

The image is a composite of two photographs. The top photograph shows a wide river with a sandy and grassy bank. A person is visible in the distance on the left bank. The sky is blue with scattered white clouds. The bottom photograph is a close-up of a person's hands holding a fish against an orange measuring board. The fish is a Calliope, characterized by its silver scales and a prominent yellow patch on its side. The measuring board has markings for centimeters, with the number 25 clearly visible. The text 'Calliope River Fish Recruitment' is overlaid in red with a white outline across the center of the image.

Calliope River Fish Recruitment

Calliope River Fish Recruitment

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SUMMARY

INTRODUCTION

Standardised castnet surveys were undertaken from Feb-Apr 2015 to assess the use of the area proposed as a Fish Habitat Area in the Calliope River by juvenile Barramundi and other fish species.

There were 14 sites where surveys were undertaken in the Calliope River and tributaries. One site was surveyed once on an opportunistic basis. A total of 37 surveys were undertaken from 16/2/2015-4/5/2015 at 14 sites with 1,814 individuals recorded comprising 37 fish and prawn species.

RESULTS AND DISCUSSION

Flattail Mullet was the only species recorded at all 14 sites while Sea Mullet and Estuary Glassfish were recorded at 13 sites. Yellowfin Bream were recorded at 12 sites, Pikey Bream at 7 sites and Barramundi at 2 sites.

Flattail Mullet (454) was the most caught species, second was Estuary Glassfish (266) and Sea Mullet (243) was third. Yellowfin Bream (58) ranked at 4, Pikey Bream (32) at 8 and Barramundi (6) at 23.

Catch rates were calculated based on the number of casts and standardised on 10 casts. That allowed for a comparison of catch rates between sites and catch rates in adjacent areas of Gladstone and the Fitzroy River (for Barramundi) where similar surveys were undertaken.

The overall catch rate for all surveys was 33.9 fish/10 casts and ranged from a low of 7.3 fish/10 casts at the Historical Village to a high of 73.0 fish/10 casts at the old Bruce Highway Bridge. The old Bruce Highway Bridge forms an artificial barrier and fish can only move upstream during high tide periods. Catch rates of juvenile fish at sites above the old highway bridge (upper Calliope) were significantly lower than those at most sites below the bridge (lower Calliope).

A total of 6 Barramundi were recorded at 2 sites in the upper Calliope being the Calliope Backwater and opposite Liexlip Creek. Another juvenile Barramundi was verified as caught in a castnet by a recreational fisher at the Historical Village where Barramundi had been caught in surveys in previous years. No Barramundi were recorded at sites in the lower Calliope and no reports of juvenile Barramundi were received from other fishers.

Barramundi were also recorded in historical recruitment surveys in Beecher Creek (also known as Clyde Creek) and at the Historical Village. There were a total of 4 sites where Barramundi were recorded during recruitment surveys.

Juvenile Barramundi were not recorded until after the largest spring tides of the year from 18-21 Feb and a significant freshwater flow in the river on 20-21 Feb from Cyclone Marcia. These conditions are conducive for Barramundi to recruit to upstream habitats.

Catch rates for Feb-Apr for Barramundi were compared in the Calliope River, Gladstone area (other than the Calliope River) and in the Fitzroy River. Catch rates in the Calliope River and Gladstone were similar and significantly lower than for the Fitzroy River. This was consistent with historical recruitment patterns.

It was not possible to determine growth rates of Barramundi recruits during the study period. Historical data suggests that recruits are generally 50-250mm in Jan-Feb, 100-300mm in Mar-Apr and 150-350mm in May-Jun.

Bream (Yellowfin and Pikey) are the most caught species by recreational fishers in Gladstone (Sawynok et al 2015) so recruitment is important in maintaining Bream stocks.

There were 58 Yellowfin Bream recorded at 12 sites and 32 Pikey Bream recorded at 7 sites. Yellowfin Bream were recorded throughout the proposed FHA while Pikey Bream were only recorded in the lower Calliope River. The catch rate of both species of Bream was lower in the Calliope River than in the Gladstone area although the difference was not significant. The size range of Yellowfin Bream recruits was 44-120mm and Pikey Bream recruits was 42-80mm. The flow event on 20-21 Feb did not appear to have any effect on distribution of Bream recruits.

Mullet are important species in the region for commercial fishers and for bait for recreational fishers. Mullet (Flattail and Sea) were the most common and widespread species caught with Flattail Mullet being recorded at all 14 sites while Sea Mullet were recorded at 12 sites. The catch rate for both Mullet species was slightly higher in the Calliope River than in the Gladstone area however the differences were not significant. The size range of Flattail Mullet was 55-380mm and for Sea Mullet was 40-210mm.

There were 6 other species of recreational, commercial and indigenous interest that were recorded during recruitment surveys. These were Dusky Flathead, Barred javelin, Speckled Javelin, Mangrove Jack, Sand Whiting and Banana Prawn.

Water quality parameters of temperature, salinity, pH, total dissolved solids (TDS), conductivity, dissolved oxygen and turbidity were measured during 29 surveys at 12 sites. Water quality parameters were considered to be within an acceptable range. Salinity was affected by freshwater flows with low salinity in the upper Calliope (0.1-3‰) during the project period and in the lower Calliope in early Mar after the freshwater flow from 20-21 Feb.

CONCLUSIONS

This study builds on existing historical data to confirm that the Calliope River provides valuable habitat for Barramundi recruits and is a locally significant recruitment area. While only six juvenile Barramundi were captured during this current study, and all of these were recorded in the upper Calliope, historical surveys and tagging studies indicate that juvenile Barramundi utilise most sections of the River within the study area.

The Calliope Backwater site, where five of the six juvenile Barramundi were captured in the current study, and the Beecher Creek area appear to contain particularly suitable habitat attributes for juvenile barramundi.

While the major focus of this study was on juvenile Barramundi recruits, the study has also confirmed that the Calliope River provides valuable habitat for a range of other juvenile fish and crustacean species. Most notable is the large number of juvenile Mullet and Bream that were captured and their broad distribution throughout the study area. These are key recreational, commercial and indigenous fish species in the local area.

INTRODUCTION

The central Queensland declared Fish Habitat Area (FHA) investigations program, funded by the Gladstone Ports Corporation's (GPC) marine fish habitat offsets program, is currently assessing the fisheries values of sections of the Calliope River (Gladstone), to support the possible inclusion of these areas into the FHA network. Further funding provided by GPC through their Biodiversity Offsets Strategy, developed to provide for the long-term conservation of threatened and migratory species, including their habitats, has enabled enhancement of the program through further research into areas proposed for FHA declaration.

