Pest Fish Populations in the Whitsunday Region

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For further information contact:
Tim Marsden
Fisheries Biologist
Fisheries Queensland a service of Department of Employment, Economic Development and Innovation
Ph: (07) 49670 724

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Enquires should be addressed to:
Deputy Director General
Fisheries Queensland
GPO Box 46
BRISBANE QLD 4001

Cover Figure: Botanica Estate eradication demonstration site (top); swordtails (middle); backpack electrofishing technique used during survey (bottom).
Executive Summary

The Whitsundays region has until recently been free of major pest fish incursions with only mosquitofish, *Gambusia holbrooki*, recorded in a small number of systems. Recent Fisheries Queensland sampling throughout the region in response to the identification of pest species by the public has identified that a number of ornamental species have been released in the region. The largest infestation, Botanica Lagoon with five pest species, became our demonstration eradication site. Pest fish were removed, natives relocated and the site drained. Following the wet season the lagoon will be restocked with native fish. Self-replicating populations of the swordtail, *Xiphophorus helleri*, an ornamental pest fish species, were located in the Gregory River, Dryander, Myrtle and Brandy Creeks. Data from previous Fisheries Queensland surveys suggest that this species has been present in the region for at least three years and it is evident that they have become more widespread during this time. Swordtail populations were found to be restricted to the upper catchment sections that lie within undisturbed rainforest areas, suggesting that swordtails may have sought an environment with few predators. Populations of mosquitofish were found in the Gregory River and in off-stream storages adjacent to small waterways. All of these sites were in areas of moderate disturbance, with little or no riparian zone and warm, shallow grassy margins. Mosquitofish were released throughout Australia in the 1920’s and later during World War II as a biological control for mosquitoes. As such, they have had a long period of time for natural dispersal and their eradication is unlikely. Abundances of native fish species did not appear to be hugely affected by the presence of pest fish, except one site on the Gregory River and one on Brandy Creek, where swordtails far outnumbered rainbowfish. Gut analysis performed on species sub-samples revealed that trophic overlap exists between swordtails and rainbowfish and swordtails and purple-spotted gudgeons in some components of their diets. As a result of this competition, each of these three species appeared to be supplementing their diets with other food sources to reduce rivalry. In order to ensure that swordtail populations do not threaten further waterways within the Whitsunday region, it is recommended that a pest fish management program is implemented and ongoing monitoring carried out. To assist in the control of mosquitofish it is recommended that riparian zones be maintained to suppress weeds and keep shallow margin temperatures down. To control both pest species naturally, it is also recommended that unrestricted fish passage is maintained along all waterways to ensure that native fish, especially predators, can access these environments where pest fish are present.

Introduction

The Whitsunday region incorporates an area of the Queensland coast running from the township of Bowen in the north to the O’Connell River in the south and includes the Conway Peninsula and Islands. This region has until recently, been free of major pest fish incursions with only mosquitofish recorded in a small number of systems. The Whitsunday Pest Fish Management Project was initiated in response to the identification of pest fish species by the public in the Airlie Beach/Proserpine area. It is a joint project between Fisheries Queensland and Whitsunday Catchment Landcare Inc (WCL), funded by the Whitsunday Shire Council Biodiversity Levy.

The waterways targeted in this study are those surrounding the populated areas of Proserpine and Airlie Beach (see figure 1). Many of the streams surveyed were tributaries of the Proserpine and Gregory Rivers, or short systems that emptied directly into the Coral Sea. The majority of the headwaters of these systems fall
within national parks while in the lower reaches agriculture and urbanisation dominate.

Figure 1. Whitsunday waterways surveyed for pest fish

The introduction and spread of pest fish species in various parts of the world is regarded by many as a major threat to global biodiversity and hence ecological sustainability (Corfield et al. 2008). Many ornamental fish are brought to Australia each year for stocking into home aquaria or garden ponds. Inevitably, some of these fish end up in natural waterways with some 41 species known to have established feral populations in Australia (Corfield et al. 2008). Pest fish are considered any fish that can potentially cause harm to other fish, aquatic habitats and/or humans. They come under two general categories: non-indigenous and noxious. A non-indigenous pest fish is any fish that is found in an area where it does not naturally occur and can be both native and/or exotic. A noxious fish is one that is declared harmful by Australian statute law and includes the mosquitofish (see www.deedi.qld.gov.au for a comprehensive list of species).

