Final Report Ornate Rainbowfish, *Rhadinocentrus ornatus*, project.

(Save the Sunfish, Grant ID: 19393)

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1. Introduction

1.1 Background

The *Rhadinocentrus ornatus* (Ornate Sunfish, soft spined sunfish, or Ornate Rainbowfish) is a freshwater rainbowfish from the Family Melanotaeniidae. This Melanotaeniidae family of fish is only found in Australia and New Guinea. It's a small, mainly insectivorous species, the largest individuals reaching a maximum length of approximately 80mm (Warburton and Chapman, 2007).

The *Rhadinocentrus ornatus* (*R. ornatus*) is said to be a small, obligate freshwater fish species restricted to the coastal wallum habitat of eastern Australia (Hancox *et al*, 2010), where waters are slow flowing and acidic, and submerged and emergent vegetation is plentiful (Warburton and Chapman, 2007). However, Wildlife Queensland has found this species utilising other habitat types, such as gallery rainforest along Tingalpa Creek West Mt Cotton, a finding supported by BCC (2010). Good populations of *R.ornatus* were particularly found in clear slow – medium flowing streams supporting no aquatic or emergent vegetation located within gallery rainforest.

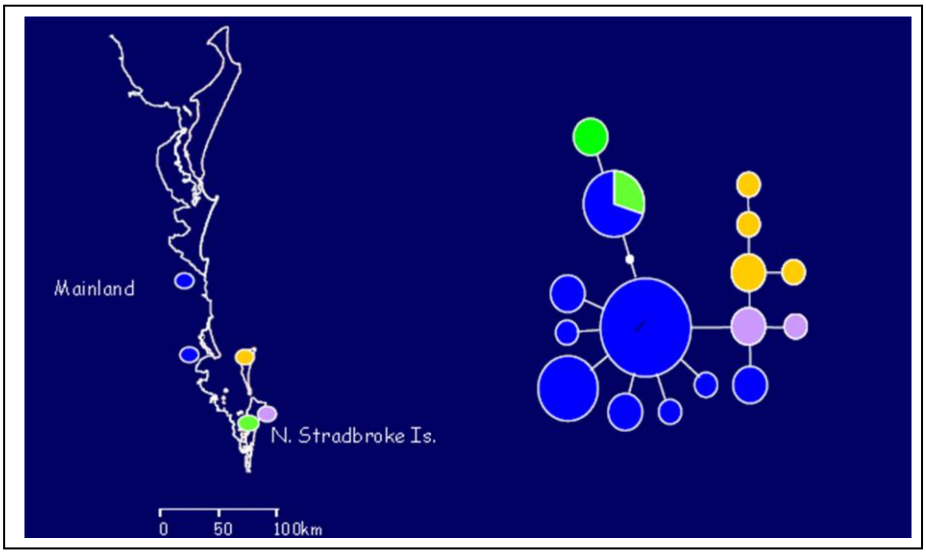
The species was particularly common in 12.3.1 Gallery rainforest (notophyll vine forest) on alluvial plains (Endangered) within a landscape comprised of 12.11.5 Open forest complex with Corymbia citriodora, Eucalyptus siderophloia, E. major on metamorphics ± interbedded volcanics and rural patches.

While *R.ornatus* was found in slow moving waterholes with high turbidity in mixed 12.3.6 Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland on coastal alluvial plains and 12.3.1 Gallery rainforest (notophyll vine forest) on alluvial plains (Endangered) within landscape comprised of 12.11.23 Tall open forest of Eucalyptus pilularis open forest on metamorphics and interbedded volcanics Alluvium (Endangered) and 12.11.5 Open forest complex with Corymbia citriodora, Eucalyptus siderophloia, E. major on metamorphics ± interbedded volcanics.

The *R. ornatus* has a highly restricted and narrow geographic distribution and is only found in a small area of South East Queensland (SEQ) and North East NSW. This includes Tin Can Bay, in the Great Sandy Region of central-eastern Queensland, to Coffs Harbour in north-eastern New South Wales (BCC, 2010). It also includes the islands: Fraser Island, Moreton Island and North Stradbroke Island, with a disjunct population occurring 350 kilometres away at Byfield in central Queensland (Warburton and Chapman, 2007).

In Brisbane *R. ornatus* was historically more widely spread in the Brisbane River system where it was common in the upper reaches of Oxley Creek and at Kholo Crossing (McKay and Johnson 1990). Prior to this report the species was still known to occur on the islands and in the upper reaches of Spring Creek and Ithaca Creek (BCC, 2010). In the Redland the species has been found at five mainland sites (NR&W 2007).

R.ornatus exists as four separate “evolutionarily significant units” (ESUs), known as “SEQ”, “CEQ”, “NWC” and “SER” (Page *et al*, 2004). The *R. ornatus* clade “SEQ” is found on North Stradbroke Island, Moreton Island, Bribie Island and the mainland (Page *et al*, 2006). These clades diverged between two and seven million years ago and so represent long-term divisions (Page *et al*, 2003).



Haplotype network for Rhadinocentrus ornatus showing relationships among haplotypes and their geographic distribution (Page *et al*, 2006).

Populations within this restricted area are highly fragmented, and due to this fact many ecologists consider the species vulnerable (Pusey et al, 2004). *R. ornatus* is now rare in the Brisbane area and is listed as significant in the city council Natural Assets Register; however, at present it is not recognised as a threatened species in national or state listings (Pusey et al., 2004).

