Freshwater Pest Fish on Boigu, Saibai, Badu and Mabuiag Islands in the Torres Straits (June 2014 survey)

Report No. 14/41

October 2014

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TropWATER

JAMES COOK UNIVERSITY
AUSTRALIA

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A report for Torres Strait Regional Authority

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1 SYNOPSIS

The Torres Strait Regional Authority (TSRA) engaged TropWATER (Centre for Tropical Water and Aquatic Ecosystem Research), James Cook University, to complete a ranger training and school educational program on Boigu Island, Saibai Island, Badu Island and Mabuiag Island. This training program was completed in two phases. The first was between 16 and 28 June 2014, while the second phase was completed during 1 and 5 December 2014. TropWATER has previously completed ranger training in the Torres Straits, including with rangers on Boigu and Saibai Islands, which also led to the documentation of the invasive climbing perch (*Anabas testudineus*) on both islands. This report provides a summary of the tasks completed in accordance with the contract between TSRA and TropWATER (CA-2014-00112). Specifically, these tasks include:

1) Survey for pest fish on Boigu, Saibai, Badu and Mabuiag Islands using a variety of gear types, including nets, traps, backpack electrofishing, and underwater video along with field observations, noting that fish such as climbing perch have proved elusive to standard techniques on previous trips;
2) Participate in community meetings on pest fish on the 4 target islands to present information sessions on pest fish impacts and identification on Boigu and Saibai Islands. The community meetings will focus on pest fish identification and control/management options, the school sessions mostly on awareness of pest fish. This is considered an important task as environmental awareness and understanding why introduction and spread should be prevented will be the most effective outcome of this project;
3) Conduct training workshops for TSRA staff on pest fish identification and management. The training will include pest fish identification, use of various fish catching methods, keeping of fish, field monitoring and record keeping as part of the implementation of a monitoring plan, selection of sites for ongoing monitoring plan etc. On Boigu and Saibai Islands, this initial training will be supplemented by additional visits by TropWATER staff during the project;
4) Undertake assessment of basic water quality parameters, such as salinity/conductivity in aquatic;
5) Undertake a stomach content analysis of any invasive fish caught;
6) Identification and testing of practical management (control) methods;
7) Establish a ranger monitoring program based on the training sessions detailed in Task 3;
8) Develop pest fish fact sheets for key pest fish species (at least 8 species);
9) Provide a project report for 2013-14 activities, including results and findings of survey activities; list of practical management (control) methods and preferred approach; a copy of training workshop material and ranger monitoring program; and community awareness material; and
10) Participate in a project review with TSRA staff to determine activities for the next phase(s) of the Invasive Fish Project, if any.

Overall, climbing perch were again reported on Boigu and Saibai Islands similar to previous surveys completed by TropWATER. It seems likely that this species is permanent and that the community on both islands are probably going to have to live with this species. An ongoing ranger netting program of major wetland areas is recommended, with surveys to be completed immediately following wet season rain and on several further occasions through the dry season, to detect and destroy any collected invasive fish (as an early warning measure). Of most serious concern is prevention of other invasive fish species present in PNG, namely, snakeheads (*Channa striata*) which are known to occur throughout most coastal wetlands and freshwater swamps (with snakeheads already known on Daru). It is recommended that additional invasive fish surveys be completed on Dauan Island, Iama Island and Mer Island in an attempt to continue expanding TSRA Ranger awareness and increasing capacity

to control and manage advancement of invasive fish species from PNG. This monitoring could also utilisation of e-dna technology, as a cost effective and more accurate method in the detection of invasive fish species. Further focused research is needed to understand the tolerance and breeding biology of these invasive species, under local environmental conditions, in order to better develop management strategies.

2 INTRODUCTION

2.1 Risk of Pest Fish Species in the Torres Straits

Many species of freshwater fish from around the world have been introduced to Papa New Guinea. The islands of Torres Straits represent a potential pathway for their entry into Australia. Many of these pest species are declared noxious under the Land Protection Act 2002. Managing pests is a key goal of QDAFF and is reflected in the Queensland State Pest Management Strategy (the Strategy).

Fisheries Queensland has an Operational Strategy for the Control of Pest Fish in Queensland Freshwaters 2011-2016. Its priority goal is preventing further spread of pest fishes, recognising that control is rarely achieved once new populations have established. This strategy recognises that control/spread prevention of pest fish is a community issue and that effective control can only be achieved by engaging the community. Three of the six priority actions in the Strategy revolve around community education. Another is reviewing risk to identify vulnerable catchments/regions.

The Strategy specifically mentions Torres Straits as a key pathway for pest fish entry into Queensland, and specifically mentions climbing perch (*Anabas testudineus*), snakeheads (*Channa striata*), walking catfish (*Clarias batrachus*), gambusia (*Gambusia holbrooki*), pacu (*Piaractus brachypomus*) and tilapia (*Oreochromis mossambicus*) as priority species. The approach of the state strategy is consistent with the National Strategy for the Management of Vertebrate Pest Animals in Australia (the Australian Pest Animal Strategy).

Under the Quarantine Act, DAFF Biosecurity (Commonwealth) also have a responsibility for preventing invasive fish introductions into Australian waters, though their mandate does not include control once they arrive. DAFF (Commonwealth) has staff on most Torres Strait Islands and TSRA has strong existing partnerships with them - these partnerships will be important as part of this project. The Queensland Biosecurity Strategy 2009-2014 outlines focus areas to prevent the introduction of new pests into Queensland, including Torres Straits; this is relevant to both cane toads and pest fish.

2.2 Pest Fish Surveys Completed to Date

Two surveys for pest fish invasion in the Torres Straits have been completed previously by TropWATER. The first survey was completed in 2009 on Saibai Island, while the second survey was completed in 2010 on Boigu Island. Both these previous surveys recorded climbing perch on each island, and in close proximity to the main townships. During the 2010 survey on Boigu Island, climbing perch were discovered in the tidal swamps in the more central areas of the island. Climbing perch are considered to be a freshwater species (Khan et al. 1976; Besra 1998), and this record in tidal swamps is the first discovery of this fish species occupying saltwater conditions, and therefore raises concerns around the tolerance of this species to a range of conditions. This discovery also raises concerns over the

spread of this species under its own mechanisms, and not solely via humans moving this species from area to area.

In these previous fish surveys, no other exotic fish species was recorded. During the Saibai Island survey (2009), however, PNG villagers visiting Saibai Island positively identified climbing perch, snakeheads and walking catfish from pictures as being present in the swamps and rivers around their villages. This information led to the conclusion that if climbing perch have made their way from PNG swamps and rivers to Torres Strait islands, other fish species (e.g., snakeheads, walking catfish, pacu, tilapia) may be the next to spread into the Torres Strait islands, and possibly Cape York Peninsula.

2.3 Climbing Perch

Climbing perch (*Anabas testudineus*) (Figure 2.1) have a highly mobile operculum and strong spines on their pectoral fins that they can use to move over land. Because of their ability to move across land or 'climb', as their name suggests, they are able to move over or past obstacles that would be a barrier, or restrict most fish species (Davenport and Matin 1990). This ability to move on land effectively means that they can colonise new locations (e.g., into isolated wetlands) that most other introduced fish would not be able to reach.

Also when swallowed by predators, their strong gill cover and fins can be splayed outward, lodging in the throat or stomach of their predators. Birds such as pelicans and cormorants have been observed to choke on climbing perch in this manner (Hitchcock 2008) as have fish and reptiles (Storey et al. 2002).

Climbing perch have an accessory air-breathing organ on their dorsal area behind their head. This allows them to tolerate low dissolved oxygen and even being out of water for considerable periods (reportedly up to six days – Allen 1991). There is also some thought that they can also burrow into the mud of drying pools and aestivate there during the dry season until water again returns (Froese and Pauly 2008; Storey *et al.* 2002). This makes them a very tolerant and hardy fish and further illustrates their potential as a serious threat to Australian freshwater ecosystems.

Figure 2.1 Climbing perch (*Anabas testudineus*) captured in a waterhole near the airport tarmac on Saibai Island (19 June 2014)

Climbing perch are native to SE Asia from India to western Indonesia (Froese and Pauly 2008). They were probably brought to Irian Jaya (the western part of New Guinea) with the transmigration of people settling there from other parts of Indonesia (Hitchcock 2008). From there, climbing perch have moved eastward through the rivers and wetlands around the southern coastline of New Guinea. Climbing perch are renowned for moving overland, especially during the wet season, and this is probably how they invaded the southern PNG coastal environments. However, they are also traded by villagers as food and have been known to move to new catchments via this means (Hitchcock 2002). They first crossed the border into PNG in the 1970's, being recorded from the Morehead River, near the Irian Jaya border in 1976 (Storey *et al.* 2002), the Bensbach River in 1985 (Hitchcock 2002), the Fly River in 1988 (Storey *et al.* 2002) and have for several years been found in rivers and wetlands on the southern coast of PNG that are directly opposite Saibai Island (Hitchcock 2008).

Boigu and Saibai Islands are part of Australian territory, even though both are only 4-6km from the PNG mainland. In November 2005, reports of climbing perch were received from Saibai Island and confirmation of their existence came from a photograph taken in January 2006, which was sent to the Queensland Department of Primary Industries and Fisheries and the Queensland Museum where it was confirmed as a climbing perch (see Hitchcock 2008). That photo was of a climbing perch making its way across the island's airstrip (something climbing perch are capable of doing). Hitchcock (2008) visited Saibai Island in January 2006 and locals reported that they had seen climbing perch moving overland within the village during the wet season and that they may have been present for 3-4 years before that (i.e., since 2002 or 2003). This provided evidence of their existence on the island, however, no specimens were located and no further information on their extent was obtained during that trip. TropWATER has previously recorded climbing perch on both Boigu (Burrows et al. 2010) and Saibai

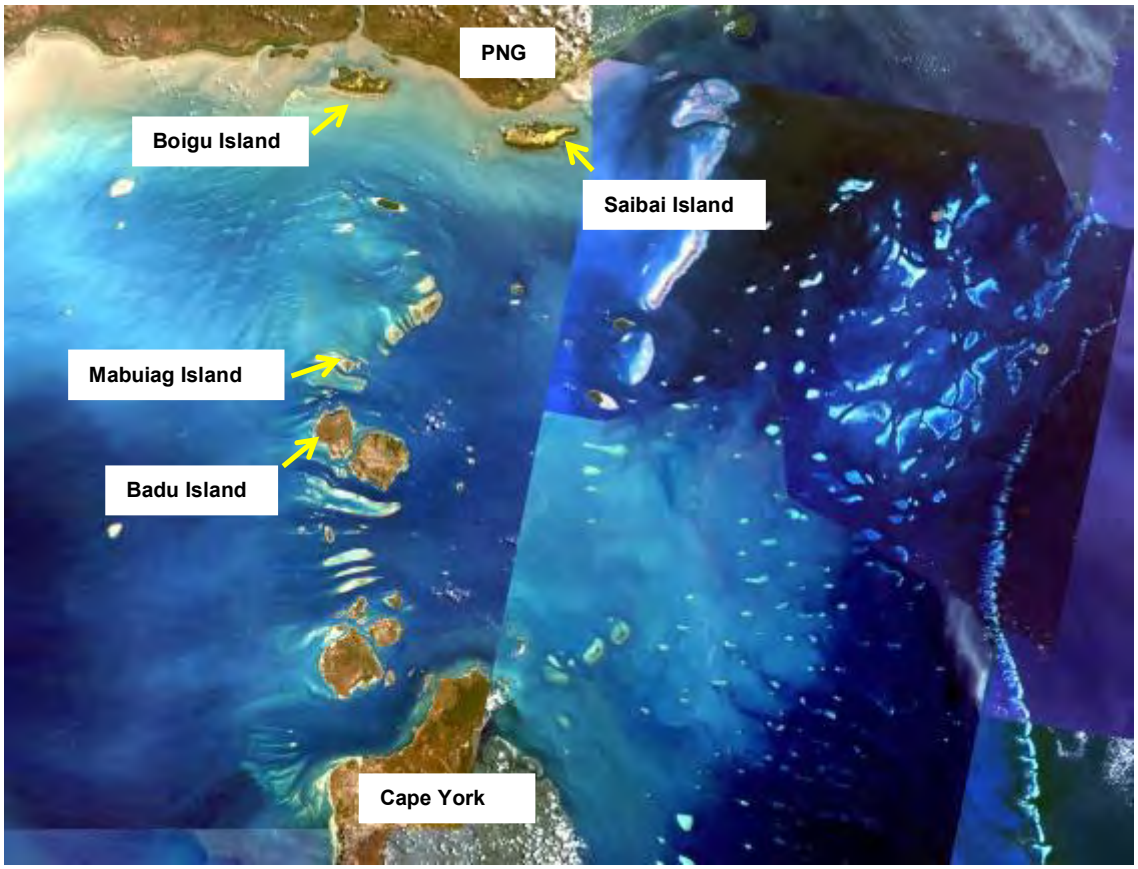
Islands (Burrows and Perna 2009) around the villages, though climbing perch were also recorded in the interior of Boigu Island, however, in low numbers.

The purpose of this field trip was to survey interior wetlands of Boigu and Saibai Islands, and to undertake the first survey of the next two main islands to the south.

2.4 Site Descriptions and Sampling

Four island communities were visited 16 - 28 June 2014, with approximately 2-4 days spent on each island. The islands visited were Boigu, Saibai, Badu and Mabuiag Islands. Boigu and Saibai Islands are the closest to Papa New Guinea (Western Province), approximately 4-6kms to the south of PNG coastline. Mabuiag Island is approximately 80km to the south of PNG, while Badu Island is approximately 90km to the south of PNG (Figure 2.2).

Figure 2.2 Islands visited in Torres Straits during project



2.4.1 Sites and Sampling Methods – June 2014

The suitability of sampling sites to examine the fish community was influenced by the Rangers on each island. The Rangers have a good local knowledge of the wetlands and where fish, including climbing perch, might be found. With the use of an amphibian all-terrain vehicle (on Boigu and Saibai Islands) and a helicopter (on Boigu, Saibai and Badu Islands), the Rangers were valuable in accessing remote parts of islands (Figures 2.3 to 2.6).

Fish were collected using a range of methods, including those used in previous surveys by TropWATER (Burrows and Perna 2009; Burrows 2010). The most obvious difference in this survey was that night sampling was not supported here, unlike previous TropWATER trips where night sampling with high powered spot lights was the main method for detecting climbing perch. On the one occasion where TropWATER staff visited at night a small waterhole on Boigu island, where previously night time sampling had been successful in recording climbing perch, again this method was successful where three climbing perch were recorded in 40mins of spot lighting effort.

The fishing methods used here included cast nets (7ft and 10ft drop with a stretch mesh of 10mm: Figure 2.7), dip nets (metal handles with 1mm stretch mesh), baited fish trap (0.4 x 0.25 x 0.25m; baited with canned fish) and a seine net (15 x 2m, 1mm stretch mesh; Figure 1.8). At each site a series of cast nets were thrown (between 2 and 18 throws), with the catch recorded and returned alive to the water (except on a few occasions where specimens were kept to confirm identification). In addition to cast nets, where possible, a seine net was dragged over an area of approximately 300m^2 (between 1 and 3 drags), dip nets (~20m), baited fish traps (2 to 24hrs), and snorkelling (~20mins) were also used. At each site, an assessment was made to determine which of these methods could be used (based on water depth, mangrove roots and debris entanglement, and recent evidence of estuarine crocodiles), and either a single or combination of sampling methods were employed in an attempt to provide an overall inventory of fish assemblage at each site.

Visual observations were also made at all sites with any additional species recorded. Where possible, a backpack electrofisher (Smith Root Model LR24) was used at freshwater sites with the entire waterhole surveyed (walked) or a subset of the waterhole (~100m) where it was too deep and long. We also deployed baited underwater cameras (Go Pros) in several locations (soak time up to 2hrs) to detect additional species present that conventional methods were not able to record.