The Calliope River is known to contain important juvenile fish habitats (in particular Barramundi habitats) however verification of precise locations, fish species and recruitment age has not been confirmed by the Department of National Parks, Sport and Racing (NPSR). Fish recruitment surveys in several tributaries of the Calliope River to confirm the quality and utilisation of these habitats, particularly by Barramundi, have been identified as an activity that will effectively enhance the knowledge and understanding of Calliope River's fisheries values and support the consultation process for declaration of the Calliope River as a FHA.

OBJECTIVES

The objectives of the project are:

1. To assess the value of the proposed Calliope FHA as a nursery habitat for juvenile Barramundi and other fish species.
2. An assessment of Barramundi recruitment and growth rates within other estuaries in Central Queensland to provide a comparison with the Calliope River study area.

AREA OF INTEREST

The area of interest for the proposed FHA in the Calliope River is shown in *figure 1*.

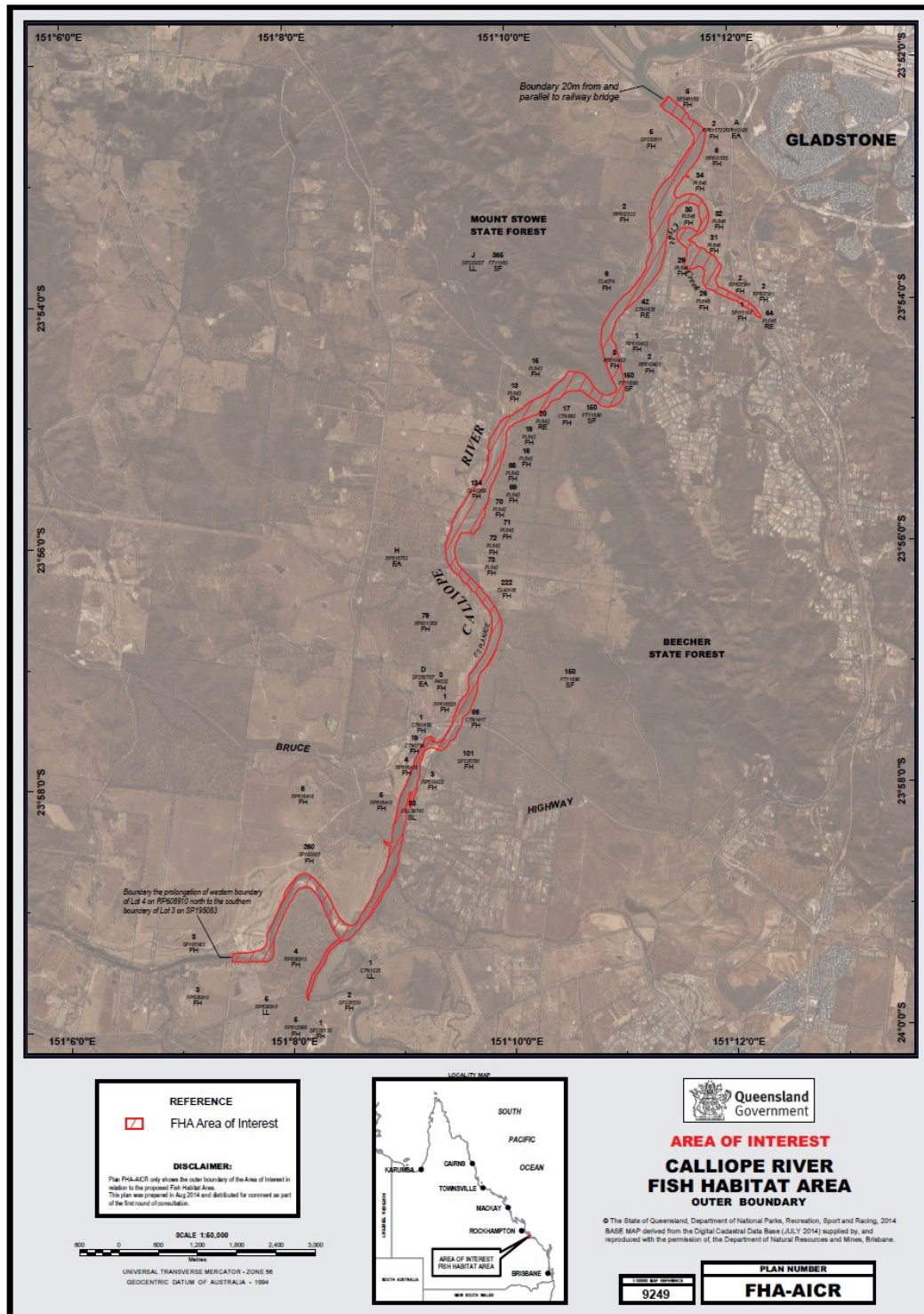


Figure 1: Calliope River Study Area

PREVIOUS STUDIES

There have been a number of previous studies into fish in the Calliope River covering or including the area of interest that are relevant to the current study.

“A Fisheries Resource Assessment of the Calliope River System in Central Queensland 1994” by SG McKinnon, CJ Lupton and PE Long identified 99 species of fish (including Barramundi), 13 species of crustaceans and 3 species of molluscs from the estuarine, brackish and riverine reaches of the Calliope River.

“A Description of the Calliope River Fisheries, Gladstone July 1996-June 1997” by JR Platten and AJ Thwaites identified 21 species or species groups caught by recreational fishers in the Calliope River, although no Barramundi were recorded. The commercial catch included 5 species groups caught in the river with Barramundi the second most caught species behind Mullet.

“Intertidal Wetlands of Port Curtis” Technical Report 43 by RM Connolly, DR Currie, KF Danaher, M Dunning, A Melzer, JR Platten, D Shearer, PJ Stratford, PR Teasdale and M Vandergragt was Technical Report 43 from the Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management. This report provided information on intertidal habitats and recreational fishing in the Gladstone area.

From 1999-2005 W Sawynok and JR Platten undertook an assessment of Barramundi nursery areas with 4 reports produced “Barramundi Nursery Areas in Central Queensland 1999-2002, 2002/03, 2003/04 and 2004/05”. The assessment included a site on Beecher Creek with 25 fish species recorded, however over that time no Barramundi were recorded.

From 2011-2014 trends in recreational fishing were examined through the Gladfish project with 3 reports produced “Gladfish 2012, 2013 and 2014”. This included recruitment surveys with 2 sites on the Calliope River being Beecher Creek and in the river at the old Bruce Highway bridge at the Calliope Historical Village. There were 19 species of fish recorded including Barramundi at both sites.