R. ornatus is subject to many environmental threats, including competition and predation by exotic fish species, most notably the *Gambusia holbrooki* (mosquitofish or plague minnow). Additionally, urban development often causes degradation in waterway health, further compromising the number of ideal habitats available to *R. ornatus*. King *et al* (2010) highlight that the conversion of native grasslands, forests, wetlands and other natural land cover to cultivated and developed land represents one of the most significant causes of declining freshwater biodiversity.

1.2 The project

A project, with the assistance of the Australia and New Guinea Fishes Association (ANGFA), frc Environmental, Brisbane City Council (BCC) and Redland City Council (RCC) was created to locate *R.ornatus* populations, and raise public awareness of their potentially threatened status.

Australia and New Guinea Fishes Association has played a key role in training volunteers to successfully locate *R. ornatus*. Frc Environmental provided expert advice.

The project was gratefully funded via the *Environmental Grants Program Application 2009/2010 – Round 2.*

2.0 Methodology

Non-destructive sampling methods were utilised to ensure minimal, if any, impact on the fish and their habitat. Fish were caught using bait traps (also referred to as funnel traps) and dip nets. Not more than four traps per person were used. Opera House traps were not used because of the potential drowning-danger they present to air-breathing creatures such as turtles and platypi. All equipment was complied with the Queensland Government regulations at http://www.dpi.qld.gov.au/28_3023.htm. Wading boots, nets, traps, and other sampling equipment were washed between sampling sites to limit the translocation of organisms between waterways.

The traps were set in a range of habitats. For each trap notes were made using the ANGFA Aquatic and Fauna survey pro-forma; this enabled immediate environment characteristics and fish numbers and species data to be collected. Traps were immersed for up to 30 minutes, but were not left unattended for more than 15 minutes at any one time. Dip netting was carried out to supplement the results obtained through bait trapping. Fish species were confirmed by ANGFA members on the day and or confirmed by Queensland Museum (Jeff Johnson) via means of digital photographs (lateral shot).

Bag and Size Limits were in accordance with the Queensland Government regulations at http://www.dpi.qld.gov.au/28_2994.htm. A bag limit (take and possession limit) is the total number of fish that one person can legally take and keep at any one time. For *R.ornatus* not more than 20 fish were in a team member's possession at any point in time thus ensuring the team was meeting the recreational fishing rules and regulations specified in Queensland legislation.

A variety of fish and invertebrates were caught and all species were recorded to assist with the development of distribution data in the Redland area. Any feral (non-native) fish caught were not returned to the water. Noxious fish such as gambusia were destroyed humanely at the location in which they are caught using an esky with an ice slurry to euthanase these noxious fish.

When native fish were removed from the water, every care was taken to preserve the health and wellbeing of the fish. They were kept out of water for the minimum time necessary, and only handled with wet hands.

A number of creeks were sampled (See table 1) between November 2010 to May 2011. Floods in early 2011 and persistent rain has caused numerous disruptions with the survey timetable.

Historical aerial photography for some targeted sites is used for the purpose explaining report findings.

Survey crews had to adhere to recommendations made in Risk Management Plan and wear clothing that meets WPH&S standards. **11 volunteers** were trained in the capture, identification and handling of native fish and to assist in the operation of the project (See photograph 1). At the completion of this project a series of fact sheets were created and are available online from http://www.wildlife.org.au/projects/ornaterainbowfish/

Supporters of the project also contributed information about native fish populations and their findings are included in this report.

Table 1: Sites

Site	Notes (Landscape details & vegetation types)
Spring Creek, Carindale (Brisbane) **2 sites – surveyed once each. #1**	**Urban matrix** with **patches of riparian habitat** (mixed exotic and native vegetation); **upper catchment supports 12.11.3** Open forest generally with Eucalyptus siderophloia, E.propinqua on metamorphics ± interbedded volcanics and **12.11.5** Open forest complex with Corymbia citriodora, Eucalyptus siderophloia, E. major on metamorphics ±interbedded volcanics .
Ithaca Creek, Bardon (Brisbane) 3 sites – surveyed once each.	**Urban matrix** with **patches of riparian habitat** (mixed exotic and native vegetation), **12.3.7** Eucalyptus tereticornis, Callistemon viminalis, Casuarina cunninghamiana fringing forest; **12.3.11** Eucalyptus siderophloia, E. tereticornis, Corymbia intermedia open forest on alluvial plains usually near coast (Of Concern); 12.11.3 Open forest generally with Eucalyptus siderophloia, E.propinqua on metamorphics ± interbedded volcanics; **12.11.5** Open forest complex with Corymbia citriodora, Eucalyptus siderophloia, E. major on metamorphics ±interbedded volcanics.
Tingalpa Creek (Brisbane / Redlands) #1 3 sites – surveyed once each.	**12.3.1** Gallery rainforest (notophyll vine forest) on alluvial plains (Endangered) within a **vegetated matrix** comprised of **12.11.5** Open forest complex with Corymbia citriodora, Eucalyptus siderophloia, E. major on metamorphics ± interbedded volcanics and **rural patches**; **12.3.6** Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland on coastal alluvial plains and **12.3.1** Gallery rainforest (notophyll vine forest) on alluvial plains (Endangered) within **vegetated matrix** comprised of **12.11.23** Tall open forest of Eucalyptus pilularis open forest on metamorphics and interbedded volcanics Alluvium (Endangered) and **12.11.5** Open forest complex with Corymbia citriodora,Eucalyptus siderophloia, E. major on metamorphics ± interbedded volcanics.
Eprapah Creek (Redlands) #2 3 sites – surveyed once each.	Riparian habitat in **fragmented vegetated matrix** large **rural patches**. **12.3.6** Melaleuca quinquenervia, Eucalyptus tereticornis,Lophostemon suaveolens woodland on coastal alluvial plains.
Little Eprapah Creek (Redlands) 1 site – surveyed once.	
Serpentine Creek (Redlands) 2 sites – surveyed once each.	
Wallaby Creek (Redlands) 1 site – surveyed once.	
Tarradarrapin Creek (Redlands) 1 site – surveyed once.	**Urban matrix** with **patches of riparian habitat** (mixed exotic and native vegetation); in upper catchment **12.3.5** Melaleuca quinquenervia open forest on coastal alluvium and **12.3.6** Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland on coastal alluvial plains.
Sandy Creek (Redlands)	
Hilliards Creek (Redlands)	