Figure 2.3 Sampling sites (site codes - Bo, Boigu – see Appendix for raw data) visited at Boigu Island 16 to 19 June 2014

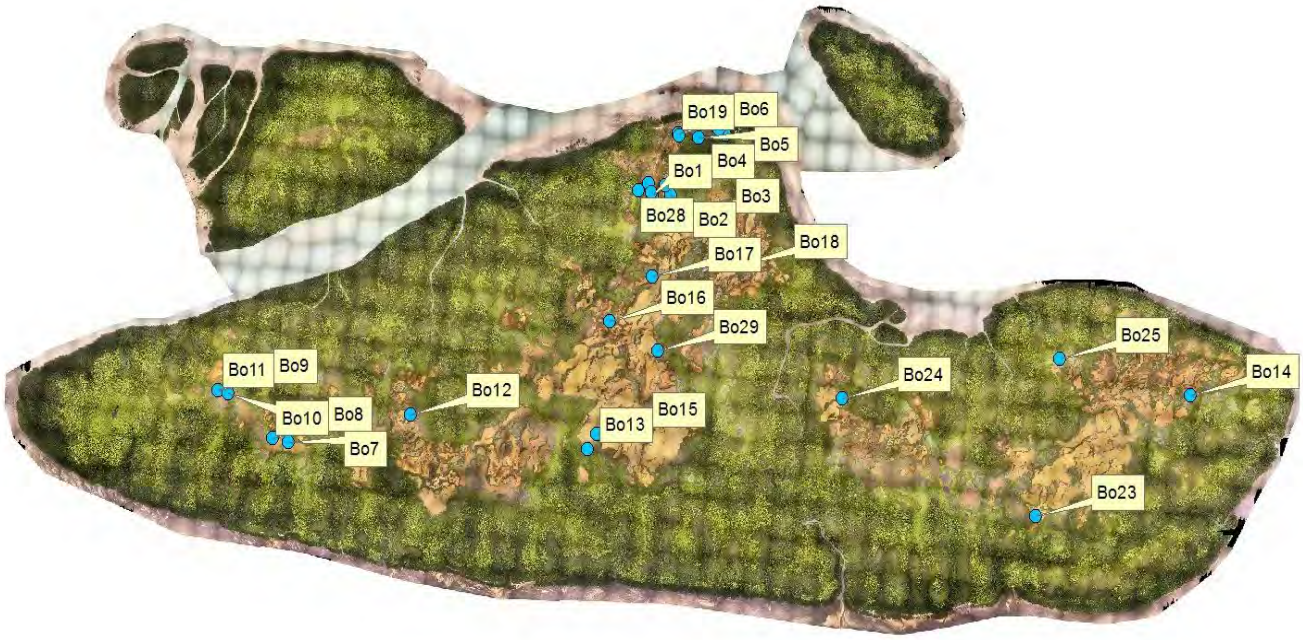


Figure 2.4 Sampling sites (site codes - S, Saibai – see Appendix for raw data) on Saibai Island visited 19 to 24 June 2014

Figure 2.5 Sampling sites (site codes - B, Badu – see Appendix for raw data) visited on Badu Island 24 to 26 June 2014

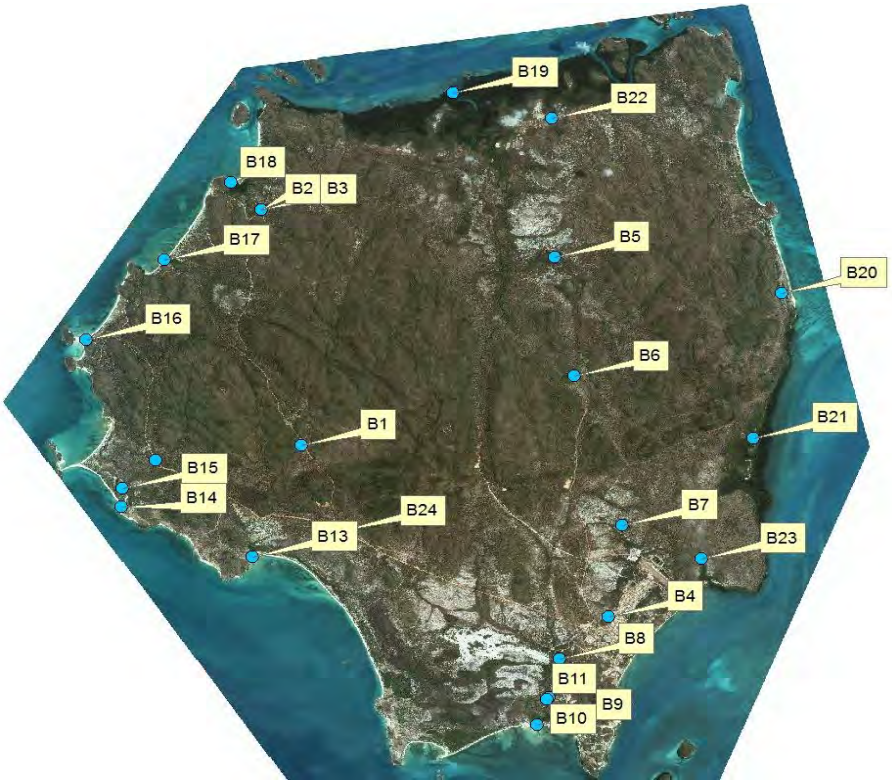


Figure 2.6 Sampling sites (site codes - M, Mabuiag – see Appendix for raw data) visited on Mabuiag Island 26 to 28 June 2014

Figure 2.7 TSRA Rangers using a cast net to catch fish

Figure 2.8 (a) Sampling using seine net along the wetland fringes; and (b) electrofishing in freshwater sites

a)

b)

Figure 2.9 Access to remote areas of Boigu and Saibai Islands was assisted with the use of an amphibian all-terrain vehicle and helicopter

2.4.2 Water Quality Sampling

Water quality was sampled using a calibrated QANTA multi-meter by holding the probe approximately 0.3m below the water surface (Figure 2.10). This probe measures temperature, conductivity, pH and dissolved oxygen. Dissolved oxygen, temperature and pH has very high spatial and temporal variability, to the point that spot readings, as presented here, should be viewed cautiously. The main purpose of water quality on this trip was to record conductivity (which is a measure of the salinity of the water). We surveyed conductivity in the wetlands and swamps, at most sites, in an attempt to provide some baseline data in case of future increased saline intrusion (e.g., under climate change/sea level rise scenarios). The conductivity of the water will influence fish communities living there, so this is also needed to interpret the fish sampling information.

Figure 2.10 Water sampling equipment (Badu Island near village)

2.4.3 Data Analysis

A range of general statistics have been applied to the data to provide an overall impression of the fish community, water quality and training extent during this field trip. Raw data is provided in the Appendix of this report for future comparison.

3 EDUCATION, TRAINING AND CAPACITY BUILDING

Ranger education and training will be very important in the on-going monitoring and reporting of new species, and also in continuing to work with the community to develop enough understanding around what invasive species are, what their impacts might be, and to not move fish species from one location to another. The community on each island, with knowledge and support from local TSRA Rangers, could become an important 'eyes and ears' in managing the spread of invasive species. During this field trip, a range of training and capacity building exercises were performed. These are discussed below.

3.1 School Visits

Presentations were delivered to school students from Prep through to year 4-7 on each island visited during this trip. During each presentation, team members from the Ranger program, TSRA and TropWATER presented an overview of the project, information on pest species, mechanism of dispersal and the problems caused by the spread, and some discussion on the key fish species targeted during this project.

During each school presentation, TropWATER staff brought into the classroom a live climbing perch (that had been caught during the field survey; even on Badu and Mabuiag islands). Bringing a live climbing perch to the classroom allowed students to see firsthand a live specimen. This had the added advantage of inspiring questions from the students including: 1) *Are they poisonous?*; 2) *What do they eat?*; 3) *What should I do if I catch a climbing perch?*; 4) *Where did they come from*; and 5) *Can we eat them*?

The school visits where an important and valuable component within this project. It provided the ideal opportunity to disseminate information on pest fish species. This had the positive effect in the broader community in that following the classroom presentations, the students (and their parents) in the following days approached TropWATER staff in the streets, asking more questions and whether more climbing perch had been caught. This connection with school students was a good outcome in spreading the project messages and raising general awareness and identification of pest fish. In addition, information fact sheets (see Appendix) were deposited at each school, and a colour photograph (A3) of a climbing perch, for students to continue referring to in the future.

The face-to-face meeting with the school students also had the impact of introducing (or reacquainted in some cases) students with the Island Rangers. This contact is important should students (and their families) find interesting aquatic plants and animals during their day-to-day activities. During school visits, we encouraged students to bring samples to the Rangers where they were not sure on the identification (though care when handling unknown plants and animals was stressed).

Ranger follow up presentations with the school students is encouraged. Empowering the community to become involved in the monitoring and management of environmental matters will assist with achieving the broader goals of island environment protection. It also, importantly, means that many people are actively looking and monitoring for (early) signs of invasive pests. In the case of pest fish species, because island families depend on the ocean for food sustenance, this means that their daily activities of gathering fish to consume can become an effective way of monitoring the fish community.

Figure 3.1 School talk delivered to Boigu Island Primary School (permission obtained from school to take these photos)

Figure 3.2 School talk delivered to Saibai Island Primary School (permission obtained from school to take this photo)

3.2 Ranger Training

The Rangers have a strong connection with the land and the sea, and this was evident during the trip where many interesting cultural stories were shared with TropWATER staff. This was particular useful during the field work where Rangers were able to guide TropWATER staff, or the helicopter pilot, to the most suitable location to undertake fish surveys.

The success of on-going pest fish management and control will be best achieved through the training of the Rangers. On each island, many hours each day were spent working and training the Rangers on fish identification, water quality, and fish and environmental protection more broadly. Ranges were given the opportunity to use a series of field sampling equipment including nets, traps and electrofishing procedures (Figure 3.4). Having two TropWATER staff had the advantage of spending more time with the Rangers, which allowed time to cover a greater number of sites whilst completing this training.

Working closely with the Rangers provided the chance to learn more about the environment on each island and, in particular, document anecdotal stories relating to fish. A summary of this account is provided below.

Boigu Island

The Rangers on Boigu Island seem to be aware of the consequences and threats of invasive fish species from PNG. Each Ranger could positively identify climbing perch (and snakeheads), presumably given that they had caught them personally on the island (except in the case of snakeheads where Rangers

had heard stories of this species or at least seen the TropWATER Pest Species Fact sheet previously). The Rangers described that climbing perch had been previously observed in the water bodies surrounding the island village, but also caught in nets during fishing trips to more distant areas of the island. The Rangers had previously captured three climbing perch in a small drain bund wall near the village, and had been keeping these individuals alive in a small esky (~5L) in their office for the seven months prior to our trip (November 2013 to June 2014). While the water had been regularly changed in the esky, the Rangers had not fed the fish at all, with each fish showing obvious signs of malnutrition (Figure 3.3). Given its proximity to PNG, Boigu Island seems likely to be at most risk of invasion of pest fish species from PNG. Of more concern will be the need to continually monitor and educate locals about the more significant threat of snakeheads reaching this island, given they are known to occur in the wetlands and coastal areas of PNG, just a few kilometres across the sea.

Figure 3.3 The three climbing perch captured November 2013 and kept in a small esky (without food) by the TSRA Rangers on Boigu Island (photo taken 18 June 2014)

Saibai Island

Rangers on Saibai Island were also aware of the threats of invasive fish species on their local fish species. Each Ranger could positively identify climbing perch (even snakeheads, which one Ranger had seen personally following trips to the adjoining villages of PNG). The Rangers described that climbing perch had been previously observed in the water bodies surrounding the main island village, in particular, the airport runway and the old water supply pond. The stories of climbing perch on the

airport tarmac many years ago were still mentioned in conversations with Rangers, though an event of that magnitude has not since been observed.

During the first day on the island, Rangers introduced TropWATER members to a Council member from a community on PNG, directly opposite to Saibai Island. This meeting was very important, as he raised concerns over the extent of pest fish species in the wetlands and coastal areas along PNG. This discussion was very interesting as the PNG local was using the scientific names to describe the pest species of concern – "Anabas" for climbing perch, "Channa" for snakeheads, both of which are correct. The local also expressed concerns over the spread of tilapia in coastal PNG, and the potential threat of them spreading to Saibai Island. When asked which species of tilapia (there are several possible candidates), however, the PNG local was not sure what species of tilapia. Of further interest, the PNG local also made the comment that Daru Island (70km to the north east of Saibai Island) has extensive populations of snakeheads and climbing perch in many wetland and coastal waters (no tilapia at this point however).

Badu Island

The Rangers on Badu Island are well respected by the local community and actively participate in training and education with the school students. The Rangers on this island were aware of climbing perch and snakeheads, though apparently had not seen live specimens (until seeing the live specimens collected on Boigu and Saibai Islands), but had seen pictures of them on the TropWATER fact sheets.

The rangers on this island were particularly interested to learn more about the local fish species caught during the field trip, with many interesting and inspiring conversations held between TSRA Rangers and TropWATER staff. Several freshwater waterholes were visited on the island, which provided the opportunity to demonstrate a range of field sampling equipment. Of most interest to the Rangers was the backpack electrofisher, which was suited to the freshwater conditions used on this island, unlike for Boigu and Saibai Islands where the higher salt content of the water negated the use of the electrofisher.

An interesting conversation on this island was that some local trading (bartering) with PNG occurs. It seems that PNG members canoe or drive boats to Badu Island to trade various products and goods. While this exchange has probably been occurring for some time, it seems important for Rangers here to ensure there is no movement of pest fish species to the island.

Mabuiag Island

Similar to Badu Island, the Rangers on Mabuiag Island are well respected by the local community and actively participate in training and education with the school students. The Rangers on this island were also aware of climbing perch and snakeheads, but again had not seen live specimens.

There are very few freshwater creeks and ponds on this island (see Figure 3.4), with the only reasonable freshwater bodies located near the airport, below the water supply pond and the wetland on the southern end of the island. For the most part, sites surveyed here were estuarine or marine, either along the small water body near the village, or on the northern side of the island where two small tidal channels drain the mangrove wetland area.

Figure 3.4 Training TSRA Rangers, and TSRA Land and Sea Team members

4 WETLAND ENVIRONMENTAL CONDITIONS

4.1 Wetlands

Overall the wetlands on all islands visited are in reasonable condition. From our visit, it seems that the range of freshwater and tidal wetlands function collectively as important habitat for many aquatic and land based animals, many of which are important food sources for locals on each island. The challenge is, therefore, in protecting and managing these unique ecosystems from not only pest species invasion, but also pollution, erosion, and climate change.

Both Boigu and Saibai Islands are virtually an entire wetland following the wet season (Figure 4.1). Both islands are relatively low lying, and therefore summer rains easily flood large areas on both islands. An assessment of the wetland flora and land based fauna has been completed previously by TropWATER (see Burrows and Perna 2009; Burrows 2010).

Figure 4.1 Example of the wet interior in June 2014: a) Boigu Island; b) Saibai Island

a)

b)

The wetlands on Badu and Mabuiag islands (Figure 4.2) are also in good condition, however, both islands are more elevated, and have more obvious freshwater habitats and smaller coastal estuaries are tidal that either drain completely during low tide, or exist as a locked coastal saltwater lagoon (Figure 4.2b). There has been no assessment of these wetland communities on both Badu and Mabuiag Islands, and a description of the wetland flora is recommended to increase the baseline ecological condition of these islands.

Figure 4.2 Example of wetland features on: a) Badu Island; and b) Mabuiag Island (June 2014)

a)

b)

Non-native animals and rubbish

Evidence of deer tracks were recorded on both Boigu and Saibai Islands (Figure 4.3). These animals can contribute to the damage of natural wetland areas, either through trampling directly on native vegetation or they can cause erosion and compaction of saltpan areas (via their walking trails) which form small drainage channels through the wetlands, which increases saltwater intrusion and scouring around mangrove roots and saltmarsh habitat.

Wild dogs were not observed during this field trip, however, a print was recorded on Boigu Island in the interior wetlands suggesting that either wild dogs exist on the island or this print was from a village dog. We did not observe any wild pigs during our trip, however, an active wild pig trapping program exists on Badu Island, which has been successful in reducing their numbers according to the Rangers.

Figure 4.3 Foot prints: a) deer; and b) dog on Boigu Island

a)

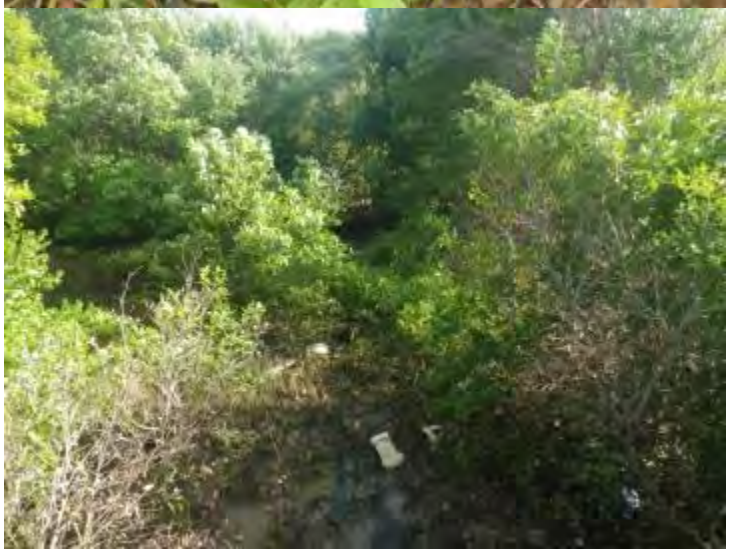
b)

The amount of human rubbish accumulating in the wetland areas was particularly obvious on Boigu Island (but occurs on all islands visited). This rubbish has been washed into the interior of the island on large tides or high seas, and has become lodged among the mangrove roots. The rubbish ranged from timber pallet planks, rubber mats, plastic bags and house hold plastic bottles (Figure 4.4). The source of the rubbish is unknown and may increase without some clean up, combined with management intervention. Measures needed to control local sources include public awareness and education, stowage of rubbish during trips into the wetland or preventing rubbish entering (washed during rainfall or wind) streets. It is also possible that this rubbish is arriving from afar, drifting into the wetlands during high tides, in which case, it will be difficult to determine the source and to manage it.

Figure 4.4 Example of house hold rubbish accumulating in wetland areas: a) Boigu Island; and b) Saibai Island

a)

b)



4.1.1 Water Quality

Water quality conditions on each island are summarised below in Table 4.1. Raw data for each individual site is presented in the Appendix. Several of the measured water quality parameters are known to change between day and night. For example, water temperature will vary considerable over the course of the day, with highest temperatures recorded usually after lunch and slowly cooling again over night. Oxygen and pH conditions can change between day and night in response to photosynthetic processes (algae and plants species).

