population increase will result in further conversion of land for residential development, which is likely to exacerbate issues associated with clearing and land use discussed in Section 2.2.2 (Olden et al., 2008; Wet Tropics Management Authority, 2024). An increased residential development footprint also increases the likelihood of introduction of invasive species and illicit collection of ‘no take’ species for aquariums (Wet Tropics Management Authority, 2024). The smaller steams and tributaries of larger rivers that surround the residential areas of Cairns are most at risk of these activities and some of these streams have multiple small weirs for extracting water for urban use. These structures impound aquatic habitat, alter flow and can be barriers to dispersal for cling gobies and other amphidromous species that inhabit these streams (B. C. Ebner et al., 2023; B. C. Ebner & Thuesen, 2011).

Increased human population, along with the high rates of tourist visitation, places increased pressure on natural areas through recreational use. Recreational use of streams in the Wet Tropics has a multitude of impacts including, but not limited to, water quality degradation, modification of riparian and aquatic habitat and facilitation of weed dispersal (Wet Tropics Management Authority, 2024). Most streams visited by bathers normally have very low concentrations of nutrients and suspended solids (TSS), but bathing activity disturbs sediments and causes a temporary increase in TSS and turbidity, which return to background levels overnight as bathing areas are flushed clean (Butler et al., 2021). Nutrient concentrations are related to visitation and faecal coliforms (both animal and human) are elevated in numerous streams (Butler et al., 2021). Modification of riparian habitat occurs when riparian vegetation is trampled by vehicles or people walking and disturbance of aquatic habitat is common in bathing areas (Buckley, 1991; B. C. Ebner et al., 2023). Bather move rocks and boulders (displacing aquatic habitat) for the purpose of constructing recreational weirs, recreational spas and rock stacks (B. C. Ebner et al., 2023).

2.2.8. Overharvesting and illicit collection

Collection of freshwater fish species is permitted within recreational catch limits under the Queensland Fisheries Act, except for species that are listed under the Queensland NC Act, or described as ‘no take’ in the Queensland Fisheries Act (Table 1). Larger species included in this risk assessment, such as khaki grunter and Wet Tropics tandan, are harvested for food by First Nations and recreational fishers and khaki grunter in particular are targeted by recreational fishers. Collection for private aquariums also occurs throughout the Wet Tropics and the brightly coloured smaller species such as the *Melanotaenia* rainbowfishes are more commonly targeted. Freshwater morays may also be targeted for collection due to their bright colouration and unique appearance, however their elusive behaviour makes them difficult to catch and likely affords them a significant level of protection from this threat. Collections for aquariums are not monitored or recorded and the degree of illicit collection of listed species is unknown. Illicit collection of cling gobies from Wet Tropics streams for aquarium collections is likely to occur due to the bright colouration of males and their proximity to urban areas (B. C. Ebner, Thuesen, et al., 2011). Amphidromous species (e.g. cling gobies) are harvested in Pacific Islands for both fisheries (particularly during the post-larval migration through estuaries) and the aquarium trade (primarily adults) (D. Boseto et al., 2007). It is unknown how these overseas collections impact the Australian populations of these amphidromous species.

2.2.9. Future changes and interacting threats

The intensity and risk of threats to freshwater fish in the Wet Tropics is expected to change over time with climate change, population increase, and land use change. Some areas that are currently degraded may become uninhabitable for fish in the future if physiological stressors increase due to changes in water temperature, water volume, or salinity that may arise from climate change or increased water extraction. The threats discussed in Sections 2.1-2.6 interact in complex ways to cause cumulative impacts, and fish may have a reduced capacity to adapt and continue to thrive in areas where they are exposed to multiple interacting stressors.

Disturbance events (e.g. fires, cyclones) and service activities (e.g. water extraction) can increase the vulnerability of the ecosystem to other threats or exacerbate the impacts of existing threats. Disturbance to the landscape makes the environment more susceptible to invasion by weeds, and the risk of invasion increases as the time between the disturbance and recolonisation by native vegetation increases (Werren, 2001). Areas grazed by cattle are highly susceptible to weed invasion following a disturbance event (Werren, 2001). An inverse interaction also applies, where areas already heavily invaded by weeds (e.g. floodplains in agricultural areas of the Wet Tropics) can be more fire-prone than those with intact native vegetation (Werren, 2001). Extreme rainfall and flood events (e.g. those experienced post Tropical Cyclone Jasper in December 2023) can accelerate the rate of dispersal of invasive aquatic species including fish (Diez et al., 2012). Water extraction and water infrastructure can interact with other threats to degrade water and habitat quality and increase the presence of invasive species (Marks et al., 2010). Reduced flow due to water extraction can interact with high nutrient, pollutant, and sediment loads from land use to severely degrade surface and groundwater quality (Tsatsaros et al., 2013) and the presence of invasive fish species can be an indicator of riverine condition (Gomes-Silva et al., 2020; M. Kennard et al., 2005). Water infrastructure creates favourable habitat for invasive species (e.g. reservoirs, weir pools) and can act as a transport vector facilitating the dispersal of invasive species (e.g. via inter-basin transfer canal networks)(F. J. Kroon et al., 2015; O'Mara, Venarsky, et al., 2023; Schmidt et al., 2020). Climate change and invasive species have been rated as the highest risk threats to the Wet Tropics region (Wet Tropics Management Authority, 2024) and threatened freshwater fish (Lintermans et al., 2020), highlighting the critical need to increase the resilience of aquatic ecosystems to these threats and protect freshwater fish biodiversity. Restoration of degraded aquatic and riparian habitat increases the resilience of native species to invasive species and climate change, and reduces the nutrient, pollutant, and sediment loads which further improves water quality (Pearson, 2016).

3. EXPERT WORKSHOP RISK ASSESSMENT OF THREATS TO RARE AND THREATENED FRESHWATER FISH OF THE WET TROPICS

3.1. Methods

The risk assessment of threats to rare and threatened fish of the Wet Tropics was undertaken at an expert workshop (Appendix 2) held in Cairns on May 7-8, 2025. The event was conducted in hybrid format (in-person and online). The workshop was attended by experts (Appendix 3) from a range of organisations including government, universities, consultancies, and included representatives from the local management organisations Wet Tropics Management Authority and Terrain NRM. The experts have previous or current experience in the research or management of freshwater fishes in the Wet Tropics and/or extensive knowledge on threat occurrence and exposure to freshwater fish in the Wet Tropics. Publicly available information species populations, distribution, biology and ecology (Appendix 1), as well as the threats faced by these species in the Wet Tropics (Section 2.2) were reviewed by experts prior to the risk assessment activity and this information, as well as their own expert knowledge was used to inform the assessment.

The risks of the threats discussed in Section 2.2 to the freshwater fish species in Table 1 were assessed using the threat assessment framework in the EPBC Act 1999 Conservation Advice assessment. The risk matrix in this framework is consistent with the Queensland Recovery Action Plans. Species were assessed in groups where possible, based on similarities in biology and ecology, distribution and/or population size. The **likelihood** and **consequence** of each threat was assessed on each species or group of species, taking into consideration the **extent** of the population affected by each threat, as well as the **timing** and **trend** of the threat impact, and the **confidence** in the assessment. Definitions for each of these categories are given in Table 3.

Table 3. Definitions of risk assessment criteria used to assess risks of threats to freshwater fishes of the Wet Tropics. Taken from the EPBC Act 1999 Conservation Advice assessment framework.

Category	Definition	Options
Timing	Temporal nature of the threat	• Past • Current • Future
Trend	Extent to which it will continue to operate on the species	• Decreasing • Stable • Increasing
Confidence	Nature of the evidence about the impact of the threat on the species	• Inferred • Observed
Extent	Spatial context in terms of the range of the species	• Part of range • All of range
Likelihood	Likelihood of the threat impacting on the whole population or extent of the species	• Almost certain – expected to occur every year • Likely – expected to occur at least once every five years • Possible – might occur at some time • Unlikely – known to have occurred only a few times

		• Unknown – currently unknown how often the threat will occur
Consequence	Severity of the threat	• Not significant – no long-term effect on individuals or populations • Minor – individuals are adversely affected but no effect at population level • Moderate – population recovery stable or declining • Major – population decline is ongoing • Catastrophic – population trajectory close to extinction

Following the assessment for each species or species group using the criteria in Table 3, the risk rating was defined using the likelihood and consequence levels for each threat by locating the risk level on the following matrix:

Likelihood of occurrence	**Consequence**				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain					
Likely					
Possible					
Unlikely					
Unknown					
Risk matrix legend/Risk rating:					
LOW RISK	MODERATE RISK	HIGH RISK	VERY HIGH RISK		

The risk rating was then summarised across all species for each threat and reviewed by the experts following the workshop to ensure the risk rating for each species or species group was consistent with expert knowledge.

3.2. Results

Threats associated with climate change, natural disasters, invasive species and land use alteration were identified as the highest risk to most of the species reviewed in the expert workshop (Table 4). The reviewed species ranged from moderate to very high risk of rising temperatures and decreased rainfall, runoff and flow regimes associated with climate change. The Daintree and Cairns rainbowfishes were considered at very high risk to impacts of both of these threats and cling gobies (except *Sicyopterus* spp.) were identified as very high risk for changes to flow due to their amphidromous life history and preference for flowing short, steep coastal streams. Both the *Melanotaenia* and *Cairnsichthys* rainbowfishes reviewed were identified as very high risk of impacts associated with the clearing of riparian vegetation. All of these rainbowfish species except the Cairns rainbowfish were also identified as very high risk of impacts of aquatic habitat degradation and invasive terrestrial animals. Rainbowfishes from the *Melanotaenia* genus included in the risk assessment were identified as very high risk of hybridization with eastern rainbowfish and this was highlighted during the workshop as a major problem to this group of species in the Wet Tropics. Bloomfield River cod were identified as very high risk due to the ecological impacts of invasive fish and translocated native fish, both of which are now found in the distribution of this species (Carpenter-Bundhoo, et al., 2025)

There were several threats associated with natural disasters and the species most at risk of these threats varied among the threat categories. Daintree rainbowfish, cling gobies (except *S. lagocephalus*) and the freshwater moray were identified as very high risk to the impacts of increased frequency/severity of cyclones extreme rainfall, and extreme floods. Other species at very high risk include upland cling goby spp. and the freshwater moray for landslides, Daintree rainbowfish and upland cling goby spp. for heatwaves and Daintree rainbowfish, lowland cling goby spp. and the scaleless goby for drought.

Most species were considered to have moderate levels of risk to threats associated with water resource management & infrastructure. However, there were some exceptions including species at very high risk of flow alteration including the Daintree and Cairns rainbowfishes, lowland cling goby spp. and the ocellated river and Mulgrave gobies.

Overharvesting/ illicit collection and altered fire regimes were generally considered low to moderate risk for all of these species. Most species were considered to be at moderate risk of impacts associated with increased human (and pet) visitor usage and modification of riparian zones and instream areas, except for the Daintree rainbowfish which was considered to be high risk to these activities due to the high rates of recreational usage throughout the restricted range of this species.

*Table 4. Risk rating of each identified threat to each species or species group reviewed in the expert risk assessment workshop. The risk rating is derived from the above matrix using the likelihood and consequence levels assigned during the risk assessment. Sicyopterus spp. includes the cleft-lipped (Sicyopterus cynocephalus) and red-tailed (Sicyopterus lagocephalus) gobies. ^Risk ratings were focused on S. lagocephalus assessment. Lowland cling goby spp. includes the black Stiphodon (Stiphodon pelewensis), the orange cling goby (Stiphodon rutilaureus) and the opal cling goby (Stiphodon semoni). Upland cling goby species includes the emerald cling goby (Stiphodon surrufus), the red-bum goby (Sicyopus discordipinnis), Fehlmann's Sicyopus (Smilosicyopus fehlmanni) and the frog goby (Smilosicyopus leprurus).*This risk is only considered high if hybridization occurs between these species and sister species, which is currently unknow for the Wet Tropics tandan and khaki grunter.*

Threat class	Threat type	Risk Rating			
		Low Risk	**Moderate Risk**	**High Risk**	**Very High Risk**
Climate change	Sea level rise and saline intrusion				
	Change in equatorial currents	• Upland cling goby spp.	• Lowland cling goby spp.		
	Rising temperatures		• Lowland cling goby spp. • Wet Tropics tandan • Khaki grunter • Bloomfield River cod	• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham) • Upland cling goby spp.	• Daintree and Cairns rainbowfishes
	Changes in rainfall, runoff, flow regimes		• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham) • Ocellated river goby • Mulgrave goby • *Sicyopterus* spp.	• Scaleless goby • Wet Tropics tandan • Khaki grunter • Bloomfield River cod	• Daintree and Cairns rainbowfishes • Cling gobies except *Sicyopterus* spp.
Land use alteration	Riparian veg clearing / degradation	• Upland cling goby spp.	• Wet Tropics tandan • Khaki grunter	• Lowland cling goby spp.	• Daintree and Cairns rainbowfishes • *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham)
	Floodplain wetland degradation/loss				
	Aquatic habitat degradation (e.g.		• Cling gobies • Wet Tropics tandan • Khaki grunter	• Cairns rainbowfish	• Daintree rainbowfish • *Melanotaenia* rainbowfishes (Malanda,

Threat class	Threat type	Risk Rating			
		Low Risk	Moderate Risk	High Risk	Very High Risk
	sedimentation, simplification)				Utchee Creek, Lake Eacham) • Scaleless goby • Ocellated river goby • Mulgrave goby • Freshwater moray
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)		• Cling gobies • Wet Tropics tandan • Khaki grunter	• Cairns rainbowfish • Ocellated river goby • Mulgrave goby	• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham) • Scaleless goby
Introduced species	Invasive riparian / aquatic weeds		• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham) • Wet Tropics tandan • Khaki grunter		
	Invasive terrestrial animals and livestock		• Utchee Creek and Lake Eacham rainbowfishes • Ocellated river goby • Mulgrave goby • Wet Tropics tandan • Khaki grunter • Bloomfield River cod	• Cairns rainbowfish	• Daintree rainbowfish • Malanda rainbowfish • Cling gobies except *Sicyopterus* spp.
	Invasive fish	• Scaleless goby • *Sicyopterus* spp.^	• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham) • Cling gobies except *Sicyopterus* spp.	• Daintree and Cairns rainbowfishes • Ocellated river goby • Mulgrave goby	• Wet Tropics tandan • Khaki grunter • Bloomfield River cod

<table>
<tr><th rowspan="2">Threat class</th><th rowspan="2">Threat type</th><th colspan="4">Risk Rating</th></tr>
<tr><th>Low Risk</th><th>Moderate Risk</th><th>High Risk</th><th>Very High Risk</th></tr>
<tr><td rowspan="3"></td><td>Translocated native fish - ecological impacts</td><td></td><td>• Melanotaenia rainbowfishes (Malanda, Utchee Creek, Lake Eacham)
• Cling gobies except Sicyopterus spp.
• Wet Tropics tandan
• Khaki grunter</td><td></td><td>• Bloomfield River cod</td></tr>
<tr><td>Translocated native fish - hybridization</td><td></td><td></td><td>• Wet Tropics tandan*
• Khaki grunter*</td><td>• Melanotaenia rainbowfishes (Malanda, Utchee Creek, Lake Eacham)</td></tr>
<tr><td>Pathogens / diseases</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Natural disasters</td><td>Increased frequency/severity of cyclones extreme rainfall, and extreme floods</td><td>• Sicyopterus spp.^</td><td>• Wet Tropics tandan
• Khaki grunter</td><td>• Cairns rainbowfish
• Melanotaenia rainbowfishes (Malanda, Utchee Creek, Lake Eacham)
• Scaleless goby
• Ocellated river goby
• Mulgrave goby
• Bloomfield River cod</td><td>• Daintree rainbowfish
• Cling gobies except Sicyopterus spp.
• Freshwater moray</td></tr>
<tr><td>Landslides</td><td></td><td>• Ocellated river goby
• Mulgrave goby
• Sicyopterus spp.^</td><td>• Lowland cling goby spp.
• Scaleless goby</td><td>• Upland cling goby spp.
• Freshwater moray</td></tr>
<tr><td>Heatwaves</td><td></td><td></td><td>• Cairns rainbowfish
• Melanotaenia rainbowfishes (Malanda, Utchee Creek, Lake Eacham)
• Lowland cling goby spp.</td><td>• Daintree rainbowfish
• Upland cling goby spp.</td></tr>
<tr><td>Drought</td><td></td><td>• Upland cling goby spp.</td><td>• Cairns rainbowfish</td><td>• Daintree rainbowfish</td></tr>
</table>

Threat class	Threat type	Risk Rating			
		Low Risk	Moderate Risk	High Risk	Very High Risk
			• Wet Tropics tandan • Khaki grunter	• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham)	• Lowland cling goby spp. • Scaleless goby
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)		• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham) • Upland cling goby spp. • *Sicyopterus* spp.^ • Wet Tropics tandan • Khaki grunter	• Scaleless goby	• Daintree and Cairns rainbowfishes • Lowland cling goby spp. • Ocellated river goby • Mulgrave goby
	Impoundment of riverine habitat		• Cling gobies except *Sicyopterus* spp. • Wet Tropics tandan • Khaki grunter	• Ocellated river goby • Mulgrave goby	
	Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)	• *Sicyopterus* spp.^	• Mulgrave goby • Wet Tropics tandan • Khaki grunter • Freshwater moray	• Ocellated river goby	
Biological resource use	Over-harvesting/illicit collection	• *Melanotaenia* rainbowfishes (Malanda, Utchee Creek, Lake Eacham) • Cling gobies • Wet Tropics tandan • Khaki grunter	• Daintree rainbowfish • Freshwater moray • Bloomfield River cod		
Natural system management & modifications	Altered fire regimes (increased severity)	• Wet Tropics tandan • Khaki grunter	• Daintree and Cairns rainbowfishes • Ocellated river goby • Mulgrave goby • Scaleless goby		

Threat class	Threat type	Risk Rating			
		Low Risk	Moderate Risk	High Risk	Very High Risk
Other threats	Increased human (& pet) visitor usage and modification of riparian zones and instream areas		• Cling gobies • Ocellated river goby • Mulgrave goby • Scaleless goby • Wet Tropics tandan • Khaki grunter • Freshwater moray		• Daintree rainbowfish
	Lack of legislative protection (e.g. through listing)			• Bloomfield River cod	

4. RECOVERY ACTION PLANNING

4.1. Desktop review of previous and current conservation and management actions

4.1.1. Threat based management

There are few threat-based management practices specific to the conservation and recovery of the freshwater fish species included in this risk assessment. However, these species are likely to benefit from wider management programs aimed at improving the health of the ecosystems in the Wet Tropics, including programs that aim to improve the health of the Great Barrier Reef which receives freshwater from Wet Tropics rivers.

The water quality of the GBR is degraded by fertilizer, pesticide, organic material, and sediment pollution associated with land use in the Wet Tropics (Brodie et al., 2013). The '*Wet Tropics Water Quality Improvement Plan*' (Terrain NRM, 2015) and '*Reef 2050 Water Quality Improvement Plan'* (Queensland Government, 2018) were developed to address the degradation of GBR water quality by reducing pollutant loads to the reef through monitoring and remediation in catchments. These monitoring programs have led to the identification and remediation of some sources of pollution to the reef and have subsequently improved the amount of pesticide runoff entering waterways in some of the southern Wet Tropics catchments (Wet Tropics Waterways, 2023). Bank stabilisation and erosion remediation works have taken place in some areas, including in the Tully and Murray catchments (Wet Tropics Plan, 2016). Further, a large investment has been made to conduct erosion remediation works over the coming years to reduce sediment loads to Wet Tropics waterways (Terrain NRM, 2024a).

Initiatives to manage land use impacts have previously given more attention to improving water quality compared to habitat remediation (Terrain NRM, 2015). However, recent Queensland Government funding under the Reef Assist program has supported several habitat remediation projects in the Wet Tropics. During the first iteration of the Reef Assist program (Reef Assist 1.0), these projects included:

- Landscape restoration works that improved the condition of native vegetation, removed weeds, controlled feral pests, and removed marine debris (Wet Tropics Management Authority)
- Environmental Restoration in the Russell River Catchment (Jaragun Ecoservices) including stabilisation of stream banks on Babinda and McPaul Creeks
- Revegetation of at-risk riparian sites in the Johnstone, Murray and Russell catchments (Terrain Natural Resource Management)

Rehabilitation projects in the second (current) round of Reef Assist include:

- Repair and revegetation of wetlands and riparian cane drainage systems in the Mulgrave catchment to deliver improved Great Barrier Reef water quality (Greening Australia, Wanyurr-Majay Aboriginal Corporation and Mulgrave Landcare)
- Establishment of a 630 m rainforest corridor along the Daintree River (Jabalbina Yalanji Aboriginal Corporation)
- Revegetation of both natural and constructed wetlands for reductions in dissolved inorganic nitrogen pollutant loads to the Great Barrier Reef (Jaragun Ecoservices)

- Revegetation of riparian sites along the Johnstone River reducing sediment and nutrient loads entering waterways and extending corridors and habitats for wildlife (Johnstone Region Landcare Group)
- Revegetation of degraded Atherton Tablelands landscapes, including planting and maintaining 65,000 seedlings (Wet Tropics Management Authority)

Reforestation schemes have been taking place in the Wet Tropics in succession since 1988, while community based projects started in the 1970's (Wet Tropics Management Authority, 2021). Major focus areas of both past rainforest clearing and subsequent revegetation (in the 1990's and early 2000's) were the upland Atherton Tablelands and lowlands of the Barron, Johnstone, Tully-Murray and Herbert River systems (Catterall & Harrison, 2006). More recent efforts are focused on priority climate refugia catchments on the Southern Atherton Tablelands and Daintree lowlands through the Wet Tropics Management Authority's Wet Tropics Restoration Program. Revegetation works on the Tablelands have been funded by both Government and conservation groups. These are ongoing, including through the Reef Assist program (Government funded) and the '*Gondwana Rainforest Trust*' organisation (an Australian non-profit organisation operating the *Rainforest Rangers* program).

In the Daintree, a significant local conservation effort has been the buyback of privately owned land. In the 1980's, a developer put forward a proposal for 900 Daintree housing lots that was rejected by local Council, but the decision was overruled by State Government and 958 blocks of tropical Daintree Rainforest were subsequently put up for sale (Douglas Shire Council, 2019). Therefore, when the WTWHA was declared in 1988, these properties were excluded despite sharing many of the same natural attributes and conservation value (Douglas Shire Council, 2019). Recognising the importance of these properties to the conservation of the Daintree Rainforest ecosystem, the Douglas Shire Council and the Queensland and Australian Governments made financial contributions ($15 M) to purchase some of this freehold land and removed development rights from over 330 vacant properties (Douglas Shire Council, 2019). Some additional lots owned by private landholders have been declared Nature Refuge and others have been purchased by conservation groups such as the '*Gondwana Rainforest Trust*' organisation (an Australian non-profit organisation operating the *Save the Daintree* program) (Douglas Shire Council, 2019; Save the Daintree, 2024). As of 2024, 30 Daintree properties have been purchased under the *Save the Daintree* program for conservation (Save the Daintree, 2024). While these examples demonstrate local actions to manage threats of habitat degradation, the wider scale threat of invasive species has also been managed locally in some areas of the Wet Tropics.

The threat of invasive species is a universal management challenge as invasive species continue to invade new areas and increase their range through dispersal. Exacerbated by increasing human population size, extreme events such as floods and fire, and global warming, the management of invasive species is critical to the conservation of the rare and threatened freshwater fish of the Wet Tropics but is costly and requires a large amount of continued effort. Invasive weed management has been undertaken across the Wet Tropics and often in collaboration with landholders. For example, local action has been taken in the form of management of hymenachne at Pungi Creek (Tully Murray catchment) and the control of aquatic weeds in Peterson's Ck (Barron catchment) (Wet Tropics Plan, 2016). The initial cost to eradicate pond apple from the whole of the Wet Tropics bioregion is estimated to be over $3M (not including follow-up costs) (Holloway, 2004). Reforestation of the riparian zone is a critical factor in the successful reduction of weeds such as para grass due to the role that shading plays in their establishment (Wet Tropics Management Authority, 2021).

A large component of the management of invasive species in the Wet Tropics has been Community education, awareness and participation. Signage and awareness campaigns have been utilised to help limit new introductions of aquarium fish into Wet Tropics streams and community events help support the control of tilapia populations (e.g. in Lake Tinaroo (Barron catchment) and Warrina Lakes (Innisfail)). New sightings of invasive fish species are managed by Biosecurity Queensland and where possible eradication efforts are undertaken.

Looking toward the future, threat management in the Wet Tropics aims to focus more on building resilience to climate change and there may be some overlap among the previously mentioned management actions and building climate resilience. Whilst there has been little action taken so far to specifically improve climate change resilience, the '*Climate Adaptation Plan for the Wet Tropics: 2020-2030'* sets out a series of objectives that require management action (Wet Tropics Management Authority, 2019). These include trialling experiment management approaches, exploring potential for science-based interventions (e.g. gene banking, assisted gene flow, captive populations, assisted migration, translocation and genetic editing) and implementing trials of direct interventions, restoration and management works that facilitate ecosystems transition but maintain ecosystem functions (Wet Tropics Management Authority, 2019).

Further planning for future restoration works is underway through the Wet Tropics Restoration Alliance (the Alliance). The Alliance was established by the Wet Tropics Management Authority, Terrain NRM and James Cook University, and consists of 28 organisations and independents including Traditional Custodians, landscape restoration practitioners, research organisations, conservation entities and investors (Wet Tropics Management Authority, 2024). The Alliance aims to support the scaling up of restoration works throughout the Wet Tropics.

4.1.2. Freshwater fish recovery actions

There are a number of on-ground recovery actions that support the conservation of rare, threatened or endemic freshwater fish species (Lintermans, 2013). These are described in Table 4 (adapted from Lintermans [2013]) in the context of the Wet Tropics. Some of these actions have been applied for the specific protection of the species listed in this report, while others have been applied generally or for other purposes that also provide benefit to some or all of these species.

Table 5. Management and actions to support the conservation and recovery of rare and threatened freshwater fish species and examples of their use in the Wet Tropics. Categories and their descriptions were adapted from Lintermans (2013).

Category	Description of action	Use of action in the Wet Tropics
Invasive species control	Invasive species control can include the removal of species that have already invaded the habitat of the threatened species or exclusion measures to prevent invasion (e.g. fish screens on inter-basin transfers)	Weed control is applied locally in some areas of the Wet Tropics.
		Feral pig control is used primarily in the WTWHA.
		The spread of invasive freshwater fish is managed through legislation (e.g. it is illegal to possess tilapia or transport them between locations) and community awareness and activity (e.g. tilapia fishing competitions). The Biosecurity Act 2014 manages fish that are not native to Australia (i.e. introduced from other countries), whereas Australian native species introduced to areas outside their natural range are managed under the Fisheries Act 1994 as 'non-indigenous fish'.
Fish passage	Fish passage remediation includes the physical removal of barriers (e.g. weirs) that limit dispersal or installation of mitigation measures such as fishways that facilitate the movement of the threatened species past the barrier	Fishways have been installed in some locations within the Wet Tropics, particularly in the Herbert and Murray River catchments between Ingham and Tully. Six fishways were built between Tully and Crystal Creek near Paluma, opening up > 100 km of creek and river systems and surveys confirmed their effectiveness. However, the cost vs. benefit of fishways needs to be considered as their function to facilitate the movement of mobile fish species may be detrimental to threatened species. For example, fishways may allow eastern rainbowfish (*Melanotaenia splendida*) to continue expanding their range and hybridising with the Malanda and Lake Eacham rainbowfishes.