1 - notable: good populations, most notable.   # 2 – notable: small populations.

Tingalpa Ck

Tingalpa Ck

Spring Ck

Tingalpa Ck

Ithaca Ck

Photograph 1: Volunteers and sites visited.

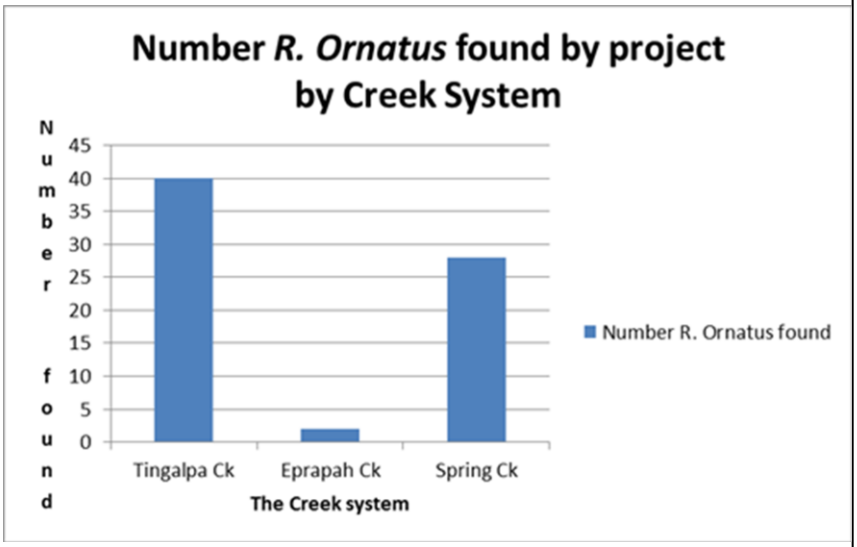
3.0 Results

Data is aggregated to provide an overview of creek systems and to avoid identifying specific sites (Refer to 3.1). Wildlife Queensland is deeply concerned that some populations are so severely restricted in their distribution that un-controlled collection could result in local extinction, concerns which are shared by residents (BCC, 2010). Specific details and data will be made available to BCC on request and to universities and supporting partners of this project.

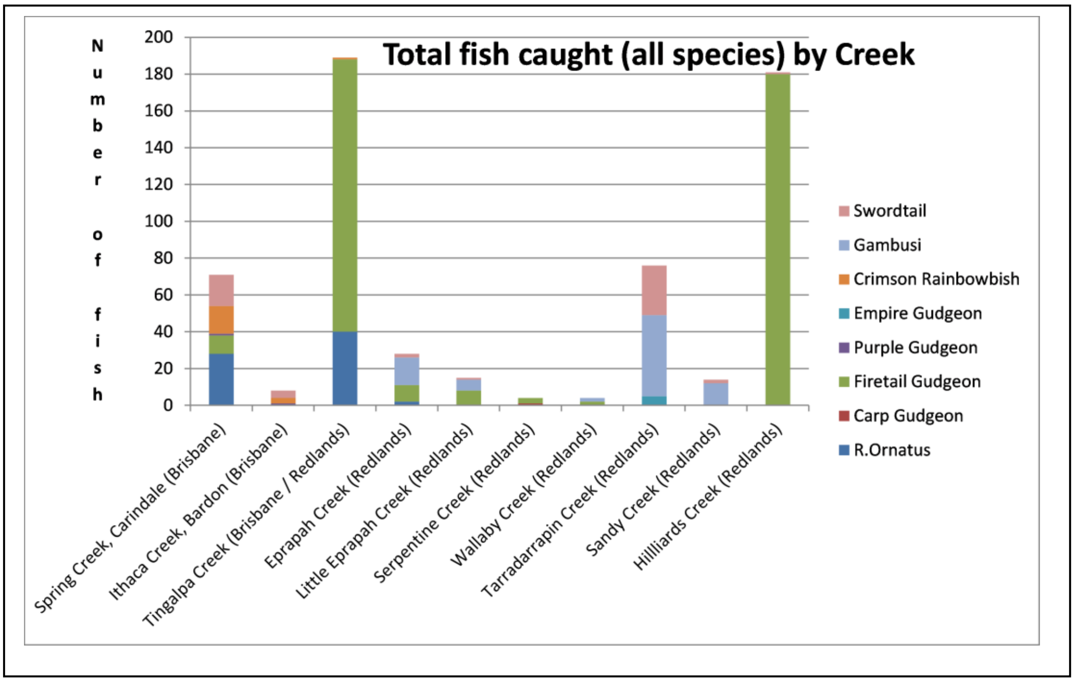
It was noted that *R. ornatus* population found in each creek, and even within different sites on that creek, vary in color (Refer 3.2, see photograph 2) making each population rare. Important to note *R. ornatus* is a unique freshwater fish species in that it displays a within-population colour polymorphism that is expressed in males and females (Hancox *et al*, 2010). Colour polymorphism is where more than one colour morph persists within a population, is not predicted under traditional selection theory and is a rare occurrence in natural populations (Hancox *et al*, 2010).