Table 4.1 Summary water quality conditions recorded on each island. Water temperature (oC) is thermal levels in the water column, conductivity is extent of saltiness of the water (<0.1 is freshwater, 56mS/cm is marine), dissolved oxygen (DO) is the amount of oxygen available for fish to breath, and pH is the level of acidity/alkalinity of the water

Water quality parameter	Over	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
Number of samples	63	22	18	13	10
Water temperature (°C)					
Average	27.97	28.64	27.44	27.44	27.53
Minimum	24.45	26.20	25.08	25.41	24.25
Maximum	33.76	31.75	29.11	29.22	33.76
Conductivity (mS/cm)					
Average	25.95	28.53	25.48	22.42	21.11
Minimum	0.054	1.69	0.101	0.054	0.098
Maximum	65.50	65.50	56.80	41.70	21.11
DO (% saturation)					
Average	74.71	65.31	87.71	69.69	77.13
Minimum	11.60	11.60	21.20	14.50	14.50
Maximum	160.2	160.2	112.9	99.1	98.30
pH					
Average	7.40	7.40	7.55	6.85	7.54
Minimum	5.91	5.97	5.91	6.01	6.81
Maximum	9.79	9.79	9.44	7.89	8.17

Conductivity (salt levels in water) provides important information into the nature of the wetlands on each island. On all islands, sites ranged between freshwater (<2mS/cm) through to marine conditions (>50mS/cm; see Figures 4.5 to 4.8). The exception was Boigu and Saibai Islands (~ 60mS/cm) where hypersaline conditions were recorded (though fish were still recorded under these conditions). These conductivity conditions are not excessively high, and are a function of the evaporation of freshwater causing the salt to become concentrated. Given that both Boigu and Saibai Islands are of relatively low relief (flat), there is a risk of saltwater intrusion into underground freshwater aquifers (either as a result of sea level rise, or increasing tidal storm surges). The underground freshwater storage is important in providing water for terrestrial plants that are not capable of processing saltwater. Without access to freshwater, this vegetation would become stressed and not survive. At this stage, there were no major evidence to suggest the intrusion of saltwater into underground aquifers, however, this will require further surveillance. There were a number of aquatic freshwater sedges noted in the ponds surrounding the village on both Boigu and Saibai Islands, which have also been recorded previously (Burrows and Perna 2009; Burrows 2010).

On Saibai Island, several freshwater ponds (<2mS/cm) exist near the village, plus two more freshwater ponds in the centre of the island (Figure 4.6). Similar to Boigu Island, these freshwater ponds are important in that we caught freshwater rainbow fish in these ponds, plus also the long necked turtle (likely a descendant from PNG, though further DNA testing will confirm this). The loss of these freshwater ponds, either through draining, pollution or saltwater intrusion would be damaging to the island biodiversity. In the case of the two freshwater ponds in the island centre, we noticed a mud hole dug by local deer, which demonstrates that local wildlife are using these waterholes.

Figure 4.5 Conductivity (salinity) measured at sites on Boigu Island. Red (<2mS/cm), yellow (2-12mS/cm), light green (12-34mS/cm), dark green (34-44mS/cm), and dark blue (44-66mS/cm)

Figure 4.6 Conductivity (salinity) measured at sites on Saibai Island. Red (<2mS/cm), yellow (2-12mS/cm), light green (12-34mS/cm), dark green (34-44mS/cm), and dark blue (44-66mS/cm)

Figure 4.7 Conductivity (salinity) measured on Badu Island. Red (<2mS/cm), yellow (2-12mS/cm), light green (12-34mS/cm), dark green (34-44mS/cm), and dark blue (44-66mS/cm)

Figure 4.8 Conductivity (salinity) measured on Mabuiag Island. Red (<2mS/cm), yellow (2-12mS/cm), light green (12-34mS/cm), dark green (34-44mS/cm), and dark blue (44-66mS/cm)

4.1.2 Fish Assemblage

Overall effort

Cast nets were the main method used to sample the fish community on each island, with over 360 throws completed (Table 4.2). The seine net was also used on Boigu and Saibai Island, but not on Badu Island and Mabuiag Islands due to the nature of sites, most being too shallow, narrow or had obstructions (i.e., logs, rocks/boulders) that would reduce the efficiency of this sampling method. Snorkelling and electrofishing were used on Badu and Mabuiag Islands in place of the seine net, where conditions were deemed safe for use.

Table 4.2 Summary statistics of fishing effort on each island

Method	Boigu Island	Saibai Island	Badu Island	Mabuiag Island	Tot
Sites	30	25	24	13	92
Cast net	155	106	63	40	364
Seine net	2	54	-	-	54
Bait traps	3	4	3	3	13
Snorkelling	-	-	3	1	4
Electrofishing	-	-	7	2	9

Overall fish community

A total of 2,829 fish representing 45 species were caught during the June 2014 survey (Table 4.3). We recorded the highest number of fish species on Badu Island (1,103), owing to the dominance of rainbow fish which was caught in large numbers in several freshwater waterholes in the centre of the island. The least number of fish caught was on Mabuiag Island (233), presumably because of the limited extent of water ponds on the island. The most commonly caught species were the banded scat (Figure 4.9). Most of the fish species caught are estuarine (i.e., can tolerate freshwater and salt water), with the rainbow fish the only true freshwater species.

Figure 4.9 Banded scat, the most common fish species captured on most islands

In a study of the fish species occupying fresh and brackish waters in the Torres Strait islands, Hitchcock et al. (2012) reported 31 species from a range of recorded studies, including their own. With the addition of this study, the number of fish species now reported from fresh or brackish habitats has increased by an additional 18 species, to 49 species. All of these additional species have probably always been present, just not yet recorded, with each of the additional species typically a brackish species.

In addition to fish, we also caught several crustacean species (Figure 4.10). These species included the banana prawn in the tidal wetlands on Boigu and Saibai Islands, and the swamp crab (sample still to be identified by Queensland Museum), both of which are consumed by village locals on both islands. On Badu Island, we also caught a large number of freshwater swamp crayfish (*Cherex rhynchotus*), particularly in the freshwater wetlands behind the airport tarmac. We only caught this crayfish on Badu Island, however, it is also present on Moa Island (Aland, 2013).

Another crustacean caught on Badu and Mabuiag Islands was the freshwater crab (*Austrothelphusa angustifrons*). This freshwater crab species has been previously recorded on Horn Island (Peter Davie – pers. comm. QLD Museum). Little is known on this freshwater crab species (e.g. diet, reproduction). Rangers on Badu Island reported that this species has been found crawling under their homes, during the wet season. This species was dug up in dry creek channels on both Badu and Mabuiag Islands

during this survey, after their burrow openings were discovered. This species seems to estivate (hibernates) during the winter dry season, a trait that is consistent with other freshwater crab species in the family Austrothelphusa (Waltham et al. 2014).

Figure 4.10 Crustacean species caught during the field trip. (a) banana prawn; (b) swamp crab; (c) freshwater crayfish (recently moulted); and (d) freshwater crab

a)

b)

c)

d)

Overall, too few climbing perch were caught during this trip to complete any meaningful assessment of their diet (stomach content). Many more individuals would be necessary to complete this, and TropWATER will continue to retain specimens during future visits in order to complete this assessment.

We caught climbing perch on Boigu and Saibai Islands, similar to previous field surveys (Burrows and Perna 2009; Burrows 2010). On Boigu Island we caught a single specimen amongst the mangrove roots of the mangrove *Avicenna marina*, in a small pool in the centre of the island where conductivity was almost half marine water (35.1mS/cm). This individual was caught in a cast net, along with 22 banded scat, three yellowfin trumpeter and two pony fish (repeated throws of the cast net at this site did not result in catching additional climbing perch). We also caught two additional climbing perch (and observed a third) in the pond adjacent to the airport tarmac (conductivity 12.64mS/cm). These three individuals were observed at night, using a high powered spotlight, within about 50mins. These individuals were approximately 12cm (fork length), which are of a breading size.

We caught climbing perch on Saibai Island (17 individuals in total). Most were captured in an overflow breakout of a pond near the town water storage pond, while a single, much larger individual was also caught in the pond near the airport tarmac. All were caught using a seine net. No climbing perch were caught or observed on Badu or Mabuiag Islands.

Table 4.3 Total number fish caught for each species on each island

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Climbing perch (*Anabas testudineus*)	4	17	0	0
	Glass perch (*Ambassis agrammus)* Could be also *A. vachellii*	114	94	2	0
	Mouth almighty (*Glossamia aprion*)	11	0	0	0
	Freshwater longtom (*Strongylura krefftii*)	0	0	2	0

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Barramundi (*Lates calcarifer*)	13	4	4	0
	Bony bream *(Nematalosa sp.)*	12	0	0	0
	Milkfish *(Chanos chanos)*	1	4	2	1
	Silver ponyfish (*Gerres subfasciatus)*	57	10	74	15

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Banded scat (*Selenotoca multifasciata*)	351	105	8	30
	Butter bream (*Monodactylus argenteus)*	4	0	6	0
	Crescent perch (*Terapon jarbua*)	6	2	22	2

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Yellowtail trumpeter (*Amniataba caudavittata*)	88	103	56	83
	Pacific blue-eye (*Pseudomugil signifer*)	66	0	127	59
	Snub nosed garfish (*Arrhamphus sclerolepis*)	3	0	0	0
	Long nosed garfish (*Zenarchopterus sp.*)	11	0	4	0

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Catfish (*Neoarius leptaspis*)	23	1	0	0
	Mullet (*Mugil sp.)*	152	22	38	22
	Oxeye herring (*Megalops cyprinoides*)	43	11	11	2
	Rainbow fish *(Melanotaenia nigrans)* *(Melanotaenia splendida inornata)* *(Melanotaenia trifasciata)* (*Melantotaenia splendida rubrostriata)*	4 0 0 2	0 49 0 57	0 638 20 0	0 0 0 0

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Barred gudgeon (*Bostrichthys zonatus*)	0	1	1	0
	Marbeled eel (*Anguilla reinhardtii*)	0	0	4	0
	Pacific short-finned eel (*Anguilla obscura*)	0	0	2	1
	Archer fish (*Toxotes chatareus*)	0	0	6	0

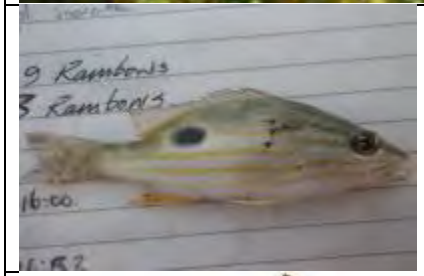
Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Sole (*Brachirus sp.)*	0	26	0	0
	Mangrove jack (*Lutjanus argentimaculatus*)	0	0	6	0
	Moses perch (*Lutjanus russelli*)	0	0	3	4
	Whiting (*Sillago sihama*)	10	0	1	1

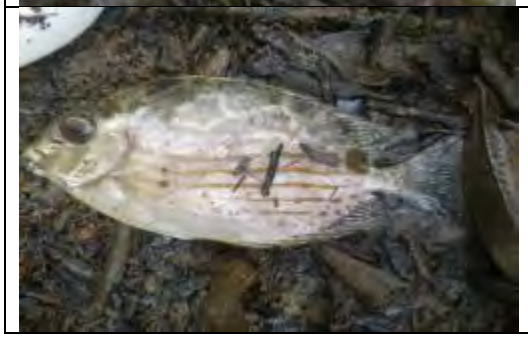
Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Estuary cod (*Epinephelus malabaricus*)	0	0	1	0
	Milk-spotted toadfish (*Chelonodon patoca)*	0	2	2	0
	Golden lined spinefoot (*Siganus lineatus*)	0	2	2	4

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Giant herring (*Elops hawaiensis*)	1	0	0	0
	New Guinea mudskipper (*Periopthalmus novaeguineaensis*)	3	0	0	9
	*Mugilgobius sp.*	0	0	13	0
	*Gobiidae sp.*	2	1	8	0

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Smooth flutemouth (*Fistularia commersonii*)	2	0	0	0
	Trevalley (*Caranx sp.*)	1	0	1	0
	Sea pike (*Sphyraena obtusata*)	2	0	1	0
	Freshwater crayfish (*Cherex rhynchotus*)	0	0	33	0

Photo of fish species	Species	Boigu Island	Saibai Island	Badu Island	Mabuiag Island
	Freshwater crab (*Austrothelphusa angustifrons*)	0	0	2	4
	Banana prawn *(Fenneropenaeus indicus)*	13	0	5	0
	Long neck freshwater turtle (*Macrochelodina rugosa* – to be confirmed)	0	4	1	0

5 ERADICATION AND MANAGEMENT OF PEST FISH IN TORRES STRAITS

5.1 Climbing Perch

The climbing perch has been recorded on several occasions in the Torres Straits. The first in 2006 on Saibai Island, and in surveys completed on Saibai in 2009 (Burrows and Perna 2009), Boigu Islands 2010 (Burrows et al, 2010), and again on Boigu and Saibai Islands in the present survey. The ongoing documentation of climbing perch on Boigu and Saibai Island suggests that populations have become established, and that the local village community on both islands have been living with this fish on their islands for many years. Pearce (2010) suggests that the population of climbing perch on Boigu and Saibai Islands seem to be centred around the freshwater waterholes surrounding the village, though in contrast to this, the data in the report here and in Burrows (2010) on Boigu Island suggests that climbing perch may reside more broadly, extending to the inner island wetland swamp where salinity is midway between freshwater and marine conditions.

The Pearce (2010) report outlines a series of eradication and control systems for climbing perch that could be considered, including benefits and problems with each. These systems include: poisoning waterholes, pumping them dry, trapping, netting, spearfishing, salinity changes, explosives, electrofishing and line fishing. Of these control systems, a focussed netting program might be the most practicable and effective method to at least eliminate a large number of climbing perch over a short period of time. In order to be successful, this focused netting program will need to be supported by ranger training, particularly given that this form of control will not initially remove fish small or the eggs of climbing perch. Repeated netting efforts will therefore be necessary to eventually have any chance of controlling numbers. The added advantage of a netting program (particularly following each wet season rainfall) is that any new invasive fish moving from PNG to Boigu and Saibai Islands will be detected early. The netting should focus on the more freshwater waterholes surrounding the villages following the wet season, and then extended to include waters in the central region of the islands as the dry season progresses and fish become more concentrated. A data sheet and location of sampling sites for this monitoring has been provided in the Appendix of this report.

An important feature of the present survey is that the invasion of climbing perch appears to be restricted to Boigu and Saibai Islands, and has not yet extended south to at least the islands surveyed here. While this may be the case, ongoing education of community and school students will be critical on all islands in the Torres Straits, to ensure that the community are well prepared with identification of local fish species, and understand the importance of reporting any unusually looking fish to rangers.

5.2 Other Invasive Fish Species

Despite the rapid spread of invasive freshwater fish species throughout PNG, in particular, the snakehead (*Channa striata)*, the climbing perch is the only recorded invasive species in the Torres Straits (excluding a single record of gambusia on Thursday Island; Burrows et al., 2010). The snakehead is a very hardy, highly invasive species that is also able to breathe from the air, and to survive long periods out of water or burrow in the mud (Courtenay and Williams, 2004). Negative impacts reported from the introduction of this species include excessive predation on fishes, including barramundi in PNG (J. Wani PNG Fisheries pers. comm.). An important component of the ongoing TSRA Ranger fish

surveillance program will be the early detection (and eradication) of snakeheads and other invasive fish species.

Another source of invasive fish introduction is through the selling of fish via aquarium industry. During this visit, the accommodation we stayed at on Horn Island had a series of large fibre glass tanks with a range of invasive fish species (including goldfish, gambusia, swordtails, guppies and platys; see Figure 5.1), which could easily escape if the tanks were emptied, or overflowed during the wet season, entering local waterways as stormwater. The trading of these fish species is legal, however, the community need to be aware of these fish escaping, or being released into the natural environment. Again, community education is the key and the release of aquarium fish is an important aquatic management issue on Horn, Thursday and Prince of Wales islands. The transient population on Thursday and Horn Island can be a major risk of aquarium fish releases into impoundments or natural waterways on these islands.

Figure 5.1 (a) open tanks in accommodation venue on Horn Island, (b) guppy from these tanks; and (c) sale of aquarium fish on Thursday Island

a)

b)

c)

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The islands and wetlands within the Torres Straits provide important habitat for many marine and freshwater fish and terrestrial species (e.g., reptiles and birds). Many of these wetlands are dynamic in response to the seasonal conditions experienced in the region. Summer rains create a large internal network of wetlands that provide habitat for many species. As the dry season takes hold, these wetland areas retract with animals either becoming more concentrated in the remaining waters, or they will need to migrate to new areas.

The wetlands visited were in relatively good condition. There was no major evidence of disturbance or erosion. The only noticeable signs of impacts were the presence of rubbish and debris in the wetland areas, particularly so on Boigu and Saibai Island, though also on Mabuiag Island.

There were some signs of scouring and trampling of wetland vegetation from deer on Boigu and Saibai Islands. These deer have been established on these islands for many decades. Management of the deer may be necessary in the future should the population increase.

This survey again showed populations of climbing perch on Boigu and Saibai Islands, and recorded a wider distribution than previous surveys. At present, there are no prospects for eradication of climbing perch on both these islands as the fish are likely to occur in many locations, most of which are very difficult to access as part of a control program (similar to spraying environmental weeds). While this survey was restricted to day sampling only, whereas previous trips included sampling at night (with success in recording climbing perch), we were still able to catch a small number of climbing perch on both islands. Despite being widespread on Boigu and Saibai islands, we did not find climbing perch to be abundant at any site.

When assessing the possible impact of an invasive species, it is important to examine the biology and ecology of the species. Little relevant information is known on climbing perch and their presence on these islands provides an opportunity to study this species. This could include their habitat and water quality tolerances, ecological preferences, diet and interaction with native species. TropWATER will continue researching this species, in an attempt to understand more about them. In the meantime, effort should be applied to conducting public education campaigns highlighting that these species are present and could be spread further (to islands further south in the Torres Straits, or to mainland Cape York). This campaign needs to target PNG villagers to not bring these species across to Torres Straits. Such a campaign would also target island rangers, AQIS and council officers, and other government staff and members of the public (e.g., recreational and professional fishers) to recognise the fishes of concern if they see them. The education and awareness campaign needs to have different messages for different audiences and to not create unnecessary fear in the community. It also needs to emphasise that the fish should not be spread further, and that any sightings should be reported to relevant authorities. Timely reporting of any unusual fish sightings is key to effective management responses and in this sense, all people in the region can act as 'eyes and ears' to help manage this threat.