Habitat enhancement or restoration	Habitat enhancement or remediation includes the installation of habitat features (e.g. woody debris for cover, hollow logs for cod nesting habitat), erosion remediation works and provision of artificial aeration during drought	Remediation in the Wet Tropics has focussed on water quality and there is little evidence of aquatic habitat enhancement or restoration aside from erosion remediation works which have taken place locally in some catchments and funds have been supplied for the continuation of these works.
Habitat protection	Habitat protection is when a particular habitat is declared as critical for the survival of the threatened species and is then protected from management or development activities (e.g. bushfire control, construction) and remediated if contamination occurs (e.g. via toxic-spill events)	There have been several habitats in the Wet Tropics that have become protected through conservation status. This includes the Wet Tropics World Heritage Area (WTWHA) and specific terrestrial habitat types including Mabi forest, Broad Leaf Tea-tree woodlands, and Littoral Rainforests. Streams within the WTWHA, national parks, or conservation areas fall under the protection status of those areas.
Riparian management	Riparian management includes planting to reestablish riparian vegetation, weed control, fencing, stock and feral animal exclusion and bank stabilisation	Bank stabilisation work and weed control has taken place in some areas of the Wet Tropics. Reforestation of some areas, including within the WTWHA and on parts of the Atherton Tablelands, has included riparian zones and this riparian reforestation has helped alleviate the choking of streams by aquatic weeds. Malanda and Lake Eacham rainbowfish particularly benefit from riparian revegetation because it ensures that stream habitat favours these species rather than eastern rainbowfish.
Harvest control	Laws that limit the collection of species from the wild (e.g. 'No take' laws under the Queensland Fisheries or NC Acts)	Several of the freshwater fish species in Table 1 are listed as 'No take' species under the Queensland Fisheries Act, including the Bloomfield River cod (*G. wujalwujalensis*) and all of the cling-goby species found in the Wet Tropics. These species are either highly restricted in distribution (Bloomfield River cod) or found in very low abundance (cling gobies) and are therefore highly vulnerable to population decline at even low levels of harvesting.
Environmental watering	Environmental watering occurs when water is released from storages to provide preferred hydrological conditions (e.g. flow velocity or longitudinal connectivity) to fish	Several rivers in the Wet Tropics have major impoundments. These include Tinaroo Dam which alters flows to the Barron River and the Koombooloomba, Copperlode, and Paluma Dams, which are located within the WTWHA. Environmental flows in these catchments are managed under the Wet Tropics Water Plan.

Water management	Restrictions on water extraction or water levels in reservoirs may also be put in place to protect threatened species	All water extraction infrastructure within the Wet Tropics World Heritage Area requires a permit, and the authority can regulate the amount of water extracted, particularly if it exceeds what was previously permitted. Water uses must follow the Water Infrastructure Code of Practice. Water licenses granted from high-flow reserves may include conditions to ensure sufficient water flow is maintained, even during times of high demand.
Rescue	Rescues of wild fish from natural environments are occasionally performed in the face of critical environmental threats (e.g. bushfire, desiccation, blackwater, invasive fish, toxicants)	There are no documented freshwater fish rescues from the Wet Tropics.
Translocation	Translocations include the release of wild captured fish into locations within their natural range or in areas outside of their natural range with suitable habitat for the establishment of insurance populations	Malanda rainbowfish have been translocated from wild genetically pure subpopulations to refuge areas (e.g., farm dams) in the upper North Johnstone catchment. Subpopulations are also being established in other sub-catchments that likely formerly contained Malanda rainbowfish or lack rainbowfish completely. These translocations have been mostly successful. The Ithaca Creek population is abundant and gradually expanding downstream and some farm dam populations have persisted.
Conservation stocking	Fish may be released from captive breeding programs	There has been an unsuccessful attempt to reintroduce 300 Lake Eacham rainbowfish into Lake Eacham from a captive breeding population (Brown & Warburton, 1997; Caughey et al., 1990; Leggett & Merrick, 1997). The translocated predatory fish that originally extirpated this species from the lake also predated upon the released individuals. Additionally, the competitive eastern rainbowfish is now also established in the Lake.

4.2 Expert workshop assessment of priority recovery actions for rare and threatened freshwater fish in the Wet Tropics

An expert workshop assessment of priority recovery actions for rare and threatened freshwater fish species in Queensland Wet Tropics region followed the approach used for Queensland Threatened Species Recovery Action Plans[1]. We focused on recovery actions to address flood-related threats (Table 6) and other threats (Table 7) to these fish species. The information in these Recovery Action Tables should be interpreted as follows:

Priority	High	Moderate	Low
	Taking prompt action is necessary to mitigate the threats and ensure the persistence of the species	Action is necessary to mitigate threats and work towards the long-term recovery of the species	Action is desirable, but not critical to recovery at this time but will provide for longer term recovery
Feasibility	High	Moderate	Low
	Possibility that an action can be implemented within a reasonable time frame and budget and that there is sufficient knowledge, expertise and willingness to implement the action		
Cost[2]	$1000's $10,000's $100,000's $1,000 000's		
Potential Contributors[3]	Identify who leads the action (L). Other contributors (C) are also identified where possible		

It is also important to note that design and implementation of any particular recovery project should be guided by appropriate experimental design considerations including the importance of monitoring effectiveness/benefits of implemented recovery actions to inform adaptive management.

[1] https://www.qld.gov.au/environment/plants-animals/conservation/threatened-species/our-work-and-partners/recovery-action-planning-and-programs/about-recovery-action-planning-and-programs/recovery-action-plans

[2] These estimates of indicative costs do not account for inflation, and do not include standard management activities on conservation estate by the Department that are to be considered as in-kind contribution. If an action is attributed a cost and it is led by the Department then at least a partial in-kind contribution is assumed. The provision of funds necessary to implement actions are subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

[3] The nominated lead for actions is not necessarily responsible for cost, however the lead should coordinate as necessary to determine source/s of funding for the activity.

Table 6. Recovery Action Table for flood-related threats to rare and threatened species in the Wet Tropics. C = contributor.

Description of action	Potential fish species benefited	Priority	Feasibility	Indicative cost	Potential contributors	Potential risks
Filling critical knowledge gaps						
Undertake systematic fish surveys of native and non-native species in impacted areas and compare with pre-impact data (where available) to understand fish population responses to extreme floods and identify priority remnant fish populations for recovery actions	Cling gobies, Bloomfield River cod, rainbowfishes, freshwater moray	High	High (except for some areas with access constraints and/or human health risks)	10,000's-100,000's	Lead: Univ/Consult, C: Gov, NRM, First Nations	
Collect and curate high quality genetic samples	All species	High	High	10,000-100,000's	Lead: Univ; C: Gov	
Develop eDNA primers for key species to inform post-flood eDNA surveys of fish species distributions	Gobies, rainbowfishes, freshwater moray	High	High	10,000's-100,000's	Lead: Univ, C: Gov,	
Undertake systematic post-flood vegetation surveys and compare with pre-impact data (where available) to understand terrestrial/riparian vegetation flood impacts and recovery trajectories (native species and invasive weeds). Ideally also monitor successional processes over time	Riparian-dependent species (e.g. rainbowfishes, grunter)	Moderate	High (except for some areas with access constraints)	10,000's-100,000's	Lead: Univ/Consult, C: Gov, NRM, First Nations	
Assessment of bank-side and in-stream physical habitat impacts and recovery processes, with a focus on hydrogeomorphology. This could be achieved by undertaking post-flood physical habitat / hydrogeomorphic surveys, assessment of sediment slug persistence and rates of downstream sediment transport over time and comparisons with pre-impact data (if available) or appropriate reference sites	Cling gobies, Bloomfield River cod, rainbowfishes, freshwater moray	High	High (except for some areas with access constraints)	10,000's-100,000's	Lead: Gov/Univ/NRM/Consult, C: First Nations	
Assessment of water quality changes due to flood impacts (e.g. turbidity, temperature, nutrients, DO, iron oxide impacts and bacterial growth, etc) and comparison with pre-flood data (if available) or appropriate reference sites to improve understanding of flood impact mechanisms and inform restoration actions (e.g. riparian revegetation)	All species	Low	High (except for some areas with access constraints)	10,000's-100,000's	Lead: Gov/Univ/NRM/Consult, C: First Nations	
Riparian and in-stream rehabilitation						

Description of action	Potential fish species benefited	Priority	Feasibility	Indicative cost	Potential contributors	Potential risks
In-stream habitat rehabilitation at high priority locations using mechanical approaches to improve hydraulic habitat diversity/complexity	Gobies, rainbowfishes, freshwater moray	Low	Moderate for small extent (low for large extent)	100,000's-1,000,000's	Lead: NRM/Consult, C: Gov, Univ, First Nations	Physical damage to sensitive riparian and in-stream habitats/species; fine sediment re-mobilisation and impacts to sensitive habitats/species; benefits likely only temporary if upstream areas are un-restored (due to continuing bank destabilisation)
Riverbank rehabilitation at high priority locations using engineered bankside stabilisation methods (pylons)		Low	Moderate for small extent (low for large extent)	1,000,000-10,000,000	Lead: NRM/Consult, C: Gov, Univ, First Nations	Physical damage to sensitive riparian and in-stream habitats/species; fine sediment re-mobilisation and impacts to sensitive habitats/species; benefits likely only temporary if upstream areas are un-restored (due to continuing sediment delivery)
Restore pool depth for priority locations affected by severe sedimentation using mechanical sediment removal and/or creation of scour holes by addition of large structures (boulders, logs)	Daintree rainbowfish	Moderate	moderate for small extent (low for large extent)	10,000's-100,000's	Lead: NRM/Consult, C: Gov, Univ, First Nations	Damage to sensitive in-stream habitats/species due to fine sediment re-mobilisation; benefits likely only temporary if upstream areas are un-restored (due to continuing sediment delivery)
Implement fish habitat enhancement options such as reintroduction of large wood structures, boulder re-arrangement, etc		Moderate	moderate for small extent (low for large extent)	10,000's-100,000's	Lead: NRM/Consult, C: Gov, Univ, First Nations	Physical damage to sensitive riparian and in-stream habitats/species
Investigate options to rehabilitate areas subject to iron oxide algal growth via mechanical/chemical control (this may be affecting high quality algal food resources at the base of the food chain)	Cling gobies, rainbowfishes	Very low	Very low	100,000's	Lead: Univ, C: Gov, Consult	
Address impacts of loss of shade from riparian vegetation destruction by establishing artificially shaded stream sections (e.g. using shade cloth)	Uncertain	Very low	Very low	100,000's-1,000,000's	Lead: NRM, Commun, Consult; C:	
Undertake post-flood riparian revegetation and weed control at sites identified as priority fish habitat	Riparian-dependent species (e.g. rainbowfishes, grunter)	Moderate	Moderate	10,000's-100,000's	Lead: NRM/Consult, C: Gov, Univ, First Nations	
Post-flood scar revegetation & weed control (to mitigate sediment delivery to downstream areas and spread of weeds)		Moderate	Moderate (low in remote areas)	100,000's-1,000,000's	Lead: NRM/Consult, C: Gov, Univ, First Nations	

Description of action	Potential fish species benefited	Priority	Feasibility	Indicative cost	Potential contributors	Potential risks
Enhance flood resistance of historically cleared and regrowth areas (these are more vulnerable to extreme flood impacts of bank slumping, sediment delivery etc) - do this by native revegetation, channel roughening (e.g. using large boulders)		Moderate	Low	1,000,000's	Lead: NRM/Consult, C: Gov, Univ, First Nations	
Fish translocation, captive breeding, rescue						
Identify candidate conservation translocation sites for narrow range endemic fishes by undertaking desktop assessments and field surveys to identify suitable habitats that are minimally exposed to threats and implement conservation translocations if deemed appropriate, permissible, and feasible	Bloomfield River cod, rainbowfishes	High	Moderate	100,000's	Lead: Univ, C: Gov, Consult	
Investigate establishing a captive breeding program to establish/maintain ex-situ insurance populations for conservation restocking	Rainbowfishes, Bloomfield River cod	High	High (rainbowfishes), moderate (Daintree rainbowfish), low (Bloomfield River cod)	10,000's-1,000,000's	Lead: Gov, Consult, Commun; C: Univ, First Nations, NRM	
Establish captive populations in publicly accessible aquaria to raise awareness and potential funding for conservation (e.g. 'adopt a fish'). Note, this is not currently permissible for NCA listed species under the NCA captive breeding legislation.	Rainbowfishes	Moderate	High	10,000's-100,000's	Lead: Consult, Commun, Gov; C: Univ, First Nations, NRM	Maintaining genetic integrity
Fish rescue from post-flood stranding by collecting fish immediately post-flood, holding off site and re-stocking after habitat has been restored	Rainbowfishes	Very low	Very low	10,000's-100,000's	Lead: NRM, Consult, Commun; C: Gov, Univ, First Nations	
Pre-emptive fish rescue prior to flood onset, holding off site and re-stocking after flood risk is reduced and/or flood-damaged habitat has been restored	Rainbowfishes	Very low	Moderate	10,000's-100,000's	Lead: NRM, Consult, Commun; C: Gov, Univ, First Nations	Unnecessary physical damage to fish of capture and holding (if flood impacts didn't actually happen)
Establish and curate cryopreserved gametes as genetic material for future conservation breeding	All species	Low	Low	1,000,000's	Lead: Univ, C: Gov	
Road and infrastructure management						

Description of action	Potential fish species benefited	Priority	Feasibility	Indicative cost	Potential contributors	Potential risks
Reduce risk of sedimentation of sensitive habitat by improving sediment spoil removal and dumping procedures and improve management of road maintenance activities. Achieve this by increasing awareness of impacts and enhance surveillance and enforcement	Gobies, rainbows, freshwater moray	Moderate	Moderate	10,000's-100,000's	Lead: Gov	
Prioritise and implement flood-resistant bridge installation to minimise damage associated with sediment delivery at road causeways		Moderate	High	10,000,000's	Lead: Gov (Main Roads for state roads, local councils for some bridges)	Riparian and in-stream habitat damage during bridge construction
Trial on-ground restoration actions to evaluate species responses to extreme floods by undertaking fish surveys around Cooper Creek overflow post-flood and comparison with pre-flood surveys	Daintree rainbowfish	Low	Moderate	10,000's-100,000's	Lead: NRM, Consult, Commun; C: Gov, Univ, First Nations	
Desktop						
Consider additional species for legislative protection through threatened species nomination and listing under the EPBC Act and NCA	Unlisted species identified as being at high risk	Low	High	10,000's	Lead: Univ, Consult; C: Gov (State and Federal)	
Develop disaster impact preparedness plan (for extreme floods and droughts) to influence / improve policy and legislation and to facilitate timely emergency interventions	All species	High	Moderate	10,000's-100,000's	Lead: Gov, C: NRM, Consult, Univ, First Nations, Commun	

Table 7. Recovery Action Table for other threats to rare and threatened species in the Wet Tropics. C = contributor.

Description of action	Potential fish species benefited	Feasibility	Indicative cost	Potential contributors
Filling critical knowledge gaps				
Address knowledge gaps relating to species distributions by collating existing species distribution records (e.g. from unpublished datasets held by experts) and uploading to Wildnet/Atlas of Living Australia	All species	High	1,000's	Lead: Univ, C: Gov, NRM
Address knowledge gaps relating to species' population status, critical habitats, ecological and life-history requirements, environmental tolerances, responses to threats	All species	Moderate	10,000's-100,000's	Lead: Univ/Consult, C: Gov, NRM, First Nations
Improve understanding of captive breeding requirements	Rainbowfish, Bloomfield River cod	High (Rainbowfishes), Moderate (Bloomfield River cod)	10,000's (Rainbowfish), 10,000's-100,000's (BR cod)	Lead: Gov, C: Univ
Improve understanding of the incidence and consequences of hybridization	*Tandanus tropicanus* (with *T. tandanus*)	Moderate	10,000's-100,000's	Lead: Univ/Consult, C: Gov,
Resolve taxonomic uncertainties	Rainbowfishes, Mogurndas, Ambassids	Moderate	10,000's-100,000's	Lead: Univ/Consult, C: Gov,
Improve understanding of the risks, benefits, costs and feasibility of many (all) of candidate conservation actions	All species	Moderate	100,000 - 1,000,000's	Lead: Univ/Consult, C: Gov,
Improve understanding of the social dimensions of conservation action implementation (what motivates people?)	All species	Moderate	100,000 - 1,000,000's	Lead: Univ/Consult/NRM, C: Gov, Commun, First Nations
Implementation				
Establish captive breeding program and facilities	Multiple species (particularly Bloomfield River cod, rainbowfishes)	moderate?	1,000,000's	Lead: Gov; C: Univ/Consult,
Institutional, legislative and socio-political*				
Investigate opportunities for First Nations people to contribute to fish conservation management (via contribution of knowledge, expertise capacity, employment) with dedicated long-term programs	All species	High	100,000-1,000,000's	Lead: First Nations, Gov, C: NRM, landholders, land managers, correctional facilities (e.g. Lotus Glen near Walkamin)

Description of action	Potential fish species benefited	Feasibility	Indicative cost	Potential contributors
Identify and influence legislative restrictions preventing effective conservation actions from being implemented for freshwater fish	Rainbowfishes?	Low?	?	Lead: Gov; C: Species experts
Improve conservation policy, implementation and enforcement		Moderate		
Seek funding to deliver a Recovery Action Plan	All species	Moderate		Lead: Gov; C: Species experts
Improve awareness of multiple stakeholders (government, land managers, land holders, anglers/aquarists, community members) to enhance conservation and reduce/prevent threats (e.g. pest fish awareness campaigns, promoting iconic Wet Tropics species) could be done with road signage, visitor centres (e.g. at Park Ranger Stations), etc	All species	High	100,000 - 1,000,000	Lead: Gov; C: NRM, Univ/Consult, First Nations, Public aquarium, QPWS
Control/prevent pollutant inputs (point source & diffuse) from cane production & other cropping, cattle grazing, dairy, urban (housing development) to improve water quality in the habitat of these species	All species at risk	Moderate	1,000,000's	Lead: Gov; C: Landholder/managers, NRM,
Control/reduce 4WD impacts (veg damage, sediment runoff, physical damage to aquatic habitats, pollutant inputs) at high priority locations	All species at risk	Moderate		Lead: Gov
Improve data capture, curation and access to inform conservation management	All species	High	100,000's	Lead: Gov; C: Univ
Improve scientific capacity in the Wet Tropics (e.g. re-establish Walkamin Research Station with appropriate staffing, budget, etc) to enable conservation measures (e.g. captive breeding) to be established	All species	Low	1,000,000's+++	Lead: Gov; C: Univ

* <u>Governance, Coordination and Resourcing Challenges</u>

There is limited dedicated governance or coordination for freshwater fish management in Queensland. While there are a range of policies, legislation and programs in place which deal with aspects of their management, there is fragmentation of activities and responsibilities, with current focus on habitats, individual threats, fisheries or threatened species rather than a more holistic approach to freshwater fish management. This includes the current challenge posed by onerous state permitting and approval process for projects aimed at ecological restoration, however this issue is not specific to freshwater fish and is currently being addressed as part of a broader program to reduce legislative barriers to rehabilitation. Partly as a lack of governance, there is very limited integrated science and monitoring to support the adaptive management of freshwater fish in Queensland. There is also limited state funding for the implementation and evaluation of the protection, management and restoration of freshwater fish and their habitats.

5. NEXT STEPS

It is anticipated that the information presented in this report can inform prioritisation and implementation of flood recovery actions to protect and restore freshwater fish and their critical habitats in the Wet Tropics regions. It can also inform the future development of Recovery Action Plans for the species addressed here and may be used to inform development of nominations of some species for legislative protection through the EPBC/NCA Acts.

The risk assessment will need to be reviewed at some time in the future to ensure species newly identified taxonomically are incorporated. The risk assessment will also need to be updated as species populations change in response to new, emerging or intensifying threats or successful management.

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7. APPENDICES

Appendix 1 - Species information

A1.1 Rainbowfishes (Melanotaenia)

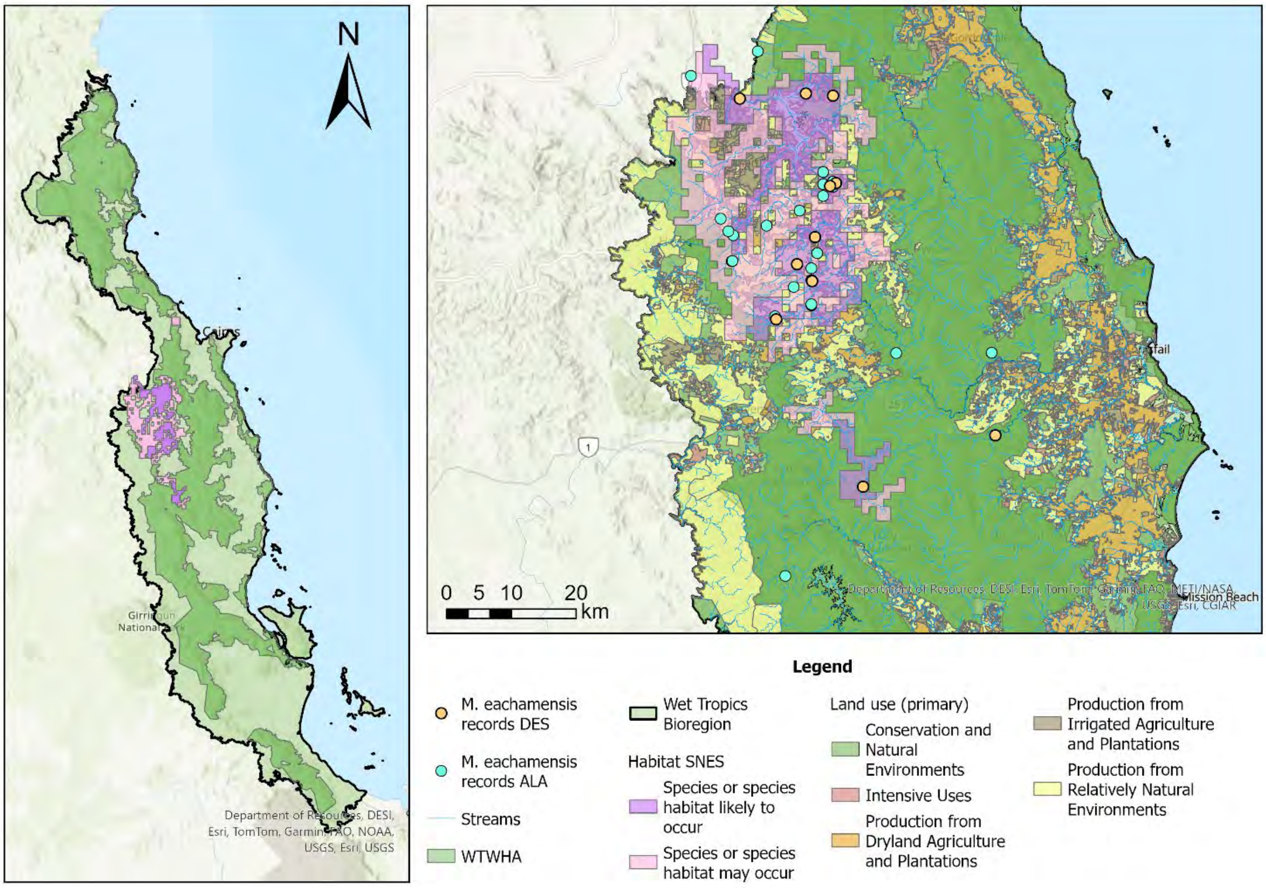
Lake Eacham rainbowfish - *Melanotaenia eachamensis*

Conservation Status, Taxonomy and Description

Listed as Endangered under the EPBC Act and IUCN Red List of Threatened Species, the Lake Eacham rainbowfish (*Melanotaenia eachamensis*) is a small species of rainbowfish, commonly around 40 mm, growing to a maximum of 65 mm (B. Pusey et al., 2004). Its appearance is characterised by a laterally compressed bluish-grey body intersected by a dark mid-lateral stripe, two faint ventral bands, and red fins (B. Pusey et al., 2004).

Species Distribution and Populations

This species derived its name from the crater lake, Lake Eacham, in which it was originally discovered and subsequently became extinct from by 1987 due to the predation by translocated native species into the lake, particularly the mouth almighty (Barlow et al., 1987). Subsequent surveys in the wet tropics confirmed a wider distribution of Lake Eacham rainbowfish to include Lake Euramoo, the upper North Johnstone River and tributaries, the upper South Johnstone River and the upper Barron River (Allen, 1995; B. Pusey et al., 1997; Zhu et al., 1998). Parts of this distribution are shared with the closely related but genetically distinct Malanda rainbowfish (*Melanotaenia* sp. nov. 'Malanda') and eastern rainbowfish (*Melanotaenia splendida*) (Brauer et al., 2023; Tims et al., 2024; Zhu et al., 1998). Natural hybridisation with eastern Rainbowfish has occurred throughout much of this range and the North Johnstone River (Dirran Creek) and Lake Euramoo subpopulations of Lake Eacham rainbowfish are considered to be the most genetically pure and distinct, warranting prioritisation for conservation (Tims et al., 2024; Zhu et al., 1998).



N
Cairns
Girringun National Park
Department of Resources, DESI, Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, USGS
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Tully
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Legend
M. eachamensis records DES
M. eachamensis records ALA
Streams
WTWHA
Wet Tropics Bioregion
Habitat SNES
Species or species habitat likely to occur
Species or species habitat may occur
Land use (primary)
Conservation and Natural Environments
Intensive Uses
Production from Dryland Agriculture and Plantations
Production from Irrigated Agriculture and Plantations
Production from Relatively Natural Environments

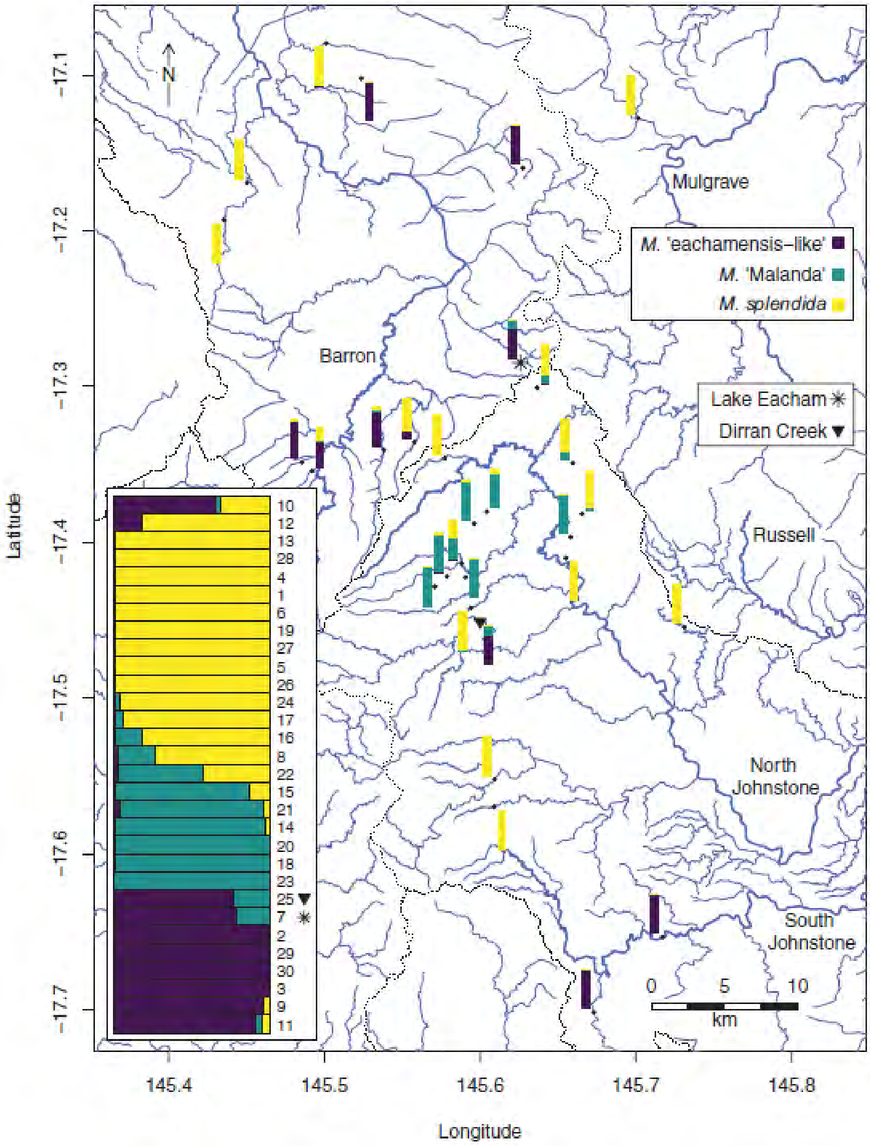


Figure 8. From Tims et al., (2024): Map showing sampled locations and admixture proportions of 30 different rainbowfish populations. Major rivers are named and denoted by thicker lines; smaller waterways are denoted by thinner lines. Dotted black lines denote catchment boundaries. The study region corresponds to the inset box in Fig. 1a. A traditional STRUCTURE plot is inset on the bottom left of the figure. Numbers correspond to locality numbers marked in Supplementary File S5 of Tims et al., (2024).