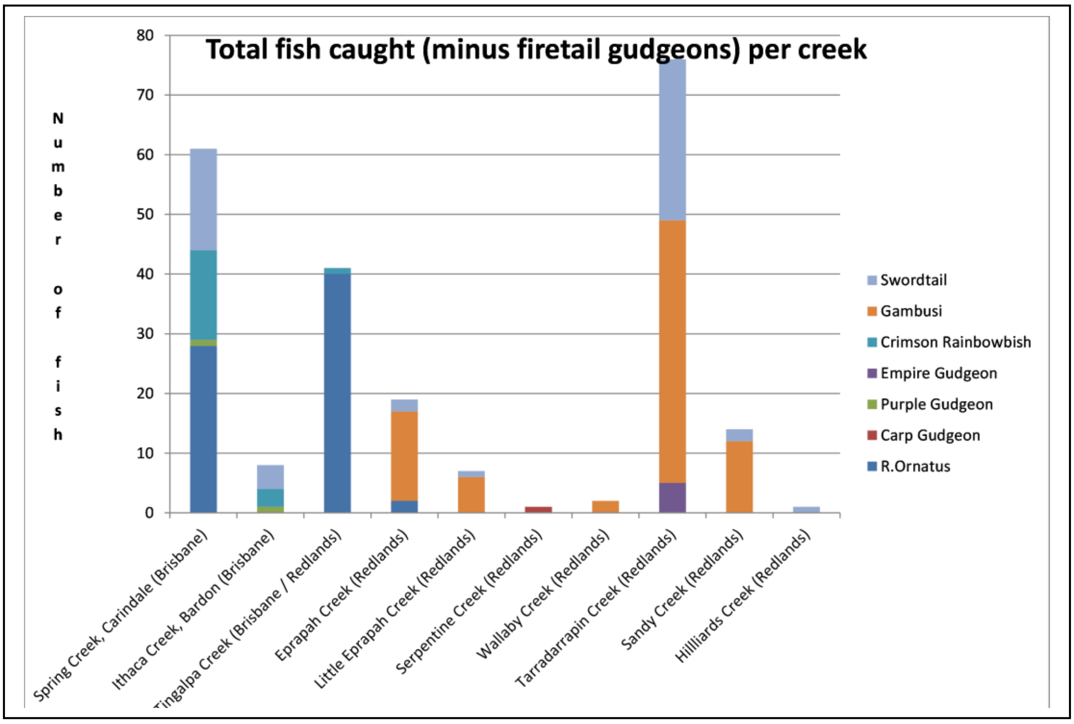
Water quality data is found at 3.4 in this report. It should be noted unusually persistent heavy rainfall events have likely affected water quality results. Iron staining was prevalent at the Tingalpa Creek and Spring Creek sites.