This paper outlines the survey conducted to identify and map pest fish populations and their current and potential impacts on native fish populations in the Whitsunday region.

**Methods**

Thirty-one sites (see figure 1) were surveyed between August and December, 2009 using a Smith-Root Model-12B-POW Backpack Electrofisher operating a 500-volt Pulsed-DC current and a standard pulse setting (1ms). An operator and single dip-netter were employed during all backpack sampling activities. The electrofishing sampling method used consisted of 300 second ‘shots’ at each site. At sites where pest fish were encountered, the total catch from each shot was identified to species level, measured and sub-samples of each species captured were kept for gut analysis to
determine trophic overlaps. Due to depth limitations, lagoon sites were only sampled around the edges with the back pack electrofisher, and therefore analyses of data collected at these sites has not been performed.

Results

Pest fish were located at 13 sites in the Whitsunday region. Three of these sites were lagoons/dams and the remainder were sites on the Gregory River, Dryander, Brandy and Myrtle Creeks (figure 2).

![Pest fish sites on major waterways.](image)

The pest species found were primarily exotic fish with one non-indigenous aquatic invertebrate (redclaw crayfish) and one noxious fish species (mosquitofish) surveyed (table 1). The greatest abundance and diversity of pest fish was found within Botanica Lagoon. Abell St Lagoon and the Proserpine State High School Farm Dam were found to have only one species of pest fish, the mosquitofish. Within the river and creek systems 10 sites within three catchments were found to have pest fish of two species, swordtail and mosquitofish (figure 2).
Table 1. Summary of pest fish sampled.

<table>
<thead>
<tr>
<th>Species</th>
<th>Gregory River</th>
<th>Dryander Creek</th>
<th>Myrtle Creek</th>
<th>Brandy Creek</th>
<th>Botanica Lagoon</th>
<th>Abell St Lagoon</th>
<th>Proserpine SHS farm dam</th>
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<tbody>
<tr>
<td>Swordtails (Xiphophorus helleri)</td>
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<tr>
<td>Mosquitofish (Gambusia holbrooki)</td>
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<td>Goldfish (Carassius auratus)</td>
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<td>Sailfin mollies (Poecilia latipinna)</td>
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<td>Oscar (Astronotus ocellatus)</td>
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<tr>
<td>Redclaw Crayfish (Cherax quadricarinatus)</td>
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<td>X</td>
</tr>
</tbody>
</table>

Individual Catchments

**Gregory River**

A total of 190 fish representing seven native and two pest species were sampled at five sites on the Gregory River (Figure 3) with pest fish being found at all five sites. Thirteen of the 190 fish were pest species, mosquitofish and sword tails, representing 7% of the total catch. The most numerous species was the purple-spotted gudgeon and rainbowfish, representing almost 50% and 13% respectively, of the total catch.

Figure 3. Gregory River total catch
At the three upper Gregory River sites, swordtails were found to represent approximately 12% of the catch (figure 4) and were the second most abundant species after the purple-spotted gudgeon (71% of catch). At site three, swordtails formed just under 7% of the total catch, while at site four and five swordtails represented 26% and 7% of the total catch, respectively.

**Figure 4. Gregory River Swordtail sites total catch.**

**Brandy Creek**

Sampling at three sites on Brandy Creek found 84 fish from four native and one pest species (figure 5). The pest fish species, the swordtail, represented 35% of the catch. Again, purple- spotted gudgeons were the most abundant species representing 38% of the catch, followed by the swordtails. At site one, swordtails formed 22% of the total catch, while at site two and three swordtails constituted 35% and 75% of the total catch, respectively.

**Figure 5. Brandy Creek total catch**
Dryander Creek

A total of thirty-three fish from three native and one pest species were sampled at one site on Dryander Creek (figure 6). Of these 33 fish, 49% were rainbowfish, followed by 27% swordtails and 21% purple-spotted gudgeons. Empire gudgeons made up only 3% of the total catch.

![Dryander Creek total catch](image)

Myrtle Creek

One hundred and ten fish from six native and one pest species were sampled in Myrtle creek (figure 7). Two swordtails were sampled making up only 2% of the catch. The most abundant species was the empire gudgeon (41%), followed by the rainbow fish (32%) and the purple-spotted gudgeon (20%).