We did not find any other invasive freshwater fish species during this trip. Of most concern is the possibility of snakeheads appearing in the Torres Straits, particularly given that this fish species occupies most coastal wetlands and inland freshwater areas of the PNG coastline, just a few kilometres across the sea from Boigu and Saibai Islands. This species is already known to be having a major impact on the PNG barramundi population. In many ways, the introduction of snakeheads to the Torres Strait islands would be of greater concern than climbing perch.

It was interesting to record the discussions with the PNG villager during our time on Saibai Island about the spread of pest fish. Clearly, education and communication with local village people will be critical in the management of invasive fish species, but also has the dual benefit of raising the community understanding and need for wetland care and protection. A program of continual education and discussions among village people must be on-going in order to be successful. Effectively, each village member can become part of the 'surveillance' program for invasive fish species.

6.2 Recommendations

A summary of the recommendations outlined in this report are provided below.

1/ Awareness and education

- **School visits** – the school visits and information provided to students and the school teachers are an important and effective method to engage with the local community and increase the number of community members observing environmental changes occurring in each island. It is recommended that Rangers and visiting TropWATER scientists regularly complete educational presentations to school students. Presentations could focus on different environmental themes, including water and marine environments. As part of this training and survey, a presentation will be generated which can be presented to school students (see Appendix);
- **Community** – a regular program of community discussions and presentations is recommended. Having the community involved and aware of the local environment means

also that the entire community are working together towards a shared outcome and vision. These discussions should also extend to include PNG visitors to the islands, and particularly so in the case of Boigu and Saibai Islands, where translocation of invasive fish aboard boats is a great risk given the proximity of PNG.

2/ Clean up plastics and other household rubbish from wetlands – an ongoing program of wetland clean up to remove plastics and other household rubbish from the wetlands on all islands is recommended. This is particularly evident within the villages on each island where plastics and general household rubbish has made its way into streets, wetlands and mangrove areas. Accumulation of these materials can have major impacts on the health and quality of each island ecosystem. The rubbish can also be mistakenly eaten by wildlife, contributing to illnesses and death of local fauna.

3/ Ranger field surveys – it is recommended that TSRA Rangers continue a surveillance program of fish sampling, using cast nets and spotlights, and recording the catch of animals at key sites across each island. This monitoring would become an early warning, should other invasive species (fish, cane toads etc.) arrive on each island, whereby management actions could be implemented quickly and effectively in controlling the invasion. A field sheet has been prepared (provided as separate document) with a small selection of sites for each island. These sites are chosen to be easily completed in a single day, and to provide an early warning for the invasion of freshwater fish species. Sampling at each site is recommended twice yearly: 1) following wet season; and 2) at the end of the dry season. All native fish captured will need to be returned to the water alive at the completion of each survey.

4/ Eradication – The ongoing Ranger field survey will provide the opportunity to not only survey fish species, but aid in eradication of climbing perch, where they can be immediately destroyed. While it is possible that the arrival of climbing perch is still possible from PNG (either via freshwater plume events or humans moving this fish from PNG to Torres Straits), ongoing surveillance for climbing perch would only assist in preventing continuing colonisation. It is specifically recommended that TSRA Rangers continue monitoring waters close to the island communities on Boigu and Saibai Islands, as a way of managing established populations. This monitoring should be completed immediately following the wet season, and continue several times across the dry season, removing and destroying any climbing perch collected and advising authorities of any new species recorded.

5/ Environmental DNA sampling - Supplementary to fish sampling, recent development of environmental DNA sampling in the TropWATER laboratories should be also included to assist in the early warning of invasive species. This method of assessing invasive species includes filtering water samples and examination of the target species DNA. Development of the primers for climbing perch, snakeheads and other invasive species (e.g. cane toads) is recommended. Once the primers have been developed at TropWATER, Rangers could continue collecting filtered water samples (with the appropriate equipment and training) and post the samples to TropWATER for analysis. This could become a regular monitoring program in the management of invasive pest species.

6/ Dry season fish survey on Boigu and Saibai Islands – given that during this field trip most of Boigu and Saibai Islands were underwater, making effective sampling difficult, a second follow up survey is recommended at the end of the dry season (~ November 2014) where most of the water would be retracted, and fish would be more concentrated in the small water regions. A dry season survey of fish communities was also recommended in the Burrows et al. (2009) report on Boigu Island, again to examine the fish community under conditions where they are less wide spread across the island.

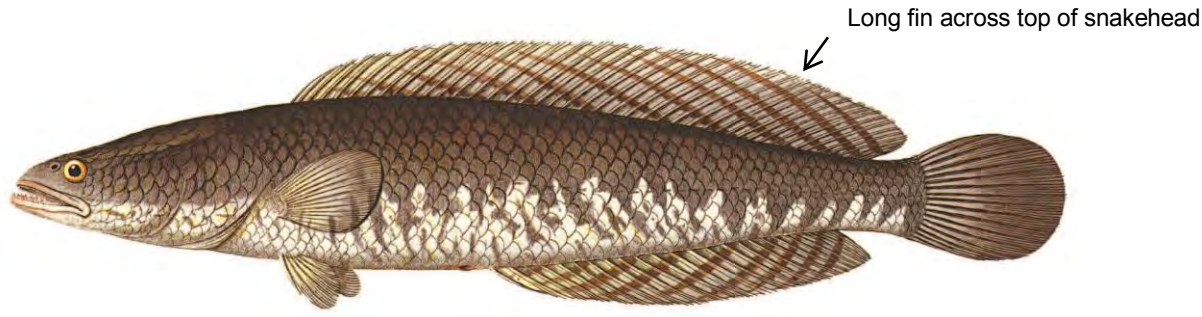
Under the dry conditions fish would be more easily caught (including climbing perch), thereby providing a greater understanding of the population size. Only Boigu and Saibai Islands are recommended here, as the risk of invasive fish species on Badu and Mabuiag Islands is probably low.

7/ New pest species records – any new pest species discovered in the Torres Straits should be lodged with the relevant government authorities. There are several ways to report new pest fish species:

- http://www.daff.qld.gov.au/fisheries/pest-fish/report-a-pest-fish-sighting
- Call Queensland Government, Department of Agriculture, Fisheries and Forestry – 13 25 23

Reporting new pest fish species is particularly important for the invasive snakehead (*Channa striata*), which is already occupying coastal freshwater and swamp areas along the PNG coast, just a few kilometres from Boigu and Saibai Islands. Should any fish resembling the snakehead (see picture below of this species, and pest fact sheet for photos), the fish should be destroyed immediately, and passed on to TSRA Rangers to freeze and to notify authorities. Rangers should continue working with the community to monitor for unfamiliar fish species.

Figure 6.1 Picture of snakehead. Most important feature is long fin across top of fish



8/ Long necked freshwater turtles – The chance recording of long necked turtles present on Saibai and Badu Islands was important in the overall conservation of freshwater habitats. The identification of this species is still to be confirmed, however, given they were found in freshwater highlights the importance of protecting these wetlands as freshwater ecosystems, particularly from invasive pest fish. Without these freshwater habitats, these turtles would be surely lost. Pressures on the freshwater ecosystems on both islands includes disturbance from human activities, water contamination, sea level rise and saltwater intrusion, overfishing, and loss of wetland vegetation margins from feral animals (e.g. feral pigs in the case of Badu Island). Further examination of this species and its habitat is necessary in order to protect this species from possible loss from the Torres Strait islands. It is recommended that if captured by locals, that the turtles are released immediately, alive, back into the wetland. Any future captures of freshwater turtles should be reported by to TSRA Rangers, where a photo should be taken to document the record.

9/ On-going monitoring of conductivity in island wetlands – This survey provided the first opportunity to examine the conductivity of waters across the islands visited. While conductivity ranged between essentially freshwater to marine, it highlights that there are a range of important aquatic habitats that exist in the Torres Strait Islands. Access to freshwater wetland habitat will be important for at least several species recorded during this survey. Access to freshwater is also important for use by locals, either for drinking or watering garden crops. Any changes to the hydrology of these wetlands, including from sea level rise and intrusion, could be reflected in changes in conductivity. Monitoring of conductivity should become a routine task for Rangers on all islands in the Torres Straits. This monitoring will provide a long term assessment and monitoring of conditions, and also an early warning in the event that conditions change. This water quality data could be stored on a database and reported each year as part of the on-going invasive fish sampling program.

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8 APPENDICES

8.1 Site Photos

Boigu Island

Water pond near airport and village – previously was source of drinking water for village

Same water pond, with baited fish trap set overnight

Catch of swamp crab in the baited fish trap

Large areas of the island were underwater following wet season rain and high tides

Ground view of wetland areas on Boigu Island

Barramundi caught in cast net

Climbing perch caught in inland swamps

TSRA Rangers fish sampling

Field sampling team on amphibious vehicle

Spotters observing for crocodiles

Sorting the catch with TSRA Rangers

Banded scats and Yellowfin trumpter

Seine drag net in pond near airport

Boigu Island state school class room

Boigu Island state school class

Deer tracks contributing to runnelling and erosion of saltpans

Saibai Island

TSRA Ranger throwing cast net in wetland

Large areas of the island centre are underwater

Ground view of swamp areas, filled with saltpan vegetation and hedges

Sampling large wetland areas

Healthy stand of mangroves

Island swamp crab (identification to be confirmed with Queensland Museum)

Major channel draining interior of the island. Many fish caught in this channel using cast net

Sampling internal wetlands on island

Freshwater pond in the centre of the island

Second freshwater pond nearby.

Rainbow fish (*M. s. inornata*) caught in freshwater pond

School class on Saibai Island following talk

Badu Island

Freshwater swamp area

Freshwater crayfish (recently moulted)

Small creek area common on Badu Island draining mangrove wetland area in background

Another small creek system

One of several freshwater creeks sampled during the field trip

Previous picture, looking downstream of rocky waterfall (~1m), tannin freshwaters flow to tidal creek downstream

Small freshwater creek

Underwater baited camera - tarpon

Underwater baited camera – rainbow fish

TSRA Rangers inspecting small estuary on northern side of island

Mabuiag Island

Freshwater pond adjacent to airport runway

Waterbody behind beach becomes tidal during storms and high seas

Sampling in small waterbody near village

TSRA Rangers undertaking seagrass monitoring

Waterlilly in freshwater pond near village

Stormwater drainage network in village

Freshwater land crab (*Austrothelphusa angustifrons*)

Healthy stand of mangroves

	
Tidal channel at low tide on northern side of island	TSRA Ranger holding freshwater crab moult

8.2 June 2014 - Raw Data

Boigu Island

Island	Site_Code	Latitude	Longitude	Temp (°C)	Cond (mS/cm)	DO (mg/L)	pH	DO (% saturation)	Fish Abundance	Fish species count	Anabas testudineus	Ambassis agrammus (vachelliii??)	Selenotoca multifasciata	Gerres subfasciatus	Megalops cyprinoides	Amniataba caudavittata	Terapon jarbua	Lates calcarifer	Pseudomugil signifer	Strongylura krefftii	Arrhamphus sclerolepis	Zenarchopterus sp	Neoarius leptaspis	Nematalosa sp.	Anguilla reinhardtii	Anguilla obscura	Glossamia aprion	Toxotes chatareus	Mugil sp	Brachirus sp	Monodactylus argenteus	Lutjanus argentimaculatus	Sillago sihama	Chanos chanos	Elops hawaiensis	Fenneropenaeus indicus	Lutjanus russelli	Melanotaenia nigrans	Melanotaenia splendida inornata	Melanotaenia trifasciata	Melantotaenia splendida rubrostriata	Chelonodon patoca	Siganus lineatus	Epinephelus malabaricus	Bostrichthys zonatus	Periopthalmus novaeguineaensis	Caranx sp	Fistularia commmersonii	Gobiidae sp	Mugilogobius sp	Sphyraena obtusata	Austrothelphusa angustifrons (crab)	Macrochelodina rugosa (turtle)	Cherex rhynchotus (freshwater crayfish)
Boigu	Bo1	-9.24026	142.2123						35	6	0	16	11	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo2	-9.24026	142.2148						11	2	0	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo3	-9.24202	142.216						20	5	0	9	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
	Bo4	-9.23908	142.214						13	5	0	0	2	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo5	-9.23348	142.2184	28.36	12.64	6.98	8.04	88.1	9	3	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
	Bo6	-9.23302	142.2158						12	5	0	0	6	2	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo7	-9.26918	142.1656	29.34	31.2	8.15	6.83	98.4	19	3	0	17	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo8	-9.26874	142.1636	30.41	33.8	8.42	9.79	160.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo9	-9.26309	142.1566	29.6	28	7.45	7.6	92.8	31	4	0	0	0	0	0	3	0	0	0	0	0	4	4	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo10	-9.26355	142.1579	31.75	37	7.53	5.97	65.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo11	-9.26355	142.1579	29.14	30.2	7.57	6.44	91.4	22	4	0	11	7	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo12	-9.26595	142.1813						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo13	-9.27	142.204	28.03	25.6	3.1	7.51	40.2	188	12	0	0	47	30	31	2	0	1	0	0	0	3	15	0	0	0	11	0	41	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
	Bo14	-9.26376	142.2815	26.67	33.6	4.08	6.6	57.2	52	4	0	0	10	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Bo15	-9.26822	142.2052	29.5	25.7	4.7	7.4	62.3	13	3	0	0	0	0	1	8	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo16	-9.25505	142.2069	30.6	28.2	7.9	7.7	113.1	28	3	0	0	8	0	1	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo17	-9.24983	142.2124	30.3	27.6	5.8	7.6	78.1	35	5	0	0	11	0	6	9	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo18	-9.24852	142.2235	28.5	24.2	4.8	7.5	65.3	37	8	0	0	20	6	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo19	-9.23332	142.2158	29.1	23.4	4.0	7.6	56.1	72	10	0	50	0	3	1	1	0	4	0	0	0	2	0	5	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
	Bo20	-9.23202	142.218	27.5	1.7	7.5	8.6	95.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo21	-9.23315	142.2218	26.6	31.5	2.4	6.3	31.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo22	-9.23257	142.221						16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo23	-9.27793	142.2617	27.9	32.6	4.5	6.9	53.6	60	6	0	0	30	0	0	20	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
	Bo24	-9.26411	142.2368	27.6	35.1	1.5	6.5	13.5	40	8	1	1	29	2	0	3	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo25	-9.25948	142.2647	28.4	49.3	2.1	6.7	29.4	22	4	0	0	9	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo26	-9.23885	142.2119	27.6	65.5	8.2	8.3	134.6	16	1	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo27	-9.23996	142.2122	27.0	33.0	3.8	8.1	50.1	117	3	0	0	105	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo28	-9.23975	142.2106	26.2	44.1	1.0	7.3	11.6	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bo29	-9.25848	142.2131	27.8	27.5	8.4	7.7	72.2	127	7	0	0	50	7	0	1	0	0	50	0	3	0	0	0	0	0	0	0	15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Saibai Island

Island	Site_Code	Latitude	Longitude	Temp (°C)	Cond (mS/cm)	DO (mg/L)	pH	DO (% saturation)	Fish Abundance	Fish species count	Anabas testudineus	Ambassis agrammus (vachellii??)	Selenotoca multifasciata	Gerres subfasciatus	Megalops cyprinoides	Amniataba caudavittata	Terapon jarbua	Lates calcarifer	Pseudomugil signifer	Strongylura krefftii	Arrhamphus sclerolepis	Zenarchopterus sp	Neoarius leptaspis	Nematalosa sp.	Anguilla reinhardtii	Anguilla obscura	Glossamia aprion	Toxotes chatareus	Mugil sp	Brachirus sp	Monodactylus argenteus	Lutjanus argentimaculatus	Sillago sihama	Chanos chanos	Elops hawaiensis	Fenneropenaeus indicus	Lutjanus russelli	Melanotaenia nigrans	Melanotaenia splendida inornata	Melanotaenia trifasciata	Melantotaenia splendida rubrostriata	Chelonodon patoca	Siganus lineatus	Epinephelus malabaricus	Bostrichthys zonatus	Periopthalmus novaeguineaensis	Caranx sp	Fistularia commmersonii	Gobiidae sp	Mugilogobius sp	Sphyraena obtusata	Austrothelphusa angustifrons (crab)	Macrochelodina rugosa (turtle)	Cherex rhynchotus (freshwater crayfish)
Saibai	S1	-9.39281	142.6346	27.7	0.2	6.9	7.7	86.6	35	4	16	9	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S2	-9.38175	142.6282	28.1	9.2	13.3	7.1	97.6	26	6	1	6	1	5	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S3	-9.38161	142.6278	28.6	20.2	6.2	7.7	83.7	7	4	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S4	-9.38156	142.6275	27.9	24.1	7.8	8.6	93.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S5	-9.39175	142.6603	25.8	6.6	7.1	8.0	88.9	67	8	0	20	6	0	0	18	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	1	0	0	0	4	0
	S6	-9.38306	142.6532	29.1	5.6	1.8	7.6	23.1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	S7	-9.39175	142.6365	27.9	0.1	8.0	9.4	98.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S8	-9.39378	142.6335	27.5	0.3	7.8	9.1	97.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S9	-9.37713	142.7693	25.1	40.0	6.1	6.6	83.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S10	-9.3851	142.7633	27.3	46.3	2.0	5.9	21.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S11	-9.39195	142.7475	27.5	42.4	7.9	7.1	112.9	83	8	0	16	27	1	0	21	0	1	0	0	0	0	0	0	0	0	0	0	4	12	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S12	-9.38014	142.7252	25.8	43.5	5.1	7.1	71.1	34	6	0	0	12	0	0	16	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
	S13	-9.38899	142.6906	28.3	47.8	7.1	7.7	108.5	32	6	0	0	2	2	0	9	0	2	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S14	-9.40812	142.6709	28.9	56.8	5.7	6.4	76.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S15	-9.40237	142.6158	27.1	47.7	4.2	7.0	62.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S16	-9.40708	142.6395	28.8	29.7	6.2	7.0	90.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S17	-9.3994	142.6583	27.0	0.3	6.5	8.1	79.6	35	2	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S18	-9.39168	142.6326						2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	S19	-9.38571	142.6338						66	3	0	23	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
	S20	-9.38388	142.6339						15	6	0	4	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	S21	-9.38116	142.6279						46	4	0	6	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
	S22	-9.38221	142.6256						17	3	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
	S23	-9.37748	142.6224	28.0	50.2	4.7	7.8	71.2	41	4	0	0	33	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S24	-9.3801	142.6258						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S25	-9.3801	142.6258						8	3	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0