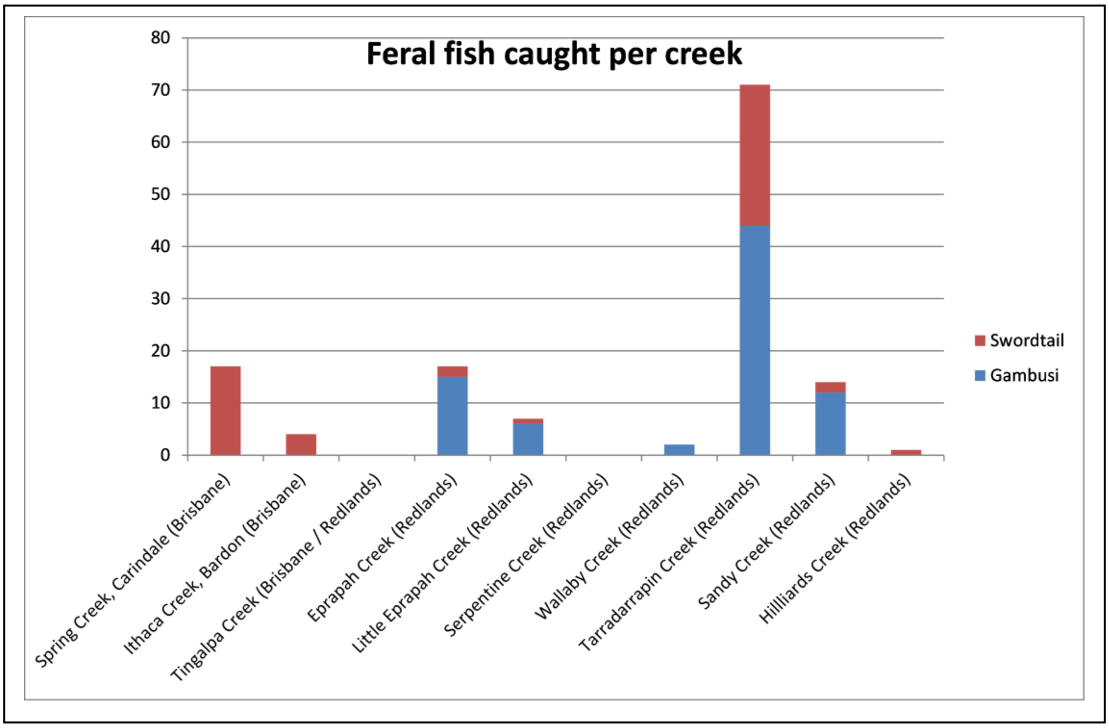
3.1 Aggregated data

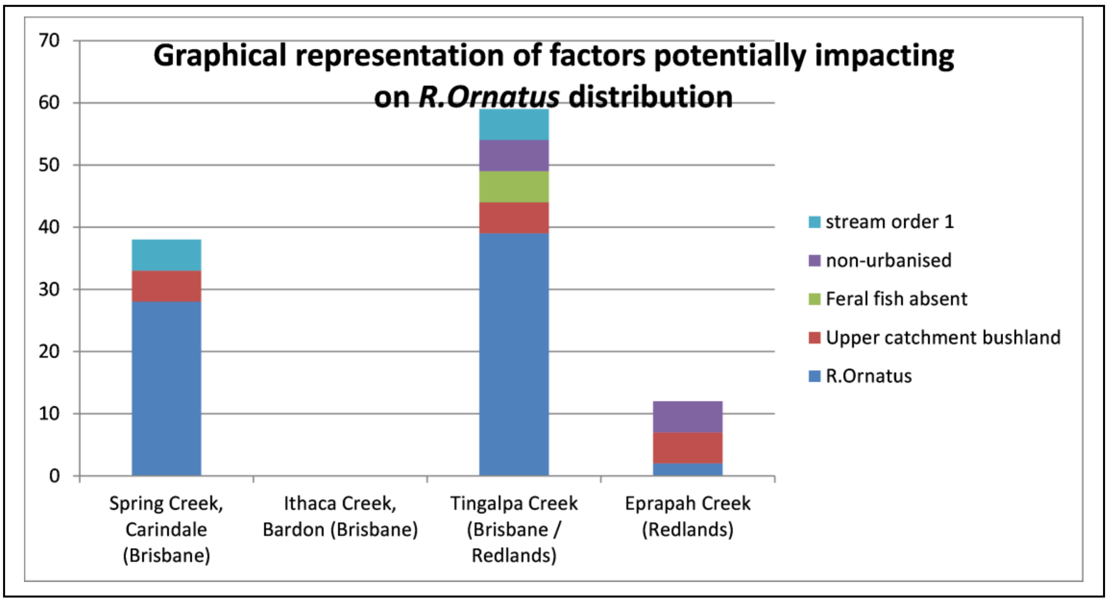


Creek System	Supported *R.Ornatus* pre-project	*R.Ornatus* identifed by project	New populations found (includes other projects)
Tingalpa Ck	√	√	√
Eprapah Ck	√	√	
Spring Ck	√	√	
Ithaca Ck	√	X	
Moggill Ck	?	X	√ (Kenmore High School)
Coolnwynpin Ck	?	X	√ (Redland Council)