Biology and Ecology

The Lake Eacham rainbowfish is omnivorous, feeding primarily on aquatic invertebrates, and to a lesser extent terrestrial invertebrates and plant material (including filamentous algae, diatoms and desmids) (B. Pusey et al., 2004). This species is fast-maturing, short-lived (around two years), and highly fecund (B. Pusey et al., 2004). Spawning may occur from August to April when water temperatures are above 17°C but mostly takes places in the dry season from August to November or when there are stable low flows (B. Pusey et al., 2004). This is likely due to larvae showing a strong preference for low to no flows (B. J. Pusey et al., 2002). Lake Eacham rainbowfish eggs are adhesive, attaching to root masses or submerged vegetation (B. Pusey et al., 2004). Small larvae hatch from the eggs in around 10 days and larval development is complete at 11-14 mm (B. Pusey et al., 2004).

The habitat of Lake Eacham rainbowfish in its current distribution within the Barron and Johnstone Rivers consists of shallow rocky/cobble bottom streams at high elevations (~700 m) with moderate to slow flow (B. Pusey et al., 1997; Zhu et al., 1998). Within these habitats, Lake Eacham rainbowfish have been found to be most abundant in the lower velocity zones, on the outer margins of submerged para grass stands and in the bottom half of the water column (B. Pusey et al., 2004). Larval Lake Eacham rainbowfish show particular preference for shaded slow-flowing marginal habitats (B. Pusey et al., 2004). Its current or past inhabitancy of lakes suggests that this species can also successfully survive and reproduce in lacustrine environments.

Despite several surveys determining the extent of the distribution of Lake Eacham rainbowfish, there is no information available on the patterns of movement of this species (B. Pusey et al., 2004). It is hypothesised that adhesion of eggs and subsequent transport between waterbodies by waterbirds or humans may have facilitated the dispersal of Lake Eacham rainbowfish into isolated lakes (Oulton et al., 2013).

Key threats

This species is able to tolerate moderately elevated turbidity for short periods, suggesting that it is somewhat adapted to periodic flooding (B. Pusey et al., 2004). Key threats to Lake Eacham rainbowfish include the translocation and dispersal of native fish species and reduction of preferred habitat due to climate change (DCCEEW, 2014). Research has shown that this species is particularly vulnerable to predation by translocated species (Barlow et al., 1987; Brown & Warburton, 1997). Described as being 'predator-naive', reintroductions of Lake Eacham rainbowfish from a captive collection in 1989 were unsuccessful due to continued predation, indicating that rehabilitation of the species in its previous known range is not possible while predatory translocated natives exist (Brown & Warburton, 1997; Caughey et al., 1990; Leggett & Merrick, 1997). While sooty grunter coexist with Lake Eacham rainbowfish in some streams, future translocations of predatory natives into the current range of Lake Eacham rainbowfish could have severe consequences for the remaining population (DCCEEW, 2014). In contrast to the upland specialist rainbowfishes (Lake Eacham, Malanda, and Utchee Creek rainbowfishes), the eastern rainbowfish is thought to be a relatively recent arrival to the Atherton Tablelands (~100,000 years ago) (Hurwood & Hughies, 2001). Continued spread of eastern rainbowfish into the current distribution of Lake Eacham rainbowfish is also a key threat due to hybridisation which reduces genetic integrity (Tims et al., 2024; Zhu et al., 1998). However, some researchers argue that this hybridisation provides resilience to climate change (Brauer et al., 2023; Turbek & Taylor, 2023). The spread of eastern rainbowfish may be exacerbated by climate change as streams inhabited by Lake Eacham rainbowfish warm, forcing Lake Eacham rainbowfish to the upper limits of these streams and increasing hybridisation with eastern rainbowfish (Brauer et al., 2023).

Expert threat risk assessment

Table A1.1.1 Expert risk assessment of threats to the Lake Eacham rainbowfish (Melanotaenia eachamensis).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible	moderate	High	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	minor	Moderate	current/ future	increasing	entire range	inferred

Land use alteration	Riparian veg clearing / degradation	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Aquatic habitat degradation (e.g. sedimentation, simplification)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
Introduced species	Invasive riparian / aquatic weeds	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Invasive terrestrial animals and livestock	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Invasive fish	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Translocated native fish	likely	minor	Moderate	past/ current/ future	increasing	part of range	observed
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	part of range	inferred
	Heatwaves	possible	moderate	High	current/ future	increasing	part of range	inferred
	Drought	possible	moderate	High	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	possible	minor	Moderate	past/ current/ future	stable?	part of range	inferred
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	past/ current/ future	stable?	part of range	inferred
Other threats	Hybridization with translocated fish	possible	catastrophic	Very High	future	stable	part of range	inferred

Previous and current management actions

Lake Eacham rainbowfish were attempted to be reintroduced into Lake Eacham from a captive collection in 1989 but the attempt was unsuccessful due to continued predation (Brown & Warburton, 1997; Caughey et al., 1990; Leggett & Merrick, 1997).

Malanda rainbowfish - *Melanotaenia* sp. nov. 'Malanda'

Conservation Status, Taxonomy and Description

Listed as Critically Endangered under the EPBC Act, QLD NCA and IUCN Red List of Threatened Species, the Malanda rainbowfish (*Melanotaenia* sp. nov. 'Malanda') is a small species of rainbowfish (males growing to 61 mm and females slightly smaller) with a laterally compressed body (Unmack et al., 2016). Taxa with similar morphology include eastern rainbowfish and Lake Eacham rainbowfish, though Malanda rainbowfish are more laterally compressed than eastern rainbowfish and shorter than both eastern and Lake Eacham rainbowfish (Unmack et al., 2016). Male Malanda rainbowfish are easier to distinguish from eastern and Lake Eacham rainbowfish due to the striking physical characteristics. This includes a brown-golden body with thin orange to brown lateral body stripes (Unmack et al., 2016). In breeding season, the body appears bright golden with thin red stripes, all fins have black edging and dorsal, anal and caudal appear a reddish colour. Female Malanda rainbowfish have a distinctly oval-shaped body that is silver-brown with paler orange-brown lateral stripes and a triangular first dorsal fin. It is difficult to distinguish female Malanda rainbowfish from females of the other two species other than by size (Unmack et al., 2016).

Species Distribution and Populations

The Malanda rainbowfish exists only in the North Johnstone River and detailed surveys were undertaken throughout the expected range of the Malanda rainbowfish between 2014 and 2018 (Moy et al., 2021). These surveys identified six remaining subpopulations, found in various parts of Williams Creek, an unnamed tributary to Molo Creek, and several instream dams on an unnamed tributary of Thiaki Creek and Wallace Road Creek (Moy et al., 2021). These surveys found that the population is declining, with only four subpopulations suggested to be remaining in the IUCN assessment (Brown, Hammer, Unmack, et al., 2019). Overlapping distributions among several rainbowfish species with similar physical characteristics, including Malanda rainbowfish, Lake Eacham rainbowfish and eastern rainbowfish, makes it challenging to distinguish these species in the field, with thorough examination of individuals required (Unmack et al., 2016). Hybridisation has also occurred between Malanda rainbowfish and eastern rainbowfish and the hybrids are especially difficult to distinguish without genetic testing (Unmack et al., 2016).

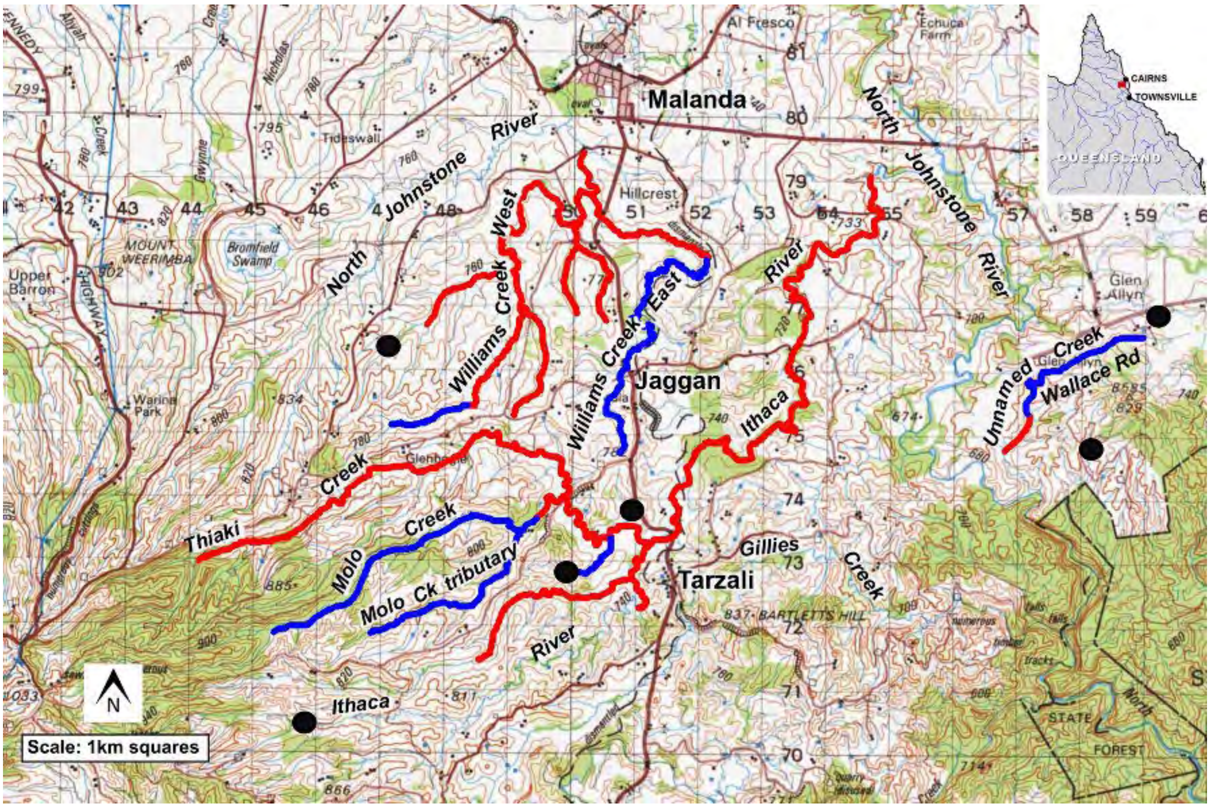
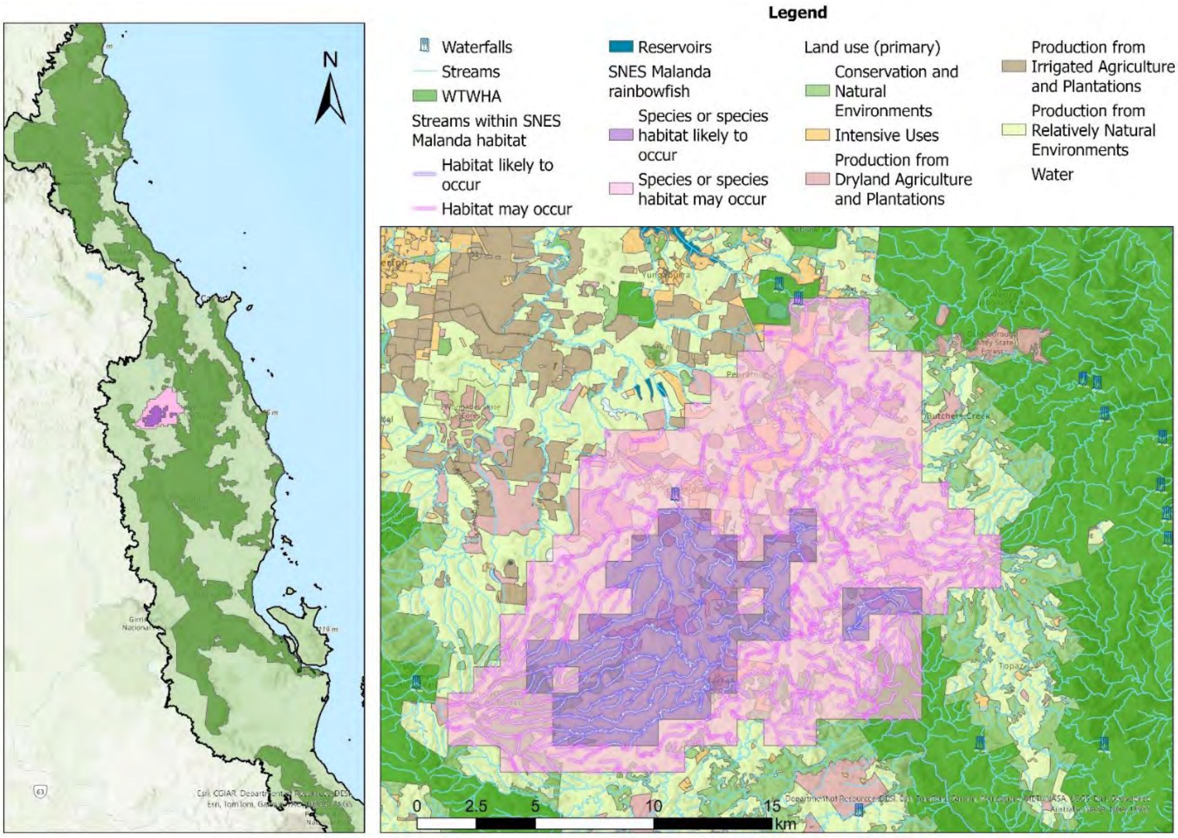


Figure 9. From Unmack et al., (2016): known distribution of Malanda Rainbowfish populations. Red lines indicate likely former distribution; blue lines indicate known distribution as at November 2016; black dots represent release sites November 2016. Insert map shows the study region (small red rectangle) in Queensland. Source base map: Geosciences Australia.



Biology and Ecology

The diet and reproductive biology of this species has not been described but is likely to be similar to the Lake Eacham rainbowfish, which is also an upland specialist of a similar size that shares part of its distribution with Malanda rainbowfish. As described above for Lake Eacham rainbowfish, this diet is likely to be omnivorous, consisting of aquatic and terrestrial invertebrates and plant material (including filamentous algae, diatoms and desmids) (B. Pusey et al., 2004). Spawning of Lake Eacham rainbowfish occurs from August to April when water temperatures are above 17°C but mostly takes places in the dry season from August to November or when there are stable low flows (B. Pusey et al., 2004). It is assumed that this is also the case for Malanda rainbowfish, which are likely to have similar eggs that adhere to submerged root masses or vegetation (DCCEEW, 2022).

The remaining subpopulations of Malanda rainbowfish are found at elevations between 650–800 m, in smaller, cool (16-22 °C), fast flowing tributaries (Unmack et al., 2016). These tributaries feature several low drop (<1 m) waterfalls and contain substrates comprised of rock platforms, boulders and cobbles, and red silt, with little aquatic vegetation (Unmack et al., 2016).

The movement or dispersal patterns of this species have not been described.

Key threats

The population of Malanda rainbowfish is suspected to have declined by around 80%, with the primary threats attributable to this decline including habitat degradation from dairy farming and hybridisation with eastern rainbowfish expanding their range (Brown, Hammer, Unmack, et al., 2019). Land clearing and associated land use has degraded streams in the area, turning them into wide, exposed, slow flowing, mud bottomed creeks choked with para grass (Moy et al., 2021). In the 1990’s, Malanda rainbowfish were present in the main channel of the Ithica River, Thiaki Creek and Williams Creek West branch but only hybrids of Malanda and eastern rainbowfish are now found in these reaches (Brown, Hammer, Unmack, et al., 2019; Moy et al., 2021). There are numerous threats that pose a high risk of causing further population decline, including reduced genetic integrity due to the continued range expansion of eastern rainbowfish, which may be accelerated in streams where land clearing facilitates increased water temperatures (DCCEEW, 2022; Unmack et al., 2016). Further land clearing will also exacerbate weed growth, decreasing water flow and connectivity, and increasing fire risk (Werren, 2001). Further construction of water infrastructure to support community and agricultural water use will also alter water flow and reduce connectivity, though a barrier effect limiting upstream dispersal of eastern rainbowfish may benefit Malanda rainbowfish in reaches that have not yet been invaded by eastern rainbowfish (DCCEEW, 2022). This is also the case for invasive guppies which have been recorded in the distribution of Malanda rainbowfish and are likely to be competitive for food and display aggression towards Malanda rainbowfish (Arthington, 1991; Pyke, 2008; Unmack et al., 2016). Climate change also threatens the habitat of Malanda rainbowfish primarily through habitat degradation during extreme events (e.g. flooding, landslides) and warmer water temperatures due to global warming, which will cause changes to the fish assemblage and accelerate the rate of invasion by eastern rainbowfish (DCCEEW, 2022). Malanda rainbowfish are among the group of endemic highland species inhabiting cool refugia streams that are thought to be most at risk of extinction as the rising temperatures forces them to the upper limits of these streams, but there is little empirical evidence to support this (Pearson et al., 2015; Wet Tropics Management Authority, 2024).

Expert threat risk assessment

Table A1.1.2 Expert risk assessment of threats to the Malanda rainbowfish (Melanotaenia sp. nov. 'Malanda').

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible	moderate	High	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	minor	Moderate	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Aquatic habitat degradation (e.g. sedimentation, simplification)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
Introduced species	Invasive riparian / aquatic weeds	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Invasive terrestrial animals and livestock	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Invasive fish	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Translocated native fish	likely	minor	Moderate	past/ current/ future	increasing	part of range	observed

Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	entire range	inferred
	Heatwaves	possible	moderate	High	current/ future	increasing	part of range	inferred
	Drought	possible	moderate	High	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	possible	minor	Moderate	past/ current/ future	stable?	part of range	inferred
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	past/ current/ future	stable?	part of range	inferred
Other threats	Hybridization with translocated fish	almost certain	catastrophic	Very High	past/ current/ future	increasing	part of range	observed

Previous and current management actions

Malanda rainbowfish have been translocated from wild genetically pure subpopulations to refuge areas (e.g., farm dams) in the upper North Johnstone catchment (Moy et al., 2021; Unmack et al., 2016). Subpopulations are also being established in other sub-catchments that likely formerly contained Malanda rainbowfish or lack rainbowfish completely (Moy et al., 2021; Unmack et al., 2016). These translocations have been mostly successful. The Ithaca Creek population is abundant and gradually expanding downstream and some farm dam populations have persisted (Moy et al., 2021).

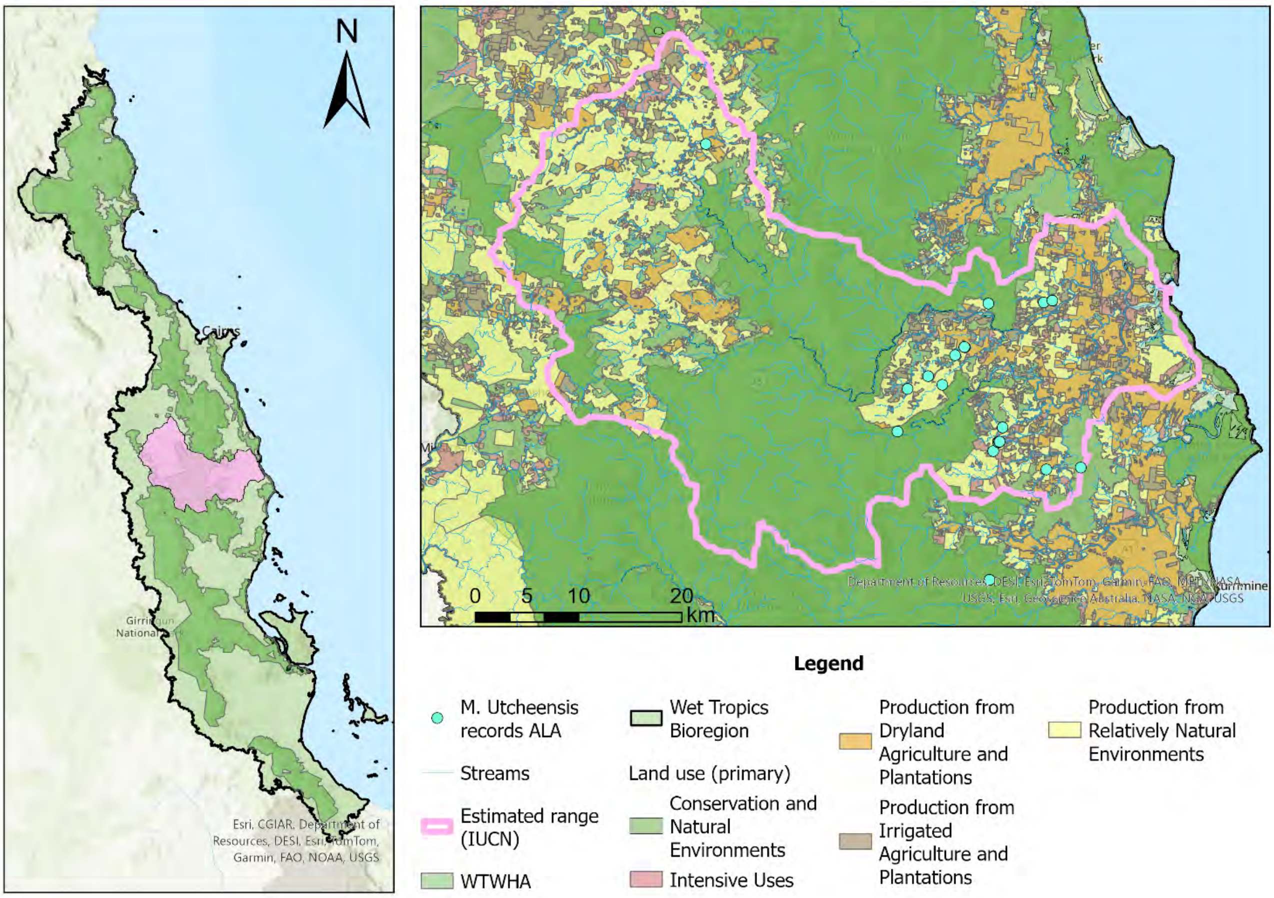
Utchee Creek rainbowfish - *Melanotaeia utcheensis*

Conservation Status, Taxonomy and Description

Listed as Endangered on the IUCN Red List of Threatened Species, the Utchee Creek rainbowfish (*Melanotaeia utcheensis*) is a moderate-sized rainbowfish growing to 60 mm SL but more commonly found between 45 to 50 mm SL (B. Pusey et al., 2004). The body is silver/blue in colour with a dark blue and an orange midlateral stripe and two to three orange stripes that extend from the caudal fin to the base of the first dorsal fin (B. Pusey et al., 2004). Dorsal, anal and pelvic fins has a thin black margin and there is a large orange spot on the operculum (B. Pusey et al., 2004). As with other rainbowfishes, sexual dimorphism is apparent, with longer pelvic, second dorsal and anal fins in males and brighter red colouration during breeding season (B. Pusey et al., 2004). Utchee Creek rainbowfish have a deeper body than eastern and Lake Eacham rainbowfish (B. Pusey et al., 2004).

Species Distribution and Populations

The Utchee Creek rainbowfish is found within a small area of the North and South Johnstone River catchments (K. C. Martin & Barclay, 2017). It is not found in main channel habitats, where eastern rainbowfish are abundant, but is locally abundant within surrounding lowland tributaries (K. C. Martin & Barclay, 2017; B. Pusey et al., 2004). Originally thought to also inhabit the Atherton Tablelands, subsequent genetic analysis revealed that population to be Malanda rainbowfish (McGuigan et al., 2000; Unmack et al., 2016).



Biology and Ecology

The diet of Utchee Creek rainbowfish is largely unknown but thought to be similarly omnivorous to Lake Eacham rainbowfish due to similar to their close relatedness and the general similarity in habitats used (B. Pusey et al., 2004). The Lake Eacham rainbowfish feeds on primarily aquatic invertebrates, and to a lesser extent terrestrial invertebrates and plant material (including filamentous algae, diatoms and desmids) (B. Pusey et al., 2004).

Although little is known on the reproduction of Utchee Creek rainbowfish, length distribution data suggests it is similar to other rainbowfish species in the area that have year round spawning but a peak around October, shortly before the onset of the wet season (B. Pusey et al., 2004; B. J. Pusey et al., 2001). This species is short lived, and likely to produce a large quantity of eggs that are adhesive to submerged vegetation and hatch in around 5 days (B. Pusey et al., 2004).

Most of the streams within the distribution of Utchee Creek rainbowfish have low to moderate water flow (B. J. Pusey et al., 2001). They are most abundant in shallow riffles or runs (<0.4 m) with a gradient of about 0.4% and water velocities less than 20 cm sec^{-1} (B. Pusey et al., 2004). Water temperatures in these areas have been recorded up to 32°C (B. Pusey et al., 2004). Areas within the distribution of Utchee Creek rainbowfish that have intact riparian vegetation and canopy there are few macrophytes, filamentous algae and submerged vegetation (e.g. para grass) (B. Pusey et al., 2004).

There is little information available on the movement or dispersal patterns of this species.

Key threats

Utchee Creek rainbowfish inhabit several streams surrounded by agricultural land use that is increasing in intensity and are therefore exposed to further habitat and water quality degradation (Brown, Hammer, & Unmack, 2019). While the species has been shown to be somewhat tolerant to hypoxic events, further intensification of agriculture may increase the intensity and severity of hypoxic events and there may be cumulative or interacting effects of low oxygen events and exposure to increased turbidity or chemical toxicant loads associated with agriculture (Brown, Hammer, & Unmack, 2019; Flint, 2005). Additionally, the population faces continued reduction of genetic integrity due to hybridisation with eastern rainbowfish (Brown, Hammer, & Unmack, 2019; Unmack et al., 2016). The small distribution of Utchee Creek rainbowfish make them especially vulnerable to impacts of extreme events such as large floods or fires that can cause severe habitat degradation (e.g. siltation from flooding) (Brown, Hammer, & Unmack, 2019).

Expert threat risk assessment

Table A1.1.3 Expert risk assessment of threats to the Utchee Creek rainbowfish (Melanotaeia utcheensis).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible	moderate	High	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	minor	Moderate	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Aquatic habitat degradation (e.g. sedimentation, simplification)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed

Introduced species	Invasive riparian / aquatic weeds	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Invasive terrestrial animals and livestock	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Invasive fish	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Translocated native fish	likely	minor	Moderate	past/ current/ future	increasing	part of range	observed
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	entire range	inferred
	Heatwaves	possible	moderate	High	current/ future	increasing	part of range	inferred
	Drought	possible	moderate	High	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	possible	minor	Moderate	past/ current/ future	stable?	part of range	inferred
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	past/ current/ future	stable?	part of range	inferred
Other threats	Hybridization with translocated fish	possible	catastrophic	Very High	future	stable	part of range	inferred

Previous and current management actions

There are no previous or current management actions for this species.