A report “Fisheries Resources of Calliope River, Gladstone Central Queensland 2014” was produced by the Department of National Parks, Recreation, Sport and Racing. The report provided an overview of the habitat and fisheries resources of the Calliope River study area.

METHODS

SITE SELECTION

1. Nursery habitats for juvenile Barramundi are generally at the top end of the tidal limit or into freshwater reaches although they will use much of the river habitat at some time (Sawynok 2002).
2. A total of 12 sites were selected throughout the Calliope River and tributaries to assess their use by juvenile Barramundi and other species. Sites were selected to include a range of habitat types including habitat types likely to be used by other species. Habitat types included gravel, sand and mud bars, artificial structures (rail bridge), side tributaries, grassy banks and backwaters.

TIMING OF SURVEYS

3. In Central Queensland Barramundi are known to recruit to nursery habitats from Jan-May each year (Sawynok 2002). Surveys were undertaken in Feb, Mar and Apr 2015 (into early May) to maximise the chances of encountering recruits.
4. Timing of surveys was generally after the largest spring tides as that was mostly when recruits access nursery habitat. Access to the nursery sites at those times is enhanced when there is a fresh following rain. Flooding in the river and logistical issues required some flexibility in the timing of surveys.

DEFINING BARRAMUNDI RECRUITS

5. First year Barramundi recruits use of the Calliope River was the focus of this study.
6. The life cycle of Barramundi has been extensively studied and is well documented (eg Davis and Kirkwood 1984, Davis 1986, Moore 1979, Moore 1982)
7. Barramundi spawn at the mouths of rivers and creeks from Oct-Jan and then recruits make their way upstream when conditions are favourable (Sawynok 2002). Movement of recruits to nursery areas is associated with large spring tides (Jan-Apr), particularly if they coincide with freshwater flows or flooding.
8. First year recruits were defined as fish being 0-250mm in Jan-Feb and 0-300mm in Mar-Apr during the recruitment season, based on data collected in the Fitzroy River and Gladstone area.
9. Recruits were also defined as fish being 0-350mm in May-Jun and Jul-Aug (little growth over winter) and 0-400mm in Sep-Oct. This was used in assessing historical records. There is an annual closed season for spawning from Nov-Jan on the east coast of Queensland.

DEFINING BREAM RECRUITS

10. Both Yellowfin and Pikey Bream spawn at the mouths of rivers and nearshore locations (Pollock 1982a) from May-Aug (Pollock 1982b) and then recruits make their way to all parts of the estuary.
11. Yellowfin Bream reach from 130-150mm after 1 year (Brown 2007, Pollock 2011, Cowden 1995). No data are available for Pikey Bream however is it expected that growth rates are similar to those of Yellowfin Bream and reaching a similar size after 1 year.

SURVEY METHODS

12. Survey apparatus used was a castnet. This is the same apparatus as used in other Infish recruitment surveys and ensured a standardised approach so that the results were comparable with other surveys. A standard castnet was a monofilament net with a drop of 2.4m and a mesh size of 20mm and a spread of 3.6m+ (Sawynok 2002). Photographs of the survey equipment in use were taken (*figure 2*).
13. Infish has a current permit issued by Fisheries Queensland to undertake surveys using a wide range of equipment. Permit number is 147717 and is current to 20/6/2016.
14. At each site a number of casts were determined depending on site size and characteristics. The number of casts was 5, 10 or 20 based on the site. The number of casts was recorded so that results could be used if the survey could not be completed for any reason (eg incoming tide). Casts were valid if the spread covered over 75% of the maximum area that can be covered by a cast.

15. At each survey at each site water quality parameters (Temp, pH, Dissolved Oxygen, Salinity/Conductivity, total dissolved solids (TDS) and Turbidity) were collected. Temperature/EC and pH were measured using a Hanna HI9991300 recorder, dissolved oxygen was measured using a Hanna HI9142 recorder, salinity was measured using a Nippon 508-IIW refractometer and turbidity measured using a Seechi disk.
16. For each cast the number of each species and length of key species was recorded to the nearest mm. For fork tailed fish the fork length was measured. For round tailed fish the overall length was recorded (*figure 3*).
17. Details of all fish were recorded in a waterproof field record book for later transfers to a standard excel spreadsheet (Infofish 2015 trip sheet).



Figure 2: Castnet method used for the recruitment surveys

MAXIMISING SURVIVAL OF FISH CAUGHT

18. To maximise the survival of fish on release, for casts where a small number of fish were caught these were removed quickly from the net, measured and then released. For casts where a large number of fish were caught the net was left in the water while the fish were removed. Subsequent casts were made a sufficient distance away from the previous cast to avoid recapture of fish.
19. Some species are hardier than others so fish that were more susceptible to mortality were removed first (eg Bony Bream). These steps maximised the survival of released fish however some mortality did occur.
20. Surveys were not undertaken when the water temperature was above 32°C as survival decreases rapidly when this temperature is exceeded.

TAGGING OF FISH

21. Barramundi and other species over 150mm were tagged using standard 30mm or 45mm Hallprint gun tags.

DATA MANAGEMENT

22. Data on the recruitment sites and from the recruitment surveys is stored in the Infofish 2015 online database located at <http://qld.info-fish.net/infofish/>. Access to the database is managed by secure login and the level of access is limited based on the user's need eg taggers can login and view their own data (read only).
23. Data from the standard excel spreadsheet was validated prior to being uploaded to the database. Validation included correcting typographical errors, ensuring fish names were correct and data were in the correct format.

DATA ANALYSIS

24. Data were analysed to determine the number of juvenile Barramundi recorded based on the size range outlined. Data were standardised based on fish/cast and fish/10 casts so that the data could be compared between sites, with other recruitment surveys undertaken by Infofish in the Fitzroy and Gladstone areas during the same period and with historic recruitment surveys. This provided a comprehensive comparison with recruitment at other sites and also with historical data. Error bars were calculated at 95% confidence.
25. Daily flows in the Calliope River were obtained for the Castlehope station 1320001A from www.dnrm.qld.gov.au/water/water-monitoring-and-data/portal. This was compared with Barramundi, Bream and Mullet recruits recorded in the Calliope River and the Gladstone area.
26. Growth of recruits was to be assessed if recaptures were made however there were low numbers of Barramundi recorded and no recaptures. The size of fish over time was used as an approximation for growth.
27. Data on other key species were also standardised based on fish/cast and fish/10 casts to allow a comparison between the Calliope River and the Gladstone area.