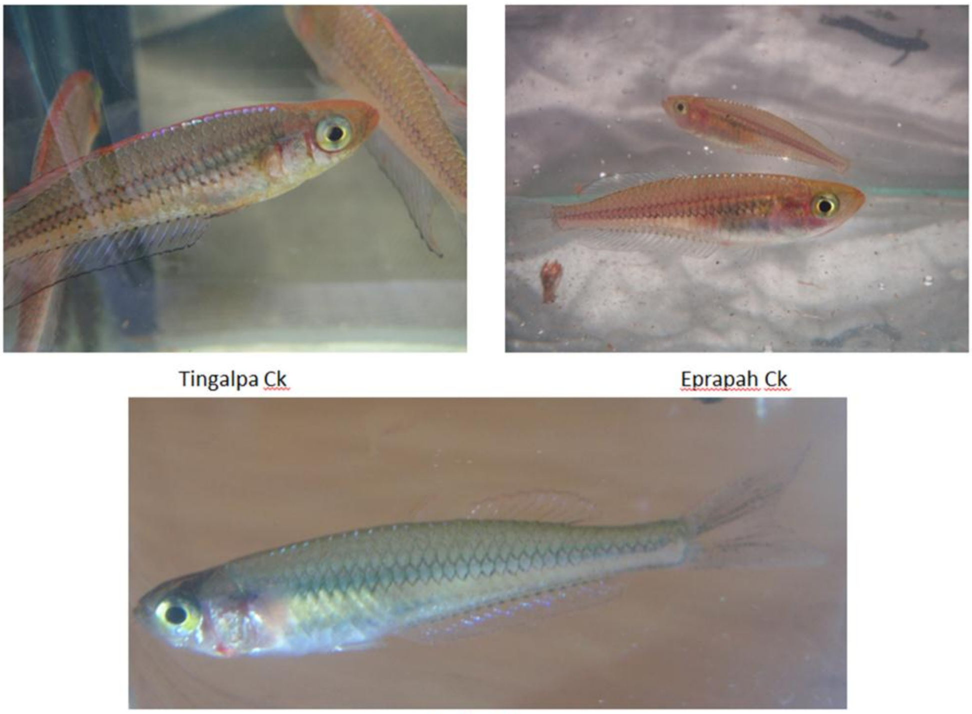

Total fish caught (all species) by Creek
Number of fish
200
180
160
140
120
100
80
60
40
20
0
Spring Creek, Carindale (Brisbane)
Ithaca Creek, Bardon (Brisbane)
Tingalpa Creek (Brisbane / Redlands)
Eprapah Creek (Redlands)
Little Eprapah Creek (Redlands)
Serpentine Creek (Redlands)
Wallaby Creek (Redlands)
Tarradarrapin Creek (Redlands)
Sandy Creek (Redlands)
Hilliards Creek (Redlands)
Swordtail
Gambusi
Crimson Rainbowbish
Empire Gudgeon
Purple Gudgeon
Firetail Gudgeon
Carp Gudgeon
R.Ornatus


Total fish caught (minus firetail gudgeons) per creek
Number of fish
80
70
60
50
40
30
20
10
0
Spring Creek, Carindale (Brisbane)
Ithaca Creek, Bardon (Brisbane)
Tingalpa Creek (Brisbane / Redlands)
Eprapah Creek (Redlands)
Little Eprapah Creek (Redlands)
Serpentine Creek (Redlands)
Wallaby Creek (Redlands)
Tarradarrapin Creek (Redlands)
Sandy Creek (Redlands)
Hilliards Creek (Redlands)
Swordtail
Gambusi
Crimson Rainbowbish
Empire Gudgeon
Purple Gudgeon
Carp Gudgeon
R.Ornatus


Feral fish caught per creek
80
70
60
50
40
30
20
10
0
Swordtail
Gambusi
Spring Creek, Carindale (Brisbane)
Ithaca Creek, Bardon (Brisbane)
Tingalpa Creek (Brisbane / Redlands)
Eprapah Creek (Redlands)
Little Eprapah Creek (Redlands)
Serpentine Creek (Redlands)
Wallaby Creek (Redlands)
Tarradarrapin Creek (Redlands)
Sandy Creek (Redlands)
Hillliards Creek (Redlands)


Graphical representation of factors potentially impacting on R.Ornatus distribution
70
60
50
40
30
20
10
0
stream order 1
non-urbanised
Feral fish absent
Upper catchment bushland
R.Ornatus
Spring Creek, Carindale (Brisbane)
Ithaca Creek, Bardon (Brisbane)
Tingalpa Creek (Brisbane / Redlands)
Eprapah Creek (Redlands)