Badu Island

Island	Site_Code	Latitude	Longitude	Temp (°C)	Cond (mS/cm)	DO (mg/L)	pH	DO (% saturation)	Fish Abundance	Fish species count	Anabas testudineus	Ambassis agrammus (vachellii??)	Selenotoca multifasciata	Gerres subfasciatus	Megalops cyprinoides	Amniataba caudavittata	Terapon jarbua	Lates calcarifer	Pseudomugil signifer	Strongylura krefftii	Arrhamphus sclerolepis	Zenarchopterus sp	Neoarius leptaspis	Nematalosa sp.	Anguilla reinhardtii	Anguilla obscura	Glossamia aprion	Toxotes chatareus	Mugil sp	Brachirus sp	Monodactylus argenteus	Lutjanus argentimaculatus	Sillago sihama	Chanos chanos	Elops hawaiensis	Fenneropenaeus indicus	Lutjanus russelli	Melanotaenia nigrans	Melanotaenia splendida inornata	Melanotaenia trifasciata	Melantotaenia splendida rubrostriata	Chelonodon patoca	Siganus lineatus	Epinephelus malabaricus	Bostrichthys zonatus	Periopthalmus novaeguineaensis	Caranx sp	Fistularia commmersonii	Gobiidae sp	Mugilogobius sp	Sphyraena obtusata	Austrothelphusa angustifrons (crab)	Macrochelodina rugosa (turtle)	Cherex rhynchotus (freshwater crayfish)
Badu	B1	-10.1276	142.1206	25.98	0.062	4.8	7.26	52.8	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B2	-10.0893	142.1148	25.41	0.057	3.52	6.86	37.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B3	-10.0893	142.1148	25.83	0.191	4.33	7.33	51	53	3	0	0	0	0	0	11	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
	B4	-10.1554	142.1654	25.88	0.054	5.89	7.89	58.9	67	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B5	-10.097	142.1575	27.67	0.054	4.32	7.85	52.7	45	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B6	-10.1164	142.1603	25.49	0.061	1.39	6.01	14.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B7	-10.1406	142.1674	25.63	0.057	1.75	6.36	17.4	16	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
	B8	-10.1623	142.1582	25.67	0.062	4.84	6.25	53.8	32	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
	B9	-10.173	142.1549	27.77	41.7	5.33	6.83	79.2	30	4	0	0	5	14	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B10	-10.1686	142.1567	26.58	0.063	4.42	7.05	55.1	112	3	0	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	71	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0
	B11	-10.1689	142.1563	27.76	0.778	5.75	6.36	73.4	14	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B12	-10.1301	142.0993	26.64	0.072	4.1	6.51	50.2	412	4	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	394	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
	B13	-10.1457	142.1134	29.22	39.9	6.56	7.16	99.1	37	10	0	2	0	13	0	6	1	0	3	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	B14	-10.1376	142.0943						11	3	0	0	0	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B15	-10.1346	142.0945						47	4	0	0	0	6	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
	B16	-10.1104	142.0891						11	5	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	5	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B17	-10.0975	142.1006						34	12	0	0	0	9	0	4	1	0	0	0	0	4	0	0	0	0	0	0	3	0	2	1	0	0	0	2	2	0	3	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0
	B18	-10.0849	142.1103						37	11	0	0	0	10	3	5	0	4	0	2	0	0	0	0	0	0	0	0	3	0	2	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	B19	-10.0703	142.1427						13	3	0	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B20	-10.1029	142.1906						85	4	0	0	0	10	0	0	20	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B21	-10.1264	142.1864						25	5	0	0	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B22	-10.0745	142.1571						3	3	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	B23	-10.146	142.1789						17	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	B24	-10.1415	142.1264						2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0

Mabuiag Island

Island	Site_Code	Latitude	Longitude	Temp (°C)	Cond (mS/cm)	DO (mg/L)	pH	DO (% saturation)	Fish Abundance	Fish species count	Anabas testudineus	Ambassis agrammus (vachellii??)	Selenotoca multifasciata	Gerres subfasciatus	Megalops cyprinoides	Amniataba caudavittata	Terapon jarbua	Lates calcarifer	Pseudomugil signifer	Strongylura krefftii	Arrhamphus sclerolepis	Zenarchopterus sp	Neoarius leptaspis	Nematalosa sp.	Anguilla reinhardtii	Anguilla obscura	Glossamia aprion	Toxotes chatareus	Mugil sp	Brachirus sp	Monodactylus argenteus	Lutjanus argentimaculatus	Sillago sihama	Chanos chanos	Elops hawaiensis	Fenneropenaeus indicus	Lutjanus russelli	Melanotaenia nigrans	Melanotaenia splendida inornata	Melanotaenia trifasciata	Melantotaenia splendida rubrostriata	Chelonodon patoca	Siganus lineatus	Epinephelus malabaricus	Bostrichthys zonatus	Periopthalmus novaeguineaensis	Caranx sp	Fistularia commmersonii	Gobiidae sp	Mugilogobius sp	Sphyraena obtusata	Austrothelphusa angustifrons (crab)	Macrochelodina rugosa (turtle)	Cherex rhynchotus (freshwater crayfish)
Mabuiag	M1	-9.94991	142.1957	27.4	0.1	8.2	6.8	92.0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M2	-9.94964	142.1956						3	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M3	-9.95894	142.1841						2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
	M4	-9.96065	142.1842	29.6	0.1	6.7	7.7	88.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M5	-9.96277	142.185	30.4	44.3	1.0	7.3	14.5	5	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M6	-9.95617	142.1896	27.1	53.0	5.0	7.8	77.6	46	8	0	0	4	14	0	21	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M7	-9.95821	142.188	28.6	46.0	6.2	8.2	98.3	46	6	0	0	25	1	0	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
	M8	-9.95163	142.1966	24.3	5.1	5.5	8.1	66.7	15	2	0	0	1	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M9	-9.95253	142.1945	24.3	53.7	1.2	7.5	19.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	M10	-9.9537	142.1881	24.6	0.2	4.6	8.1	54.8	22	2	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
	M11	-9.94645	142.1897	33.8	52.1	4.8	7.4	83.1	86	4	0	0	0	0	0	30	0	0	30	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
	M12	-9.94488	142.1879	32.4	55.7	5.3	7.9	87.6	12	4	0	0	0	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0

8.3 Ranger field sampling sheets

Boigu Island Wetland Sampling Sheet

Ranger name					Ranger name				
Site number	Site 1				Site number	Site 2			
Date					Date				
Time					Time				
GPS co-ords					GPS co-ords				
Conductivity mS/cm					Conductivity mS/cm				
Temperature ºC					Temperature ºC				
Time since last significant rain	today		1 to 6 days		Time since last significant rain	today		1 to 6 days	
	1 to 4 weeks		>1 month			1 to 4 weeks		>1 month	
Wind	no wind	light	medium	strong	Wind	no wind	light	medium	strong
Photo #					Photo #				
Notes					Notes				

Ranger name					Ranger name				
Site number	Site 3				Site number	Site 4			
Date					Date				
Time					Time				
GPS co-ords					GPS co-ords				
Conductivity mS/cm					Conductivity mS/cm				
Temperature ºC					Temperature ºC				
Time since last significant rain	today		1 to 6 days		Time since last significant rain	today		1 to 6 days	
	1 to 4 weeks		>1 month			1 to 4 weeks		>1 month	
Wind	no wind	light	medium	strong	Wind	no wind	light	medium	strong
Photo #					Photo #				
Notes					Notes				

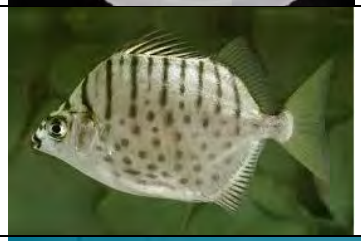
Saibai Island Wetland Sampling Sheet

Ranger name	
Site number	Site 1
Date	
Time	
GPS co-ords	
Conductivity mS/cm	
Temperature ºC	
Time since last significant rain	today / 1 to 6 days / 1 to 4 weeks / >1 month
Wind	no wind / light / medium / strong
Photo #	
Notes	

Ranger name	
Site number	Site 2
Date	
Time	
GPS co-ords	
Conductivity mS/cm	
Temperature ºC	
Time since last significant rain	today / 1 to 6 days / 1 to 4 weeks / >1 month
Wind	no wind / light / medium / strong
Photo #	
Notes	

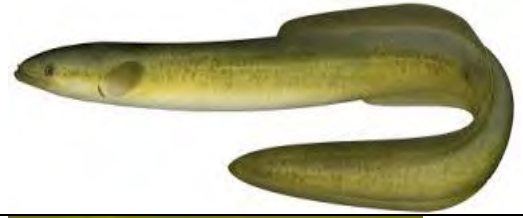
Ranger name	
Site number	Site 3
Date	
Time	
GPS co-ords	
Conductivity mS/cm	
Temperature ºC	
Time since last significant rain	today / 1 to 6 days / 1 to 4 weeks / >1 month
Wind	no wind / light / medium / strong
Photo #	
Notes	

Ranger name	
Site number	Site 4
Date	
Time	
GPS co-ords	
Conductivity mS/cm	
Temperature ºC	
Time since last significant rain	today / 1 to 6 days / 1 to 4 weeks / >1 month
Wind	no wind / light / medium / strong
Photo #	
Notes	

Aquatic animal name	Picture of fish	Features	Number caught
Mabal wapi Climbing perch		• Sharp gill cover and spines • Can walk on land • Greeny, dark colour • Small black dot on tail fin	
Karmuy Banded scat		• Black bands • Small mouth • Sharp painful spines • Silver colour	
Yalaithi Butter bream		• Yellow tips on fins • Silver colour • Large eye • Typically swims in schools	
Zaram Yellowtail trumpeter		• Black/yellow spots • Sharp spines • Black blotches on tail fin • Small fish	

Aquatic animal name	Picture of fish	Features	Number caught
Mabu Crescent perch		• Brown/yellow strips • Small fish	
Uzi Mouth almighty		• Large mouth • Solid bands • Mouth breeder, may contains eggs in mouth	
Watawat Wathawath Acher fish		• Black blotches • Large, up facing mouth • Fast swimmer	
Gawathaw Thup Pony fish		• Silvery colour • Small, downwards mouth • Typically swims in large school	
Parma Mangrove jack		• Red/black colours • Sharp teeth • Very aggressive • Sharp spines	

Aquatic animal name	Picture of fish	Features	Number caught
Batha Barramundi		• Can grow very large • Silver colour • Large tail fin • Sharp fins	
Bon-a-Bon Milkfish		• Narrow and elongated • Small mouth • Small fins	
Yamu Tarpon		• Large eye • Large mouth • Silver in colour	
Bug Fork tail catfish		• Whiskers under mouth • Sharp spines on back and underside • Large mouth	
Thawopay Bunal zaber Snub nosed garfish		• Extended lower jaw • Long thin fish • Large eye	

Aquatic animal name	Picture of fish	Features	Number caught
Koeykuthal Bunal zaber Long nosed garfish		• Very extended lower jaw • Long thin fish • Eye smaller than short nosed garfish	
Ngukiw thup Bony bream		• Small mouth • Scales removed easily when handled • Flesh very bony • Broad fish	
Dhaybi Marbled eel		• Long slender body • Large mouth • Moves like a snake • Long tail	
Dhoedhuwab wapi Rainbow fish		• Small fish, to 10cm • Colourful, reds, yellows, black • Small mouth • Typically freshwater species	

Aquatic animal name	Picture of fish	Features	Number caught
Malu Kuyup Blue eyes		• Small fish, to 5cm • Large blue eye • Tolerates very salty water	
Goebay Glass perch		• Clear small fish • Sharp spines • Small mouth	
Pakawiya Sea mullet		• Silver colour • Small mouth for size • Can swim in schools	
Barred grunter		• Black bands along body • Two fins along top of fish (unlike snakeheads which have single fin along top of fish) • Yellow marks along belly of fish	

Aquatic animal name	Picture of fish	Features	Number caught
Thanic Moses perch		• Sharp teeth • Yellow lines along fish • Black dot along back o fish	
Kupur Whiting		• Slender fish • Small mouth • Can swim in schools	
Kyaual Kurup Estuary cod		• Large mouth • Black bands and spots • Large tail, similar to barramundi • Found in tidal creeks and coral reef	
Malpal Sole		• Flat fish • Found over sand and muddy areas	

Aquatic animal name	Picture of fish	Features	Number caught
Gaygay Kubi Trevally		• Fast swimming fish • Sharp bones near tail • Large mouth and eye • Can swim in schools	
Pituy Mudskipper		• Fish skips over mud at low tide • Can be seen walking over mud • Eyes on top of head	
Tabu Goby		• Small fish found over mud and sand • Large mouth for size • Various colours	
Parsa Golden lined spinefoot		• Large eye • Yellow lines with black blotches along top of fish • Can be found in schools • Eats plants	
Mugaray Pike		• Sharp teeth • Long slender • Black bands • Extended mouth	

Aquatic animal name	Picture of fish	Features	Number caught
Thawur Longtom		• Sharp teeth • Long slender • Extended mouth	
Korenqa Puffer fish		• Small fish • Puffs up when caught • White spots	
Gawatha Githalay Swamp crab		• Found in mangroves • Sharp claws for catching prey • Hard shell on outside • Swimming and walking legs	
Kaguy Banana prawn		• Hard shell • Many smaller walking legs • Long antennae • Large eye on top of head	
Koby Freshwater turtle		• Freshwater turtle • Long neck • Walking legs with claws, which is different to ocean turtle • Hard outer shell • Found in freshwater	

Aquatic animal name	Picture of fish	Features	Number caught
Gagi Freshwater crayfish		• Large, sharp front claws • Hard outer shell • 6 small walking legs	
Ngukiwur gethalay Freshwater crab		• Large claws for catching prey • Land based animal though found in water • Hard outer shell • Bright orange claws on males	

Badu Island Wetland Sampling Sheet

Ranger name				
Site number	Site 1			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today		1 to 6 days	
	1 to 4 weeks		>1 month	
Wind	no wind	light	medium	strong
Photo #				
Notes				

Ranger name				
Site number	Site 2			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today		1 to 6 days	
	1 to 4 weeks		>1 month	
Wind	no wind	light	medium	strong
Photo #				
Notes				

Ranger name				
Site number	Site 3			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today		1 to 6 days	
	1 to 4 weeks		>1 month	
Wind	no wind	light	medium	strong
Photo #				
Notes				

Ranger name				
Site number	Site 4			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today		1 to 6 days	
	1 to 4 weeks		>1 month	
Wind	no wind	light	medium	strong
Photo #				
Notes				

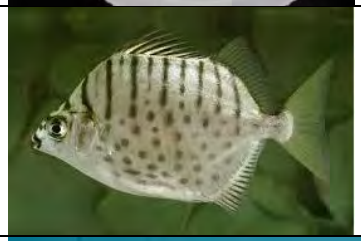
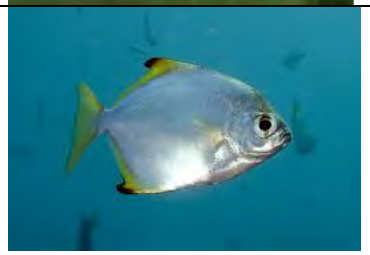
Mabuiag Island Wetland Sampling Sheet

Ranger name				
Site number	Site 1			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today	1 to 6 days		
	1 to 4 weeks	>1 month		
Wind	no wind	light	medium	strong
Photo #				
Notes				

Ranger name				
Site number	Site 2			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today	1 to 6 days		
	1 to 4 weeks	>1 month		
Wind	no wind	light	medium	strong
Photo #				
Notes				

Ranger name				
Site number	Site 3			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today	1 to 6 days		
	1 to 4 weeks	>1 month		
Wind	no wind	light	medium	strong
Photo #				
Notes				

Ranger name				
Site number	Site 4			
Date				
Time				
GPS co-ords				
Conductivity mS/cm				
Temperature ºC				
Time since last significant rain	today	1 to 6 days		
	1 to 4 weeks	>1 month		
Wind	no wind	light	medium	strong
Photo #				
Notes				

Aquatic animal name	Picture of fish	Features	Number caught
Climbing perch		• Sharp gill cover and spines • Can walk on land • Greeny, dark colour • Small black dot on tail fin	
Karrmui Banded scat		• Black bands • Small mouth • Sharp painful spines • Silver colour	
Butter bream		• Yellow tips on fins • Silver colour • Large eye • Typically swims in schools	
Zarram Yellowtail trumpeter		• Black/yellow spots • Sharp spines • Black blotches on tail fin • Small fish	