Figure 3: Barramundi recruit recorded in Calliope Backwater

COMPARISON WITH HISTORIC TAGGING AND RECRUITMENT SURVEYS

28. Survey results were compared with the Gladstone area (Suntag maps Curtis Island Gladstone CISG, Gladstone harbour GLD and Boyne River BRG) and the Fitzroy River (Suntag maps Fitzroy River Rockhampton FRR, Raglan Creek RAG and Curtis Island CIS) and with historic recruitment surveys undertaken from 1999-2004 and 2012-2014. Maps are available from the Suntag website at www.suntag.org.au.

SITE LOCATIONS AND SURVEYS

There were 14 sites where surveys were undertaken in the Calliope River and tributaries. One site was surveyed once on an opportunistic basis. *Figure 4* shows the locations of sites and the Suntag grid map CR02 and *table 1* lists the sites with survey summaries. Sites were selected to include a range of habitat types used by juvenile fish. Details of sites are stored in the Infofish 2015 database along with photographs of each site and a Google Earth map showing the location of the site. Details of the sites are contained in Appendix 1.

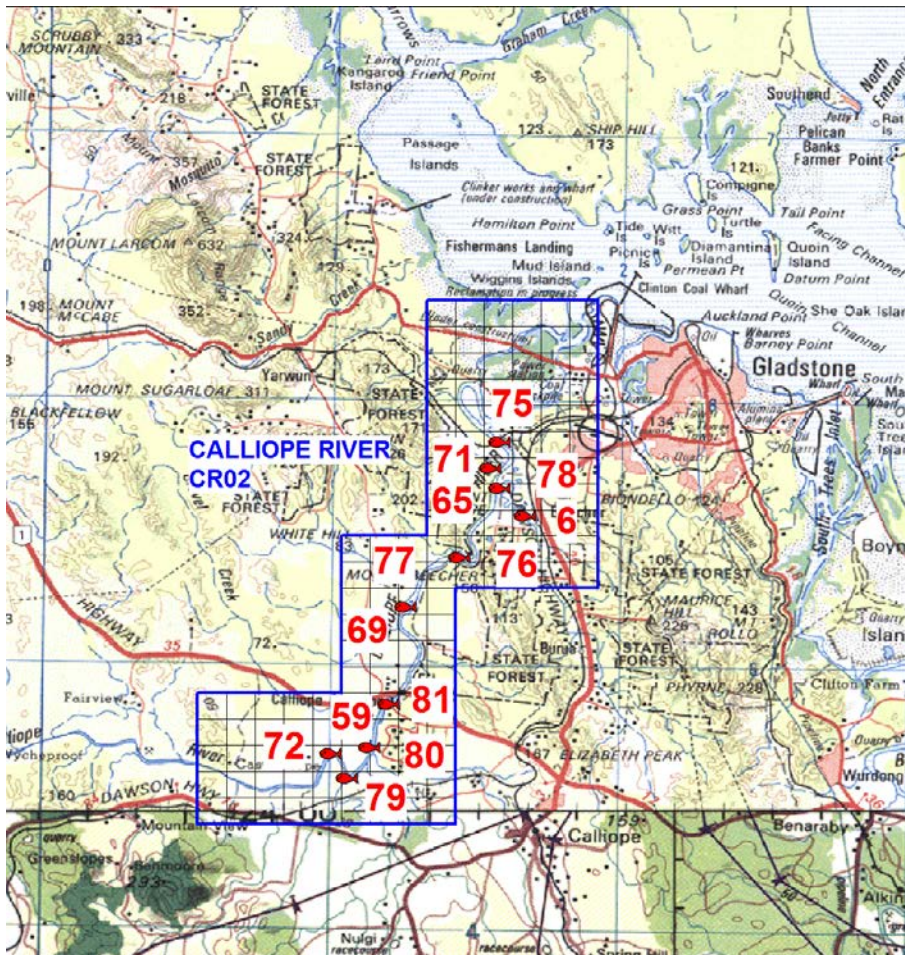


Figure 4: Site locations in the Calliope study area and Suntag grid map CR02

Table 1: Sites and surveys

Site ID	Site Name	Surveys	Casts
75	CALLIOPE RAIL BRIDGE	3	30
71	CALLIOPE DRAIN 1	3	30
65	CALLIOPE GRAVELBAR	2	20
78	BEECHER CREEK MOUTH	3	30
6	BEECHER CREEK	4	80
77	DEVILS ELBOW DRAIN	1	5
76	CALLIOPE DEVILS ELBOW	3	60
69	FARMERS ISLAND	2	40
70	FARMERS ISLAND DRAIN	1	10
81	OLD BRUCE HIGHWAY BRIDGE	3	30
59	HISTORICAL VILLAGE	3	50
80	OPPOSITE LEIXLIP CREEK	3	30
79	CALLIOPE BACKWATER	3	60
72	CALLIOPE SPLIT CHANNEL	3	60
	TOTAL	37	535

RESULTS

SUMMARY OF SURVEYS

There were a total of 37 surveys undertaken from 16/2/2015-4/5/2015. A total of 37 fish and prawn species were recorded with 1,814 individuals recorded. *Figure 5* shows the number of sites where each species was recorded and the total number of each species. A list of all species including scientific names is shown in Appendix 2.

Flattail Mullet was the only species recorded at all 14 sites while Sea Mullet and Estuary Glassfish were recorded at 13 sites. Yellowfin Bream were recorded at 12 sites, Pikey Bream at 7 sites and Barramundi at 2 sites.

Flattail Mullet (454) was the most caught species, second was Estuary Glassfish (266) and Sea Mullet (243) was third. Yellowfin Bream ranked at 4, Pikey Bream at 8 and Barramundi at 23.

Catch rates were calculated for each site based on the number of casts. Catch rates were standardised as fish/10 casts. The overall catch rate was 33.9 fish/10 casts. *Figure 6* shows the catch rate at each site. Catch rates for sites below the Old Bruce Highway Bridge (lower Calliope) were generally higher, but not significantly different, than catch rates above the bridge (upper Calliope). The bridge forms an artificial barrier that maintains water levels above the bridge when the tide goes out. At low tide there is around 1m or more difference in water level with an extensive riffle that separates the 2 parts of the river. This limits the opportunity for fish to move upstream to periods around high tide.