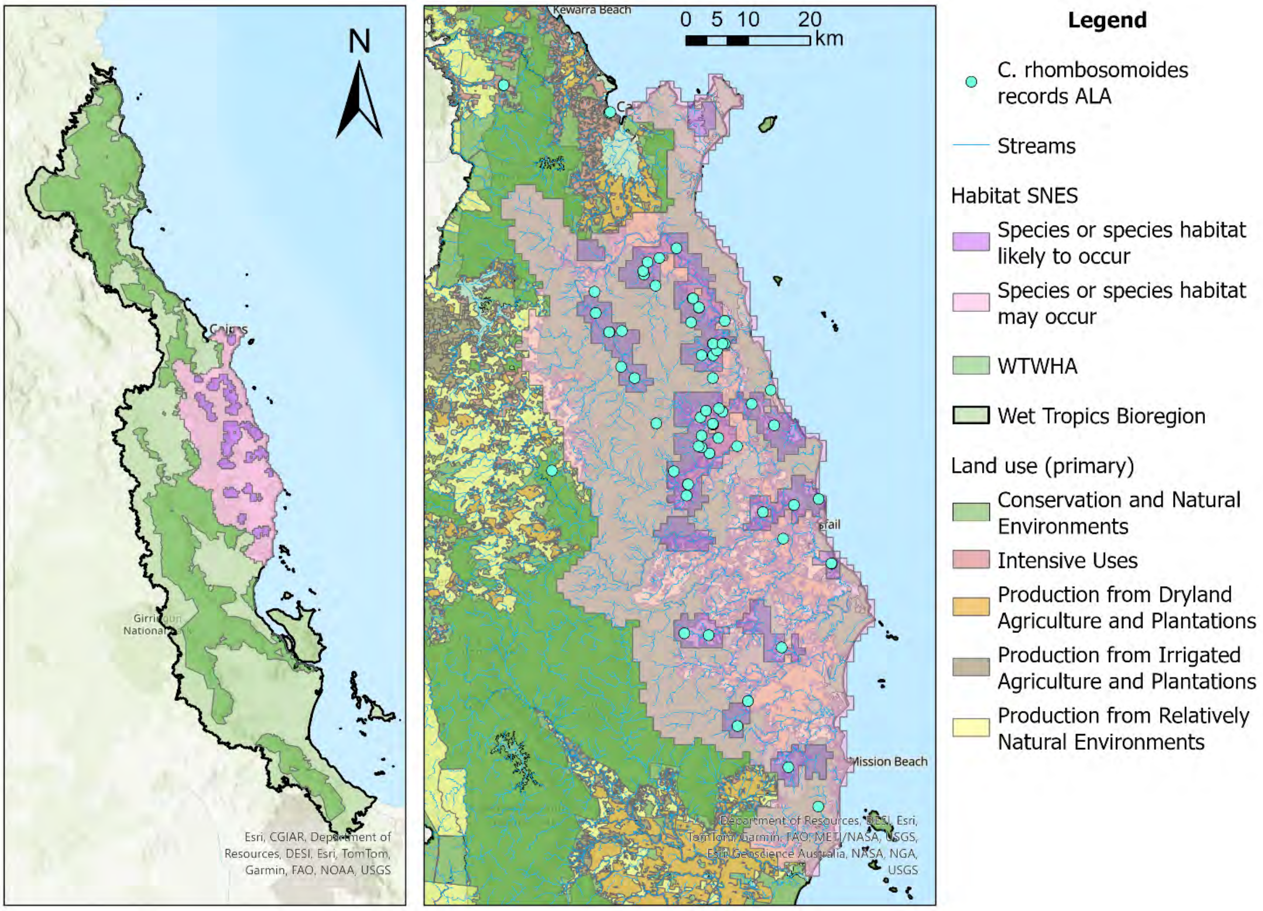
Cairns rainbowfish - *Cairnsichthys rhombosomoides*

Conservation Status, Taxonomy and Description

Listed as Endangered under the EPBC Act, QLD NCA and IUCN Red List of Threatened Species, the Cairns rainbowfish (*Cairnsichthys rhombosomoides*) is a moderate-sized rainbowfish growing to 70 mm SL but more commonly found to 60 mm SL (B. Pusey et al., 2004). This species of rainbowfish is clearly distinguished from eastern, Lake Eacham, Malanda, and Utchee Creek rainbowfish by its slender body which is rhombofusiform and laterally compressed similar to that of *Rhadinocentrus ornatus* which is found further south on the Australian continent (Aarn & Ivantsoff, 1997). The body is bright tan-yellow on the dorsal half and white on the ventral side (B. Pusey et al., 2004). A distinct black midlateral stripe and more diffuse ventral black stripe extends between the caudal and pectoral fin base. The fin margins of the dorsal surface are an iridescent yellow and a there is a large iridescent yellow spot on the operculum (B. Pusey et al., 2004). The *Cairnsichthys* genus was previously thought to be monotypic, containing only the Cairns rainbowfish but the most northern population has since been shown to be genetically unique and is now described as the Daintree rainbowfish (*Cairnsichthys bitaeniatus*) (Hammer et al., 2018; K. C. Martin & Barclay, 2013).

Species Distribution and Populations

The Cairns rainbowfish has a patchy distribution in small foothill streams from Cairns south to Liverpool Creek and Hull River catchments. Surveys have found it to reside in tributaries of the Mulgrave and Russell River systems, a few small areas of the North and South Johnstone Rivers, Liverpool Creek, Maria Creek, and the North Hull catchment (B. Ebner, Brown, et al., 2019; K. C. Martin, 2018; K. C. Martin & Barclay, 2013). It was also once found in Freshwater Creek, a major lowland tributary of the Barron River catchment, but is now believed to be locally extinct from this tributary (K. C. Martin, 2018). The wider distribution of Cairns rainbowfish is made up of several different populations, some of which have little mixing between them despite their close proximity, indicating vulnerability for further local extinctions to occur (P. Thuesen et al., 2008).



Biology and Ecology

The Cairns rainbowfish feeds primarily on terrestrial invertebrates from the water surface (B. Pusey et al., 2004). The diet also includes aquatic diptera, chironomid and trichopteran larvae and ephemeropteran nymphs (B. Pusey et al., 2004). It has also been observed consuming small benthic shrimps that are found in more complex habitats that include, overhanging riparian vegetation, exposed tree roots, and undercut banks (Ebner et al. 2019).

Similar to other rainbowfish in the Wet Tropics, some reproduction occurs year round but peak spawning likely occurs in August to November, prior to the wet season (B. J. Pusey et al., 2001). The Cairns rainbowfish is short lived (2-3 years) and highly fecund (though less fecund than eastern and Lake Eacham rainbowfish), reaching sexual maturity before the age of 1 at around 34 and 27.5 mm for female and male fish, respectively (B. J. Pusey et al., 2001). Eggs are likely to be adhesive to submerged vegetation and root masses and are thought to hatch in around 7 days (Allen & Cross, 1982; B. Pusey et al., 2004).

The Cairns rainbowfish is mostly found in small coastal foothill streams and to a lesser extent in short, steep coastal streams. Most records of this species have occurred at elevations < 50 m and within 2 km of foothills (B. Ebner, Brown, et al., 2019; K. C. Martin, 2018; B. Pusey et al., 2004). These are usually flowing, clear water streams with a granite boulder or sand dominated substrate (B. Ebner, Brown, et al., 2019; K. C. Martin, 2018; B. Pusey et al., 2004; P. Thuesen et al., 2008). Within the Mulgrave/Russell and Johnstone River systems, the distribution of Cairns rainbowfish with respect to elevation and distance from the river mouth is bimodal (B. Pusey et al., 2004). Typical habitat is in small high gradient tributaries at about 50 to 60 m asl with a limited number of other species present (B. Pusey et al., 2004). However, small adventitious low gradient streams located close to the river mouth also contain Cairns rainbowfish (B. Pusey et al., 2004). These streams are typically low gradient with a mud, sand and fine gravel substrates and contain a species-rich assemblage (B. Pusey et al., 2004). An intact riparian zone is a feature of their habitat regardless of location within each catchment (B. Pusey et al., 2004).

The Cairns rainbowfish is mostly commonly found in water depths of 10-60 cm and flows less than 0.1 m sec^{-1} (B. Pusey et al., 2004). Flowing water does not appear to be as crucial as water permanency, with individuals found in non-flowing anabranch habitats (B. Ebner, Brown, et al., 2019). This species appears to be most abundant in the section of stream between the base of the steep mountain range and the deeper, slower flowing, downstream section (DCCEEW, 2023b). This preferred location often coincides with the presence of large predators such as mangrove jack (*Lutjanus argentimaculatus*) and the widespread eastern rainbowfish with which it is likely to be competitive (DCCEEW, 2023b). Its abundance varies among sites and appears to be lower in sites that also contain eastern rainbowfish, with which they are typically allopatric (B. Pusey et al., 2004).

Key threats

Complete extinction of this species is unlikely due to the numerous small populations of this species that are distributed through various river systems (P. Thuesen et al., 2008). However, further local extinctions could occur due to exposure to increasing threats within the current distribution, and these vary spatially with different land uses and water extraction activities that each subpopulation is exposed to (B. Ebner, Brown, et al., 2019). Populations in the foothills close to Cairns are at risk from urban expansion, as are those on the north bank of the Johnstone River, which has experienced an expansion in suburban development. Some subpopulations are located in or downstream of national parks and the WTWHA, providing buffering of some threats at these locations (B. Ebner, Brown, et al., 2019).

The habitat of the Cairns rainbowfish is a key component of its survival and habitat degradation due to land use (e.g. clearing of riparian vegetation with expanding urban areas or expanding agriculture) or extreme events (e.g. siltation due to large floods) pose a key threat to this species (DCCEEW, 2023b). Loss or damage of the riparian zone is perhaps one of the greatest threats to this species due to its strong affinity to streams with an intact riparian zone (B. Pusey et al., 2004). Changes to the flow regime due to water extraction also threatens this species due to its patchy, disconnected distribution and preference for flowing water (DCCEEW, 2023b). The loss of permanent stream flow is a possible cause of extirpation in sites impacted by changes to flow (B. Ebner, Brown, et al., 2019). The spread of invasive species including weeds and pigs, which degrade riparian and aquatic habitat, also threaten the condition of the habitat of Cairns rainbowfish (DCCEEW, 2023b). Invasive tilapia and eastern rainbowfish are likely to impact some subpopulations where distributions currently overlap and continual dispersal or increased abundance of these species may result in the decline of Cairns rainbowfish populations (DCCEEW, 2023b).

Expert threat risk assessment

Table A1.1.4 Expert risk assessment of threats to the Cairns rainbowfish (Cairnsichthys rhombosomoides).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible	major	Very High	current/ future	increasing	entire range	inferred

	Changes in rainfall, runoff, flow regimes	almost certain	major	Very High	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	likely	major	Very High	past/ current/ future	increasing	part of range	observed & inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	likely	moderate	High	past/ current/ future	increasing	part of range	inferred
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	likely	moderate	High	current/ future	increasing	part of range	inferred
Introduced species	Invasive terrestrial animals and livestock	likely	moderate	High	past/ current/ future	increasing	part of range	inferred
	Invasive fish	likely	moderate	High	current/ future	increasing	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	part of range	inferred
	Heatwaves	possible	moderate	High	current/ future	increasing	part of range	inferred
	Drought	possible	moderate	High	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	inferred
Natural system management & modifications	Altered fire regimes (increased severity)	unlikely	moderate	Moderate	future	stable?	part of range	inferred

Previous and current management actions

There are no previous or current management actions for this species.

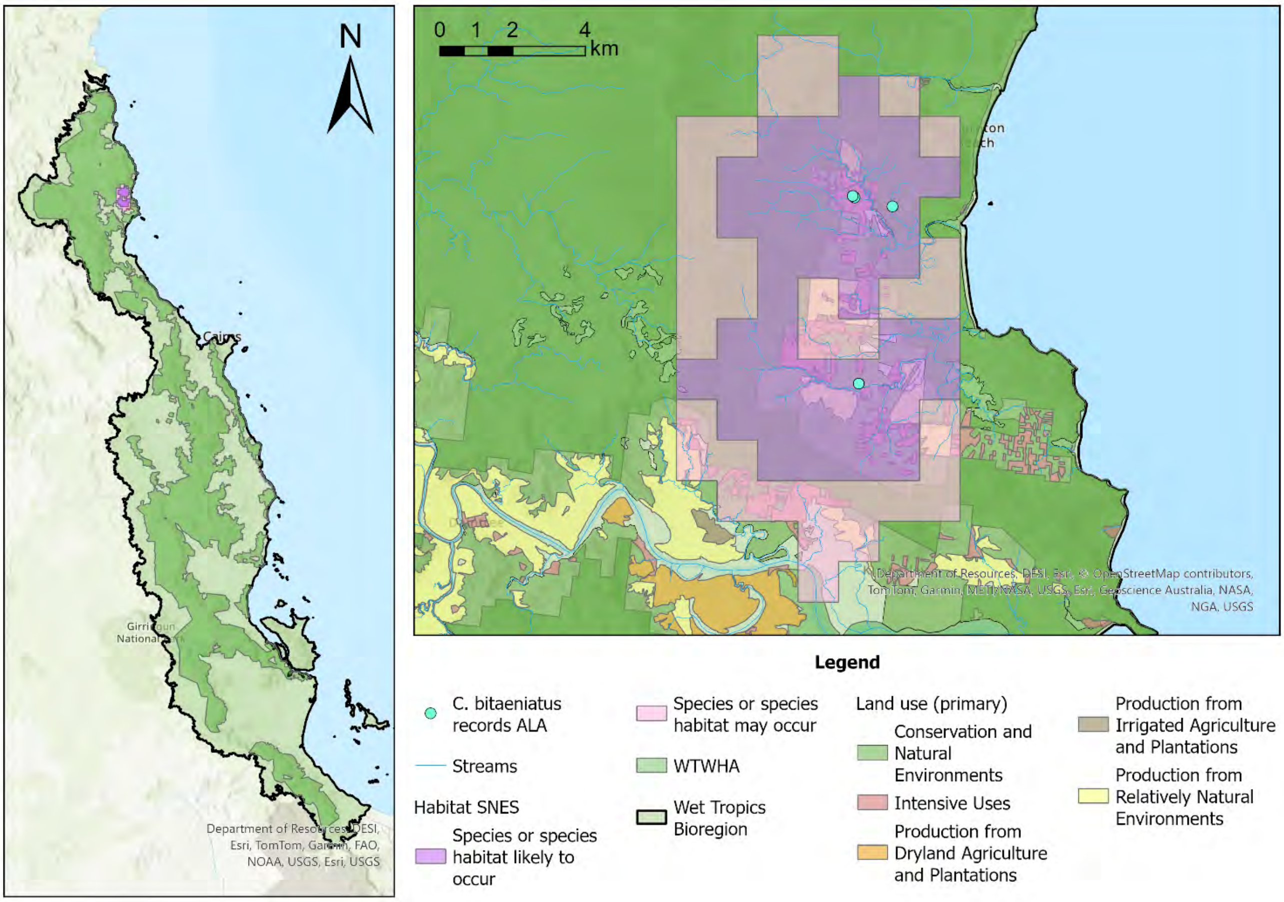
Daintree rainbowfish - *Cairnsichthys bitaeniatus*

Conservation Status, Taxonomy and Description

Listed as Critically Endangered under the EPBC Act, QLD NCA and IUCN Red List of Threatened Species, the Daintree rainbowfish (*Cairnsichthys bitaeniatus*) is a moderate-sized rainbowfish growing to around 66 mm SL (Hammer et al., 2018). This species of rainbowfish is clearly distinguished from eastern, Lake Eacham, Malanda, and Utchee Creek rainbowfish by its slender body which is rhombofusiform and laterally compressed but is morphologically similar to the Cairns rainbowfish and it was previously thought to be part of this species (Aarn & Ivantsoff, 1997; K. C. Martin & Barclay, 2013). Whilst it shares the slender body form and generally similar colouration and markings of the Cairns rainbowfish, there are subtle morphological differences that distinguish the two species (Hammer et al., 2018). The Daintree rainbowfish has a more slender and narrow shape, featuring a flatter, straighter predorsal profile, a shorter second dorsal fin base, and smaller and more numerous lateral and predorsal scales (Hammer et al., 2018). Colouration varies slightly with a distinct yellow patch on the body, a more robust, short black stripe across the upper operculum and a more prominent second dark stripe on the lower body (Hammer et al., 2018). Additionally, adult males usually have yellowish fins compared to the reddish fins of male Cairns rainbowfish (Hammer et al., 2018).

Species Distribution and Populations

The Critically Endangered status of the Daintree rainbowfish reflects the extremely restricted range of this species and low abundance of known populations (K. Martin et al., 2019). Surveys conducted by Martin and Barclay (2013) and Hammer et al., (2018) found that it exists only in three small subpopulations in small tributaries of the Cooper and Hutchinson Creek systems in the Daintree region of the Wet Tropics. This inhabited area is contained within a 12km^2 extent of occurrence, within only 1200m of stream length (K. Martin et al., 2019). Further surveys have recorded the species in an additional two tributaries of these creeks (DCCEEW, 2023a; K. C. Martin & Barclay, 2021). “the population is thought to be declining as indicated by a reduction in the area of occurrence and a reduction in the abundance of mature individuals in those locations in which they persist (K. Martin et al., 2019).



Biology and Ecology

There is little information on the trophic and reproductive ecology of the Daintree rainbowfish since it was only recently recognised as a distinct species (Hammer et al., 2018). However, its diet and reproductive ecology is likely to be similar to the Cairns rainbowfish due to highly similar morphology between the two species (K. Martin et al., 2019). The Cairns rainbowfish is thought to feed primarily on terrestrial invertebrates from the water surface (B. Pusey et al., 2004) and the Daintree rainbowfish has been observed feeding on terrestrial invertebrates on the surface, or capturing small prey entrained in the current (K. Martin et al., 2019). The diet of the Cairns rainbowfish has also been shown to include small benthic shrimp, aquatic diptera, chironomid and trichopteran larvae and ephemeropteran nymphs (B. Ebner, Brown, et al., 2019; B. Pusey et al., 2004).

Daintree rainbowfish may share similar spawning behaviour to other Wet Tropics rainbowfishes, where some reproduction occurs year round but peaks in August to November, prior to the wet season (B. J. Pusey et al., 2001). The Cairns rainbowfish is short lived (2-3 years) and highly fecund (though less fecund than eastern and Lake Eacham rainbowfish), reaching sexual maturity before the age of 1 at around 34 and 27.5 mm for female and male fish, respectively (B. J. Pusey et al., 2001). Eggs are likely to be adhesive to submerged vegetation and root masses and are thought to hatch in around 7 days (Allen & Cross, 1982; B. Pusey et al., 2004). The Daintree rainbowfish is a similar size and are therefore likely to have a similar age at maturity and fecundity, but more research is needed to determine whether this holds true.

The streams in which Daintree rainbowfish currently exist are mostly shaded, clear water, permanently flowing lowland rainforest streams (20-40 m asl) with little to no aquatic vegetation (K.

C. Martin & Barclay, 2013). One subpopulation was found in a mostly shallow (<0.5 m) sandy creek with a wetted width of around 5m, while the other two populations are located in wider (~10 m wetted width) sand and cobble bottom creeks (K. C. Martin & Barclay, 2013). These wider creeks were generally deeper (>1 m) containing runs, deeper pools (up to 4m), and large submerged wood habitat around which Daintree rainbowfish were located (K. C. Martin & Barclay, 2013). Within these streams, Daintree rainbowfish are usually found swimming near the surface to midwater depth in deeper pools in areas of high flow (K. Martin et al., 2019).

There is no information available on the movement or dispersal patterns of the Daintree rainbowfish.

Key threats

This species is highly vulnerable to threats due to its restricted range and small population size (DCCEEW, 2023a; K. Martin et al., 2019). Most of the streams currently inhabited by Daintree rainbowfish are surrounded by rainforest, but some are located adjacent to private properties (K. C. Martin & Barclay, 2013). While most of these properties have retained the riparian rainforest, some have cleared and there is a cattle property situated on Hutchinson Creek which is likely to contribute to elevated nutrient loads and subsequent suspended algae presence during periods of lower flow (K. C. Martin & Barclay, 2021). The strong habitat affinity this species shows to permanently flowing streams at the foothills of mountain ranges suggests its vulnerability to any changes in flow caused by water extraction or climate change (K. Martin et al., 2019). Water extraction already occurs along much of these creeks and results in very little flow and lower water levels towards the end of the dry season (DCCEEW, 2023a). Reduced rainfall or increased droughts due to climate change could exacerbate this issue by further reducing streamflow and subsequently the area of available preferred habitat for Daintree rainbowfish (K. Martin et al., 2019). Similarly extreme events that degrade habitat (e.g. landslides due to large cyclones, siltation doe to large floods, reduced water quality due to bushfires) also threaten the entire population of Daintree rainbowfish (DCCEEW, 2023a). Given they only inhabit smaller tributaries, it is unknown whether they would disperse to new suitable habitats if these events were to occur within the current distribution (DCCEEW, 2023a).

Other potential threats include the illegal collection of wild individuals for aquariums, and the spread of invasive weeds and fish into Daintree rainbowfish habitat (DCCEEW, 2023a). There are currently no invasive fish species present in the distribution of the Daintree rainbowfish, but the native eastern rainbowfish co-occurs throughout much of its range (DCCEEW, 2023a; K. C. Martin & Barclay, 2021). Competition with eastern rainbowfish is unknown but is a potential threat (DCCEEW, 2023b). Translocated predatory natives (e.g. grunters) could severely impact the Daintree rainbowfish and keeping these streams free of these species is a key conservation action (DCCEEW, 2023a; K. Martin et al., 2019).

Expert threat risk assessment

Table A1.1.5 Expert risk assessment of threats to the Cairns rainbowfish (Cairnsichthys bitaeniatus).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible	catastrophic	Very High	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	catastrophic	Very High	current/ future	increasing	entire range	inferred

Land use alteration	Riparian veg clearing / degradation	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	likely	major	Very High	current/ future	stable/ increasing?	part of range	observed
Invasive species	Invasive terrestrial animals and livestock	almost certain	moderate	Very High	past/ current/ future	stable?	entire range	inferred
	Invasive fish	possible	moderate	High	future	increasing	entire range	inferred
Natural disasters	Increased frequency/severity of cyclones, extreme rainfall, and extreme floods	possible	catastrophic	Very High	current/ future	increasing	entire range	inferred
	Heatwaves	possible	major	Very High	current/ future	increasing	entire range	inferred
	Drought	possible	catastrophic	Very High	current/ future	stable?	entire range	inferred
Water resource management & infrastructure	Altered hydrology	almost certain	major	Very High	past/ current/ future	stable?	entire range	observed
Biological resource use	Over-harvesting/illicit collection	possible	minor	Moderate	current/ future	stable?	part of range	inferred
Natural system management & modifications	Altered fire regimes (increased severity)	unlikely/ unknown	moderate	Moderate	future	increasing	part of range	inferred
Other	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	almost certain	major	Very High	current/ future	increasing	part of range	observed

Previous and current management actions

There are no previous or current management actions for this species.

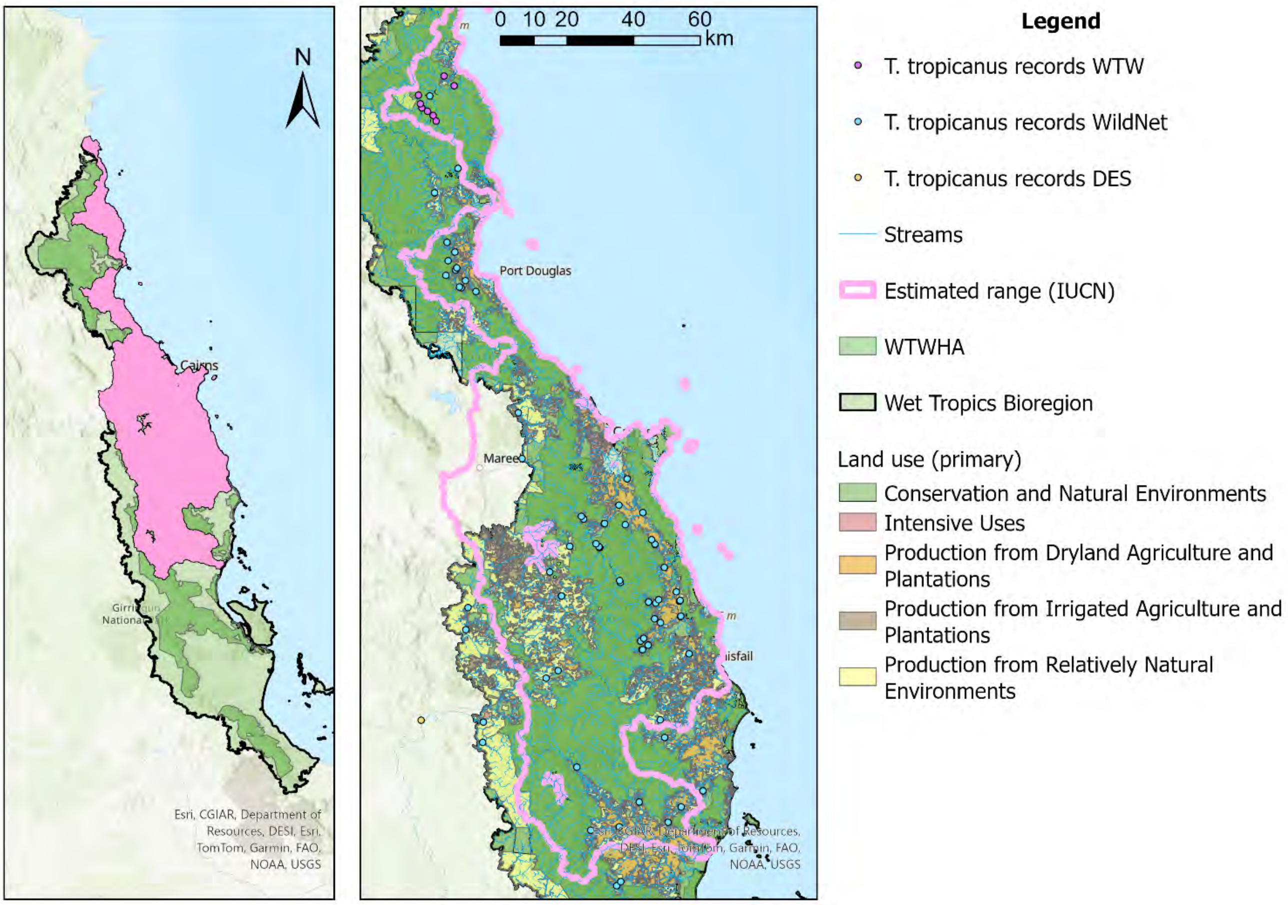
A1.2 Wet Tropics tandan - *Tandanus tropicanus*

Conservation Status, Taxonomy and Description

The Wet Tropics tandan (*Tandanus tropicanus*) is a species of eeltail catfish that is listed as Least Concern on the IUCN Red List of Threatened Species (Brooks, Ebner, et al., 2019). Previously thought to be the widespread eeltail catfish (*Tandanus tandanus*), the Wet Tropics tandan was described as a separate species in 2014 following genetic analysis of samples from the *Tandanus* genus collected across eastern Australia (Jerry, 2008; Welsh et al., 2014). With a similar appearance to *T. tandanus,* the Wet Tropics tandan is recorded to around 400 mm SL and has an elongate and robust body that is slightly convex in its anterior half, becoming progressively compressed towards the caudal fin (Welsh et al., 2014). Colouring varies between yellow-brown, brown and grey and colouring pattern can be mottled or uniform (Welsh et al., 2014). Sexual dimorphism is subtle, with the only difference being triangular urogenital papilla in adult females and cylindrical urogenital papilla in adult males (Welsh et al., 2014).

Species Distribution and Populations

Endemic to coastal rivers of the Wet Tropics, the Wet Tropics tandan is confirmed to inhabit the Daintree, Mulgrave-Russell, Johnstone, and Tully rivers, and Five Mile Creek (Welsh et al., 2014). It has also been found in the Bloomfield River (Kelly et al., 2016; Carpenter-Bundhoo, et al., 2025) and is suspected of being translocated into that system (Brooks, Ebner, et al., 2019). More research is needed to determine whether the Wet Tropics tandan occurs in other Wet Tropics basins (Welsh et al., 2014).