Aquatic animal name	Picture of fish	Features	Number caught
Bathu buth Crescent perch		• Brown/yellow strips • Small fish	
Mouth almighty		• Large mouth • Solid bands • Mouth breeder, may contains eggs in mouth	
Archer		• Black blotches • Large, up facing mouth • Fast swimmer	
Pony fish		• Silvery colour • Small, downwards mouth • Typically swims in large school	
Mangrove jack		• Red/black colours • Sharp teeth • Very aggressive • Sharp spines	

Aquatic animal name	Picture of fish	Features	Number caught
Bartha or Meun Barramundi		• Can grow very large • Silver colour • Large tail fin • Sharp fins	
Kubi Milk fish		• Narrow and elongated • Small mouth • Small fins	
Yam Tarpon		• Large eye • Large mouth • Silver in colour	
Boug Folk tail catfish		• Whiskers under mouth • Sharp spines on back and underside • Large mouth	
Muduth Snub nosed garfish		• Extended lower jaw • Long thin fish • Large eye	

Aquatic animal name	Picture of fish	Features	Number caught
Zaberr Long nosed garfish		• Very extended lower jaw • Long thin fish • Eye smaller than short nosed garfish	
Bony bream		• Small mouth • Scales removed easily when handled • Flesh very bony • Broad fish	
Goerr Marbled eel		• Long slender body • Large mouth • Moves like a snake • Long tail	
Rainbow fish		• Small fish, to 10cm • Colourful, reds, yellows, black • Small mouth • Typically freshwater species	

Aquatic animal name	Picture of fish	Features	Number caught
Blue eyes		• Small fish, to 5cm • Large blue eye • Tolerates very salty water	
Glass perch		• Clear small fish • Sharp spines • Small mouth	
Makerr Sea mullet		• Silver colour • Small mouth for size • Can swim in schools	
Kanawai Barred grunter		• Black bands along body • Two fins along top of fish (unlike snakeheads which have single fin along top of fish) • Yellow marks along belly of fish	

Aquatic animal name	Picture of fish	Features	Number caught
Tanik Moses perch		• Sharp teeth • Yellow lines along fish • Black dot along back o fish	
Kupurr Whiting		• Slender fish • Small mouth • Can swim in schools	
Kurrup Estuary cod		• Large mouth • Black bands and spots • Large tail, similar to barramundi • Found in tidal creeks and coral reef	
Malpal Sole		• Flat fish • Found over sand and muddy areas	

Aquatic animal name	Picture of fish	Features	Number caught
Gai Gai Trevally		• Fast swimming fish • Sharp bones near tail • Large mouth and eye • Can swim in schools	
Mudskipper		• Fish skips over mud at low tide • Can be seen walking over mud • Eyes on top of head	
Goby		• Small fish found over mud and sand • Large mouth for size • Various colours	
Azam Golden lined spinefoot		• Large eye • Yellow lines with black blotches along top of fish • Can be found in schools • Eats plants	
Mugari Pike		• Sharp teeth • Long slender • Black bands • Extended mouth	

Aquatic animal name	Picture of fish	Features	Number caught
Baiag Longtom		• Sharp teeth • Long slender • Extended mouth	
Mokan Puffer fish		• Small fish • Puffs up when caught • White spots	
Gethalai Swamp crab		• Found in mangroves • Sharp claws for catching prey • Hard shell on outside • Swimming and walking legs	
Banana prawn		• Hard shell • Many smaller walking legs • Long antennae • Large eye on top of head	
Kobi Freshwater turtle		• Freshwater turtle • Long neck • Walking legs with claws, which is different to ocean turtle • Hard outer shell • Found in freshwater	

Aquatic animal name	Picture of fish	Features	Number caught
Karg Freshwater crayfish		• Large, sharp front claws • Hard outer shell • 6 small walking legs	
Goetti Freshwater crab		• Large claws for catching prey • Land based animal though found in water • Hard outer shell • Bright orange claws on males	

8.4 Addendum : Community presentations and fish survey - December 2014

8.4.1 Introduction

The Torres Strait Regional Authority (TSRA) engaged TropWATER (Centre for Tropical Water and Aquatic Ecosystem Research), James Cook University, to present the results of the June 2014 survey to the community and school students on Boigu and Saibai Islands, and to complete a late dry season fish survey in the remaining waterholes on both islands. This was a recommendation following the June 2014 survey. This field trip was completed between 1 and 5 December 2014. This section provides a summary of the results as an addendum to the June 2014 data.

8.4.2 Community and Student presentations

Presentations were delivered to the community and school students on each island during this trip. (The exception was the Boigu Island community presentation which did not proceed as it was cancelled by TSRA staff on the trip). During presentations, Rangers, TSRA and TropWATER presented an overview of the June 2014 survey, information on pest species, mechanism of dispersal and the problems caused by the spread, and some discussion on the key fish species targeted during this (Figure 8.4.1). The community presentations also provided the opportunity to learn more on the range of fish caught in the wetlands on both islands. These presentations were very effective in the dissemination of information back to the community, and will require further follow up presentations and discussions, so that the messages remain on the community mind when they are traveling around the islands.

Figure 8.4.1 (a) Community, and (b) school talks were completed on both islands to present the results of June 2014 survey. It also provided the opportunity to spread the key message of pest fish invasion (permission obtained from school to take these photos)

a)

b)

8.4.3 Site Descriptions and Sampling

The sampling equipment utilised during the December field trip was similar to the June 2014 (the exception was the use of a smaller seine drag net during this trip owing to the smaller sized waterholes encountered). The main difference compared to the June 2014 survey was that many of the waterholes and wetland areas were dry, and therefore only a limited number of sites were visited on both islands. On both islands, however, several of the same waterholes examined during June 2014 where revisited during the December 2014 survey (see Figure 8.4.2).

Figure 8.4.2 Boigu Island sampling sites: red June survey, blue December 2014 survey. Bo30 new site in addition to June 2014 survey

Figure 8.4.3 Saibai Island sampling sites: red June survey, blue December 2014 survey (S27 – S33 new sites in addition to June 2014 survey)

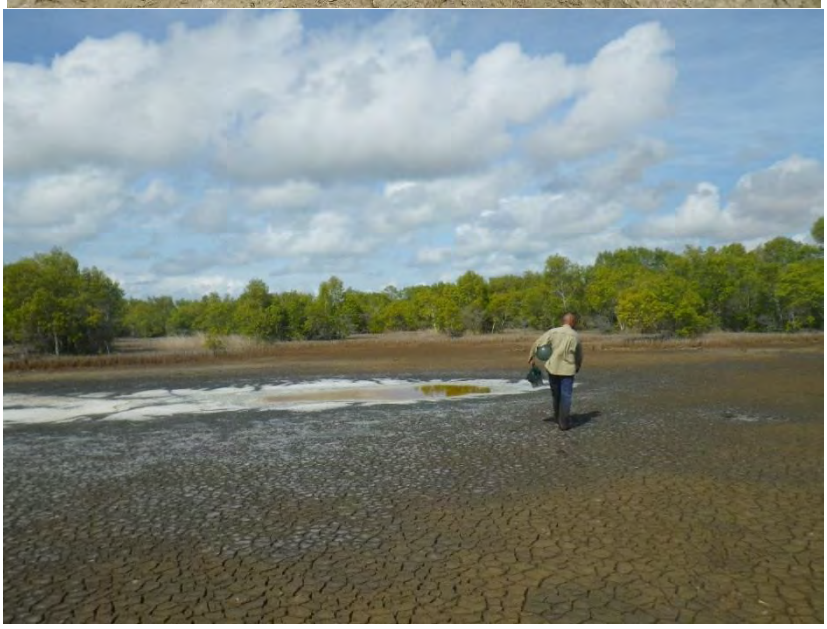
8.4.4 Wetland Environmental conditions

The most obvious difference in the wetlands between June and December on both islands was a distinct lack of water available for sampling, with nearly all the wetland areas present in June now dry in December. In several areas on Boigu Island, previously extensive wetland areas surveyed had dried completely, which led to the entrapment of fish. (Each fish found decomposing was inspected for the presence of climbing perch in their mouth or throat; no climbing perch were found). For the remaining wetland areas, the water was very salty, up to approximately twice that of seawater (Figure 4.4.1b).

Figure 8.4.4 Example of the interior wetlands in December 2014

a)

b)



8.4.5 Water Quality

Water quality was measured at all sampling sites using the same equipment as used in the June survey. A summary of the data is provided in Table 8.4.1.

Table 8.4.1 Measured water quality on Boigu and Saibai Islands. Water temperature (°C) is thermal level in the water column, conductivity is extent of saltiness of the water (<0.1 is freshwater, 56mS/cm is marine), dissolved oxygen (DO) is the amount of oxygen available for fish to breath, and pH is the level of acidity/alkalinity of the water. Numbers in parentheses are for June 2014

Water quality parameter	Boigu Island	Saibai Island
Number of sites	5 (22)	15 (18)
Water temperature (°C)		
Average	34.50 (28.64)	34.08 (27.44)
Minimum	31.48 (26.20)	29.04 (25.08)
Maximum	36.65 (31.75)	38.05 (29.11)
Conductivity (mS/cm)		
Average	56.21 (28.53)	43.49 (25.48)
Minimum	2.48 (1.69)	0.388 (0.101)
Maximum	96.30 (65.50)	99.50 (56.80)
DO (% saturation)		
Average	54.48 (65.31)	74.61 (87.71)
Minimum	21.10 (11.60)	5.3 (21.20)
Maximum	94.50 (160.2)	159.3 (112.9)
pH		
Average	7.58 (7.40)	8.18 (7.55)
Minimum	6.75 (5.97)	6.61 (5.91)
Maximum	8.37 (9.79)	9.88 (9.44)

Water temperature was higher in this survey than compared to the June survey. This is a consequence of the warmer summer conditions experienced at this time of year. Conductivity (salt levels in water) was generally higher in wetland areas visited owing to the accumulation of salts in the wetlands as they retract during the dry season. Concentrations were recorded over 90mS/cm which is considerable higher than marine water conditions (~56mS/cm). Even under these conditions, though in fewer numbers and diversity, fish were still present. Several of the freshwater waterholes examined in June on Saibai Island were still present in December. These freshwater holes function as important refugia for freshwater fish (e.g., rainbow fish) and the freshwater turtle.

The available oxygen content in the wetlands was generally lower during this survey compared to the June survey. This is probably a combination of the presence of oxygen consuming algae and bacteria that assist in the decomposition of plant material. The low concentrations are also related to limited exchange of water from tidal channels and the sea.

pH was generally within the range that would be expected in wetland areas, ranging between 6 and 10.

8.4.6 Fish Assemblage

Cast nets were again the main sampling method used on each island with 97 throws completed (Table 8.4.2). In addition, the seine net was also used along with the back pack electrofisher in several freshwater holes on Saibai Island.

Table 8.4.2 Summary statistics of fishing effort on each island. (*) Electrofishing effort totals (~15mins – 5mins at S1, and 10mins at S32)

Method	Boigu Island	Saibai Island	Total
Sites	6	15	21
Cast net	28	69	97
Seine net	-	2	2
Electrofishing *	-	2	2

A total of 513 fish representing 20 species (including the long neck freshwater turtle on Saibai Island) were caught during the December survey (Table 8.4.3). Unlike the June survey were the banded scat was the most common species, the climbing perch was the most common owing to the high number of individuals caught in a disused water well on Saibai Island (Figure 8.4.2). In this small water well (approximately 3m diameter and 0.5m deep), we removed 137 climbing perch by dragging the cast net through the water. The conditions in this waterhole were poor with high water temperature (35.3^{o}C) and critically low available oxygen (5.3%). Another climbing perch was captured in a waterhole near the airport landing strip on Saibai Island. At that site, water quality conditions were, again, poor with oxygen critically low (5.7%), though interestingly conductivity was high (70.7mS/cm); the highest recorded condition for climbing perch based on the available literature.

Table 8.4.3 Summary of fish caught on Boigu and Saibai Islands. (*) refers to dead fish specimens captured

Fish	Boigu Island	Saibai Island
Climbing perch (*Anabas testudineus*)	0*	138*
Glass perch (*Ambassis sp.*)	20	5
Banded scat (*Selenotoca multifasciata*)	11	14
Spotted scat (*Scatophagus argus*)	1	-
Pony fish (*Gerres subfaciatus*)	10	24
Pony fish (*Gerres filamentosus*)	1	3
Oxeye herring (*Megalops cyprinoides*)	-	7
Yellowfin trumpeter (*Amniataba caudavittata*)	51	38
Barramundi (*Lates calcarifer*)	5	1
Pacific blue eye (*Pseudomugil signifier*)	20	23
Long-nosed garfish (*Zenarchopterus sp.*)	3	-
Bony bream (*Nematalosa sp.*)	-	1
Eel (*Anguilla reinhardtii*)	-	1
Mullet (*Mugil sp.*)	-	7
Sole (*Brachirus sp.*)	-	8
Rainbow fish (*Melanotaenia splendida inornata*)	-	68
Golden-lined spinefoot (*Siganus lineatus*)	-	3
Mudskipper (*Periophthalmus novaeguineaensis*)	-	20
Goby (undetermined Gobidae sp.)	20	9
Long neck freshwater turtle (*Macrochelodina rugosa*)	-	1
Total	**142**	**371**

Unlike in June, we recorded the dried remains of climbing perch near several waterholes on both islands (Figure 8.4.3). In its native range, this species is reported to estivate during dry conditions, digging holes in the mud to remain until the next wet season rain. We had planned to dig up parts of these dried wetlands, however, each wetland site had been recently refilled following spring high tides and rainfall, and we were therefore not able to test this observation.

Figure 1.4.5 Disused water well on Saibai Island where 137 climbing perch were removed

Figure 1.4.6 Remains of climbing perch in freshwater wetland well on Saibai Island

We did not catch climbing perch on Boigu Island during this field trip, even in the large waterhole near the airport landing strip where we had previously caught them at night using spotlights. The fact we did not catch them this trip may suggest an absence, though more likely this is a reflection of the daytime sampling in comparison to night time spotlighting which has been successful previously. We did, however, catch in the cast net the dried remains of climbing perch at a wetland site where Boigu Rangers had caught 200 climbing perch about six weeks prior to our visit (Figure 4.4.7). This, along with the high density of climbing perch in the disused waterhole on Saibai Island, demonstrates the plasticity of climbing perch to deal with the water quality vagaries experienced in the Boigu and Saibai Islands (e.g., dissolved oxygen, overcrowding, high water temperature and high conductivity). The

data collected this late in the dry season shows the ability to adapt to available habitat with conditions here well outside that reported in the literature.

During this trip, we recorded a new fish species that has not been previously recorded on Boigu Island (Figure 4.4.8). This species, the spotted scat (*Scatophagus argus*), was caught in a waterhole adjacent to the air landing strip. This species is common to mangrove areas but can also be found in lower freshwater regions of northern Australia.

Figure 1.1.7 Wetland area on Boigu Island were over 200 climbing perch were caught Rangers approximately six weeks prior to our trip. We caught several dried climbing perch remains in the cast net, confirming reports by the Rangers (66.7mS/cm)

Figure 1.4.8 Spotted scat, a new recording for Boigu Island (11cm total length)

8.4.7 Conclusions and Recommendations

The late dry season survey provided the opportunity to examine fish assemblage in the wetlands on both these islands. Climbing perch exist in a range of wetland areas on both islands, and in large numbers. The range of water quality conditions measured where climbing perch were present has not been previously documented. For example, climbing perch were recorded in waterholes with very high conductivity conditions, well beyond that which has been previously considered. The opportunity to examine the fish community during the late dry season has provided important additional data in our understanding of climbing perch physiology and ecology.

The data here suggests that the late dry season wetlands support a very limited number and diversity of fish species when compared to the June survey, and that this is probably expected given the harsh water quality conditions presented. The most obvious is the hypo-saline conditions and trapping of fish in drying wetlands, until the summer rain and high tides again replenish the internal wetland network on both islands.

On Saibai Island several freshwater waterholes remain and function as critical freshwater habitat for the rainbow fish and freshwater long neck turtle. These waterholes are also an obvious watering point for invasive deer, and fencing access to these freshwater wetlands would protect them from further impact. This is particularly important for the freshwater turtle that utilises the soft banks to lay their eggs below the water surface. As water levels recede during the dry season, the eggs get exposed, whereby eggs on the water edge could be trampled by deer as they access the waterholes.

Other than climbing perch, we did not catch any other invasive fish species known to exist in Papua New Guinea. Discussions with community members on Saibai Island during the presentations, however, revealed stories that maybe these invasive species have in fact been present. Whether these observations by community are factual is unclear, however, it highlights the importance of on-going education and engagement with the community in controlling spread of invasive species from Papua New Guinea. Further routine surveys are recommended along with the use of advancements in the detection of invasive species using genetic technologies (e.g. environmental DNA – see www.jcu.edu.au/tropwater).