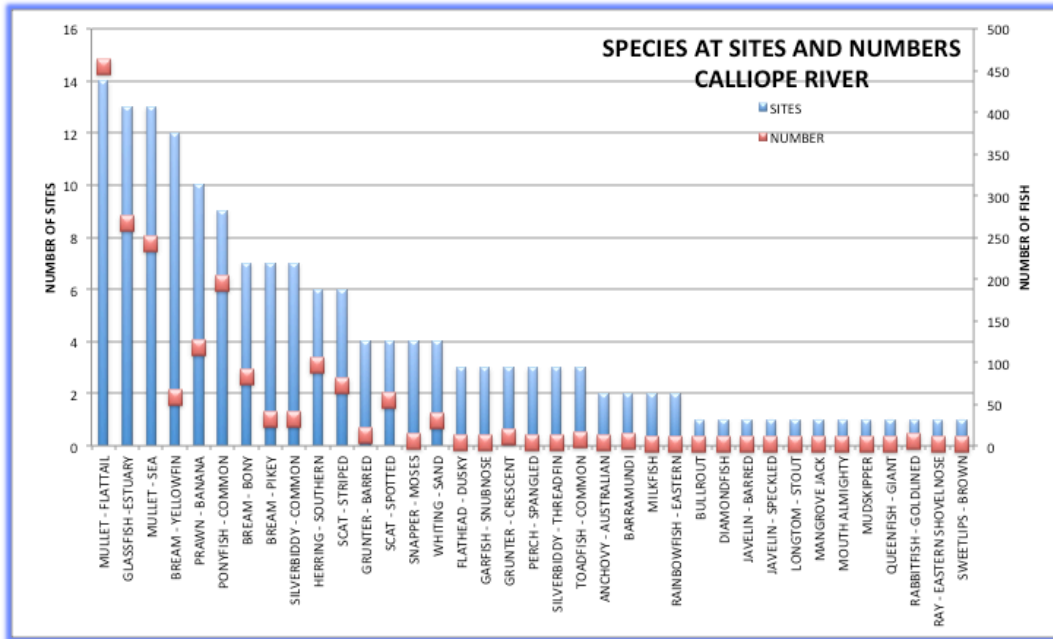


Figure 5: Number of sites where species were recorded

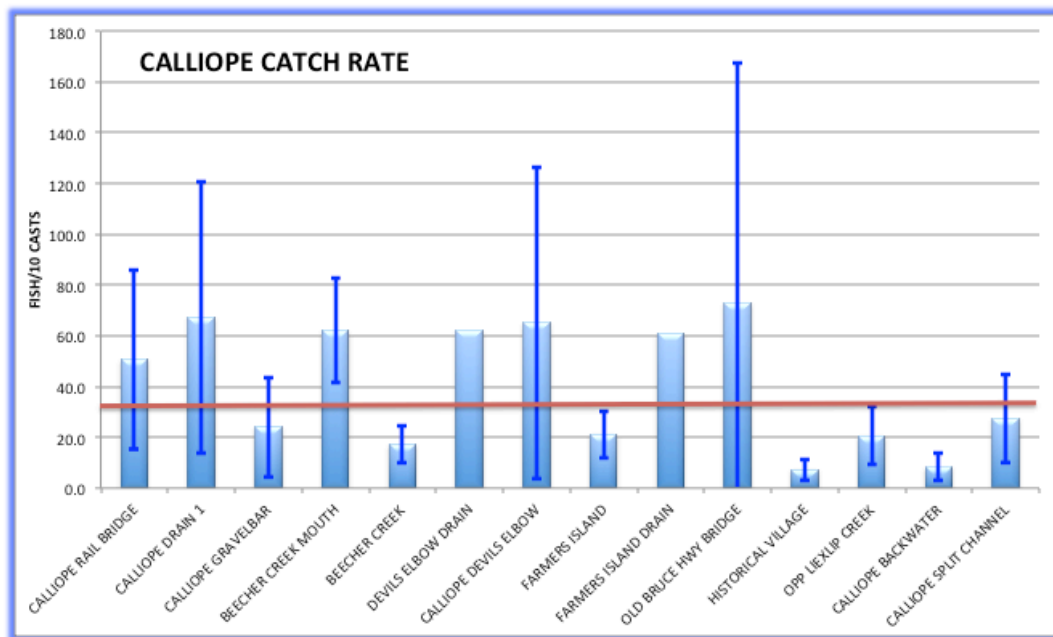


Figure 6: Castnet surveys catch rates (10 casts) at survey sites in Calliope River

Catch rates ranged from a low of 7.3 fish/10 casts at the Historical Village to a high of 73.0 fish/10 casts at the Old Bruce Highway Bridge. These sites are adjacent to each other above and below the bridge and this supports the reduced opportunity for fish to move upstream.

Figure 7 shows the catch rates for the key species Flattail Mullet, Sea Mullet, Yellowfin Bream, Pikey Bream and Barramundi in the Calliope River and Gladstone from Feb-Apr 2015. While there are differences in the catch rates they were not significant.

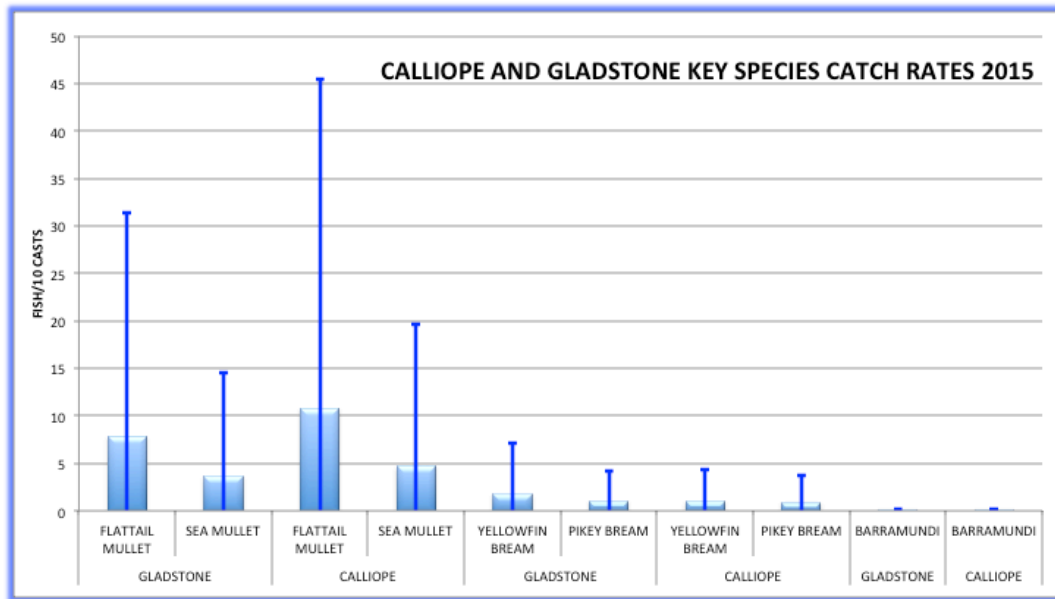


Figure 7: Catch rates (10 casts) for key species in Calliope River and Gladstone Feb-Apr 2015

BARRAMUNDI

There were 6 Barramundi recruits recorded at 2 sites in the upper Calliope River above the Old Bruce Highway Bridge. The sites were Calliope Backwater (5 fish) and Opposite Liexlip Creek (1 fish). A further fish was confirmed as caught in a castnet by a recreational fisher at the Historical Village. There were no Barramundi recruits from the lower Calliope River recorded during recruitment surveys and no reports from other fishers.