![Myrtle Creek total catch](image)
Of all the sites found to have pest fish populations, Brandy Creek had the most significant pest fish population with 54% of the total pest fish catch (figure 8). The Gregory River having both swordtails and mosquito fish had the second highest pest fish populations with a total of 24.5% of the total pest fish catch followed by Dryander Creek which had 17% of the total catch. Myrtle Creek with 3.87% of the total pest fish catch, had the smallest pest fish population.

![Total Pest Fish Catch](image)

**Figure 8. Total pest fish abundances.**

### Discussion

**Swordtails**

Eight of the ten sites where pest fish were sampled contained swordtails. A total of 73% of these sites were located within a rainforest setting where riparian vegetation is very dense, providing cover and shade, and where habitat disturbance is very low and water quality high. This contradicts the popular notion that swordtails prefer still waters with grassy marginal areas in altered habitats (Arthington et al., 1983).

The swordtails were found to share habitat with an average of 3.16 other fish species. The most common species they were found with were purple-spotted gudgeons (*Mogurnda mogurnda*) and rainbowfish (*Melanotaenia splendida*). Small numbers of blue eyes (*Pseudomugil signifier*), empire gudgeons (*Hypseleotris compressa*) and midgley’s carp gudgeons (*Hypseleotris klunzingeri*) were also present with swordtails at some sites. The most common predator found at 37.5% of the swordtail sites was the long-finned eel (*Anguilla reinhardtii*) whose diet (as an adult) consists of 28.2% fish (Pusey et al., 2004). Other predators found with the swordtails in low numbers were tarpon (*Megalops cyprinoides*) and spangled perch (*Leiopotherapon unicolor*) whose diet consists of 29% and 10% fish at the adult stage, respectively (Pusey et al., 2004).

Sites surveyed that contained no pest fish had significantly higher numbers of these predatory fish, as well as mouth almighty’s (*Glossamia aprion*) who consume fish at 16.3% of their diet (Pusey et al., 2004). The data indicates that swordtails may have sought habitats that possess low predator numbers, which may suggest why most of the swordtail populations were located in the upper rainforest sections beyond the point where most predatory fish inhabit.
Previous Fisheries Queensland surveys conducted in Myrtle Creek in October 2006 (2 fish), May 2007 (4 fish) and December 2007 (20obs) and on the upper Gregory River, August 2008 (100’s obs) also found swordtail populations. This indicates that swordtail populations have been present in Myrtle Creek for at least 3 years and in the Gregory River for at least 18 months. It is believed that Myrtle Creek may have been the original release site for swordtails. From here, it is highly probable that they have made their way across to the Gregory River and up into Dryander Creek during flood conditions, and have travelled to find their way into Brandy Creek, a tributary of Myrtle Creek. Without genetic sampling of the swordtail populations, proving this is very difficult and the notion of separate introduction sites throughout the region is not being dismissed.

Analysis of data indicates that native fish abundances are not being significantly reduced by the presence of swordtails at approximately half of the sites. However, at two of the sites, (Brandy Creek Site 3 and Gregory River Site 4) the data shows that swordtail numbers far outweigh rainbowfish numbers, 12:1 and 5:0, respectively. It is projected that of all the native species inhabiting the same aquatic environment as the swordtail, the eastern rainbowfish is the most susceptible to being affected as literature suggests that they have the most significant dietary overlap. Both the swordtail and the rainbowfish are omnivorous, feeding primarily on algae, but also with invertebrates as a small component of their diets (Arthington, 1989, Pusey et al., 2004).

Gut analyses performed on species sub-samples (Appendix 1) revealed that there is significant dietary overlap in particular between swordtails and rainbowfish, and also between swordtails and purple-spotted gudgeons. The most significant trophic overlap was found to be the single-celled algae component of the species diets between both swordtails and rainbowfish (62.5% overlap) and swordtails and purple-spotted gudgeons (37.5% overlap). At the sites where these overlaps occurred, swordtails supplemented their diets with other algae while rainbows and purple-spots were supplementing their diet with bugs, ants and occasionally other algae. This ability to find alternative food sources when there is high competition for one particular food, may suggest why the numbers of rainbowfish and purple spotted gudgeons are not significantly affected at all of the sites sampled. At only one site, Brandy Creek Site 3, there was no trophic overlap; rainbowfish were eating bugs and swordtails algae.