Biology and Ecology

Whilst there is no new information on the biology and ecology of the Wet Tropics tandan following its recognition as a different species to *Tandanus tandanus,* previous fish surveys and tropics analyses of *Tandanus* spp. in the Wet Tropics are likely to include the Wet Tropics tandan and are therefore described here. *Tandanus* spp. are widespread in both upstream and downstream tributaries and main channels across a range of altitudes (10 - >700 m asl) in the Wet Tropics (B. J. Pusey et al., 1995). While *Tandanus* spp. appear to be found across almost all mesohabitat types in the Wet Tropics, juveniles are most common in fast flowing, shallow water habitats and in particular utilise riffle and run mesohabitats for feeding (B. Pusey et al., 2004; Rayner, 2006). Small juveniles that have not long left the nest appear to prefer sheltering under the leaves of *Aponogeton bullosus* (a perennial aquatic plant list as Endangered under the EPBC Act 1999) and other aquatic plants which occur in riffles . Adults display a stronger habitat affinity for deeper, slow waters over a mixed substrate (mostly mud and sand) with root masses and deep undercut banks (B. Pusey et al., 2004; Rayner, 2006). These ontogenetic differences in habitat use may result in ontogenetic differences observed in feeding ecology (B. Pusey et al., 1995; B. J. Pusey et al., 1995). In the Wet Tropics, *Tandanus* spp. consume a mixture of aquatic macroinvertebrates (e.g. Trichoptera and Ephemeroptera larvae) and foods based on detrital production (including terrestrial leaf litter and detritus) (B. Pusey et al., 1995; Rayner et al., 2010).

There is little information on the reproductive biology and ecology of *Tandanus* spp. from the Wet Tropics. *Tandanus* spp. from elsewhere in Australia reach sexual maturity within five years and complete their entire lifecycle in freshwater (T. L. O. Davis, 1975). *Tandanus* spp. are able to reproduce in ponds and impoundments and have been successfully reared in aquaria (T. L. O. Davis, 1975; Lake, 1967; Llewellyn, 1971). In southern Queensland, spawning occurs from October to March but in the Wet Tropics nest construction commences in late September or October and very small individuals have been recorded in November or December, suggesting spawning may also occur in September (B. Pusey et al., 2004). In the Wet Tropics, nests are located along the thalweg close to the head of riffles in an area of downwelling. Mature males have been observed in higher abundance at site level than the number of nests and larger males defend their nest from other males, suggesting competition among males for nest location (*Pers comms.,* B. Pusey). *Tandanus* spp. eggs hatch in around a week or so (Lake, 1967; B. Pusey et al., 2004).

Movement studies conducted on *Tandanus tandanus* in southern Queensland and northern New South Wales suggest that *Tandanus* spp. are relatively sedentary species with a small home range, and males may use the same nest location in consecutive years (Burndred et al., 2018; Carpenter-Bundhoo et al., 2021; B. Pusey et al., 2004). Relationships between movement and flow are inconsistent among rivers, inter-pool movements during low and base flows observed in one system (Burndred et al., 2018) and larger movements during high flow events observed in another (Carpenter-Bundhoo et al., 2021). Movements patterns in the Wet Tropics are therefore largely unknown and warrant further investigation.

Key threats

Due to its widespread distribution in the Wet Tropics and relatively common occurrence within known basins, there are no immediate and critical key threats to the Wet Tropics tandan. However, it is unclear how widely this species is distributed throughout the Wet Tropics and whether *Tandanus tandanus* (a commonly translocated species) also exists in its distribution. Overlapping distributions between the two species may result in hybridisation and subsequent loss of genetic integrity (Brooks, Ebner, et al., 2019). These knowledge gaps hinder a comprehensive understanding of the likely resilience of the Wet Tropics tandan to current and future threats in the Wet Tropics.

The only documented threat to the Wet Tropics tandan is exposure to pathogens carried by invasive species. Research suggests that Wet Tropics tandan have been exposed to pathogens carried by ornamental aquarium species. Kelly et al., (2018) detected the US bacterial pathogen *Edwardsiella ictaluri* (considered to be one of the most significant pathogens of farmed catfish in the US) in Wet Tropics tandan collected from the Tully River. However, the distribution of this pathogen in Wet Tropics rivers and its effects on the host organism are not well understood.

Due to its larger adult size, predation by invasive or translocated native species is likely only to impact early life stages Wet Tropics tandan (Burrows, 2004). However, competition with tilapia for nest sites may occur. The species is also well poised to adapt to climate change, due to its widespread distribution across a range of water temperatures that exist along river profiles in the Wet Tropics (Welsh et al., 2014). The preference shown by juveniles for shallow fast flowing mesohabitats is perhaps among the most vulnerable of its traits to climate change, where predicted changes to cloud height and rainfall in the dry season could reduce reliability and availability of this preferred habitat (DES, 2019; B. Pusey et al., 2004). Activities that result in an increase in sediment into rivers and streams are likely to pose a threat to this species due to smothering of the substrate and particularly colmation in downwelling areas.

Expert threat risk assessment

Table 1.2 Expert risk assessment of threats to the Wet Tropics tandan (Tandanus tropicanus).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible	minor	Moderate	future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible (decrease in rainfall/runoff)	moderate	High	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	possible (myrtle rust)	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Introduced species	Invasive riparian / aquatic weeds	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Invasive terrestrial animals and livestock	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Invasive fish	likely (tilapia competition for nest sites etc)	major	Very High	past/ current/ future	increasing	entire range	inferred

	Translocated native fish	likely (*T. tandanus*)	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	minor	Moderate	current/ future	increasing	part of range	inferred
	Drought	possible	minor	Moderate	current/ future	increasing	entire range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Impoundment of riverine habitat	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)	likely	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Biological resource use	Over-harvesting/illicit collection	almost certain	not significant	Low	past/ current/ future	increasing	part of range	inferred
Natural system management & modifications	Altered fire regimes (increased severity)	unlikely	minor	Low	future	stable?	part of range	inferred
Other threats	Hybridization with translocated fish (	possible	moderate	High	past/ current/ future	increasing	part of range	inferred
	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	likely	minor	Moderate	current/ future	increasing	part of range	inferred

Previous and current management actions

There are no previous or current management actions for this species.

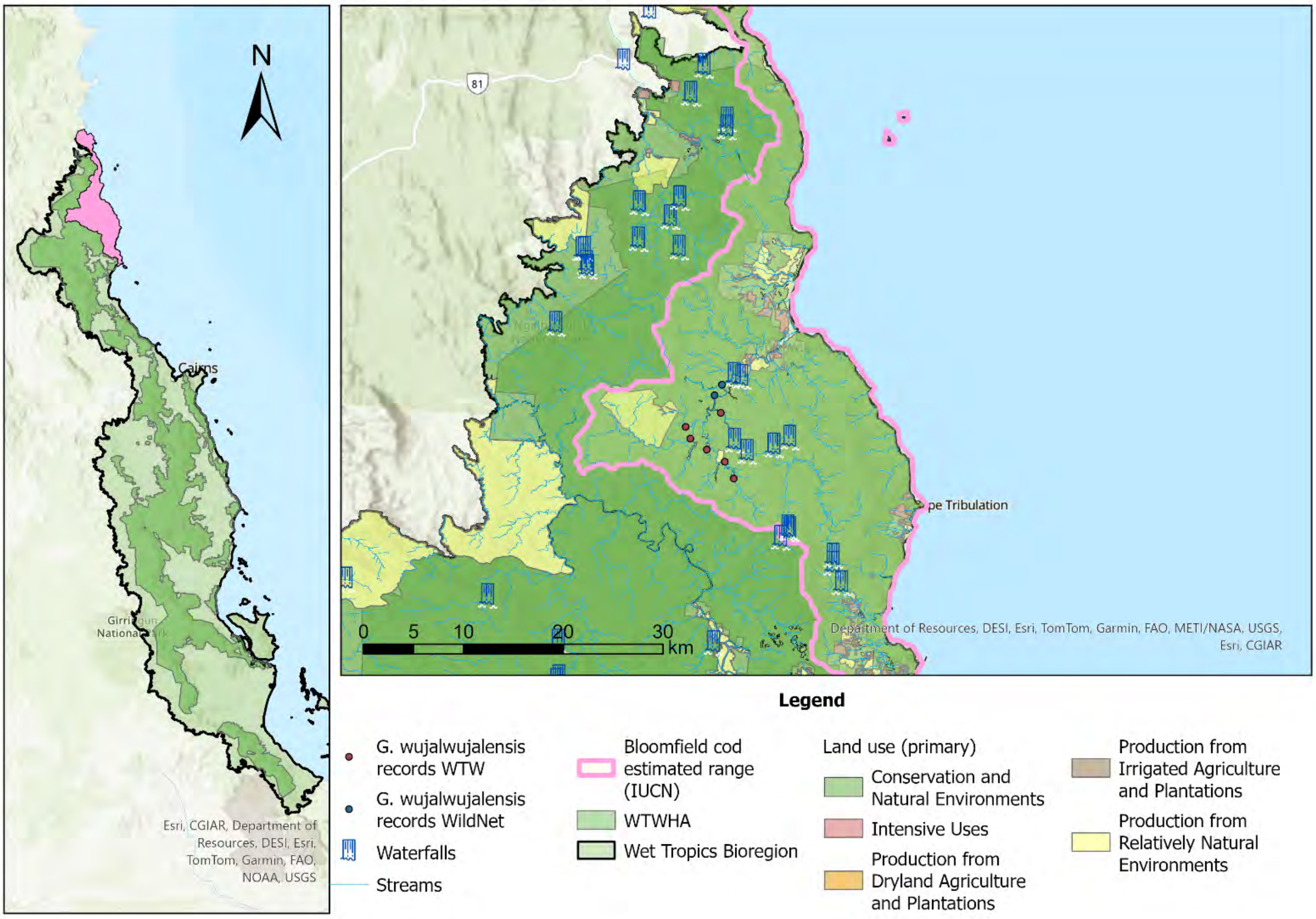
A1.3 Bloomfield River cod - *Guyu wujalwujalensis*

Conservation Status, Taxonomy and Description

Listed as Vulnerable on the IUCN Red List of Threatened Species, the Bloomfield River cod (*Guyu wujalwujalensis*) is a small fish (growing to 101 mm SL) with a profile typical of fish from the Percichthyidae family (Brooks, Kennard, et al., 2019; B. Pusey & Kennard, 2001). It has a deep body, tapered and naked snout, scaled cheek and operculum, and completely lateral line that follows the dorsal profile (B. Pusey & Kennard, 2001). Colouration varies depending on location and time of day, appearing light khaki dorsally and silver-white with iridescent green/blue ventrally during the daytime, dark green dorsally and khaki-green ventrally when in shaded areas, and dark green all over at night (B. Pusey & Kennard, 2001). The Bloomfield River cod is an example of the relict ancient freshwater fauna found in the Wet Tropics and its lineage is phylogenetically unique to that of the rest of the present day Wet Tropics freshwater fish assemblage (B. Pusey et al., 2008). It is thought to be one of the only remaining previously more widespread fauna that are now restricted to temperate and sub-tropical Australia and is therefore of high conservation significance (B. Pusey, 2001).

Species Distribution and Populations

While the previous distribution of the species is unknown, in the present day it is endemic to the Bloomfield River in the north of the Wet Tropics (B. Pusey et al., 2008). The evolutionary history of the Bloomfield River cod suggests that is has inhabited the Bloomfield River for millions of years (B. Pusey et al., 2008). Surveys in the 1990's that first noted the then undescribed species found it to only be present in the Bloomfield River between Bloomfield Falls and Roaring Meg Falls (B. J. Pusey & Kennard, 1996). However, recent surveys have found Bloomfield River cod in several upstream tributaries (D. Moffat, Unpublished data; Carpenter-Bundhoo et al., 2025). It is locally abundant within its highly restricted range and the population structure is unknown (Brooks, Kennard, et al., 2019).



Biology and Ecology

The Bloomfield River cod is almost exclusively carnivorous, consuming mostly aquatic insects, terrestrial invertebrates and fish, foraging on both the stream-bed and water surface (B. Pusey & Kennard, 2001). Little is known about the age, growth, and age at maturity of the Bloomfield River cod, except that males and females are able to be distinguished internally at lengths above 42- and 43-mm SL, respectively (B. Pusey et al., 2004). Spawning season, and reproduction are unknown, however, ripe individuals have been collected in April (B. Pusey et al., 2004).

Earlier surveys that observed the species only in main channel habitats between the Bloomfield and Roaring Meg falls described these habitats as wide (30-40 m) reaches with varying depths (from < 1 m to > 4 m) (B. Pusey et al., 2004). These reaches feature a complex mix of cascade sections, runs and deep pools, with velocities ranging from > 1 m sec^{-1} in the cascade sections to 0.03 m sec^{-1} in the pools (B. Pusey et al., 2004). The reaches examined consisted of clear water, boulders, some undercut banks with root masses, and sparse woody debris (B. Pusey et al., 2004). During the day, Bloomfield River cod seek refuge under and around these habitat features but at night swim high in the water column in open water near the riverbank (B. Pusey et al., 2004). The habitat of the upstream tributaries in which the Bloomfield River cod were recently recorded has not been described, but their presence at these sites indicates that tributaries are also likely to provide suitable habitat and ample food.

Little is known on the movement and dispersal patterns of the Bloomfield River cod. It’s recent detection in tributaries upstream of where it was previously recorded suggest that it is able to disperse to these habitats. It is unknown whether it makes upstream spawning migrations similar to that of the more southern Macquarie Perch (*Macquaria australasica*) (Koster et al., 2013).

Key threats

The highly restricted distribution of Bloomfield River cod within a single catchment highlights its vulnerability to current and future threats (Brooks, Kennard, et al., 2019). The Bloomfield River cod has been exposed to a number of threats in the past few decades, including the introduction of invasive and translocated native fish into the known habitat of the cod. Translocated natives into the reach of the Bloomfield River inhabited by Bloomfield River cod include the Wet Tropics tandan (*Tandanus tropicanus*) and the khaki grunter *Hephaestus tulliensis* (Carpenter-Bundhoo et al., 2025). The khaki grunter is a large bodied (to 300 mm SL) carnivorous species endemic to other Wet Tropics waterways now found throughout the range of the Bloomfield River cod. It is unknown whether the presence of the khaki grunter has resulted in the dispersal of Bloomfield River cod into upstream tributaries and there is a critical need for research that investigates the impacts of khaki grunter on the Bloomfield River cod. Their introduction could cause a decline in the number of immature and mature individuals (through competition and/or predation) (Brooks, Kennard, et al., 2019). Recent surveys have also recorded the invasive guppy (*Poecilia reticulata*) at several sites in the Bloomfield River (D. Moffat, *Pers comms,* Carpenter-Bundhoo et al., 2025) and competitive interactions with this species are also unknown.

The Bloomfield River cod has not yet been successfully reared in captivity and there is anecdotal evidence to suggest illegal harvesting of Bloomfield River cod is occasionally occurring despite it being listed as a 'No take' species on the Queensland Fisheries Act (Brooks, Kennard, et al., 2019).

Another key threat to the Bloomfield River cod is flow alteration (due to water extraction or climate change) due to its preference for flowing habitats. Water extraction is currently minimal in the catchment but future increases in water take could impact the habitat of this species (Brooks, Kennard, et al., 2019). The restricted range of the species makes it vulnerable to habitat degradation due to droughts, land use impacts or extreme events such as large floods, which may increase in frequency and intensity with climate change (McInnes et al., 2015). The December 2023 cyclone Jasper event made landfall near the town of Wujal Wujal on the Bloomfield River and caused large scale flooding and multiple significant landslides in the catchment (Wet Tropics Management Authority, 2024). The flooding caused scoured and subsequently damaged riparian vegetation, and the landslides left deep scars on the landscape and caused a major influx of suspended sediment and debris into the river, reducing water quality (Wet Tropics Management Authority, 2024). However, the damage caused by cyclone Jasper, particularly to the Bloomfield River cod habitat, has not been fully assessed and warrants investigation.

Expert threat risk assessment

Table A1.3 Expert risk assessment of threats to Bloomfield River cod (Guyu wujalwujalensis)

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible	minor	Moderate	future	increasing	entire range	inferred

	Changes in rainfall, runoff, flow regimes	possible (decrease in rainfall/ runoff)	moderate	High	current/ future	increasing	entire range	inferred
Introduced species	Invasive terrestrial animals and livestock	possible	minor	Moderate	past/ current/ future	increasing	entire range	inferred
	Invasive fish	almost certain	major	Very High	past/ current/ future	increasing	part of range	observed
	Translocated native fish	almost certain	major	Very High	past/ current/ future	increasing	entire range	observed
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	entire range	inferred
Biological resource use	Over-harvesting/illicit collection	possible	minor	Moderate	current/ future	stable	entire range	inferred
Other threats	lack of legislative protection (e.g. through listing)	possible	moderate	High	current/ future	increasing	entire range	inferred

Previous and current management actions

This species is listed as 'No take' species under the Queensland Fisheries Act. There are no other previous or current management actions for this species.

A1.4 Khaki grunter - *Hephaestus tulliensis*

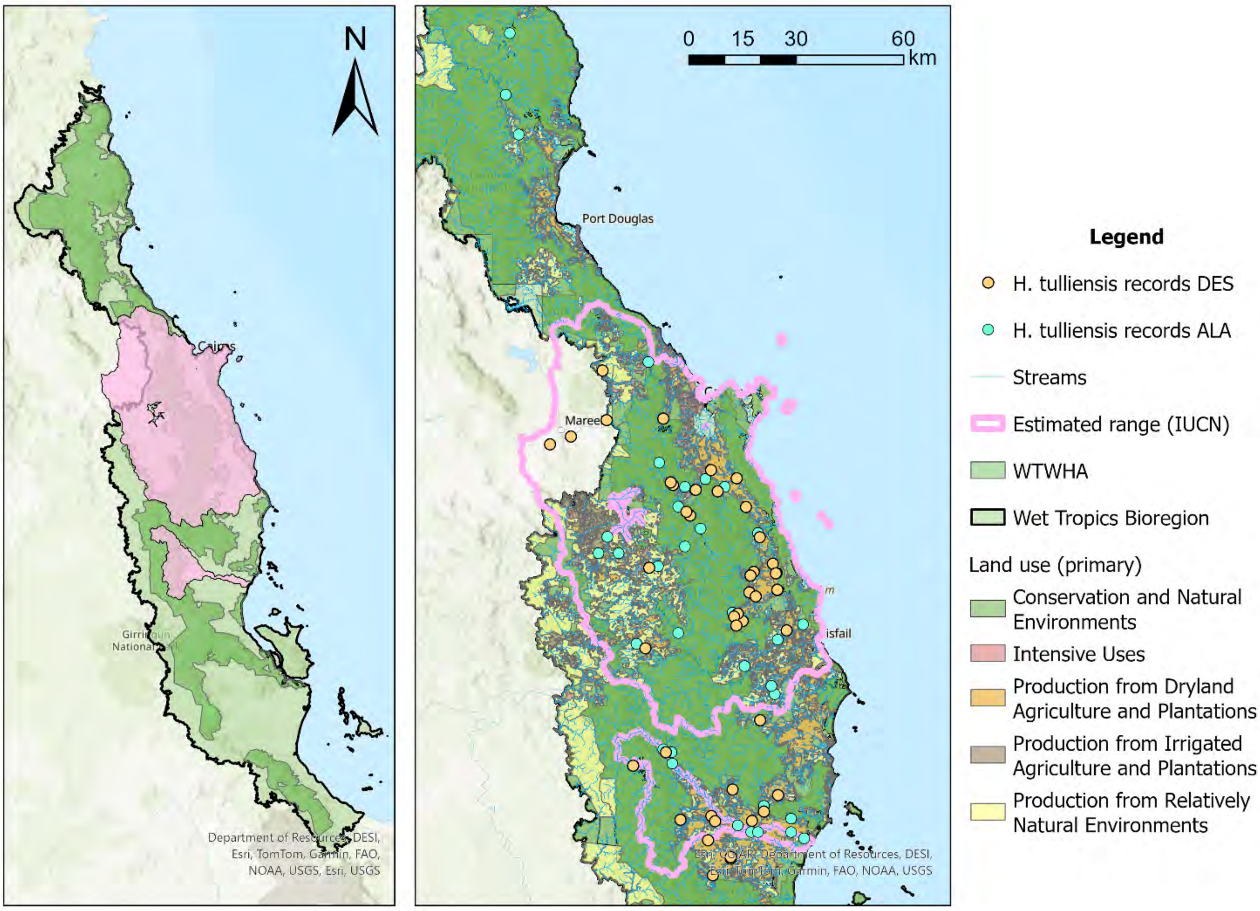
Conservation Status, Taxonomy and Description

The khaki grunter (*Hephaestus tulliensis*), also known as Tully grunter, is a large-bodied (up to 300 mm SL, but more commonly to 200 mm) freshwater grunter endemic to the Wet Tropics region. It has a complicated taxonomic history due to its morphological similarities with the co-occurring sooty grunter (*Hephaestus fuliginosus*) (B. Pusey, 2001). The khaki grunter was originally described as *H. tulliensis* by C.W. De Vis in 1884 but was clumped into the *H. fuliginosus* species in 1978 and it wasn't until 1999 when it was redescribed by Allen and Pusey that it was again recognised as *H. tulliensis* (Allen & Pusey, 1999).

The khaki grunter is generally smaller than the sooty grunter and is characterised by a deep, laterally compressed body deep, small mouth, short head and sharp snout (B. Pusey et al., 2004). It is commonly a dusky grey-brown to a khaki green colour with narrow white scale margins but has also been observed as a pale yellow body colour which may be associated with breeding (B. Pusey et al., 2004). Similar to the body colour, it has grey-brown fins except for the soft rays of the pelvic and anal fins which are pale yellow and the pectoral fins are translucent (B. Pusey et al., 2004). The iris is red or orange (B. Pusey et al., 2004). It can be differentiated from *H. tulliensis* by many features, including a deeper body, larger eye, smaller mouth, and deeper and shorter caudal peduncle, among other features (B. Pusey et al., 2004). The most useful differentiating features in the field are the difference in iris colour (reddy-orange vs. dusky brown), the number rows above the lateral line (7–8 vs. 8–10) and length of the pelvic fins (B. Pusey et al., 2004). Some individuals have been found with enlarged lips, known as the "blubber lip" form (*Pers comms.,* B. Pusey).

Species Distribution and Populations

The khaki grunter is found in several lowland river catchments in the Wet Tropics between the Herbert River and Daintree River and is relatively common within its distribution (B. Pusey et al., 2004; Rayner, 2006). Within this distribution it is sympatric with, but usually more abundant than sooty grunter (except in the Herbert River) (B. Pusey et al., 2004). It has also been translocated into other rivers in the Wet Tropics (e.g. the Bloomfield River) and elsewhere (M. Kennard & Brooks, 2019).



Biology and ecology

The khaki grunter is omnivorous, feeding on a variety of aquatic and terrestrially derived animal and plant material, including aquatic insects, filamentous algae and riparian fruits (A. M. Davis et al., 2011; B. Pusey et al., 2004, 2008). Individuals of the "blubber lip" form consume smaller prey than equivalently sized "standard" form individuals (*Pers comms.,* B. Pusey). Little is known about the reproductive biology of khaki grunter, other than that it spawns between July and October, and reaches sexual maturity at 13 cm (Allen et al., 2002). Spawning has been observed in shallow, still water adjacent to a fast flowing rapid (B. Pusey et al., 2004). This is similar to the spawning behaviour of the sooty grunter which spawn in aggregations in shallow, lateral, still waters adjacent to riffle/rapid habitats in water temperatures above 25°C (B. Pusey et al., 2004).

The khaki grunter resides mostly in main channel habitats but is found across a wide range of habitats from small first-order headwater tributary streams to larger lowland sixth-order rivers (B. Pusey et al., 2004). While it may occur over a wide range of depths (<10 – >100 cm) and flows (0 – 0.8 m sec^{-1}), most fish have been recorded in depths between 20 and 60 cm and flows less than 0.3 m sec^{-1} (B. Pusey et al., 2004). It occurs mostly in the bottom third of the water columns over coarse or bedrock (B. Pusey et al., 2004). The "blubber lip" form only occurs in stream reaches with a cobble/rock substratum (*Pers comms.,* B. Pusey). Larger individuals show a strong micro habitat affinity for deep undercut banks (Rayner, 2006), except for during spawning when it may aggregate in shallow, still water habitats adjacent to flowing rapids (B. Pusey et al., 2004).

There is no quantitative information available on the movement and dispersal patterns of khaki grunter, but anecdotal evidence suggests that an upstream spawning migration may occur, similarly to the sooty grunter (B. Pusey et al., 2004). During or shortly after the wet season, sooty grunter migrate upstream into main channels or tributaries to spawn before migrating back downstream to main channel habitats once spawning has been completed (B. Pusey et al., 2004).

Key threats

This species is relatively common across several Wet Tropics catchments and is therefore not considered vulnerable to any current threats (M. Kennard & Brooks, 2019). Its potential dependence on flowing habitats for spawning flag it as a species that may be susceptible to the impacts of water abstraction which can rapidly de-water these habitats, but more research is needed to clarify its seasonal habitat use before these impacts can be properly assessed (B. Pusey et al., 2004). It is also likely to be impacted by loss or degradation of the riparian zone (e.g. due to agricultural land use or flood damage, which may be exacerbated by climate change) due to the large contribution of terrestrial material from the riparian zone to its diet (A. M. Davis et al., 2011; M. Kennard & Brooks, 2019; B. Pusey et al., 2008).

Expert threat risk assessment

Table A1.4 Expert risk assessment of threats to the khaki grunter (Hephaestus tulliensis)

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Rising temperatures	possible (may favour *H. fuliginosus*)	minor	Moderate	future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible (decrease in rainfall/runoff)	moderate	High	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	possible (myrtle rust)	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Introduced species	Invasive riparian / aquatic weeds	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Invasive terrestrial animals and livestock	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Invasive fish	likely	major	Very High	past/ current/ future	increasing	entire range	inferred
	Translocated native fish	likely (*H. fuliginosus*)	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	minor	Moderate	current/ future	increasing	part of range	inferred

	Drought	possible	minor	Moderate	current/ future	increasing	entire range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Impoundment of riverine habitat	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)	likely	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Biological resource use	Over-harvesting/illicit collection	almost certain	not significant	Low	past/ current/ future	increasing	part of range	inferred
Natural system management & modifications	Altered fire regimes (increased severity)	unlikely	minor	Low	future	stable?	part of range	inferred
Other threats	Hybridization with translocated fish	possible	moderate	High	past/ current/ future	increasing	part of range	inferred
	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	likely	minor	Moderate	current/ future	increasing	part of range	inferred

Previous and current management actions

There are no previous or current management actions for this species.

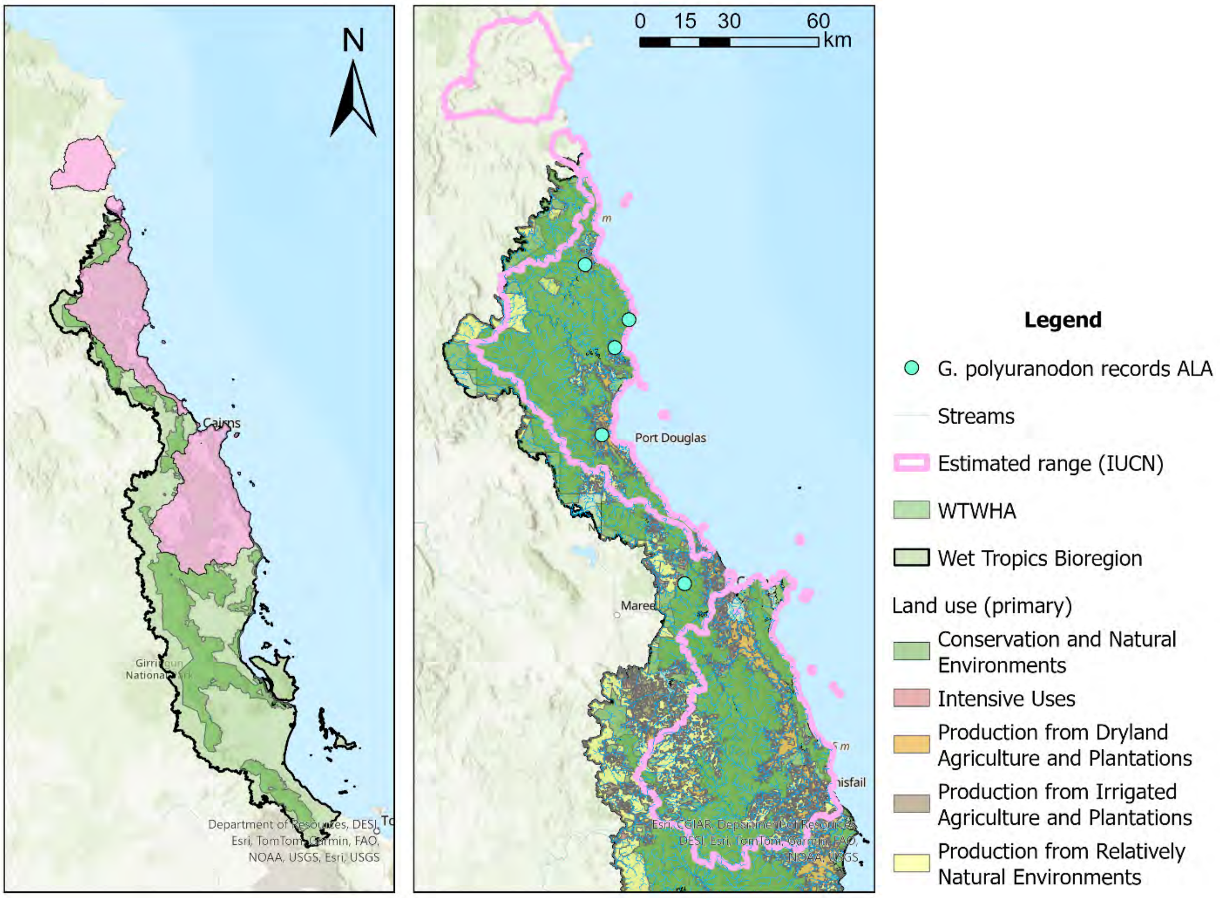
A1.5 Freshwater moray - *Gymnothorax polyuranodon*

Conservation Status, Taxonomy and Description

Listed as Least Concern on the IUCN Red List of Threatened Species, the freshwater moray eel (*Gymnothorax polyuranodon*) is a large (growing to 150 cm TL) species that is an exception to the moray group that typically occupy marine waters (Allen, 1991; Allen et al., 2002). Similar to other moray eel species, it has an elongate, firm, muscular and compressed body that is scaleless and covered in skin (Allen, 1991; Allen et al., 2002). Colouration changes as the eel matures, with juveniles a relatively uniform grey and adults an olive-tan colour with large, irregular, brown spots forming longitudinal streaks on the head, snout, and lower jaw (Allen, 1991; Allen et al., 2002).