Barramundi recruitment surveys in the Calliope River (map CR02) were compared with surveys in the remaining Gladstone area (maps CISG, GLD and BRG) and the Fitzroy River (maps FRR, RAG and CIS)¹. From Feb-Apr there were 56 fish recorded in the Fitzroy River, 10 in Gladstone and 6 in the Calliope River. *Figure 8* shows the catch rate standardised to 10 casts. Catch rates for the Fitzroy River were significantly higher than for the Calliope River and Gladstone.

Figure 9 shows the daily flow in ML in the Calliope River and Barramundi recruits recorded in the Calliope River and the Gladstone area with the survey periods shown in red boxes. The flows on 20-21 Feb resulted from Cyclone Marcia and coincided with the highest spring tides of the year from 18-21 Feb with recruits recorded shortly after. No recruits were recorded prior to these events. Historically in many years recruits are not recorded until after the Feb spring tides.

Figure 10 shows the lengths of individual fish recorded from Feb-Apr 2015 in each area with the survey periods shown in red boxes. It was not possible to determine growth rates of Barramundi recruits during the study period. The size range of fish suggests that there were a number of successful spawning events during the spawning period from Oct-Jan and shows the growth of fish over time. Historical data suggests that recruits are generally 50-250mm in Jan-Feb, 100-300mm in Mar-Apr and 150-350mm in May-Jun.

¹ Maps available from www.suntag.org.au

Figure 11 shows where recruits were recorded at 2 sites in the upper Calliope River and at 2 sites during historical recruitment surveys. There was also one other fish where another fish was confirmed caught by a recreational fisher in a castnet. There were 4 other sites in the Gladstone area and 9 sites in the Fitzroy estuary where Barramundi recruits were recorded in 2015.

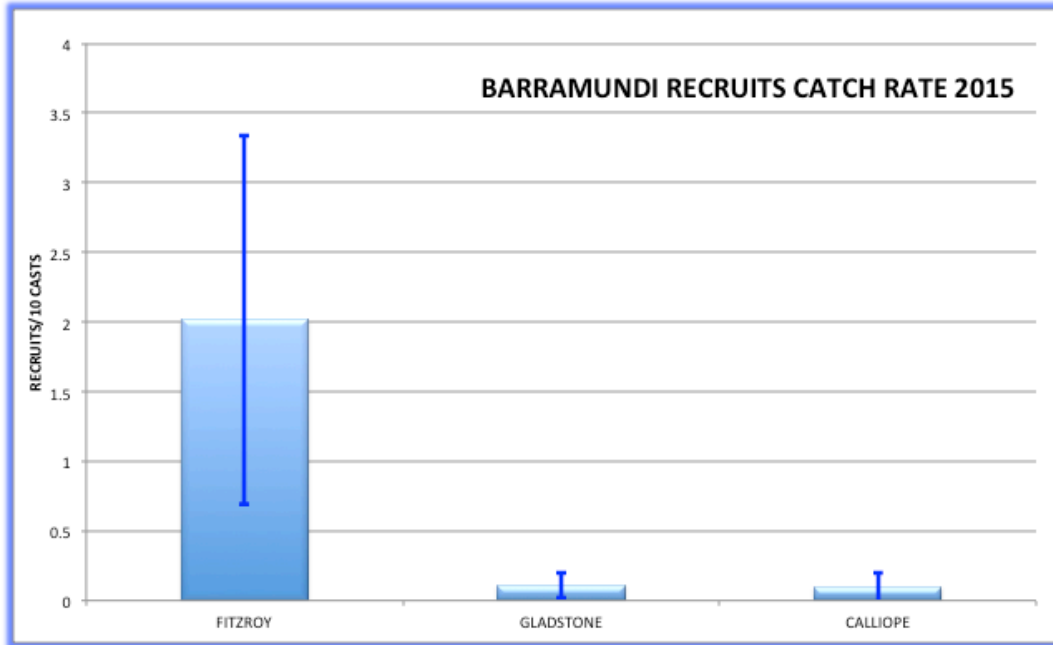


Figure 8: Catch rate (10 casts) of Barramundi recruits Feb-Apr 2015

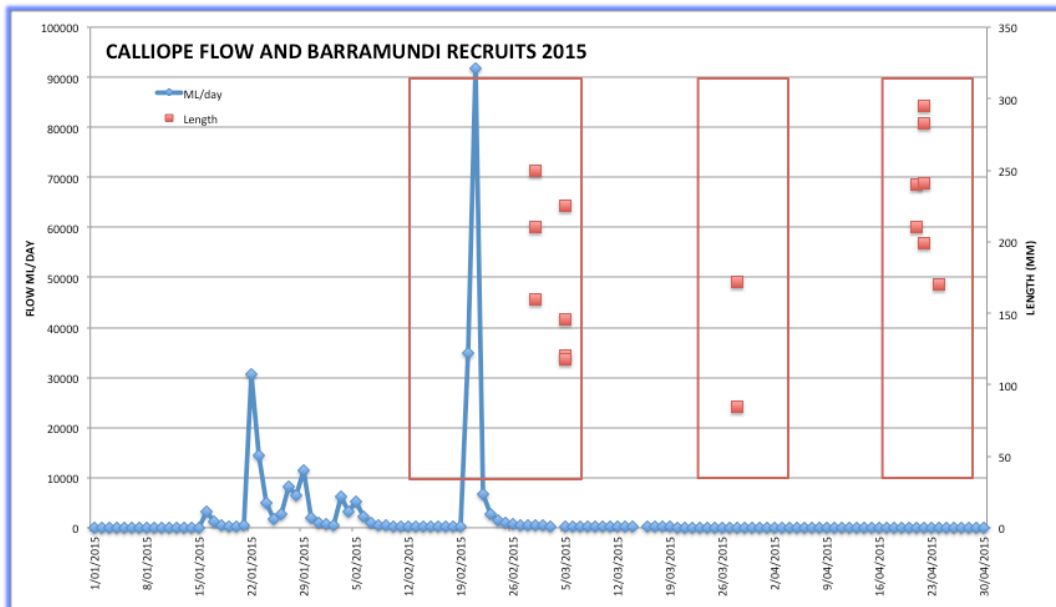


Figure 9: Calliope River daily flows and Barramundi recruits Calliope River and Gladstone Feb-Apr 2015 showing survey periods each month (red boxes)