Raw Data for December 2014

Dec 2014Site	Sampled June 2014	Latitude	Longitude	Water Temp (oC)	Conductivity ms/cm	Dissolved oxygen (mg/L)	pH	Dissolved Oxygen (%)	Abundance	Sp. Count
S26		-9.38188	142.6126	35.31	0.729	0.59	7.12	5.3	137	1
S27		-9.38679	142.6166	36.05	99.5	5.44	8.78	121.7	0	0
S28		-9.38134	142.6278	38.05	92.5	3.06	7.79	62.7	33	3
S3	Y	-9.38171	142.6278	32.95	24.6	6.92	8.3	104.7	15	13
S4	Y	-9.38174	142.6275	31.12	36.5	8.1	8.42	117.1	56	3
S29		-9.38037	142.6278	36.09	90.2	7.78	8.16	159.3	17	15
S30		-9.3819	142.6258	29.04	70.7	0.44	7.99	5.7	1	1
S31		-9.37958	142.636	35.42	78.7	2.78	6.61	51.2	0	0
S8	Y	-9.39396	142.6336	35.51	0.388	0.85	9.88	8.3	0	0
S7	Y	-9.39208	142.6368	37.8	0.415	7.6	8.54	113.9	2	2
S1	Y	-9.39315	142.635	30.19	0.29	6.65	8.77	96.1	8	3
S15	Y	-9.40212	142.6169	32.44	83.6	4.52	8.15	38.6	0	0
S32		-9.38138	142.635	31.58	0.482	6.52	7.64	78.3	23	4
S17	Y	-9.3994	142.6583	36.6	0.446	6.13	8.9	87.1	48	5
S33	Y	-9.38082	142.6186	33.18	73.3	3.89	7.62	69.1	31	6
Bo18	Y	-9.24854	142.2235	35.01	88.5	2.36	7.65	50.2	0	0
Bo13	Y	-9.27033	142.2037	36.14	96.3	1.53	6.74	26.1	0	0
Bo30		-9.23941	142.2179	36.65	66.7	1.17	7	21.1	0	0
Bo5	Y	-9.23377	142.2184	33.24	27.1	4.24	8.15	80.5	138	8
Bo20	Y	-9.23225	142.2176	31.48	2.48	7.24	8.37	94.5	4	4

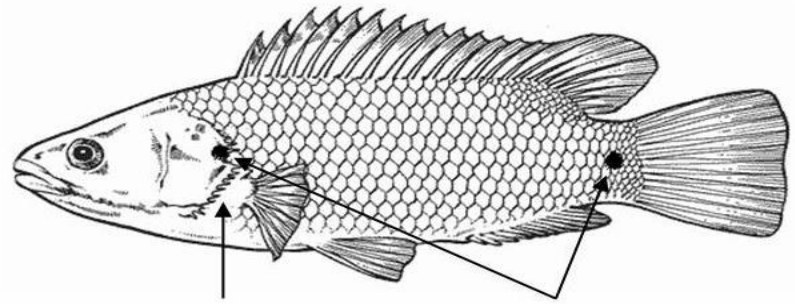
Dec 2014Site	Anabas testudineus	Ambassis sp.	Selenotoca multifasciata	Scatophagus argus	Gerres subfasciatus	Gerres filamentosus	Megalops cyprinoides	Amniataba caudavittata	Lates calcarifer	Pseudomugil signifer	Zenarchopterus sp.	Nematalosa sp.	Anguilla reinhardtii	Mugil sp.	Brachirus sp.	Melanotaenia splendida inornata	Siganus lineatus	Periophthalmus novaeguineaensis	Gobidae sp.	Macrochelodina rugose
S26	137																			
S27																				
S28										23					8				2	
S3			5		4	3	1	2												
S4					20			30											6	
S29			7				2	2				1		2			3			
S30	1																			
S31																				
S8																				
S7							1		1											
S1		1														6			1	
S15																				
S32		4					3						1			15				
S17																47				1
S33			2					4						5				20		
Bo18																				
Bo13																				
Bo30																				
Bo5		20	10		10			50	5	20	3								20	
Bo20			1	1		1		1												

8.5 Pest Fish Fact Sheets

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Anabas testudineus* (Bloch, 1795)
Common Name	climbing perch; climbing gouramy
Order : Family	Perciformes : Anabantidae



Impact summary	Very hardy, highly invasive species; may out-compete native species for space and food. They can alter water quality through disturbing sediments and increasing nutrient levels. Burrow into sediments and can survive there for up to 6 months even when the water dries up. Spines on gill covers and fins can injure and even lodging in the throat of predators such as fish, crocodiles, snakes and birds when they attempt to eat the fish, resulting in starvation
	There is a high risk of the species introduction and establishment on the northern Australian mainland; now confirmed present in Torres Strait Islands (Saibai). This is declared a noxious, prohibited species in Queensland. If found report to QDPI Fisheries on 132523
Appearance & Size	Slender body with large scales; dark to pale green to brown; top area dusky to olive; bottom of head with stripes; reddish-gold; gill cover margins strongly spined; juveniles have a dark spot on rear of gill and at base of tail fin; maximum size 25cm.
Native Range	Tropical-subtropical 28°N-10°S; Indian subcontinent through South East Asia to Indonesia and China.
Habitat	Occurs in fresh and brackish (slightly salty) water; prefers slow or still waters and found in a range of water bodies including rivers, lakes, swamps, marshes and estuaries. Can tolerate muddy or stagnant waters; remains buried in mud during dry season and then reemerges when water returns. Will 'walk' overland using gill cover spines, pelvic fins and tail, thus moving to new waterbodies, especially during the wet season. It can breath directly from the air with a special respiratory organ, the labyrinth, located above the gills, and can survive prolonged exposure out of water if kept moist.
Feeding	Omnivore: mainly feeds on aquatic plants, detritus, but also eats crustaceans (shrimps), snails, worms, insects and small fish.
Human Use	Used in aquaculture and commercial fisheries in native range
Image	1. Kim, T.H. in Lim and Ng (2008) 2. QDPIF, Brisbane, Qld. (line drawing)

Introduction History in Papua New Guinea

First reported from PNG in 1976 from the Morehead River near the Irian Jaya border. Polon (1994) reported large numbers of the species from swamps and creeks along the entire coast of the Western Province from the Irian Jaya border to the mouth of the Fly River. Lawrence (1995) reported the species in coastal waters at Kadawa, a PNG village near Daru and north-east of Saibai Island. Hitchcock (2006) made the first report of the species in Australian waters from Saibai Island located 4km from the PNG coast.

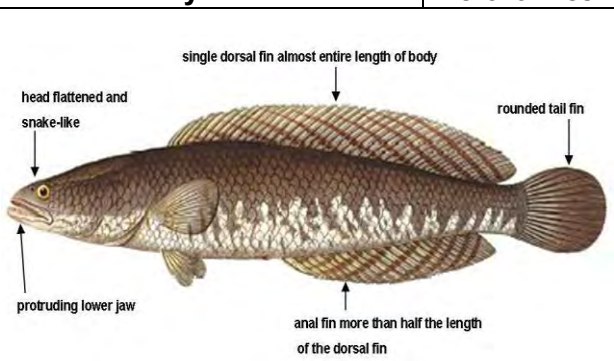
TropWATER

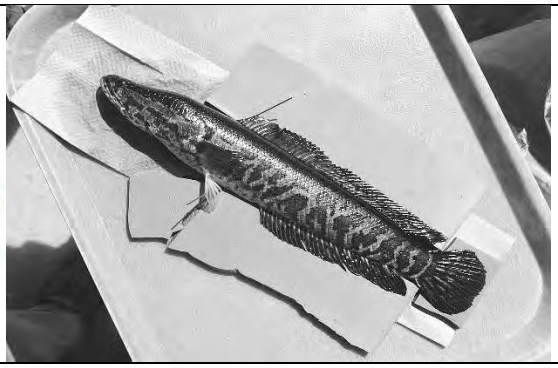
Pest fish in North East Queensland

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Channa striata* (Bloch, 1793)
Common name	snakehead murrel; common snakehead
Order : Family	Perciformes : Channidae





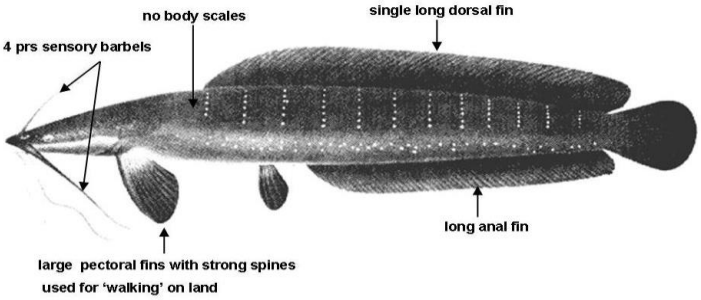
Impact summary	Very hardy, highly invasive species. Is able to breathe from the air and to survive long periods out of water or burrow in mud and survive during dry periods. Negative impacts reported from introduced range include excessive predation upon smaller fishes including juvenile barramundi; **known to cause serious bite injuries to humans.**
	There is a high risk of the species introduction and establishment on the northern Australian mainland and Torres Strait Islands. This is declared a noxious, prohibited species in Queensland. If found report to QDPI Fisheries on 132523
Appearance & Size	Cylindrical, elongate body; head flattened and snake-like; large mouth with many well-developed teeth; lower jaw extended; single long top and bottom fins are more than half of the length of the fish; tail fin is rounded; surface and sides usually brown to black with mottling and faint dark, banding which is also on the fins. Bottom surface is white. Grows to approx 100 cm long and 3kg weight.
Native Range	Tropical – subtropical; 35°N -18°S; found throughout Indian sub-continent, Nepal and Bhutan; South-East Asia to Indonesia and southern China.
Habitat	Prefers slow moving or still water. Often found in muddy or stagnant swamps and pools. Migrates overland to new waterbodies during wet season. Has a special respiratory structure above gills to enable it to breather air. Can move across land to escape extreme conditions or burrow in mud during drying periods
Feeding	Aggressive, territorial, ambush predator; feeds on fish, frogs, snakes, insects worms, crustaceans – even small birds and mammals
Human Use	Commercial fishery; aquaculture; aquarium
Introduction History	13 introductions (8 established; 4 unknown status; 1 not established); it is established in USA, Hawaii, New Caledonia, Mauritius, Madagascar, Malaysia, Indonesia (inc. Irian Jaya) and PNG. Recently arrived in wetlands of the southern PNG coast directly opposite Saibai Island in Torres Strait
Image	USGS Circular 251 original image: Bloch 1793

TropWATER

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Clarias batrachus* (Linnaeus, 1758)
Common name	walking catfish; magur
Order : Family	Siluriformes : Clariidae



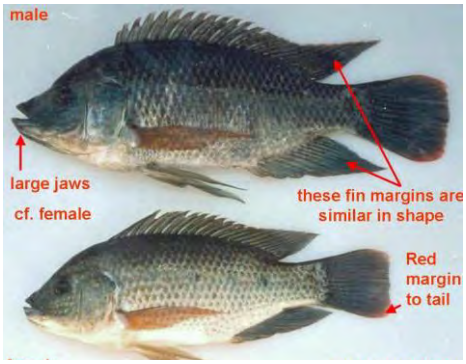
Impact Summary	Highly invasive species. Can breathe from the air and survive long periods out of water. Burrows in mud during extended dry periods. Negative impacts reported from several countries – especially where it is a predator dominating temporary refuge pools or entering aquaculture ponds (USA, Mexico). Reported in the Philippines dominating lakes and rivers which has led to large reductions in native catfish species through predation and competition
	There is a high risk of the species introduction and establishment on the northern Australian mainland and Torres Strait Islands. This is declared a noxious, prohibited species in Queensland. If found, report to QDPI Fisheries on 132523
Appearance & Size	Elongate body with a flattened, thin head. Colour usually slate grey to olive with pale bottom surface; slightly projecting lower jaw with 4 pair of long sensory whiskers; large fins with strong spines on sides; long continuous fins; small; no scales present on all of the body. Usually grows to ~47cm TL, but occasionally reported growing to >60cm long and approx. 1.5kg
Native Range	Tropical/equatorial regions 29°N -7°S; South-east Asia,
Habitat	Lives in freshwater and brackish water; prefers slow or still waters – lowland streams, ponds and swamps; often found in turbid with dense vegetation; a floodplain migrator during the wet season; it is an air breather with a special respiratory organ above the gills which allows the fish to emerge and travel overland to avoid
Feeding	Carnivore – feeds on aquatic invertebrates, including insect larvae, worms, snails, crustaceans, small fish, and some plant material and detritus
Human Use	Commercial fishery; aquaculture; aquarium
Introduction History	Introduced to 11 countires (9 established; 2 not established); first reported in Papua from Irian in the Lake Sentani region then in 1995 in the Bensbach River, Western Province, PNG. Recently reported from PNG coastal wetlands directly across from Saibai Island, Torres Strait
Images	Rainboth (1996) FAO

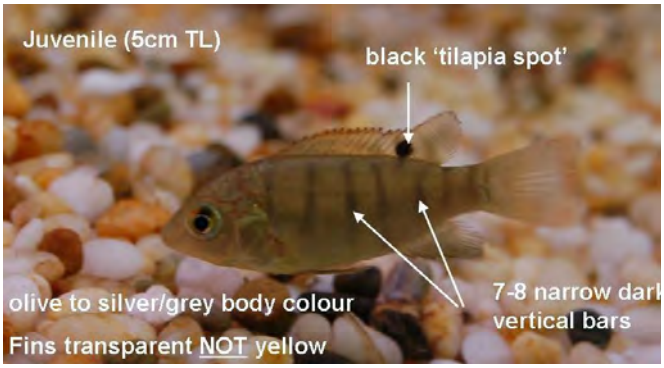
TropWATER

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Oreochromis mossambicus* (Peters, 1852)
Common name	Mozambique tilapia; Mozambique mouth brooder
Order : Family	Perciformes : Cichlidae





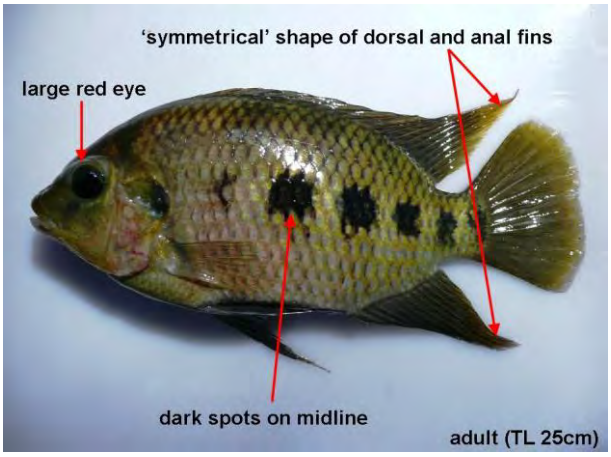
Impact Summary	A very hardy and highly invasive species with wide ecological tolerances. It is aggressive and territorial during the spawning season (which is most of the year in the tropics), chasing away native fish. Ecological impacts are reported from several countries with declines in native species through competition for food and habitat; inhibition of spawning behaviour and predation; also known to cause changes in water quality where very large populations are present with increased turbidity and release of nutrients in wastes causing algal blooms.
	The species is already present in northern Queensland in coastal waterways between Townsville and Cairns and now in the Endeavour River, Cooktown. It is declared as a noxious, prohibited species in Queensland. It is a major pest in north Queensland waters. If found report to QLD Fisheries on 132523
Appearance & Size	Deep-bodied fish with a continuous dorsal (top) fin (all Australian native fish have a separation or dip between the front and rear parts of the dorsal fin). The rear margins of the top and bottom fins have tapered (pointy) ends that make them similar in shape to each other. These fin extensions are longer in males than in females. The jaws of sexually mature males are enlarged with the upper profile of the head often humped. Males usually grow to about 40-44cm; females to approx. 35cm; Under environmental stress (eg. crowded conditions, shallow waters) the species can mature and breed at a small size (~ 5-10cm TL), known as 'stunting'. Fry and juveniles of both forms are similar in appearance. They are pale olive to silvery grey and have vertical bars with or without blotches, but no stripes. A clear-ringed black spot is present on the rear part of the top fin.
Native Range	Tropical-sub-tropical 17°S-33°S; eastern coastal Africa, including Botswana, Malawi, Lesotho, Mozambique, Swaziland, Zimbabwe and South Africa
Habitat	Occurs in a wide range of habitats including fresh, brackish and marine waters; prefers slow moving or standing waters, including swamps, lagoons, lakes, streams and rivers; seasonally migrates across floodplains, although long range dispersal is through movement of juveniles.
Human Use	Commercial fishery, aquaculture, baitfish; animal feed; biocontrol (weeds), aquarium
Introduction History	Introduced into at least 94 countries (established in most of these) mostly in equatorial, tropics and subtropical regions including Indonesia, Papua New Guinea and Australia (Qld and WA);
Images	1,2, A.Webb, ACTFR.