Species Distribution and Populations

The freshwater moray eel is found across the Indo-West Pacific, including in Australia, Sri Lanka, Indonesia, Borneo, New Guinea, Philippines, New Caledonia, and Fiji (Cabebe-Barnuevo et al., 2023; B. C. Ebner, Kroll, et al., 2011; Sudasinghe et al., 2024; Tsukamoto et al., 2014). It is the only species of moray eel to inhabit freshwaters in Australia, and in its Australian distribution is limited exclusively to the Wet Tropics coastal rivers (B. C. Ebner, Fulton, et al., 2016; B. C. Ebner, Kroll, et al., 2011). Throughout Australia, Papua New Guinea, and Fiji, it is considered rare and recorded in low abundance when found (B. C. Ebner, Fulton, et al., 2016; B. C. Ebner, Kroll, et al., 2011; Mailautoka et al., 2019).



Biology and ecology

The freshwater moray is thought to be a mostly nocturnal hunter, feeding on fish and invertebrates including crabs and shrimps (Bray & Gomon, 2019). While there are no known predators of adult freshwater moray, they coinhabit streams with other predatory eels such as Anguilla spp. which may result in some competition (B. C. Ebner, Fulton, et al., 2016).

Little is known about its reproductive biology except that it is likely to be catadromous, where early life stages are spent in marine waters before migrating into estuarine and freshwaters (Tsukamoto et al., 2014). Most individuals recorded in the Wet Tropics of Australia have been recorded from freshwater reaches, at a maximum of 30 km upstream of the estuary (B. C. Ebner, Fulton, et al., 2016; B. C. Ebner, Kroll, et al., 2011). They can spend considerable time in freshwater but their spawning behaviour is completely unknown (B. Ebner, 2017).

The freshwater moray appears is a habitat specialist that occupies the interstitial spaces beneath large boulders in pools of short, steep coastal streams in tropical regions (B. C. Ebner, Fulton, et al., 2016). They are rarely found in riffle or run mesohabitats (B. C. Ebner, Fulton, et al., 2016). Competition for these habitats may occur with anguillid eels which also occupy large interstitial spaces in streams (B. C. Ebner, Fulton, et al., 2016). These pool habitats are characterised by slow flow, depths of less than 40 cm, and the presence of large boulders (B. C. Ebner, Fulton, et al., 2016).

Key threats

Key threats to the freshwater moray include changes to river flows (i.e. due to water extraction or climate change) that reduce the availability of pool habitats in short, steep coastal streams (B. C. Ebner, Fulton, et al., 2016). In stream barriers are also a key threat due to the dispersal challenge they pose to the presumably obligatory upstream migration that juveniles undergo to reach freshwater habitats (B. C. Ebner, Fulton, et al., 2016; Tsukamoto et al., 2014).

Expert threat risk assessment

Table A1.5 Expert risk assessment of threats to the freshwater moray (Gymnothorax polyuranodon)

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Land use alteration	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	major	Very High	current/ future	increasing	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	major	Very High	current/ future	increasing	part of range	inferred
	Landslides	possible	major	Very High	current/ future	increasing	part of range	inferred
Water resource management & infrastructure	Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)	likely	minor	Moderate	past/ current/ future	increasing	part of range	observed
Biological resource use	Over-harvesting/illicit collection	likely	minor	Moderate	past/ current/ future	increasing	part of range	observed
Other threats	Increased human (& pet) visitor usage and modification of riparian	likely	minor	Moderate	past/ current/ future	increasing	part of range	observed

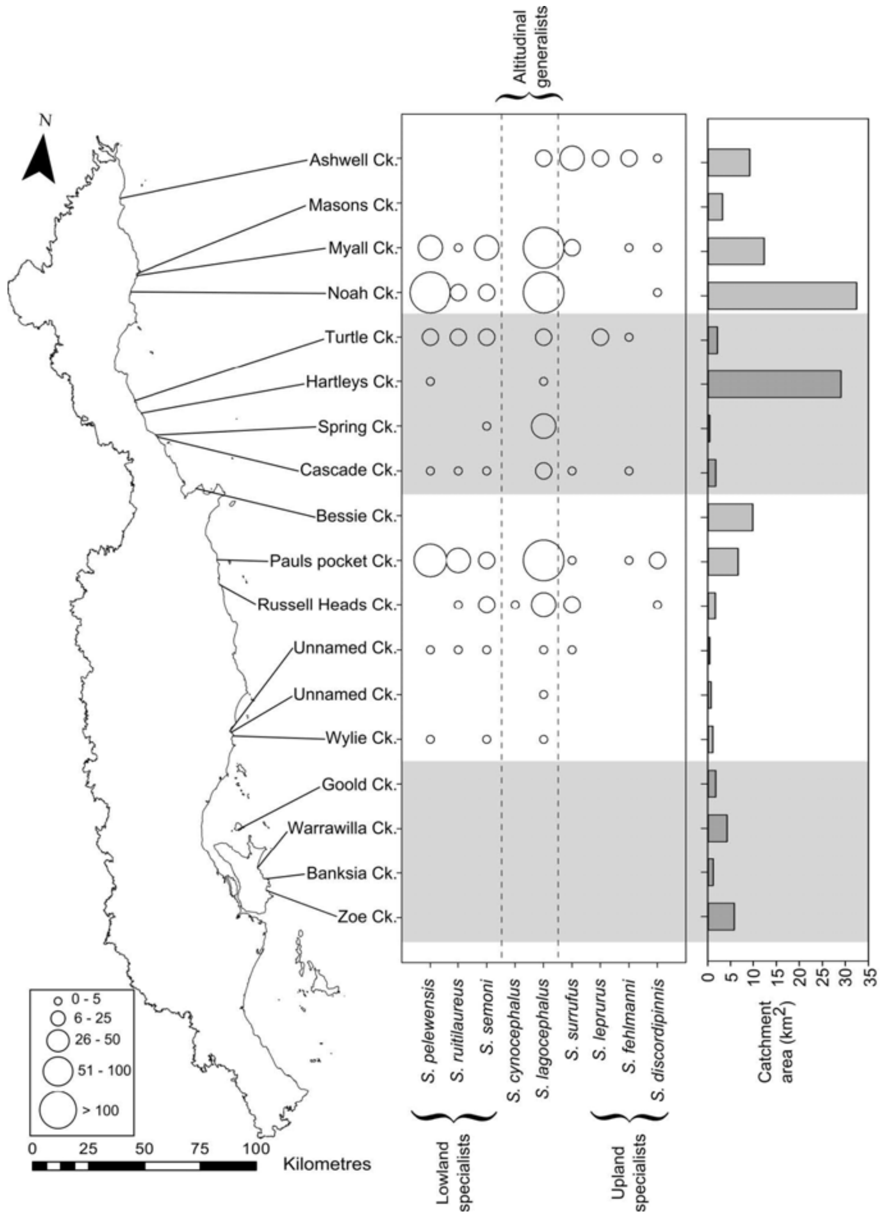
zones and instream areas		

Previous and current management actions

There are no previous or current management actions for this species.

A1.6 Cling gobies

Surveys conducted by Ebner et al., (2016) have recorded nine species of cling goby from four genera within the Sicydiinae subfamily (B. C. Ebner, Donaldson, et al., 2016). The Sicydiinae subfamily are amphidromous gobies with specialised pelvic fins with highly branched pelvic fin rays and thickened pelvic fin spines with a fleshy pad at the distal tip (Keith, 2003; Keith & Taillebois, 2014). These modified pelvic fins function as a rounded sucking disc, allowing them to cling to rocks and disperse upstream past barriers such as cascades and waterfalls (Keith, 2003; Keith & Taillebois, 2014). The figure below was taken from Ebner et al., (2016) and shows the distribution and abundance of species from the Sicydiinae subfamily in the Wet Tropics. The species information is provided below according to genus.



From Ebner et al., (2016): The relative distribution of sicydiine species in the 18 streams surveyed completely during this study. Circle diameters relate to the number of individuals each observed within catchments and upland and lowland specialists, as well as elevational generalists, are shown. Grey shading represents the two (relatively) dry sub-regions; Hinchinbrook and Port-Douglas/Cairns, and catchment area is provided in the graph to the right.

Stiphodon cling gobies

Conservation Status, Taxonomy and Description

Cling gobies from the *Stiphodon* genus (sub-family Sicydiinae) are amphidromous small, slender fishes with fused disc-like pelvic fins that they used to cling to rocks in fast flowing streams (Keith et al., 2015; Watson, 1995b, 1996). Their body is elongate, cylindrical anteriorly and somewhat compressed posteriorly (Maeda & Tan, 2013). There are four species of cling gobies from the *Stiphodon* genus found in the Wet Tropics of Australia (B. C. Ebner, Donaldson, et al., 2016; B. C. Ebner & Thuesen, 2011). These include the black Stiphodon (also known as the Palauan stiphodon goby; *Stiphodon pelewensis*, formerly *S. atratus*), the orange cling goby (also known as the golden-red stiphodon, red and gold goby or rutilaureus cling goby; *Stiphodon rutilaureus*), the opal cling goby (*Stiphodon semoni*), and the emerald cling goby (*Stiphodon surrufus*, formerly *S. birdsong*). All four species are listed as Least Concern on the IUCN Red List of Threatened Species and 'No take' species under the Queensland Fisheries Act. However, their listings on the EBPC Act and QLD NCA 1992 vary, with opal cling gobies listed as Critically Endangered on the EBPC Act, black Stiphodon and orange cling gobies listed as Vulnerable on the QLD NCA 1992 and emerald cling gobies listed as Endangered on the QLD NCA 1992. Similarly to other *Stiphodon* species, these species are sexually dimorphic and dichromatic (Keith et al., 2015).

The black Stiphodon (*S. pelewensis*) is the largest of the four Wet Tropics *Stiphodon* species, commonly found in the 51-80 mm TL size range and females are usually more abundant than males (B. C. Ebner & Thuesen, 2011). Males are brown with 5-6 indistinct bars between the second dorsal and anal fins, a metallic green head, and reddish-brown to dusky second dorsal and anal fins (Bray, 2023b; Keith et al., 2015). Females have a dark mid-lateral stripe and dark blotches on the caudal peduncle (Bray, 2023b; Keith et al., 2015).

The orange cling goby (*S. rutilaureus*) is a smaller species, found to ~40 mm TL in Wet Tropics streams (B. C. Ebner & Thuesen, 2011). Colouration varies between sexes and males have been observed to be more abundant than females in Wet Tropics streams (B. C. Ebner & Thuesen, 2011). Females are pale with a dark, midlateral stripe a black spot encircled by yellow to red on the caudal-fin base (Bray, 2023c; Watson, 1995b, 1996). Males have bright orange bars along the body, 6-7 dark saddles on the dorsal side of the body, a pale belly, and a metallic blue face on the ventral side (Bray, 2023c; Watson, 1995b, 1996).

The opal cling goby (*S. semoni*) is found at lengths of 31-50 mm TL in Wet Tropics streams (B. C. Ebner & Thuesen, 2011). Females have a cream or brown body, with two dark horizontal stripes that appear serrated along the side and a large black spot on the caudal peduncle (Bray & Gomon, 2023; Maeda & Tan, 2013). Males have a pale brown body with a vivid blue, green or pinkish stripe along the side from the snout to the upper part of the caudal peduncle, grey fins with blue flecks and a bright blue margin on the anal fin, and a white patch behind the pectoral-fin base (Bray & Gomon, 2023; Maeda & Tan, 2013).

The emerald cling goby (*S. surrufus*) is a small species of cling goby, growing to around 25 mm TL (Bray, 2018b; Keith et al., 2015). Females are almost transparent with dull dusky markings while males are bright orange-red (Bray, 2018b; Keith et al., 2015).

Species Distribution and Populations

Gobies of the genus *Stiphodon* are found in freshwater rivers throughout the central and western Pacific (Watson, 1995b, 1996). The orange cling goby (*S. rutilaureus*) is found in Australia (Queensland), Fiji, Indonesia (Bali, Maluku, Papua), New Caledonia, Papua New Guinea, Solomon Islands, and Vanuatu (B. Ebner, 2019d). The black Stiphodon (*S. pelewensis*) is found in Australia

(Queensland), Fiji, Guam, Indonesia (Bali, Jawa, Lesser Sunda Is., Maluku, Papua), Micronesia, New Caledonia, Northern Mariana Islands, Palau, Papua New Guinea, Solomon Islands, and Vanuatu (Jaafar, 2019b). The opal cling goby (*S. semoni*) occurs in Australia (Queensland), Indonesia (Bali, Jawa, Lesser Sunda Is., Maluku, Papua, Sulawesi, Sumatera), New Caledonia, Papua New Guinea, Solomon Islands, Timor-Leste, and Vanuatu (Jaafar, 2019c). The emerald cling goby (*S. surrufus*) is found in Australia (Queensland), Indonesia (Maluku, Papua), Japan (Kyushu), Palau, Papua New Guinea, Philippines, Solomon Islands, Taiwan, and China (Jaafar, 2019d).

In the Australian Wet Tropics, surveys between 2010 and 2015 found that the four cling gobies from the *Stiphodon* genus (*S. rutilaureus, S. pelewensis, S. semoni* and *S. surrufus*) were widely distributed throughout short, steep coastal streams but were most abundant in the Cape Tribulation subregion, between Ashwell and Noah Creeks, and in the Malbon-Thompson subregion, in Pauls Pocket and Russell Heads Creeks (B. C. Ebner, Donaldson, et al., 2016; B. C. Ebner & Thuesen, 2011). Black Stiphodon and opal cling gobies were found in 16 and 17 different streams, respectively, while the orange cling goby was found in 12 and the emerald cling goby in ~8 streams (B. C. Ebner, Donaldson, et al., 2016). Abundance varied among the four species and among streams, with some streams containing fewer than five individuals of each species. Higher numbers were recorded in some streams, with over 100 black Stiphodon found in Noah Creek, 26-50 orange cling gobies found in Pauls Pocket Creek, 26-50 opal cling gobies found in Myall Creek, and 26-50 emerald cling gobies found in Ashwell Creek (B. C. Ebner, Donaldson, et al., 2016).

Elsewhere in the pacific, the status of the populations of the black Stiphodon are unknown (Jaafar, 2019b), while the orange cling goby is rare in Queensland (B. C. Ebner, Donaldson, et al., 2016) compared to the Solomon Islands (D. T. Boseto et al., 2016; B. Ebner, 2019d). The abundance of the opal cling goby varies dramatically among islands, being recorded as locally abundant in Sulawesi (Haryono *et al*. 2002) and rarely encountered in New Caledonia and Vanuatu (Jaafar, 2019c). The emerald cling goby appears to be rarely encountered across its range despite being widely distributed (Jaafar, 2019d).

Biology and ecology

Cling gobies from the *Stiphodon* genus are highly adapted to the fast-flowing habitats of short, steep, coastal streams, using their disc-like fused pelvic fins to cling to rocks and boulders while they scrape algae and diatoms from the surfaces of bedrock, boulders, and cobble (B. C. Ebner & Thuesen, 2011; Nelson et al., 1997; Ryan, 1991). Some species, such as the orange cling goby, also occasionally ingest benthic invertebrates (B. C. Ebner & Thuesen, 2011; Keith et al., 2015). Larvae and juveniles feed on benthic microalgae and zoobenthic, with larva exhibiting more specialised feeding than juveniles and the success of recruitment is strongly influenced by prey presence (Amaliah et al., 2023).

While there has been little research on the reproductive biology of the four *Stiphodon* species found in the Wet Tropics, they are expected to show similar reproductive characteristics to other *Stiphodon* species. Reproduction occurs in freshwater, with male *Stiphodon* observed courting in the water column, displaying bright colouration towards females and chasing rival males (Amaliah et al., 2023; D. T. Boseto et al., 2016; Yamasaki & Tachihara, 2006). Yamasaki and Tachihara (2006) observed *S. percnopterygionus* laying eggs masses on the undersurface of stones in freshwater which were then guarded by the male. Newly hatched larvae are carried by stream flows to the ocean before they migrate back to fresh water as post-larvae (Keith, 2003). The black Stiphodon and the orange and opal cling gobies have an average pelagic larval duration of 66.29, 73 and 71 days, respectively (Keith et al., 2015; White, 2015). *Stiphodon* gobies may take part in upstream mass migrations and can be found in multi-species shoals of goboid post-larvae (Burhanuddin & Haris, 2019). In Indonesia, large aggregations of opal cling gobies have been observed undertaking an upstream migration from the estuary (K. Martin, 1999).

This amphidromous life cycle is likely to be responsible for the successful inhabitation of *Stiphodon* species in streams of tropical islands (D. T. Boseto et al., 2016). Outside of Australia, genetic studies on the orange cling goby and other *Stiphodon* species have found low genetic diversity among samples from different streams on different islands, suggesting high connectivity of the population through larval drift (D. T. Boseto et al., 2016; Chabarria et al., 2014). Whilst it is not known whether the cling gobies of the Wet Tropics are also highly connected to the rest of the Pacific population, the rarity of cling gobies in Australia suggests that larval drift from other Pacific regions may be a source for their recruitment into Wet Tropics streams.

Following the upstream migration of post-larvae, cling gobies settle and mature in freshwater habitats of short, steep, coastal streams. In the Wet Tropics, black Stiphodon (*S. pelewensis*), opal (*S. semoni*), and orange cling gobies (*S. rutilaureus*) were consistently observed at low elevation (typically less than 30 m ASL and often below the first major instream barrier) (B. C. Ebner, Donaldson, et al., 2016). The emerald cling goby (*S. surrufus*) was mostly found at intermediate elevation and above at least the first major in stream barrier (B. C. Ebner, Donaldson, et al., 2016). Microhabitat use varies among the four Wet Tropics *Stiphodon* species and generally reflects longitudinal differences in their distribution within each stream (B. C. Ebner & Thuesen, 2011). The orange cling goby was commonly found in riffle-run sequences immediately upstream of the tidal mark, and frequently in the absence of other *Stiphodon* species (B. C. Ebner & Thuesen, 2011). The range of the opal cling goby extended further upstream than that of the black Stiphodon by a few pools equating to less than 100 m (B. C. Ebner & Thuesen, 2011).

All four Wet Tropics *Stiphodon* species are benthic dwellers and mostly reside in areas with no water-surface flow or low flow (B. C. Ebner, Donaldson, et al., 2016; B. C. Ebner & Thuesen, 2011). However, the orange cling goby has been occasionally observed close to high flow when was grazing on biofilms in shallow water, generally facing headfirst into the current (B. C. Ebner & Thuesen, 2011). The orange cling goby is frequently associated with cobbles and occasionally sand, while the black Stiphodon is mainly found on boulders, the opal cling goby on bedrock, and the emerald cling goby on pebble or rock substrates (B. C. Ebner & Thuesen, 2011; Watson, 1996).

Key threats

Due to the high diversity of rare freshwater species they contain, short, steep coastal streams in the Wet Tropics are considered to be areas of special fauna biodiversity value (DES, 2019). These streams are considered remnants of a relatively stable environment across geological time and consequently contain a diverse assemblage of relictual fauna (DES, 2019). A key characteristic of this stability is the continuous streamflow which maintains critical habitat for species including cling gobies (DES, 2019). The majority of the streams in which these gobies are found are located within Indigenous Protected Areas or national parks (B. C. Ebner, Donaldson, et al., 2016).

Threats that can cause reduced flow in short, steep coastal streams of the Wet Tropics (e.g. water extraction, damming, climate change) are likely to pose the highest risk to cling gobies due to a potential reduction in the availability of preferred habitat (DES, 2019). Barriers pose a threat because they limit the longitudinal distribution of these species within streams (B. C. Ebner et al., 2021). The orange cling goby (*S. rutilaureus*) is potentially more vulnerable to lower course instream barriers than the other three *Stiphodon* gobies because it occupies the lowest part of freshwater streams immediately upstream of the estuary or ocean mouth (B. Ebner, 2019d). This also makes it vulnerable to cumulative impacts of pollution, water extraction and sedimentation due to flooding (B. Ebner, 2019d).

Cling gobies in the Wet Tropics may also be impacted by invasive fish species (e.g. tilapia) or translocated predatory native species and excluding these species from key streams inhabited by cling gobies is an important conservation action (Jaafar, 2019c, 2019b).

Whilst they are considered 'No take' species under the Queensland Fisheries Act, illegal collection of cling gobies from Wet Tropics streams for aquarium collections is likely to occur. Collection for aquariums occurs across the Pacific and *Stiphodon* gobies are often sold commercially as ornamental fish in many countries, including Singapore (Maeda & Tan, 2013). The western slope of Sumatra is believed to be one of the main sources of *Stiphodon* for the aquarium trade (Maeda & Tan, 2013). It is believed that *Stiphodon* gobies are unable to be captive bred due to their long pelagic larval time and associated difficulty in feeding larval stages (Maeda & Tan, 2013). All *Stiphodon* gobies sold in the aquarium trade are therefore likely to be collected from the wild (Maeda & Tan, 2013). Harvesting for aquarium collections is not the only form of harvesting that cling gobies are subjected to, where mass migrations of larvae migrating upriver are harvested throughout the pacific as a dietary source (Ryan, 1991). Both aquarium collecting and harvesting of larvae throughout the Pacific could impact the abundance of larvae drifting into the Wet Tropics from other regions (D. Boseto et al., 2007). There is little to no monitoring of populations from which harvesting occurs, and this activity may be unsustainable in the long-term, particularly in areas where other threats are prominent (D. Boseto et al., 2007; Maeda & Tan, 2013).

Other threats to *Stiphodon* gobies in the Pacific islands (e.g. Solomon Islands) include extensive deforestation activities such as logging, mining, clearing for cattle ranches, cocoa and palm oil plantations, small-scale agricultural farming, water and hydroelectric damming, alien species, destructive fishing methods, and climate change (D. T. Boseto et al., 2016; Jenkins et al., 2010).

Expert threat risk assessment

Table A1.6.1 Expert risk assessment for upland cling goby species, including the emerald cling goby (Stiphodon surrufus).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Change in equatorial currents	unlikely	minor	Low	current/ future	increasing?	entire range	inferred
	Rising temperatures	possible	moderate	High	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	major	Very High	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	possible	not significant	Low	past/ current/ future	increasing	part of range	inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	minor	Moderate	current/ future	stable?	part of range	inferred
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Moderate	current/ future	stable?	part of range	inferred

Introduced species	Invasive terrestrial animals and livestock	almost certain	moderate	Very High	past/ current/ future	stable?	part of range	inferred
	Invasive fish	possible	minor	Moderate	future	stable?	part of range	inferred
	Translocated native fish	possible	minor	Moderate	future	stable?	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred
	Landslides	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred
	Heatwaves	possible	major	Very High	current/ future	increasing	entire range	inferred
	Drought	possible	minor	Moderate	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Impoundment of riverine habitat	possible	minor	Moderate	past/ current/ future	stable?	part of range	observed
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	current/ future	stable?	part of range	inferred
Other threats	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	almost certain	minor	Moderate	current/ future	increasing	part of range	observed

Table A1.6.2 Expert risk assessment for lowland specialist cling goby species, including the black Stiphodon (Stiphodon pelewensis), the orange cling goby (Stiphodon rutilaureus) and the opal cling goby (Stiphodon semoni).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Change in equatorial currents	possible	minor	Moderate	current/ future	increasing?	entire range	inferred
	Rising temperatures	possible	minor	Moderate	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	major	Very High	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	possible	moderate	High	past/ current/ future	increasing	part of range	inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	minor	Moderate	current/ future	stable?	part of range	inferred
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Moderate	current/ future	stable?	part of range	inferred

Introduced species	Invasive terrestrial animals and livestock	almost certain	moderate	Very High	past/ current/ future	stable?	part of range	inferred
	Invasive fish	possible	minor	Moderate	future	stable?	part of range	inferred
	Translocated native fish	possible	minor	Moderate	future	stable?	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred
	Landslides	possible	moderate	High	current/ future	increasing	part of range	inferred
	Heatwaves	possible	moderate	High	current/ future	increasing	entire range	inferred
	Drought	possible	major	Very High	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	observed
	Impoundment of riverine habitat	possible	minor	Moderate	past/ current/ future	stable?	part of range	observed
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	current/ future	stable?	part of range	inferred
Other threats	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	almost certain	minor	Moderate	current/ future	increasing	part of range	observed

Previous and current management actions

Cling gobies are listed as ‘No take’ species under the Queensland Fisheries Act. There are no other previous or current management actions for these species.

Sicyopterus cling gobies

Conservation Status, Taxonomy and Description

There are two species of gobies from the *Sicyopterus* genus that are found in the Wet Tropics, the cleft-lipped (*Sicyopterus cynocephalus*) and red-tailed (*Sicyopterus lagocephalus*) gobies, both of which are listed as Least Concern on the IUCN Red List of Threatened Species (B. Ebner, de Alwis Goonatilake, et al., 2019; Jaafar, 2019a). They have a slender, elongate body with a rounded snout and a modified pelvic fin that allows them to cling to rocks (Keith et al., 2015). *Sicyopterus* species are known for their distinct upper lip morphology, which can be either smooth, crenulated, or with papillae, and with or without clefts (Lord et al., 2019). The cleft-lipped and red-tailed gobies both have smooth upper lips with three clefts (Lord et al., 2019). The mouth and pelvic sucker are important locomotory organs, aiding in the upstream migration of juveniles and colonisation of freshwater habitats (Keith, 2003; Lord et al., 2019).

The cleft-lipped goby (*S. cynocephalus*) is a large species of goby, growing to 200 mm TL (B. C. Ebner et al., 2017). Males can be white or brown with dark saddles and mottling along the back, brown and yellow mottling on the nape, a dark bar below the eye, a red iris, a horizontal dark bar from the eye to the upper part of the pectoral-fin base, and two dark stripes on the pectoral fin (B. C. Ebner et al., 2017; Keith et al., 2015). Female cleft-lipped gobies are plain brown with striped pectoral fins (B. C. Ebner et al., 2017; Keith et al., 2015).