BREAM

Bream (Yellowfin and Pikey) are the most caught species by recreational fishers in the Gladstone area comprising 20.7% of the catch and 20.3% of the kept catch from 2006-2014 (Sawynok et al 2015) Therefore Bream recruitment is important for maintenance of fish stocks.

Both species of Bream spawn from May-Aug and then recruits make their way to all parts of the estuary. As part of the Gladstone Healthy Harbour project, surveys commenced in Nov 2014 and Bream recruits were recorded then and in each month since then.

From Feb-Apr, in the Calliope River there were 58 Yellowfin Bream recorded at 12 sites (all except sites 70 and 80) and 32 Pikey Bream at 7 sites. Pikey Bream were recorded at 7 of the 8 sites in the lower Calliope below the Old Bruce Highway Bridge and were not recorded at any site in the upper Calliope.

Figure 12 shows the catch rate for Bream in the Gladstone area and Calliope River from Feb-Apr 2015. The catch rate in the Gladstone area was higher for both species although the difference was not significant.

Figure 13 shows the daily flow in the Calliope River and length of Bream recruits in the Calliope River from Feb-Apr 2015 showing survey periods each month (red boxes). The length of Yellowfin Bream recruits ranged from 44-120mm and Pikey Bream recruits ranged from 42-80mm. It also shows the growth of recruits over time. The flows on 21-24 Feb 2015 did not appear to have any effect on the distribution of recruits.

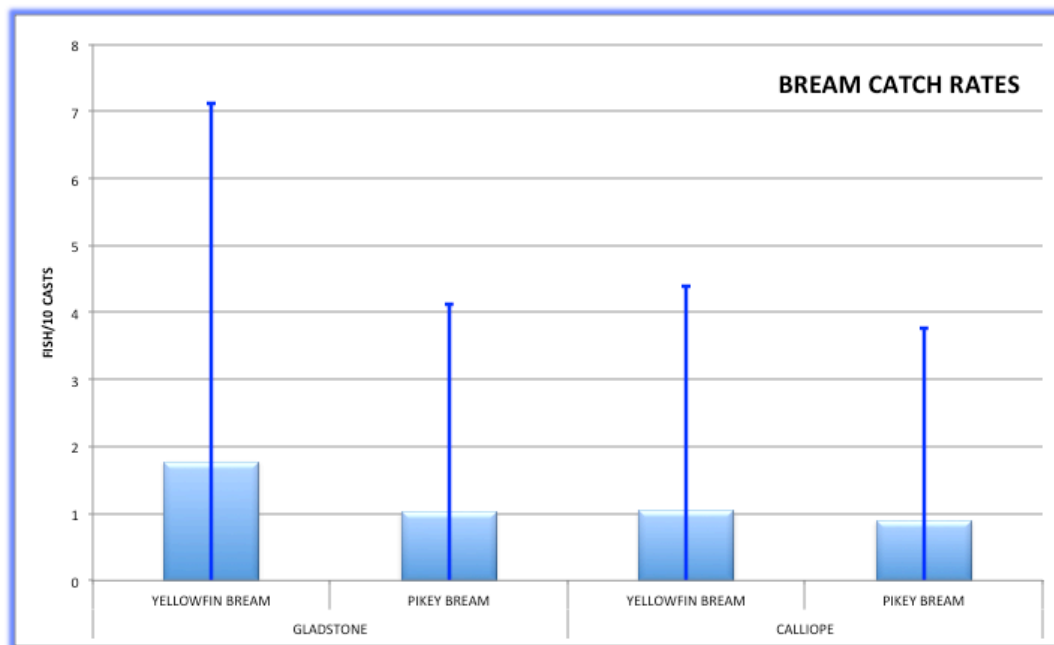


Figure 12: Catch rates for Bream in Gladstone and Calliope River Feb-Apr 2015

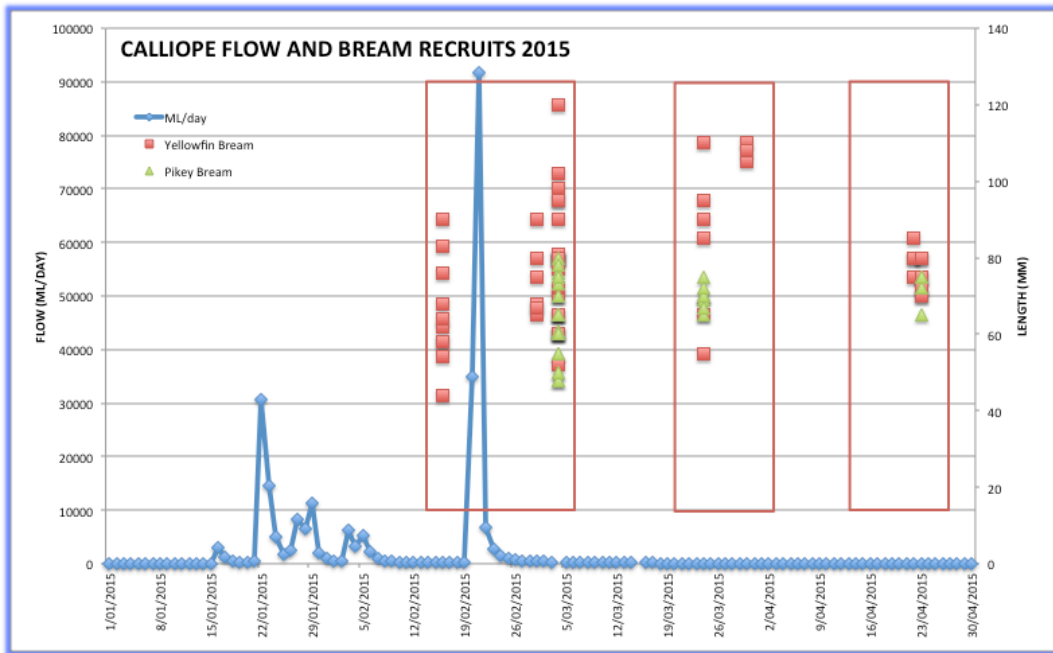


Figure 13: Calliope River daily flows and Bream recruits Calliope River Feb-Apr 2015 showing survey periods each month (red boxes)

Figure 14 shows the locations where Yellowfin Bream recruits were recorded and figure 15 shows the locations where Pikey Bream recruits were recorded from Feb-Apr 2015. Yellowfin Bream recruits were recorded throughout the project area while Pikey Bream were only recorded in the lower Calliope River.