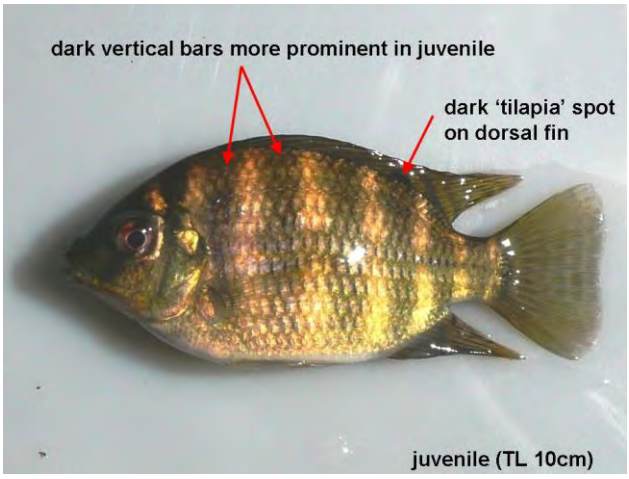
TropWATER

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Tilapia mariae* (Boulenger, 1899)
Common name	spotted tilapia, black mangrove cichlid, Niger cichlid
Order:Family	Perciformes : Cichlidae





Impact Summary	There is very little information or detailed studies on impacts of the species in its introduced range. **It is territorial and aggressive in the spawning season and able to rapidly spread, increase in numbers and dominate communities. It therefore is likely to have a negative effect by out competing some native species for food and space.**
	This is a hardy, highly invasive species capable of spreading rapidly and population increase. There is a high risk of its introduction and establishment in far northern Australia. The species already occurs widely in the Cairns region, including the upper and lower Barron River catchment, the Johnstone, Russell and Mulgrave River systems. It was also recently found in a tributary (Eureka Creek) of the Mitchell River but there is an ongoing attempt to eradicate it from there. This is declared a noxious, prohibited species in Queensland. If found, report to QDPI Fisheries on 132523
Appearance & Size	Thin rounded body; large reddish eye, rounded nose with small mouth and thick lips; dark olive-green to light yellow-green body with 8-9 dark bars in young fish, but fading in adults, with a series of 2-6 dark spots between the bars along the middle. Juveniles have a characteristic dark 'tilapia spot' on top fin which fades in adults. Some individuals may have rows of white spots and a pink edge to dorsal fin and tail fin; pinkish flush present especially on the belly and lower head during mating season. Grows to 40cm but can mature at a smaller size (9-18cm length)
Native Range	Tropical-equatorial, (9°N-2°N); coastal regions of central western Africa- southern Cameroon to the Ivory Coast, including Benin, Ghana and Nigeria
Ecology	Occurs in still or flowing fresh and brackish waters (estuaries and coastal lagoons); prefers rocky or silt-sand substrate with vegetation cover
Human Use	Commercial fishery, aquarium
Introduction History	3 introductions (2 established) introduced into Russia, USA (Florida, Nevada) and Australia (northern Queensland and Victoria*) and established in the latter two countries; (*established only in thermally heated wastewater ponds from a power station).
Images	A. Webb, ACTFR

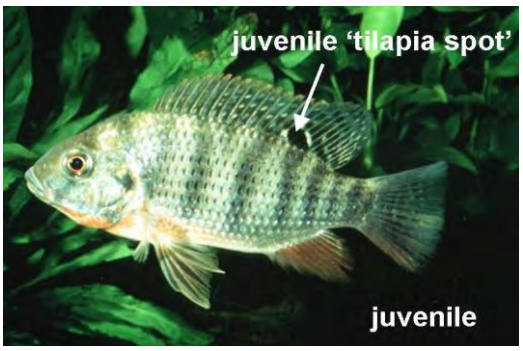
TropWATER

Pest fish
in North East Queensland

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	Tilapia rendalli (Boulenger, 1896)
Common name	Redbreast tilapia
Order : Family	Cichlidae



Impact summary	Adverse impacts reported due mainly to its feeding behaviour causing habitat disturbance (loss of aquatic weed beds and their dependant aquatic fauna; change in water quality leading to organic pollution with increased turbidity) and disease transmission (introduction of parasites). Feed on algae, plants insects and crustaceans.
	A large, hardy and invasive species; there is a high risk of the species' establishment if introduced on the northern Australian mainland. This is declared a noxious, prohibited species in Queensland. If found, report to QDPI Fisheries on 132523
Appearance & Size	Deep-bodied fish. Base colour is olive green, darker on top surface and with paler sides. Scales have a dark edge. Series of 5 or 6 dark bars on body in juveniles and adult; top fin olive green with thin red margin and white to grey spots; tail fin with white spots and red-yellow on basal half. Throat and bottom surface reddish especially in adults. Juveniles more silvery base colour with distinct black 'tilapia' spot on rear of dorsal fin that fades in adults. Grows to 45cm and 2.5kg
Native Range	Sub tropical, tropical-equatorial; 20°N-20°S; western, central and southern Africa especially in large river systems (Congo, Zambezi, Senegal and Niger) and rift lakes (Malawi, Natal, Okavango, Cunene); found in estuaries in Mozambique and Natal
Ecology	Prefers slow moving, well-vegetated margins of streams, rivers; backwaters and swamps; a floodplain migrator; also occurs in brackish water
Human Use	Small commercial fishery; aquaculture; biocontrol (weeds); aquarium
Global Introduction History	Introduced to 37 countries (22 established; status unknown: 8; not established: 7); established in several African countries outside native range, in tropical South America (Colombia, Brazil) and Latin America (Mexico, El Salvador, Puerto Rico), in Cuba, Hawaii, Turkey, Thailand and in the Sepik River floodplain, PNG
Image	1.M.K. Oliver (2008); 2. Seegers (1996)

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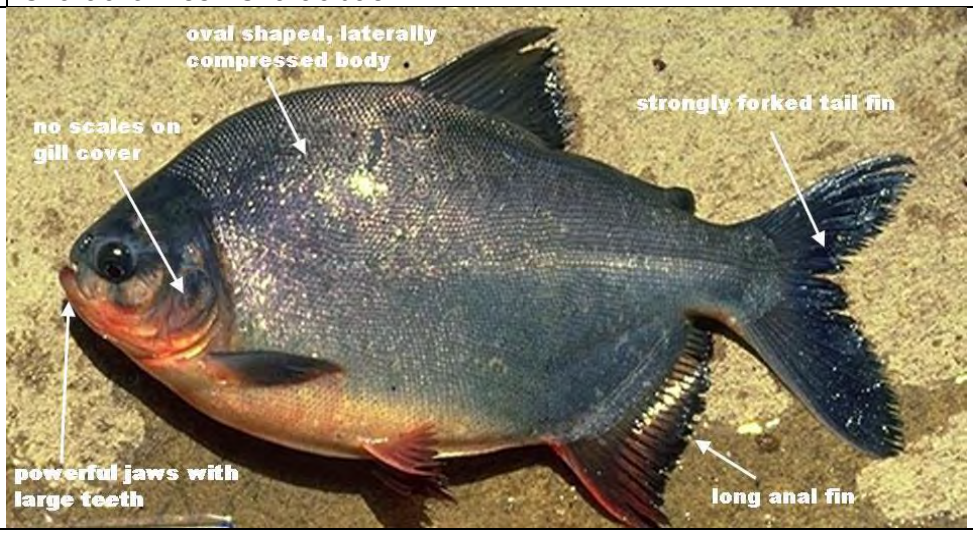
Pest fish
in North East Queensland

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Piaractus brachypomus* (Cuvier, 1818)
Common name	pirapatinga; red belly or black pacu; tambaqui
Order : Family	Characiformes : Characidae



Impact summary	Large, hardy species; ecological impacts in its introduced range not documented; it has a broad diet, mainly plant material, **but considered dangerous as it is known to cause serious bites from its powerful jaws and teeth; juveniles easily mistaken for red-bellied piranha**
	High establishment risk in northern mainland Australia if they are introduced. If found, report to QDPI Fisheries on 132523
Appearance & Size	Large species, round and thin body; broad head and gill covers without scales; base colour greenish to silvery grey or black on sides; with red-orange on belly and fins; tail fin broadly forked, powerful jaws with large well-developed teeth; grows to 85cm and 20kg
Native Range	Tropical/equatorial; 23°N – 11°S; Amazon and Orinoco River basins, and Argentina, South America
Habitat	Freshwater species; occurs in lowland rivers and lakes but migrates in large schools up tributary rivers into flooded forests; very powerful swimmer
Human Use	minor commercial fishery; aquaculture and aquarium
Introduction History	Introduced to 20 countries (established in 3; 14 unknown status; 3 not established) Established in China and in the Sepik River floodplain, PNG and there are now recent reports of its occurrence along the southern PNG coast; status of the species in most countries is unknown. In the USA, it has been reported from many states, mainly as single specimens – probably from home aquaria releases or escapees from fish farms
Image	L. Lovshin (USGS - NAS) http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=427

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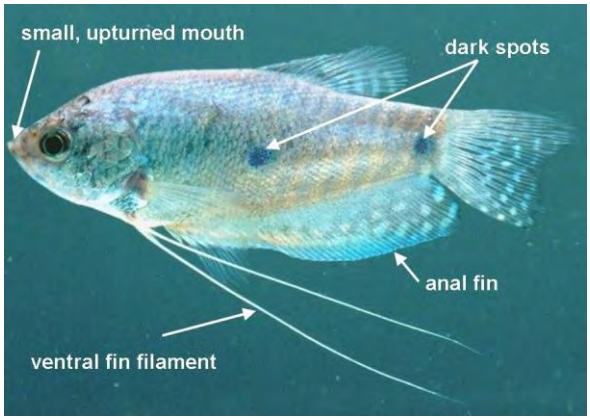
Pest fish
in North East Queensland

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Trichogaster trichopterus* (Pallas, 1770)
Common name	Three-spot gourami, blue gourami
Order : Family	Perciformes : Osphronemidae



Impact summary	**Very hardy, highly invasive species that can breathe air directly and can thus survive long periods out of water if kept moist**. There is virtually no information on impacts from the species' introduced range but it has been reported to have caused the decline of an endangered fish species in SE Asia. Very tolerant of poor water quality. Also see fact sheet on the related snakeskin gourami *Trichogaster pectoralis*.
	This species is well-established and spreading in the Townsville-Burdekin area. There is a high risk of its introduction and establishment on the northern Australian mainland and Torres Strait Islands. If found report to QDPI Fisheries on 132523
Appearance & Size	Elongate, compressed body; Ventral pelvic fins form a pair of long thin sensory filaments. Mouth is small and turned upward. Long anal fin extends from ventral fin to the tail. Uniform blue colour with a pale olive tinge; two dark spots may be present – one on the body at the base of the tail and one centrally on the midline of the body (the third "spot" from the species common name is the eye); dark irregular mottling may be present almost obscuring base body colour. Whitish spots on fins form a series of parallel bands. Can grow to 15-20cm, but usually to 10cm long.
Native Range	Tropical-subtropical; South East Asia Mekong Basin – Laos, Yunnan China, Thailand, Cambodia and Vietnam; also Myanmar, Indonesia (incl Java, Sumatra, Bali and Borneo)
Ecology	Heavily vegetated, shallow sluggish or standing water (e.g., marshes, swamps, canals, rivers and lakes) and seasonally flooded forest. Migrates cross floodplains. Feeds on zooplankton and aquatic insects, plant material and detritus.
Human Use	Commercial fishery; aquaculture; aquarium
Introduction History	Introduced to 11 countries (established in 8 - Namibia (Africa), Colombia, Sri Lanka, Philippines, Dominican Republic, Florida (USA) and Australia (spreading through the Townsville and lower Burdekin region, North Qld) and PNG

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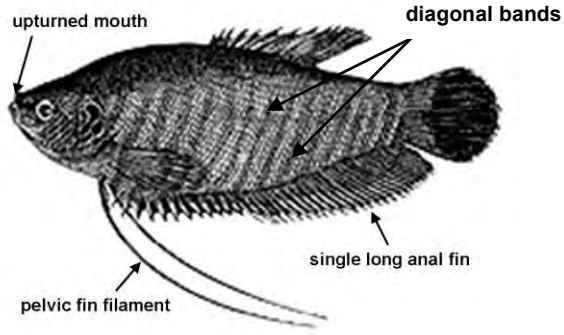
Pest fish
in North East Queensland

Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Trichogaster pectoralis* (Regan, 1910)
Common name	Snakeskin gourami
Order : Family	Perciformes : Osphronemidae



Impact Summary	The species is aggressive and territorial. While adverse impacts have been reported (decline of native species following introduction), there are no detailed studies of these impacts available in the literature. Also see fact sheet on three-spot gourami *Trichogaster trichopterus*.
	This species is a hardy, air-breather and highly invasive species; there is a high risk of its introduction and establishment in northern Australian and Torres Strait Island fresh waters **If found report to QDPI Fisheries on 132523**
Appearance & Size	Medium sized fish with deep thin body. Side fin forms a long moveable filament extending back to edge of tail fin. Anal fin extends along the ventral part of body from pelvic fins to the tail. Mouth is small and directed upward. Body with numerous variably dark diagonal bars and a dark irregular stripe extending from the eye to the base of the tail. Adult body is olive-greenish grey with a silver sheen and whitish belly; fins grey-green with orange-red along margins. Juveniles have pronounced zig-zag patterns along sides from eye to tail. Grows to 25cm TL and 0.5kg
Native Range	From Chao Phraya basin in Thailand to Mekong basin of Laos, Cambodia, Vietnam
Ecology	Occurs in shallow, slow or still waters with dense vegetation, eg. swamps, canals, lakes and rice fields often with low oxygen levels. The species is capable of breathing air directly from the atmosphere and to migrate across floodplains.
Human Use	Commercial fishery, aquaculture, aquarium
Introduction History	Introduced to 15 countries (established in 9 of these). Introduced to other S.E. Asian countries incl. Singapore, Malaysia, Myanmar, Philippines and Indonesia, and elsewhere: New Caledonia Sri Lanka, India, Colombia and PNG.

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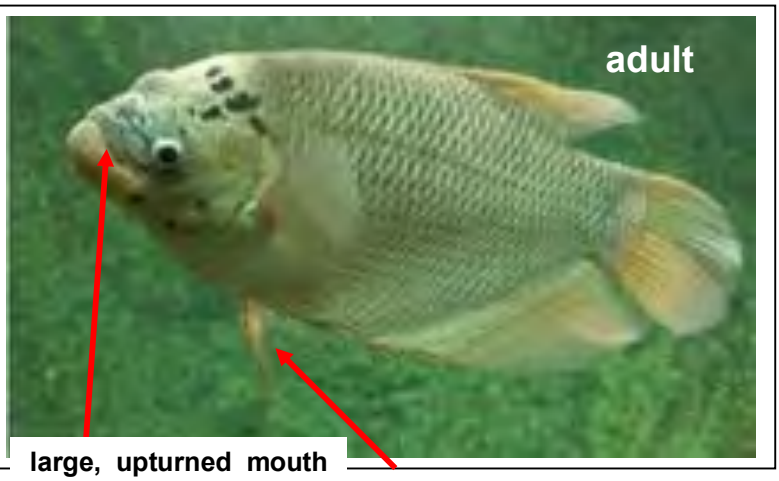
Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website: https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Osphronemus goramy* (Lacepede, 1801)
Common name	Giant gourami
Order : Family	Perciformes : Osphronemidae



Impact Summary	A large species that is aggressive and territorial during spawning season. It eats plants and animals, mostly plants, fruit, insects and worms but also small fish and frogs
	Virtually no information on the status or ecology of the species in its introduced range, including PNG.; little information available on environmental tolerances– **as a tropical species that can also breathe directly from the air, there is a potentially high risk of its transport into, and establishment in northern Australian waters. If found report to QDPI Fisheries on 132523**
Appearance & Size	Large, round and thin; grows to 70cm and 9kg; adult males have a large hump on top of head; large eyes; fleshy lips; fins set toward end of body; side fins elongate and thread-like extending to or beyond tail fin; adults grey-brown sides with silvery shinny scales and paler underbelly; fins pale brown; juvenile are reddish brown with 8-10 dark brown bars and have a smaller, more pointed head than adults
Native Range	From Pakistan through southeast Asia to Indonesia and China
Habitat	Inhabits swamps and large rivers. Prefers slow-moving or still water associated with dense vegetation. Migrates across floodplains. Bubble–spawner, male guards nest and fry.
Human Use	Commercial fishery; aquaculture; aquarium species
Introduction History	Has been introduced to 21 countries (11 established; 4 status unknown; 6 not established). Has been stocked in several districts, in the upper Ramu floodplain and in the Sepik River floodplain of PNG
Image	1. F.Busson (2002) http://www.palais-portedoree.org/ [Fishbase 2008] 2. D. Bjerregaard (2004) NREB, Sarawak/DANDA [Fishbase 2008]

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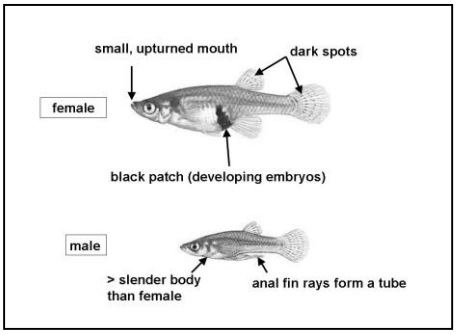
Potential Invaders of Cape York and Torres Strait Islands

TropWATER Pest Fish in NE Queensland website:
https://research.jcu.edu.au/research/tropwater/research-programs/aquatic-fauna-and-invasive-species

Species	*Gambusia holbrooki* (Girard, 1859)
Common names	Eastern gambusia, plague minnow, mosquitofish
Order : Family	Cyprinodontiformes : Poeciliidae



Impact summary	Very hardy, highly invasive species. It can out-compete native species for space and food; predates on eggs and young of many species and can kill larger fish through fin nipping. They also continually harass other species and have been implicated in the decline of several native fish and amphibian species
	There is a high risk of the species introduction and establishment on Cape York and Torres Strait Islands and they are already present on Thursday Island. It is widespread in Queensland south of Cairns. This is declared a noxious, prohibited species in Queensland. If found report to QDAFF Fisheries on 132523
Appearance & Size	Small species with grey to olive-brown ground colour and light belly; sometimes with a bluish colour; dark spots present on the top and tail fin; females larger with a more rounded body tapering to the tail and mature adults with dark patch on belly; males smaller; females grow to about 8cm and males to about 4cm maximum, but are typically smaller than this, usually being 5-6cm for females and 3cm for males
Native Range	USA - temperate 40°N – 25°N areas of the eastern Atlantic and Gulf Drainages of USA from New Jersey to Alabama
Habitat	Occurs in fresh and brackish (slightly salty) waters; prefers warm, slow flowing or still waters among aquatic vegetation in shallow margins of water bodies.
Human Use	Used in aquaria. Spread in many countries to control mosquito larvae but is not effective at this.
Introduction History	Introduced to 31 countries (established in at least 27 of these) in temperate and tropical regions throughout Europe, Middle East; Hawaii, China; India, Iran, Iraq, Afghanistan, Turkmenistan, Uzbekistan, Singapore, Madagascar; present in PNG (or possibly the closely related *G. affinis*)
Image	1. Australian Nature Live (2008) Feral Animals in Australia http://www.snakeshow.net/nature_links_feral_animals.html 2. A. Webb, ACTFR
Further Information	ACTFR Pest Fish website:http://www.actfr.jcu.edu.au/Projects/Pestfish/Index.htm DPIF website: http://www2.dpi.qld.gov.au/fishweb/1347.html

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Pest fish
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