The red-tailed goby (*S. lagocephalus*) is also a larger species of goby, growing to around 150 mm TL (Ambarwati et al., 2023). Males can be easily distinguished from females by their bright colouration and more slender and longer body (Keith et al., 2015; Teichert et al., 2012). Males are blue-green with a rounded caudal fin that is yellow to pink, or greyish but turns bright orange or red during breeding season (Pouil & Colsoul, 2021). Females have bulbous urogenital papilla and are a brownish colours with white belly that can have a variety of different markings, including dusky to black saddles on the dorsal side, dusky streaks and spots on the side of the body, even rows of black spots on the ventral to midline region, or a black midlateral stripe (Gomon & Bray, 2021; Keith et al., 2015).

Species Distribution and Populations

The cleft-lipped goby is widespread across the Indo-Pacific and has been found in Indonesia (Bali, Jawa, Lesser Sunda Is., Maluku, Papua, Sulawesi, Sumatera), Papua New Guinea, Philippines, Solomon Islands, Timor-Leste, and the Wet Tropics of Australia (Jaafar, 2019a). The oldest population likely originated in the western Pacific, from which the eastern Pacific and the Indian Oceans were colonised (Lord et al., 2012). Its population size across this range is unknown, but it has been recorded as relatively common in Flores (Tjakrawidjaja, 2002) and extremely rare in the Wet Tropics of Australia where it has been recorded on video surveillance but is evasive to visual assessment (e.g. via snorkelling) (B. C. Ebner et al., 2017). Given the rarity of the cleft-lipped goby in Australia and known amphidromous life history, it is unlikely that the Wet Tropics population is self-sustaining but rather seeded with larvae drifting in from elsewhere in the Indo-Pacific (B. C. Ebner et al., 2017).

The red-tailed goby is the most widely distributed goby of the *Sicyopterus* genus and is found throughout the Indo-Pacific area from Comoros Islands in the Indian Ocean to French Polynesia in the Pacific Ocean (Keith et al., 2005). It is abundant in many coastal streams of the Pacific Islands, however, the population status of this species is largely unknown due to most research being undertaken on the larval and post-larval stages (B. Ebner, de Alwis Goonatilake, et al., 2019; Keith et al., 2015). In the Wet Tropics of Australia, it is considered rare, and low numbers of individuals have been recorded from several streams, including Pauls Pocket Creek (B. C. Ebner & Thuesen, 2011), Noah and Emmagen Creeks (B. C. Ebner, Thuesen, et al., 2011), the Bloomfield River (B. J. Pusey &

Kennard, 1996), and Russell-Mulgrave River system in Harvey Creek, Fishery Falls Creek and Fig Tree Creek (B. C. Ebner, Thuesen, et al., 2011) and an unnamed coastal stream south of Cairns (B. C. Ebner et al., 2017).

Biology and ecology

These gobies from the *Sicyopterus* genus feed by scraping algae from the surface of rocks (Keith et al., 2015). Adults live in freshwater and red-tailed gobies reside in areas with high availability of suitable nesting substrate (ranging from small cobble to small boulder) with intragravel flow (Teichert et al., 2013). Water depth and velocity had less of an effect on the selection of a spawning area but they generally preferred shallow (<60 cm) riffle and cascade mesohabitats (Teichert et al., 2013). They lay an egg clutch on the inferior side of large rocks that are embedded in sand and gravels on the bottom of the river, so that they remain on a surface that will be stable in the river flow (Ellien et al., 2016).

On the island of Reunion, the female red-tailed goby has been found to produce 50 000–70 000 ova and upon hatching the embryos repeated swim to the water surface then sink before moving back to the surface, facilitating their transport to the sea (Keith, 2003; Keith et al., 1999). Development varies according to water depth along the downstream migration and their arrival at the sea triggers morphological transformations (Valade et al., 2009). During this period, the maximum survival time in freshwater is four days, suggesting that the embryos would die before they reach the sea if the freshwater travel time is too long (Valade et al., 2009).

Larvae can spend over 130 days at sea, potentially drifting large distances before beginning recruitment into estuaries (Lord et al., 2010). Larvae can be observed undergoing mass migrations into estuaries with biomass so large that they are harvested as a commercial fishery in some places (Keith, 2003; Pouil & Colsoul, 2021). Post-larvae begin to metamorphose from a larval to juvenile form as they enter freshwater, changing from a pelagic to a benthic form (Keith, 2003; Keith et al., 2008). The fins and pelvic suction cup that they develop allow them to rapidly migrate upstream through freshwaters and adults are usually more abundant than juveniles as the distance from the estuary increases upstream (Keith et al., 2008; Teichert et al., 2014). There has been little research documenting the reproductive biology of the cleft-lipped goby, but it is also amphidromous and therefore likely to have similar life cycle characteristics to the red-tailed goby.

Adult red-tailed gobies inhabit small or large fast-flowing clear rainforest streams with rocky substrates, from 0-600 m altitude (Keith et al., 2015). Adult cleft-lipped gobies inhabit the mid to upper reaches of fast flowing streams with gravel and boulder substrates, as far as 60 km upstream (Allen, 1991). They have been observed congregating in a single pool of a stream in the Wet Tropics where they are present in low abundance (B. C. Ebner et al., 2017). Colour variation in *Sicyopterus* species is thought to allow communication between congeners and agonistic relationships appear to exist between individuals in a stream (B. C. Ebner et al., 2017; Keith et al., 2015).

Key threats

There a several threats to the *Sicyopterus* gobies due to their amphidromous life history (B. Ebner, de Alwis Goonatilake, et al., 2019; Jaafar, 2019a). Both species found in the Wet Tropics are harvested throughout the Pacific as post-larvae in mass migrations through estuaries (B. Ebner, de Alwis Goonatilake, et al., 2019; Jaafar, 2019a; Pouil & Colsoul, 2021). The impacts of this harvesting on the populations are unknown but it is likely to reduce recruitment success (Pouil & Colsoul, 2021). Water extraction and the construction of barriers along rivers is another key threat to this species which could hinder both downstream migration of embryos and upstream migration of juveniles (B. Ebner, de Alwis Goonatilake, et al., 2019; Jaafar, 2019a). Sedimentation due to land use or flooding could also impact these species during the nesting phase of its lifecycle due to their preference for nesting in areas with interstitial flow (Teichert et al., 2013).

Another threat with unknown impacts is infection with parasites, where *Sicyopterus* gobies in the Indo-Pacific region have been recorded to be infected with a cryptogonimid parasite (Mathews et al., 2023).

Expert threat risk assessment

The following risk assessment scores were based on an assessment for *S. lagocephalus* and applied also to *S. cynocephalus* due to similar habitat preferences. However, due to few records and limited knowledge of *S. cynocephalus* distribution in the Wet Tropics, it is possible that these threats have pose a different risk to *S. cynocephalus* and should be re-evaluated following updated distribution survey data.

Table A1.6.2 Expert risk assessment for the cleft-lipped (Sicyopterus cynocephalus) and red-tailed (Sicyopterus lagocephalus) cling gobies.

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Changes in rainfall, runoff, flow regimes	possible (decrease in rainfall/ runoff)	minor	Moderate	current/ future	increasing	entire range	inferred
Land use alteration	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Introduced species	Invasive fish	possible	not significant	Low	past/ current/ future	increasing	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	not significant	Low	past/ current/ future	increasing	part of range	inferred
	Landslides	possible	minor	Moderate	current/ future	increasing	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	possible	minor	Moderate	current/ future	increasing	part of range	inferred
	Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)	possible	not significant	Low	past/ current/ future	increasing	part of range	inferred
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	current/ future	increasing	part of range	inferred

Previous and current management actions

Cling gobies are listed as ‘No take’ species under the Queensland Fisheries Act. There are no other previous or current management actions for these species.

Sicyopus cling gobies

Conservation Status, Taxonomy and Description

Listed as Least Concern on the IUCN Red List of Threatened Species, the red-bum goby (*Sicyopus discordipinnis*) is a small, elongate goby (40-60 mm TL) (B. C. Ebner, Donaldson, et al., 2016). Males and females have distinctly different colouration. Females are pale and relatively translucent with a pale orange belly and a dark stripe ends in a small spot on the caudal peduncle (B. C. Ebner, Thuesen, et al., 2011). The males have distinct horizontal stripes, including a prominent white stripe (that can at times have a golden sheen) that passes through the eye that is bordered on the top and bottom by grey stripes (B. C. Ebner, Thuesen, et al., 2011). The fins are transparent and on the posterior ventral side, two thirds of the body is a bright orange that turns red in breeding males (B. C. Ebner, Thuesen, et al., 2011). During breeding season, the grey stripes on males can turn jet-black (B. C. Ebner, Thuesen, et al., 2011).

Species Distribution and Populations

The red-bum goby is widespread and has been recorded in Papua, Papua New Guinea, Indonesia, the Solomon Islands and the Wet Tropics of Australia (B. Ebner, 2019a; B. C. Ebner, Donaldson, et al., 2016; Keith et al., 2015). It has not been found in high abundance anywhere, and most surveys record just a few individuals in each stream (B. Ebner, 2019a). Nurjirana and Keith (2022) report this species from central Sulawesi in four rivers, with only one individual found in each river. In the Wet Tropics of Australia it has been recorded in five streams including Ashwell, Myall, Noah, Pauls Pocket, and Russell Heads Creeks, with less than five individuals found in each of these creeks except for Pauls Pocket Creek which had less than 10 individuals (B. C. Ebner, Donaldson, et al., 2016). These records of low numbers of individuals highlight the amphidromous life history of this species, where colonisation of some of these remote islands is facilitated by long-distance larval dispersal because the low abundances in these streams mean that the probability of encounter with the opposite sex is too low to result in successful breeding events (Jamonneau et al., 2024; Stephens & Sutherland, 1999).

Biology and ecology

Little is known on the biology and ecology of this species. It feeds as a benthic microcarnivore and has an amphidromous life history (B. C. Ebner, Donaldson, et al., 2016; Keith et al., 2015). Its reproductive life history is therefore like to be similar to other cling gobies from the subfamily Sicydiinae, which lay eggs in freshwater and hatched embryos travel downstream to the sea where they undergo larval development before recruiting to estuaries (Keith, 2003). Once recruitment to estuaries occur, they develop into post-larvae which undergo rapid metamorphosis, changing into a benthic form with a specialised pelvic fin that allows them to migrate upstream into freshwaters past barriers such as cascades and waterfalls (Keith, 2003).

The red-bum goby is found in clear, fast-flowing, high gradient streams with gravel and boulder substrate (B. C. Ebner, Donaldson, et al., 2016; Keith et al., 2015; Watson, 1995a). It is an upland specialist, often found at higher elevations than other cling gobies, above at least the first major instream barrier, including large waterfalls (B. C. Ebner, Donaldson, et al., 2016). When other species from the Sicydiinae subfamily co-exist the red-bum goby may extend its distribution higher upstream (B. C. Ebner, Donaldson, et al., 2016).

Key threats

Whilst the red-bum goby is considered 'No take' species under the Queensland Fisheries Act, illegal collection of cling gobies from Wet Tropics streams for aquarium collections may occur (B. C. Ebner, Thuesen, et al., 2011). Collection for aquariums from the Wet Tropics and elsewhere across the range of the red-bum goby is considered a threat due to the low abundance of this species in each stream (B. Ebner, 2019a). When abundance becomes too low, reproduction is unlikely to occur and the populations then rely on recruitment from other areas (Jamonneau et al., 2024).

Threats that impact water and habitat quality (e.g. agricultural or urban land use, large floods) are also likely to pose a threat to this species due to its habitat preference for clear, fast-flowing streams (B. Ebner, 2019a). Red-bum gobies in the Solomon Island and New Guinea are threatened by gold mining impacts, including deforestation, land clearing and chemical pollution (B. Ebner, 2019a). In the Wet Tropics, sedimentation due to erosion from agricultural and grazing land uses, as well as large floods, pose a threat to the habitat of this species (B. Ebner, 2019a). Water extraction and other anthropogenic activities that reduce flow or longitudinal connectivity (e.g. construction of barriers) also threaten this species due to its amphidromous life history (B. Ebner, 2019a).

Expert threat risk assessment

Table A1.6.3 Expert risk assessment for upland specialist cling goby species, including the red-bum goby (Sicyopus discordipinnis).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Change in equatorial currents	unlikely	minor	Low	current/ future	increasing?	entire range	inferred
	Rising temperatures	possible	moderate	High	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	major	Very High	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	possible	not significant	Low	past/ current/ future	increasing	part of range	inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	minor	Moderate	current/ future	stable?	part of range	inferred
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Moderate	current/ future	stable?	part of range	inferred
Introduced species	Invasive terrestrial animals and livestock	almost certain	moderate	Very High	past/ current/ future	stable?	part of range	inferred
	Invasive fish	possible	minor	Moderate	future	stable?	part of range	inferred
	Translocated native fish	possible	minor	Moderate	future	stable?	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred

	Landslides	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred
	Heatwaves	possible	major	Very High	current/ future	increasing	entire range	inferred
	Drought	possible	minor	Moderate	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Impoundment of riverine habitat	possible	minor	Moderate	past/ current/ future	stable?	part of range	observed
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	current/ future	stable?	part of range	inferred
Other threats	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	almost certain	minor	Moderate	current/ future	increasing	part of range	observed

Previous and current management actions

Cling gobies are listed as 'No take' species under the Queensland Fisheries Act. There are no other previous or current management actions for these species.

Smilosicyopus cling gobies

Conservation Status, Taxonomy and Description

Listed as Least Concern on the IUCN Red List of Threatened Species, Fehlmann's Sicyopus (*Smilosicyopus fehlmanni*) is a small, elongate goby with a blunt head that grows to 60 mm TL (B. C. Ebner, Donaldson, et al., 2016; Keith et al., 2015). Its body is a pale grey/cream colour, and some individuals have diffuse dusky bands along the dorsal side of the body to the midline (Bray, 2023a; Keith et al., 2015). It has small black spots on the top and side of the head and on the dorsal-fin membranes. The pelvic frenum may be completely pale tan or be deep brown/red on the anterior portion (Bray, 2023a; Keith et al., 2015). Juvenile females may have an orange tinge to the belly and breeding females have a bright, blood-red belly. Adult males have a light brown or reddish-brown belly (Bray, 2023a; Keith et al., 2015).

Listed as Least Concern on the IUCN Red List of Threatened Species, the frog goby (*Smilosicyopus leprurus*) is a small, elongate goby with a uniform pale grey body and a distinct black line above the upper lip, appearing as a fine and short moustache (Keith & Taillebois, 2014).

Species Distribution and Populations

Fehlmann's Sicyopus is found in the Indo-Pacific in Palau, Papua New Guinea, Solomon Islands, New Caledonia, Vanuatu and the Wet Tropics of Australia (B. Ebner, 2019b). This species is moderately common in the Solomon Islands (B. Ebner, 2019b). In the Wet Tropics, Fehlmann's Sicyopus has been found in five streams in low abundance, with less than five individuals recorded in four of these streams (B. C. Ebner, Donaldson, et al., 2016).

The frog goby is found throughout the Indo-Pacific from Ryukyu Islands to Palau, Australia and Papua (Keith & Taillebois, 2014) but the extent its distribution is not well known because the taxonomy of the *Smilosicyopus* genus was only recently resolved (Keith et al., 2015). It is relatively common in some parts of its range (e.g. Palau, Taiwan) but is rare in the Wet Tropics of Australia, being found in only two streams, including Ashwell and Turtle Creeks (B. Ebner, 2019c; B. C. Ebner, Donaldson, et al., 2016; Lu et al., 2016).

Biology and ecology

Gobies from the *Smilosicyopus* genus are omnivorous, feeding mostly on invertebrates (e.g. shrimp) from rocky surfaces or drifting downstream in the water column (B. C. Ebner, Kroll, et al., 2011; Keith et al., 2015).

Little is known about the reproductive biology of gobies from the *Smilosicyopus* genus but due to their amphidromous life history, they are likely to have similar reproductive characteristics to other goby species in the Sicydiinae subfamily (Keith, 2003). Gobies in the Sicydiinae subfamily lay eggs in freshwater and hatched embryos travel downstream to the sea where they undergo larval development before recruiting to estuaries (Keith, 2003). Fehlmann's Sicyopus has a pelagic larval duration of about 54 days (Taillebois et al., 2013). Once recruitment to estuaries occur, they develop into post-larvae which undergo rapid metamorphosis, changing into a benthic form with a specialised pelvic fin that allows them to migrate upstream into freshwaters past barriers such as cascades and waterfalls (Keith, 2003).

Gobies from the *Smilosicyopus* genus inhabit the mid-course of clear, fast-flowing high gradient streams (Keith et al., 2015). In the Wet Tropics of Australia, *Smilosicyopus* gobies are considered to be high elevation specialists and were found above at least the first major instream barrier, and often well above major and multiple instream barriers, highlighting their dispersal ability (B. C. Ebner, Donaldson, et al., 2016; B. C. Ebner, Thuesen, et al., 2011). These are limited numbers of these types of streams in Australia, which may partially explain the rarity of these species in the Wet Tropics (B. C. Ebner, Donaldson, et al., 2016).

Key threats

In Australia threats to these species are likely to vary spatially. The few known populations of Fehlmann's Sicyopus are situated within national parks and Indigenous Protected Areas (B. Ebner, 2019b). One population of the frog goby is situated in a national park, providing some level of protection, while the other population is subject to small scale water offtake (B. Ebner, 2019c). Water extraction and other anthropogenic activities that reduce flow or longitudinal connectivity (e.g. construction of barriers) threaten these species due to their amphidromous life history and preference for higher elevation than most of the other cling goby species (B. Ebner, 2019b, 2019c; B. C. Ebner, Thuesen, et al., 2011).

Threats that impact water and habitat quality (e.g. agricultural or urban land use or large floods in the Wet Tropics, gold mining and removal of riparian forest in islands of the Pacific) are also likely to pose a threat to these species due to its habitat preference for clear, fast-flowing streams (B. Ebner, 2019b, 2019c). Sedimentation due to erosion from agricultural and grazing land uses, as well as large floods, may degrade the habitat of these species (B. Ebner, 2019b, 2019c).

Outside of Australia, these species are collected for aquariums and the impacts of this activity on the population is unknown (Lu et al., 2016). Whilst Fehlmann's Sicyopus and the frog goby are considered 'No take' species under the Queensland Fisheries Act, illegal collection of cling gobies from Wet Tropics streams for aquarium collections may occur (B. C. Ebner, Thuesen, et al., 2011). Collection for aquariums is considered a threat due to the low abundance of these species in each stream (B. C. Ebner, Thuesen, et al., 2011). When abundance becomes too low, reproduction is unlikely to occur and the populations then rely on recruitment from other areas (Jamonneau et al., 2024).

Expert threat risk assessment

Table A1.6.4 Expert risk assessment for upland cling goby species, including Fehlmann's Sicyopus (Smilosicyopus fehlmanni) and the frog goby (Smilosicyopus leprurus).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Change in equatorial currents	unlikely	minor	Low	current/ future	increasing?	entire range	inferred
	Rising temperatures	possible	moderate	High	current/ future	increasing	entire range	inferred
	Changes in rainfall, runoff, flow regimes	possible	major	Very High	current/ future	increasing	entire range	inferred
Land use alteration	Riparian veg clearing / degradation	possible	not significant	Low	past/ current/ future	increasing	part of range	inferred
	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	minor	Moderate	current/ future	stable?	part of range	inferred
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Moderate	current/ future	stable?	part of range	inferred

Introduced species	Invasive terrestrial animals and livestock	almost certain	moderate	Very High	past/ current/ future	stable?	part of range	inferred
	Invasive fish	possible	minor	Moderate	future	stable?	part of range	inferred
	Translocated native fish	possible	minor	Moderate	future	stable?	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred
	Landslides	possible	catastrophic	Very High	current/ future	increasing	part of range	inferred
	Heatwaves	possible	major	Very High	current/ future	increasing	entire range	inferred
	Drought	possible	minor	Moderate	current/ future	stable?	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	minor	Moderate	past/ current/ future	increasing	part of range	observed
	Impoundment of riverine habitat	possible	minor	Moderate	past/ current/ future	stable?	part of range	observed
Biological resource use	Over-harvesting/illicit collection	possible	not significant	Low	current/ future	stable?	part of range	inferred
Other threats	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	almost certain	minor	Moderate	current/ future	increasing	part of range	observed

Previous and current management actions

Cling gobies are listed as 'No take' species under the Queensland Fisheries Act. There are no other previous or current management actions for these species.

A1.7 Other gobies

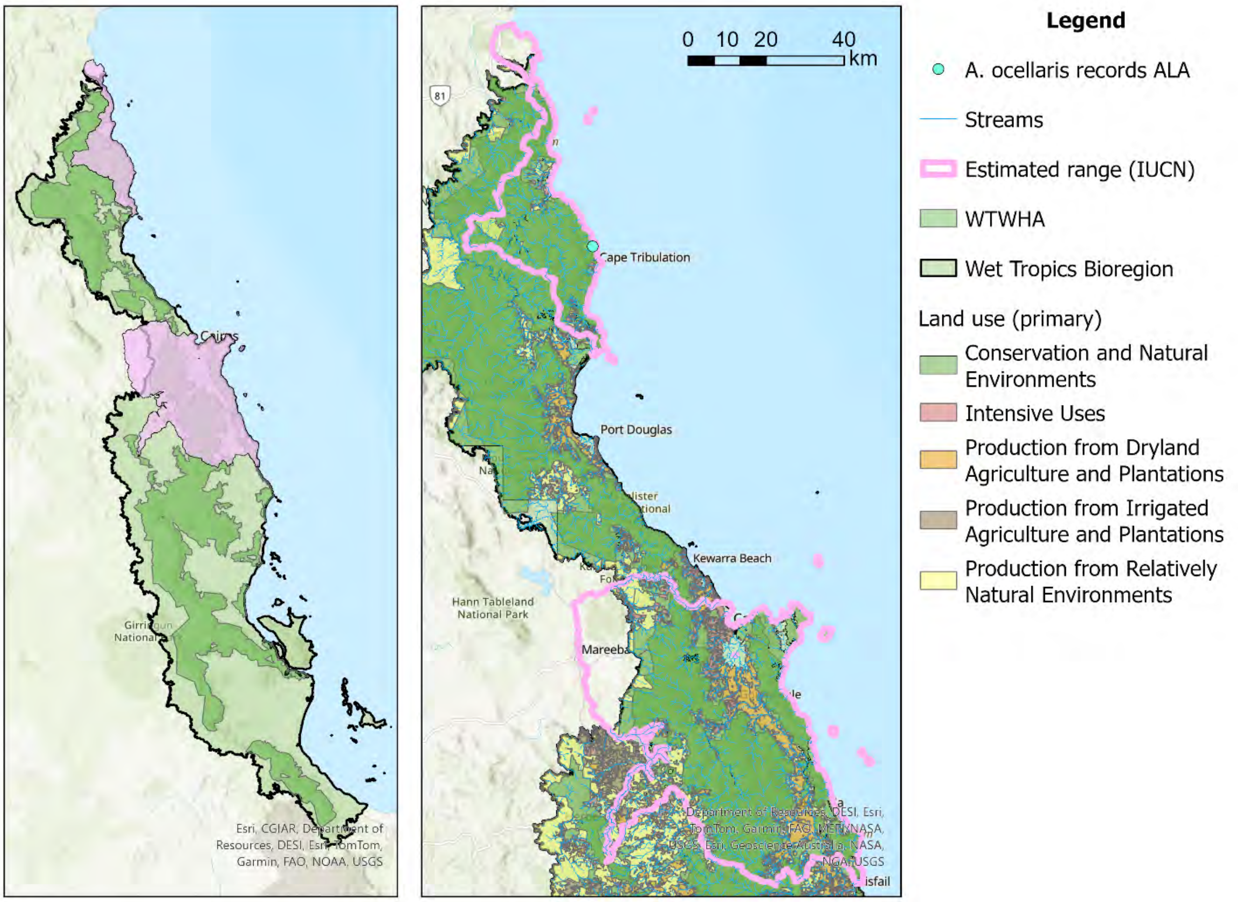
Ocellated river goby - *Awaous ocellaris*

Conservation Status, Taxonomy and Description

Listed as Least Concern on the IUCN Red List of Threatened Species, the ocellated river goby (*Awaous ocellaris*) is a small fish commonly found at lengths of 27-131 mm SL (keith et al 2000). It has an elongate, tubular body that tapers towards the caudal end and a thick, slightly extended upper jaw (Bray, 2018a). The body has a cream-yellow base colour with dark blotches and fins are transparent with black or white spots/blotches and a distinctive black ocellus spot on the rear of the first dorsal fin (Bray, 2018a).

Species Distribution and Populations

This species inhabits the Indo-Pacific in India, Melanesia (Papua New Guinea, Solomon Islands, Vanuatu, New Caledonia and Fiji), Polynesia (Samoa, Cook Islands, Wallis and Futuna (Futuna island), French Polynesia (Society Islands and Austral Islands) and South East Asia (Phillipines) and can be locally common in some of these areas (Asis et al., 2013; Keith et al., 2000; Larson et al., 2019; Pasisingi et al., 2020). It is also found in the Wet Tropics of Queensland, where it is extremely rare and occurs in protected areas in some parts of its range (Larson et al., 2019).



Biology and ecology

Little is known on the biology and ecology of the ocellated river goby. It is amphidromous and larvae often form mass migrations in estuaries (Keith et al., 2002; Pasisingi et al., 2020). It inhabits estuaries and freshwater in both streams and rivers and can be found in tidal-influenced rivers as well as fast-flowing streams (Keith et al., 2002). The species is commonly found on sand, gravel or rock substrates, and occasionally silt (Keith et al., 2002).

Key threats

There are few key threats to the ocellated river goby in the Wet Tropics and its rarity suggests that larval drift from elsewhere in the Indo-Pacific may be a source for the population here. Barriers to migration may limit its longitudinal distribution within streams, and it is unknown whether access to freshwater habitats is crucial for its life cycle (Larson et al., 2019). Elsewhere, this species is harvested in larval form as part of a commercial fishery and in adult form for use as bait (Asis et al., 2013; Pasisingi et al., 2020; Vedra & Ocampo, 2014). The ocellated river goby is also caught as bycatch in other fisheries and may be impacted by destructive fishing methods such as cyanide fishing, electric fishing, and use of fine mesh nets (Vedra & Ocampo, 2014). The impacts of these harvesting activities are unknown and there are no monitoring programs for the species.

Expert threat risk assessment

Table A1.7.1 Expert risk assessment of threats to the ocellated river goby (Awaous ocellaris).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Changes in rainfall, runoff, flow regimes	possible (decrease in rainfall/runoff)	minor	Moderate	current/ future	increasing	entire range	inferred
Land use alteration	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	major	Very High	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	moderate	High	past/ current/ future	increasing	part of range	inferred
Introduced species	Invasive terrestrial animals and livestock	possible	minor	Moderate	past/ current/ future	stable?	part of range	inferred
	Invasive fish	likely	moderate	High	past/ current/ future	increasing	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	part of range	inferred
	Landslides	possible	minor	Moderate	current/ future	increasing	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	inferred
	Impoundment of riverine habitat	possible	moderate	High	past/ current/ future	increasing	part of range	inferred
	Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)	likely	moderate	High	past/ current/ future	increasing	part of range	inferred
Natural system management & modifications	Altered fire regimes (increased severity)	unlikely	moderate	Moderate	future	stable?	part of range	inferred

Other threats	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred

Previous and current management actions

There are no previous or current management actions for this species.