Trophic overlap, however, is not the only threat swordtails pose to native fish populations. Previous studies report that aggression, predation on eggs and fry and loss of aquatic macrophytes are causes of decline in native fish populations in urban streams supporting swordtails (Arthington et al, 1983, Arthington et al., 1990, Milton and Arthington, 1984). Additionally, swordtails are livebearers which eliminate the chances of their eggs being preyed upon increasing reproductive success.

**Mosquitofish**

Mosquitofish were found at four survey locations, two of these in dams adjacent to small watercourses and two on the Gregory River. Observations revealed that the populations in the dams were more significant than those in the river. Research indicates that mosquitofish like warm, still and shallow water at the edges of pools often where exotic grasses have grown partly into the water (Arthington et al., 1983 and Pyke, 2005). All mosquitofish sampled were captured in the shallow margins of both the dams and the Gregory River.

Due to a lack of surrounding vegetation and shade at all of these sites, the shallow margins are easily warmed by the sun and exotic grasses are able to grow into the
water. The sites with mosquitofish on the Gregory River are surrounded by cattle farms and sugar cane in a reach where there is very little riparian vegetation. Habitat disturbance in this area would be considered moderate. Mosquitofish were not found in the upstream rainforest sections, supporting the popular notion that they prefer a moderately degraded habitat.

Mosquitofish have been successfully introduced from North America to all continents except Antarctica making them the most widely distributed freshwater fish in the world (Krumholtz, 1948; Lloyd, 1984; Lloyd and Tomasov, 1985; Lloyd, 1986; Pyke, 2005). They were initially introduced to Australia in the 1920's and again during World War II firstly as an aquarium fish and later into waterways as a biological control for mosquitos for which it has been recognised native fish are far superior (Arthington, 1991, Arthington and Marshall, 1999). Mosquitofish are now widespread throughout the continent and their eradication is highly improbable.

**Conclusion**

It is evident from this survey and from those performed in the past that swordtails in the Whitsunday Region are forming self-replicating populations in several waterways. Current populations appear to be restricted to the top of catchments where habitat disturbance is low and few predators exist. This suggests the possibility that the swordtails have sought habitats where they can most successfully colonise without the threat of predators, or alternatively, that populations lower down in the catchments have been eradicated by predators.

As the area is susceptible to flooding during wet season rains, the spread of swordtails to further Whitsunday waterways is probable, leading to potential difficulties in their management. Dry season stream conditions, however, may facilitate management as waterways are reduced to a series of isolated pools. When this occurs there are several options for their control, including:

- capturing and euthanising all swordtails;
- relocating natives and drying-out pools; or,
- use of poison (rotenone) to destroy swordtails in isolated pools.

Swordtails populations may be controlled naturally by ensuring that native fish, especially predators, have unrestricted access to upper catchment sections. This can be achieved by ensuring that no fish passage barriers exist.

Populations of mosquitofish in the Whitsunday Region are well known, and have been confirmed by this survey at both instream and off-stream storage locations. Unfortunately, as a result of their widespread release and several decades of natural dispersal time, eradication of the mosquitofish is highly unlikely but its control may be achievable by maintaining habitat conditions. Such habitat conditions include:

- good riparian zones to prevent grassy weeds growing into streams and to keep temperatures down in shallow margins;
- weed management in riparian zones; and,
- maintain access for predators by ensuring that no fish passage barriers exist.
Recommendations

The biodiversity of native fish species in the Whitsunday Region are under threat by growing populations of pest fish. To ensure that this threat is abated it is recommended that a pest fish management program be implemented. Such a program may include:

- Eradication of known populations of swordtails during the dry season as fish are confined to small pools.
- Monitoring of waterways for future outbreaks.
- Initiate riparian revegetation programs in key pest fish locations.
- Encourage effective riparian vegetation management.
- Ongoing pest fish awareness campaigns.
References


Appendix 1. Mean percent gut contribution to each dietary category for swordtails, *Xiphophorus helleri*, and native species that were sampled with them.