3.2 *R.Ornatus* forms



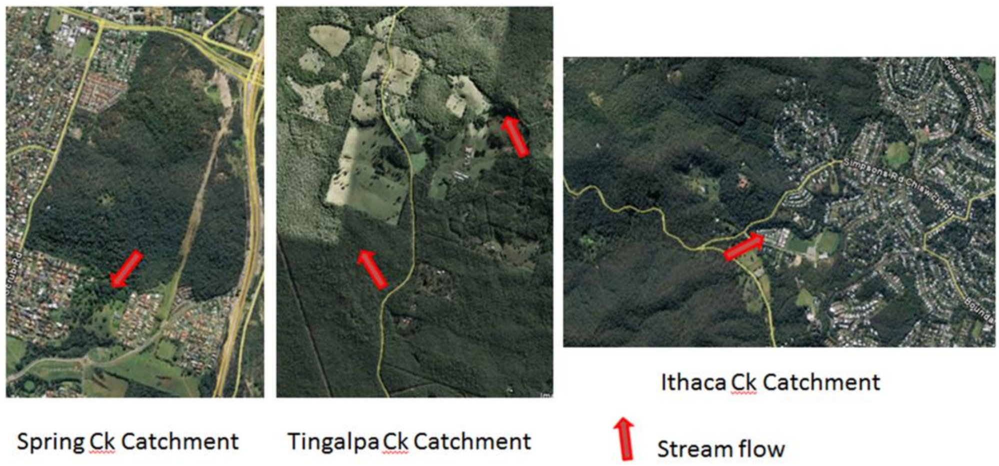
Tingalpa Ck

Eprapah Ck

Spring Ck

Photograph 2: ***R. Ornatus***

3.3 Catchments



Photographs 3: Catchments

3.4 Water Quality

Sitename	Creek	Substrate	Flow	Depth	Turbidity	Water tmp	pH	Alkalinity
OSPEPR01	eprapah ck	clay sand silt	still	1	medium tannin			
OSPEPR02	eprapah ck	gravel	medium	0.5	low			
OSPEPR03	eprapah ck	gravel sand	medium	pool - 1.0m; ck - 0.2m	medium tannin		6.8	< 80ppm
OSPHLD01	hilliards ck	silt mud	medium	0.5	medim			
OSPITH01	Ithaca Creek	sand	slow	0.5	low			
OSPITH02	Ithaca Creek	gravel	slow	0.5	medium			
OSPITH03	Ithaca Creek	sand & gravel	medium	0.5	low			
OSPLEP01	little epraph ck	clay slit	medium	1	medium tannin	20.1	6.5	120 ppm
OSPSDC01	Sandy ck	gravel mud	medium	0.5	medium tannin			
OSPSRP01	Serpentine ck	gravel silt	medium	0.5	low	23.5	7.7	
OSPSRP02	Serpentine ck	gravel silt	slow	0.75	low	24.5	7.7	
OSPSGC01	Spring ck	gravel	medium	0.75	medium			
OSPSGC02	Spring ck	gravel	medium	0.5	medium	23	7.7	
OSPTAR01	tarradarrpin ck	mud	medium	3	high			
OSPTG01	tingalpa ck	gravel rock	medium	0.2m	clear	19.4	7	120 ppm
OSPTG02	tingalpa ck	mud	nil	0.75	high			
OSPTG03	tingalpa ck	gravel silt	medium	pool - 1.0m; ck - 0.2m	medium tannin	20.4	7.1	< 80ppm
OSPWAL01	wallaby ck	gravel	slow	1	medium tannin			

4.0 Discussion

It should be noted that due to high rainfall and flooding during the study period, most sites were only visited once. While this provided valuable data, more intense and regular surveying is required to improve/enhance the statistical accuracy of our findings.

R. ornatus were found in Tingalpa Creek, Eprapah Creek and Spring Creek, with the largest population found in Tingalpa Creek followed by Spring Creek. Interesting to note that 42% (11) of the fish found in Spring Creek were juvenile, as the survey was conducted on the 30th January 2011. This is expected given October – December is their spawning season (BCC, 2010). Populations were once found in Ithaca Creek (Warburton and Chapman, 2007) but their fears about the lack of recruitment from the 2006-2007 spawning season may have been realized with no *R. ornatus* found in this creek between November 2010 and May 2011.

Three new populations were discovered, one in the far upper catchment of Tingalpa Creek on private property and another in Coolnwynpin Creek and a third in Moggill Creek by students from Kenmore High School and Leo Lee of ANGFA (per comms Leo Lee).

Tingalpa Creek supported the largest number of native fish while Spring Creek supported the greatest diversity. Feral fish were prevalent in Redland creeks except Serpentine and Tingalpa Creek, which are located within extensive bushland. Spring Creek and Ithaca Creek supported feral species (Swordtail, *Xiphophorus helleri*) but not noxious species like *Gambusia holbrooki* (Primary Industries and Fisheries, 2010). *Gambusia* is highly aggressive, and has been recorded attacking native species including the *R.Ornatus* (BCC, 2010). In NSW they are recognized as a key threatening process (DEC, 2005). *Gambusia* was prevalent in disturbed landscapes, such as Eprapah Creek, Little Eprapah Creek, Sandy Creek, Wallaby Creek and Tarradarrapin Creek but interestingly not in Ithaca Creek. It should be noted that Tarradarrapin Creek has at times supported very large numbers of Firetail Gudgeon, *Hypseleotris galii* and during the survey period healthy breeding Empire Gudgeon, *Hypseleotris compressa*. It would seem a set of conditions may influence the waxing and waning of the abundance of native and exotic fishes in some streams.

The most abundant native fish was the Firetail Gudgeon, *Hypseleotris galii*, particularly abundant in Tingalpa Creek and Hilliards Creek. Hilliards Creek when surveyed supported an abundance of juvenile Firetail Gudgeon. The *R.Ornatus* was also an abundant fish in Tingalpa Creek and Spring Creek.

While data collection was designed to simply identify if a species was present in a Creek the data collected does provide some insights that would be useful to consider in Conservation Management.

The most notable aspect is that *R.Ornatus* is abundant in lower order creeks (1st Order) and where the habitat and catchment upstream is vegetated. Tingalpa Creek and Spring Creek highlight this observation (Refer 3.3, see photograph 3). While the Eprapah Creek catchment is vegetated it is heavily fragmented by rural patches. Further, one of the Eprapah Creek sites was located adjacent to a heavily urbanized patch (Victoria Point). We can assume as feral species and urbanization increases *R.Ornatus* numbers decline. Important to note that with urbanisation comes impermeable surfaces and therefore increased pollutants entering waterways (Nilon, 2009; Eason *et al*, 2009). This is a concern as King *et al* (2010) found a clear and synchronous threshold decline of 46% of macroinvertebrate taxa in response to low levels of impervious cover. King *et al* (2010) found approximately 80% of the declining taxa did so between ~0.5–2% impervious cover, whereas the last 20% declined sporadically from ~2 to 25% impervious cover. Guntenspergen *et al* (2009) found similar results in their research. This clearly suggests as a vegetated matrix within a landscape is transformed to a more urban landscape and becomes more impervious aquatic biodiversity declines. We would suggest that urbanization, as King *et al* (2010) suggests, represents a significant threat to aquatic biodiversity.

4.1 Brisbane

Given Brisbane will see a projected 156,000 new dwellings by 2031 and the Redlands 21,000 (DLG&P, 2009) there are reasons to be concerned about the future of our native fish species. Using examples the report emphasizes this concern.