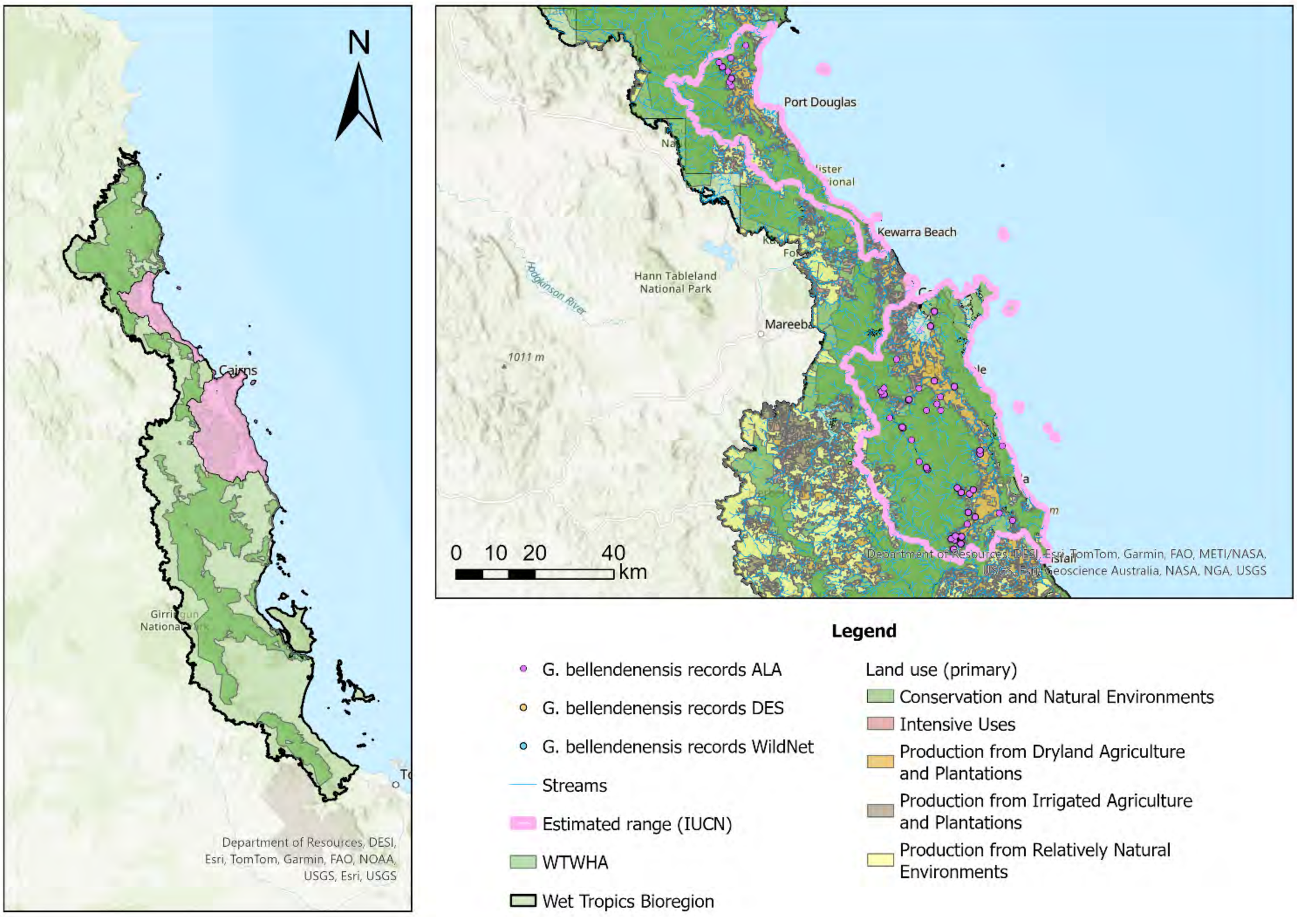
Mulgrave goby - *Glossogobius bellendenensis*

Conservation Status, Taxonomy and Description

Listed as Endangered on the IUCN Red List of Threatened Species, the Mulgrave goby (*Glossogobius bellendenensis*) is a small goby growing to 60 mm SL but commonly to 41 mm. It has an elongate, tubular and slightly laterally compressed body, depressed head depressed, bulbous cheeks with mouth extending back to its eye and enlarged lips (Hoese & Allen, 2009; B. Pusey et al., 2004). It has a dusky brown body and darker brown head, with a distinct reticulated pattern on the body due to darkened scale margins and a series of large black spots along the side of the body and black markings on the head (Hoese & Allen, 2009; B. Pusey et al., 2004). The first dorsal fin has a posterior black spot that may be surrounded by yellow whereas the second dorsal fin and the anal fin are a dusky colour with dark spots that may be surrounded by orange (Hoese & Allen, 2009; B. Pusey et al., 2004). The belly and throat are usually pale brown to white but may be an orange during reproduction (Hoese & Allen, 2009; B. Pusey et al., 2004).

Species Distribution and Populations

the Mulgrave goby is endemic to the Wet Tropics of Australia and has a restricted range, occurring only in the Russell-Mulgrave rivers and in Saltwater Creek in Cairns (B. Ebner & Hammer, 2019; Hoese & Allen, 2009; F. J. Kroon & Johnson, 2006; B. Pusey et al., 2004). Within its distribution, it can be locally moderately abundant (e.g. it was the sixth most abundant species over a range of 12 Mulgrave River sites sampled in 1991; B. J. Pusey et al., 1995) and it is common within lowland streams of the Bellenden Kerr range (B. Ebner & Hammer, 2019).



Biology and ecology

The Mulgrave goby is almost entirely an aquatic insectivore, with 93% of its diet comprised of the immature stages of aquatic insects typical of riffle habitats, primarily mayfly, trichopteran, and chironomid larvae (B. Pusey et al., 2004). Smaller individuals (<40 mm) consume more chironomid larvae than larger conspecifics (B. Pusey et al., 2004).

The reproductive biology of the Mulgrave goby is largely unknown except that collection of gravid females at certain times suggests that it spawns in the dry season (August to November) (B. Pusey et al., 2004). Eggs are probably attached to the undersides of stones and guarded by males (B. Pusey et al., 2004).

While it is not confirmed whether this species has a marine larval phase, it is highly unlikely given the species was not detected during extensive larval fish sampling in the lowlands of the Russell-Mulgrave system (Godfrey et al., 2022). There is an absence of records of juveniles of this species, suggesting that more research is needed to fill knowledge gaps on reproductive ecology and movement patterns for the species.

The Mulgrave goby prefers clear flowing waters and occurs in both small tributary streams and main river channels (Hoese & Allen, 2009; B. Pusey et al., 2004). It is a benthic species found on course sand, rock and cobbles and is most abundant in riffles and rapids of medium-sized streams with moderate flow and moderate riparian cover (B. Pusey et al., 2004).

Key threats

The Mulgrave goby is well protected throughout much of its range that falls within the WTWHA and Wooroonoora National Park (B. Pusey et al., 2004). However, it also occurs in streams outside of this protection and near the Cairns urban area (B. Pusey et al., 2004). Populations in tributaries of Trinity Inlet may be most at risk due to the extent of urban development and stream modification in the area (B. Pusey et al., 2004). Some of the Russell River tributaries are also degraded due to channelisation and drainage works (B. Pusey et al., 2004).

There are several key threat to this species, with the primary threats being activities that modify river flow or degrade habitat quality, and the presence of invasive or translocated fish species (B. Ebner & Hammer, 2019; B. Pusey et al., 2004). Reduced flow due to climate change or water extraction for agricultural, domestic and urban water supply will reduce the availability of riffle habitats with which this species is strongly associated (B. Ebner & Hammer, 2019; Morrongiello et al., 2011). Sedimentation of streams due to land uses such as grazing and agriculture pose a threat to this species via the smothering of habitat utilised by its prey and potential smothering of its egg masses (B. Pusey et al., 2004). Reduced flow will exacerbate water quality impacts (B. Pusey et al., 2004). Barriers along the river also pose an unknown threat due to the unknown early life history stages of the Mulgrave goby (B. Pusey et al., 2004).

There are several introduced fish species in the distribution of the Mulgrave goby and the goby has been found to be less abundant at sites containing guppies (*P. reticulata*), platys (*X. maculatus*), and spotted tilapia (*P. mariae*) (F. J. Kroon et al., 2015). Guppies and platys feed on aquatic invertebrates and may therefore compete with the Mulgrave goby for food (F. Kroon et al., 2011).

Expert threat risk assessment

Table A1.7.2 Expert risk assessment of threats to the Mulgrave goby (Glossogobius bellendenensis).

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Changes in rainfall, runoff, flow regimes	possible (decrease in rainfall/runoff)	minor	Moderate	current/ future	increasing	entire range	inferred
Land use alteration	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	major	Very High	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	moderate	High	past/ current/ future	increasing	part of range	inferred
Introduced species	Invasive terrestrial animals and livestock	possible	minor	Moderate	past/ current/ future	stable?	part of range	inferred
	Invasive fish	likely	moderate	High	past/ current/ future	increasing	part of range	inferred
Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	part of range	inferred
	Landslides	possible	minor	Moderate	current/ future	increasing	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	almost certain	moderate	Very High	past/ current/ future	increasing	part of range	inferred
	Impoundment of riverine habitat	possible	moderate	High	past/ current/ future	increasing	part of range	inferred
	Fragmentation of longitudinal connectivity (e.g. dams, weirs, culverts)	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred
Natural system management & modifications	Altered fire regimes (increased severity)	unlikely	moderate	Moderate	future	stable?	part of range	inferred
Other threats	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	possible	minor	Moderate	past/ current/ future	increasing	part of range	inferred

Previous and current management actions

There are no previous or current management actions for this species.

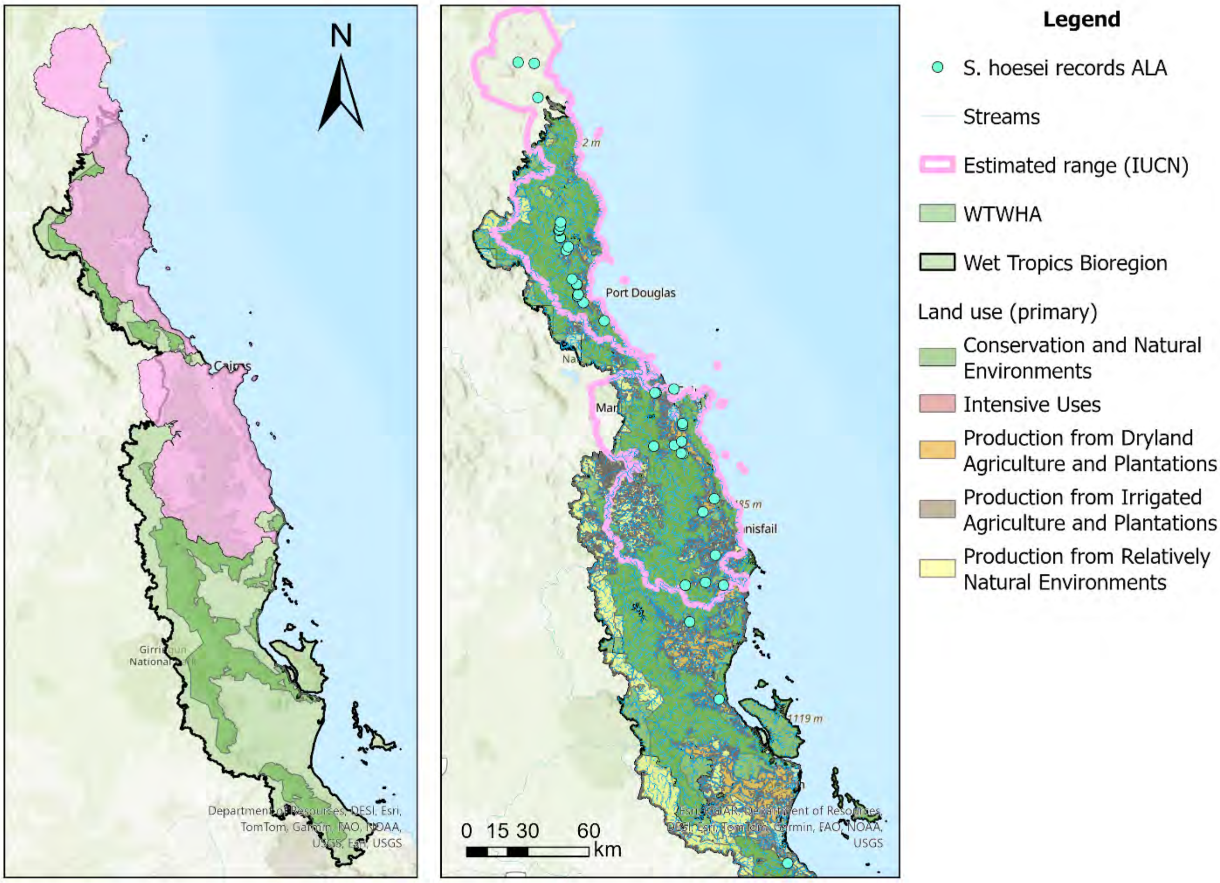
Scaleless goby - *Schismatogobius hoesei*

Conservation Status, Taxonomy and Description

Listed as Least Concern on the IUCN Red List of Threatened Species, the scaleless goby (*Schismatogobius hoesei,* previously misidentified as *Schismatogobius insignum*) is a small fish growing to 39 mm SL but rarely exceeding 35 mm SL and males are slightly larger than females (Keith et al., 2017; B. Pusey et al., 2004). It has a large head with bulbous cheeks and a large mouth that reaches well behind the eye in males, and just behind the posterior margin of the orbit in females (B. Pusey et al., 2004). It is dorsoventrally compressed anteriorly and ventrally compressed dorsally with a pelvic fin that almost reaches the anus (B. Pusey et al., 2004). It has a striking colouration pattern, with a swirling mix of browns and oranges on its body and a series dark brown-black bars (4-5) on the dorsal surface extending about three-quarters of the way down the flanks and interspersed with blotches of a similar colour on the ventral half (B. Pusey et al., 2004). These bars and blotches are outlined with a thin white margin (B. Pusey et al., 2004). The underbelly is a pinkish-white while the head tends to be dark brown (B. Pusey et al., 2004). Fins are striated with brown and black on the fin rays and it has a very distinctive dark brown cross is present on the caudal peduncle (B. Pusey et al., 2004). Males have orange on the throat and inside of the mouth. The pelvic and anal fins of adults males can be almost black with a fine bright orange margin, though the anal fin colouration is less intense (B. Pusey et al., 2004).

Species Distribution and Populations

The scaleless goby is endemic to the Wet Tropics where is has been recorded in low numbers from the Endeavour, Daintree, Mossman, Mulgrave, Russell, Johnstone and Liverpool catchments (B. Pusey et al., 2004). However, it has recently been observed as widespread and abundant in short, steep, coastal streams throughout the Wet Tropics (B. Ebner & Kennard, 2019a).



Biology and ecology

The diet of the scaleless goby is not well known but a small number of individuals analysed by Pusey et al., (1995) were found to mostly consume chironomid midge and trichopteran larvae. There is also limited data on the reproductive biology of the species, but spawning is thought to occur during the dry season and only once per female (B. Ebner & Kennard, 2019a). Two individuals analysed by Pusey et al., (2004) had between 2300 and 2900 eggs that were 0.31-0.51 mm in size. Reproductive behaviour is assumed to be similar to another species in the *Schismatogobius* genus, which lays its eggs on a flat surface within a nest that hatch within four days (Pethiyagoda, 1991). It is unknown whether there is a downstream larval drift and subsequent upstream migration as observed in other species from the *Schismatogobius* genus (Baihaqi et al., 2022).

The scaleless goby has highly specialised habitat requirements, occurring in clear, shallow waters, less than one metre in depth with steady water flow and sand and fine gravel substrate (Donaldson et al., 2013; Keith et al., 2017; B. Pusey et al., 2004). In surveys of larger river systems, Pusey et al., (2004) found it to be mostly confined to rock/cobble substrate at the head of fast-flowing riffles within 50 km of the ocean and at elevations of less than 50 m asl.

Movement patterns of this species are largely unknown but little movement is expected to occur (B. Pusey et al., 2004).

Key threats

Due to its highly specialised habitat requirements of shallow flowing waters, the scaleless goby is likely to be significantly impacted by changes to water flow (e.g. due to climate change or agricultural, domestic and urban purposes) (Donaldson et al., 2013; B. Ebner & Kennard, 2019a). These impacts are likely to be localised and if the species is amphidromous, streams may be recolonised with incoming larval recruits from the ocean (B. Ebner & Kennard, 2019a). However, construction of barriers would also hinder the downstream larval drift or upstream migration of juveniles (B. Pusey et al., 2004).

Expert threat risk assessment

Table A1.7.3 Expert risk assessment of threats to the scaleless goby (Schismatogobius hoesei)

Threat class	Threat type	Likelihood	Consequence	Risk rating	Timing	Trend	Extent	Confidence
Climate change	Changes in rainfall, runoff, flow regimes	possible (decrease in rainfall/runoff)	moderate	High	current/ future	increasing	entire range	inferred
Land use alteration	Aquatic habitat degradation (e.g. sedimentation, simplification)	possible	major	Very High	past/ current/ future	increasing	part of range	observed
	Water quality degradation (e.g. toxicants, suspended sediments, nutrients)	possible	minor	Very High	past/ current/ future	increasing	part of range	inferred
Introduced species	Invasive fish	possible	not significant	Low	past/ current/ future	increasing	part of range	inferred

Natural disasters	Increased frequency/severity of Cyclones extreme rainfall, and extreme floods	possible	moderate	High	current/ future	increasing	part of range	inferred
	Landslides	possible	moderate	High	current/ future	increasing	part of range	inferred
	Drought	possible	major	Very High	current/ future	increasing	part of range	inferred
Water resource management & infrastructure	Altered hydrology (e.g. flow regulation, water extraction)	possible	moderate	High	current/ future	increasing	part of range	inferred
Natural system management & modifications	Altered fire regimes (increased severity)	likely	minor	Moderate	current/ future	increasing	part of range	inferred
Other	Increased human (& pet) visitor usage and modification of riparian zones and instream areas	almost certain	minor	Moderate	current/ future	increasing	part of range	observed

Previous and current management actions

There are no previous or current management actions for this species.

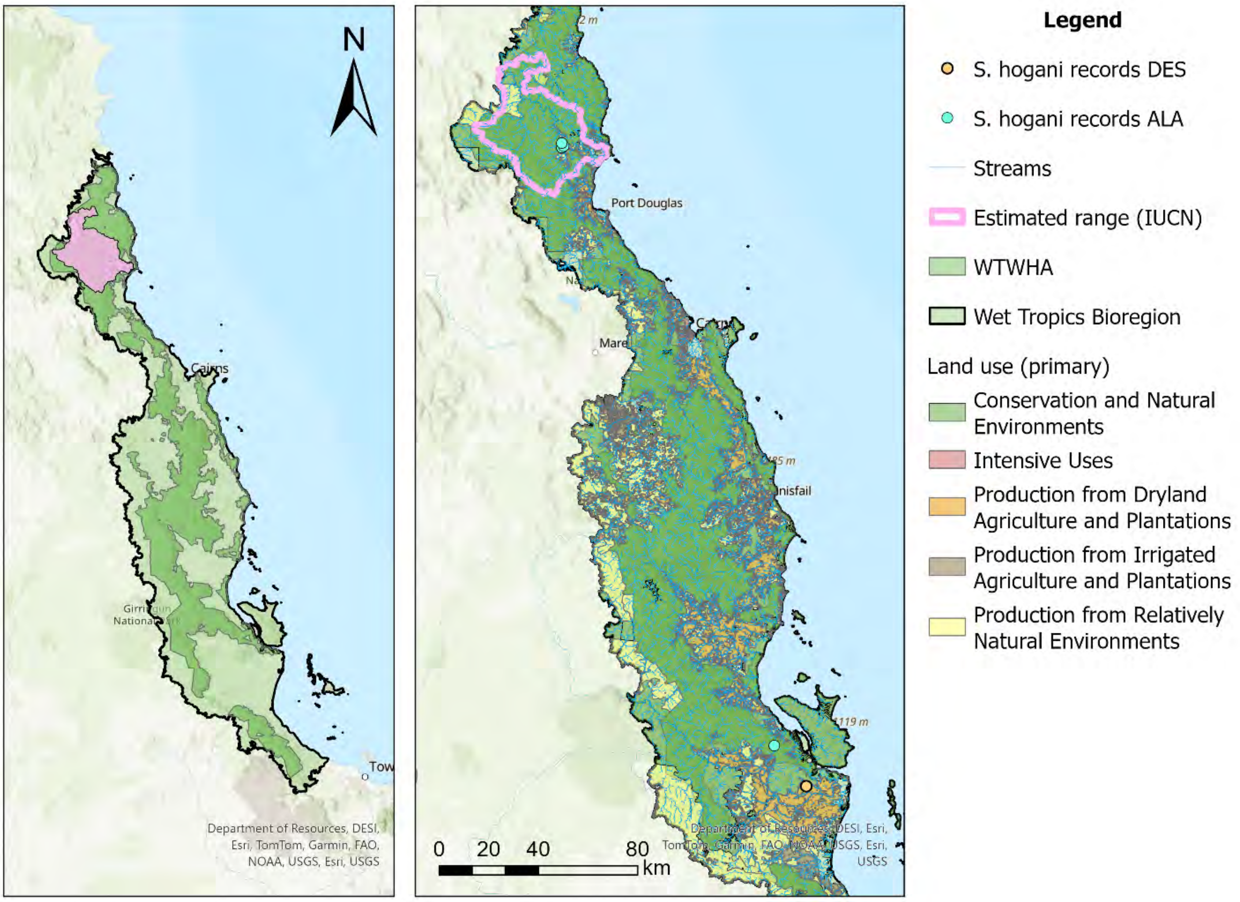
A1.8 Hogan's Sole - Synclidopus hogani

Conservation Status, Taxonomy and Description

Listed as Data Deficient on the IUCN Red List of Threatened Species, Hogan's sole (*Synclidopus hogani*) is a pale creamy-brown sole with about 22-26 irregular and discontinuous pale tan to dark chocolate brown bands (B. Ebner & Kennard, 2019b; Johnson & Randall, 2008). It also has three longitudinal rows of 5-6 large diffuse dark brown spots (Johnson & Randall, 2008).

Species Distribution and Populations

This species is known from the lower freshwater reaches including the upper tidal zone of the Daintree River, upstream from Daintree, Queensland, Australia (Johnson & Randall, 2008). It is a rare species and has been collected only twice in 2002 and 2006 and is known from only six specimens (B. Ebner & Kennard, 2019b). It is currently known from only one location but could occur more widely given that surveys have been limited due to accessibility of preferred habitat (Johnson & Randall, 2008).



Biology and ecology

This species' biology and ecology is largely unknown. The gut contents of one paratype of Hogan's sole included fragments of insect larvae and numerous sand grains (Johnson & Randall, 2008). It inhabits a broad shallow sand bank on the southern side of the Daintree River on a coarse sand and gravel bottom with fallen leaves and open shells of freshwater bivalve molluscs (Johnson & Randall, 2008). This region has flowing clear water and is around 5-6 km upstream from brackish water zone (B. Ebner & Kennard, 2019b). Tidal influences raise and fall the water level around 75 cm (B. Ebner & Kennard, 2019b).

Key threats

Key threats are largely unknown due to data deficiency regarding population size, distribution, biology and ecology. All recorded individuals have been within the WTWHA, which likely affords this species a significant level of protection (B. Ebner & Kennard, 2019b).

Expert threat risk assessment

This species was initially selected to be part of the risk assessment due to its known occurrence in small, isolated populations within the Wet Tropics. However, upon review of this species during the expert workshop it was unanimously agreed that there was insufficient knowledge on the distribution, biology, and ecology of this species to inform an assessment of risks to the species. It was suggested that this was likely due to the lack of fish surveys in the narrow longitudinal distribution of the species within river channels or the low abundance resulting in few records.

Previous and current management actions

There are no previous or current management actions for this species.

Appendix 2 – Expert Workshop agenda

This workshop is supported by the jointly funded *Commonwealth-State Disaster Recovery Funding Arrangements* and through the *National Environmental Science Program*.

Expert Workshop

Threats, risk assessment and recovery action planning for rare and threatened freshwater fish in Queensland's Wet Tropics region

Dates:
Workshop Day 1: 10.00 – 1700. Wednesday 7th May 2025
Workshop Day 2: 08.30 – 1700. Thursday 8th May 2025

Location
The Boardroom, Wet Tropics Management Authority, Cairns.
Ground Floor, Ports North building. Cnr Grafton and Hartley St, Cairns Queensland.

Workshop Purpose:

- Get together and talk about fish!
- Assess threats to priority endemic, rare, and threatened freshwater fish species of Queensland's wet tropics region (Table 1), with a particular focus on impacts of extreme flood events associated with Tropical Cycle Jasper
- Assess risks to priority freshwater fish species from key threats
- Identify and prioritise candidate recovery actions for each species
- Identify priority flood recovery actions to protect and restore freshwater fish and their critical habitats

Contact:
Professor Mark Kennard
Australian Rivers Institute, Griffith University
Mob. 0427 499 458
email: m.kennard@griffith.edu.au

This workshop is supported by the jointly funded *Commonwealth-State Disaster Recovery Funding Arrangements* and through the *National Environmental Science Program*.

Workshop Agenda.

Date	Activity	Presenter/facilitator*
Wednesday 7th May	**Workshop Day 1**	
10.00 – 10.30	Arrival, Morning tea/coffee and snacks	All
10.30 – 10.45	Acknowledgement of Country, Welcome & Introductions	MK, all
10.45 – 11.00	Background, workshop aims and approach	MK
11.00 – 11.15	**Priority rare and threatened freshwater fish species** in the Wet Tropics regions	MK
11.15 – 12.15	**Overview of threats** to freshwater fish species in the Wet Tropics region	KOM, KM (flood impacts)
12.15 – 12.30	General Discussion	All
12.30 – 13.15	Lunch	
13.15 – 15.00	**Threat Impact Assessment** for each fish species	MK, all
15.00 – 15.30	Afternoon tea/coffee	
15.30 – 17.00	**Risk prioritisation** for each fish species	MK, all
18.30 – 21.30	Workshop dinner (venue to be advised)	all
Thursday 8th May	**Workshop Day 2**	
8.30 – 9.00	Arrival, Morning tea/coffee	
9.00 – 9.30	**Overview of candidate recovery actions** for freshwater fish species in the Wet Tropics region	KOM
9.30 – 10.30	**Prioritisation of recovery actions** for each fish species	MK, all
10.30 – 11.00	Morning tea/coffee and snacks	
11.00 – 12.30	**Prioritisation of recovery actions** for each fish species *(cont'd)*	MK, all
12.30 – 13.00	Lunch	
13.00 – 15.00	**Identifying priority flood recovery actions** to protect and restore freshwater fish and their critical habitats	MK, all
15.00 – 15.30	Afternoon Tea/Coffee	
15.30 – 16.30	**Identifying priority flood recovery actions** *(cont'd)*	
16.30 – 17.00	Next steps, Workshop close	MK, all
18.30 – 21.30	Workshop dinner (venue to be advised)	

* MK: Mark Kennard, KOM: Kaitlyn O'Mara, KM: Keith Martin

Appendix 3 – Expert Workshop panel

The risk assessment presented in this report was undertaken at an expert workshop held in Cairns on May 7-8, 2025. The event was conducted in hybrid format (in-person and online). The workshop was attended by experts from a range of organisations including government, universities, consultancies, and included representatives from local management organisations included Wet Tropics Management Authority and Terrain NRM. The experts have previous or current experience in the research or management of freshwater fishes in the Wet Tropics and/or extensive knowledge on threat occurrence and exposure to freshwater fish in the Wet Tropics.

Following is a list of in-person attendees:

- Kaitlyn O'Mara – Griffith University
- Mark Kennard – Griffith University
- Brad Pusey – University of Western Australia
- Aaron Davis – James Cook University
- Damien Burrows - James Cook University
- Brendan Ebner - New South Wales Department of Primary Industries (Fisheries)
- Tim Lucas - Queensland Department of Primary Industries (Fisheries)
- Peter Negus - Queensland Department of the Environment, Tourism, Science and Innovation (Water Planning Ecology)
- Jonathan Marshall - Queensland Department of the Environment, Tourism, Science and Innovation (Water Planning Ecology)
- Peter Unmack – University of Canberra
- Keith Martin – Australia New Guinea Fishes Association
- Sarah Compagnoni - Queensland Department of the Environment, Tourism, Science and Innovation (Environment, Heritage Policy and Programs)
- Tara Ganley – Terrain NRM
- Terry Carmichel – Wet Tropics Management Authority

Online attendees:

- Luke Geelen – Queensland Department of Environment, Tourism, Science and Innovation (Threatened Species Operations)
- David Moffat - Queensland Department of the Environment, Tourism, Science and Innovation (Aquatic Ecosystem Health)
- Christina Howley – Cape York Water Partnership
- Ori Albert-Mitchell – Cape York Water Partnership