The information below is based on the following statistics. People per household is calculated at 2.4 person/home based on 1996 data, Brisbane's population 991,000, number of dwellings 397,000 (DLG&P, 2009). The ratio of vehicles to persons over 17 years in 1996 was 0.83 with many households having two or more vehicles (DLG&P 2008). The average distance travelled in the Brisbane Statistical Division (BSD) per capita by passenger vehicles was estimated to be approximately 8,840 km per annum in 2004 (DLG&P 2008). This is well below the ABS (1996) statistic of 14,600km/yr; we use the smaller travelling distance in this report. This report does not consider tyre dust generated by non passenger vehicles, which must be considerable.

Approximately 3kg of tyre dust is produced by each vehicular tyre per year (Environmental Research Foundation, 1995; Councell *et al*, 2004) while zinc (Zn) release alone from tyre abrasion was calculated at 14gZn/km/yr on residential streets to 810 gZn/km/yr on highspeed motorways (Councell *et al*, 2004). Heavy metals like Zinc cannot be chemically transformed or destroyed and as Davis *et al* (2001) showed 25% of Zinc in urban stormwater was estimated to come from tyre wear and 73% from residential streets (University of Wisconsin, 2000), which included tyre wear. The concern is Zinc is known to be toxic to aquatic species (University of Wisconsin, 2000) and it's often found in stormwater (Councell *et al*, 2004).

Assuming there are two vehicles per each new household this represents an extra 3,744,000kg (3,744 tonnes) of tyre dust being generated annually in Brisbane and 504,000kg (504 tonnes) annually in the Redlands. Even using Atech Group (2001) more conservative figure of 0.03 g/km per tyre (1.06kg/vehicle/year) this still equates to 330,720kg (331 tonnes) of extra tyre dust generated by new dwellings in Brisbane by 2031 and likewise 44,520kg (44.5 tonnes) annually in the Redlands.

Tyre dust contains rubber (40%), HAoils (PAH), Phenols, Phthalates, Zinc (Lawrence, 2011; Swedish Chemical Agency, 2007) and heavy metals (Adachi & Tainosho, 2004). Many of these compounds are harmful to humans, the environment (Adachi & Tainosho, 2004; Swedish Chemical Agency, 2007) and particular aquatic species. This does suggest that Moreton Bay is potentially receiving between 2,548.8 tonnes and 225.3 tonnes of toxic material annually due to tyre dust from passenger vehicles.

4.2 Redlands

We examined the Kinross Road Master Development Area (MDA) gazetted in 2010 under Section 133 of the Sustainable Planning Act (SPA) 2009. This area exists in the upper catchment of Hilliards Creek previously an area devoid of extensive urban development. This creek system was identified by the Redland City Council for rehabilitation of native fish species under the proposed *Fish 'n Creeks Project* in 2009. When fully established the MDA will support a further 2013 dwellings (RCC, 2008). Currently, the vehicle movement in this area is about 44 vehicle movements/hr during peak hour, when the MDA is completed the vehicle movement will increase by 2,838% (1,249 vehicles/hr) (Baltais, 2011). The consequence is that within the upper catchment of Hilliards Creek somewhere between 48,312kg (48 tonnes) and 4,267kg (4.3 tonnes) of extra tyre dust will be generated annually. Of this material 60% (28.8 – 2.58 tonnes annually) is toxic and it should be realized this is only one source of pollutant; some of the many pollutants created within the urban landscape.

5.0 Conclusion

The project was limited in its capacity to thoroughly examine native fish species including *R.Ornatus* but was sufficient to confirm their existence and general health.

R.Ornatus continues to thrive in the Tingalpa Creek catchment and survive within the upper Spring Creek Catchment and young specimens suggest normal life cycle processes are being maintained. Eprapah Creek also supports small numbers of *R.Ornatus* but drought has seen many waterholes dry up so it will be interesting to monitor the species for the next several years to see if recent high rainfall events have been a benefit.

Feral fish and fragmentation of native vegetation and habitat loss are contributing to the loss of the species (Warburton and Chapman, 2007; BCC, 2010; King *et al* 2010). It therefore seems appropriate to use King *et al* (2010) research to better understand how urbanization is undermining the survival of aquatic species, like *R.Ornatus*, and take steps to address the impervious nature of the urban landscape. The application of Water Sensitive Urban Design (Healthy Waterways, 2011) would seem critical if native fish species are to survive in our urban landscape. Likewise applying legislation and technology that captures tyre dust and other vehicular pollutants before they made their way into urban stormwater would be beneficial. While WSUD can be applied it would only take one event in some instances to undermine the survival of *R.Ornatus*. Gutenspergen *et al* (2009) also showed that soil can become saturated with some nutrients and therefore pollutants can still be exported into our waterways despite the efforts of WSUD and natural wetlands.

If urban development is allowed to encroach upon our lower order streams the risk to our aquatic biodiversity would appear to increase substantially. This suggests that the protection of first order streams in some form of conservation estate is also critical if we are to ensure the survival of species like *R.Ornatus*. Protecting *R.Ornatus* will also benefit many other species as suggested by Abell *et al* (2011). Abell *et al* (2011) state, 'an investment in freshwater conservation is in many cases an investment in terrestrial (and marine) conservation as well, since protecting a freshwater system can be as much about protecting the integrity of its catchment as about protecting the aquatic system itself'.

The difficulty will be that each population is potentially unique and protecting sufficient habitat for each population will be a challenge. However, failing to meet the challenge has the consequence that we will lose a unique form equating to the potential loss of genetic diversity and therefore leaving our aquatic landscape just that much poorer.

Acknowledgement

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