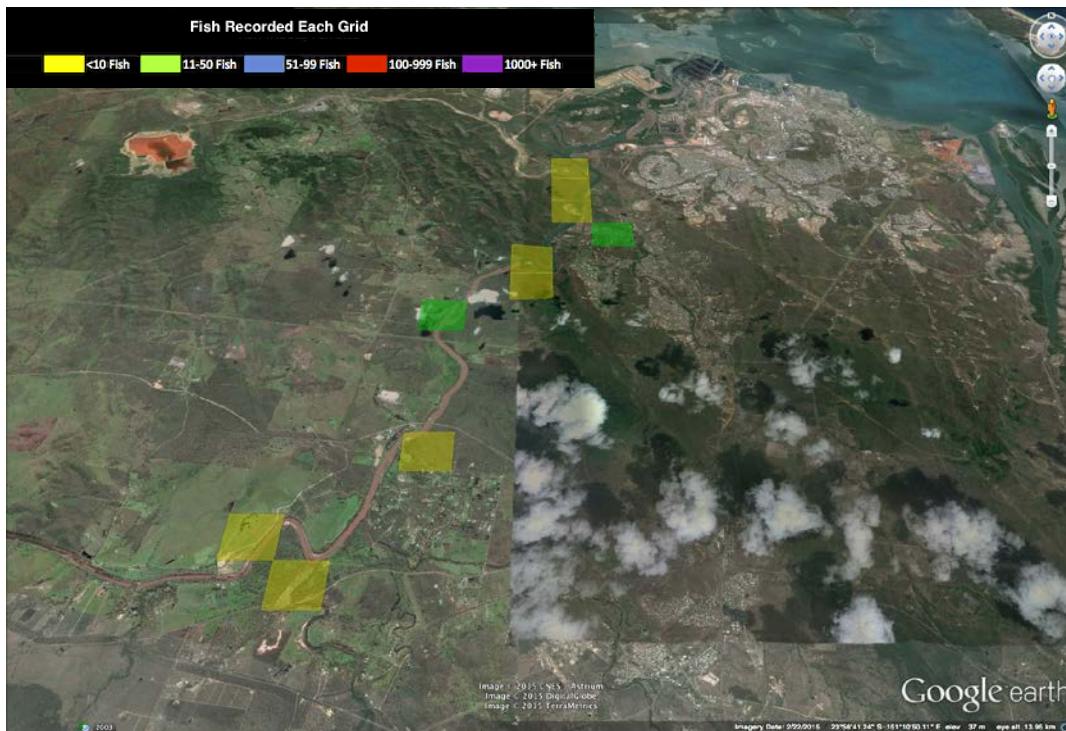


Figure 14: Locations where Yellowfin Bream recruits were recorded in 2015



Figure 15: Locations where Pikey Bream recruits were recorded in 2015

MULLET

Mullet are important species in the region for commercial fishers and for bait for recreational fishers. Mullet (Flattail and Sea) were the most common and widespread species caught with Flattail Mullet being recorded at all 14 sites while Sea Mullet were recorded at 13 sites in the Calliope River.

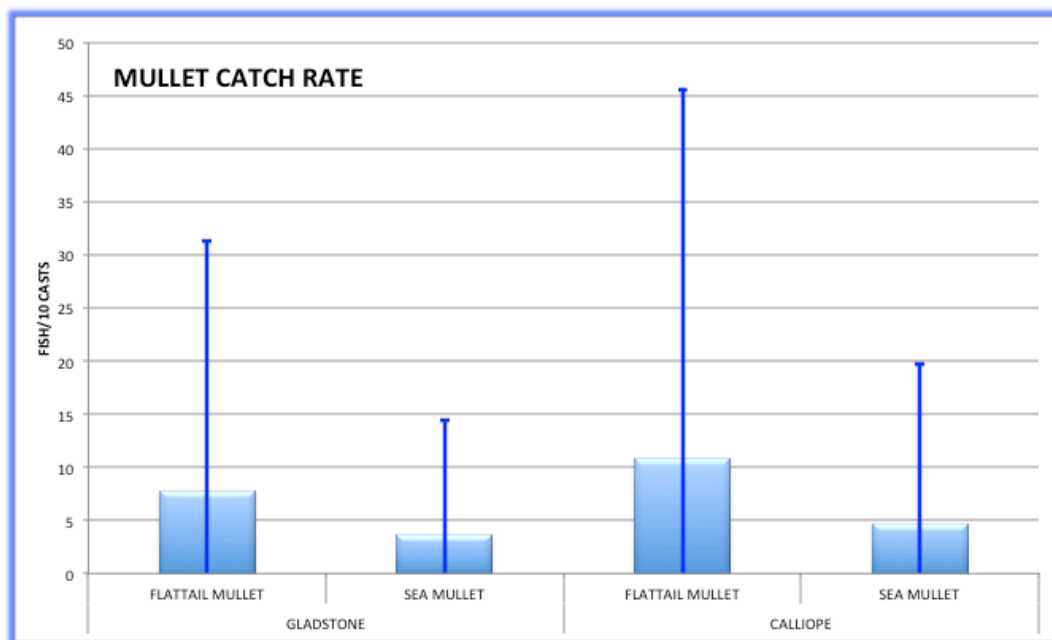


Figure 16: Catch rates for Mullet in the Gladstone and Calliope River Feb-Apr 2015

Figure 16 shows the catch rate for Mullet in the Gladstone area and the Calliope River from Feb-Apr 2015. Catch rates for Mullet were slightly higher in the Calliope River, however the differences were not significant.

Figure 17 shows the daily flow in the Calliope River and the length of Mullet. The length of Flattail Mullet ranged from 44-380mm and for Sea Mullet ranged from 40-210mm. Figure 18 shows the locations where Flattail Mullet were recorded and figure 19 shows the locations where Sea Mullet were recorded. Both species of Mullet were widely distributed throughout the study area.

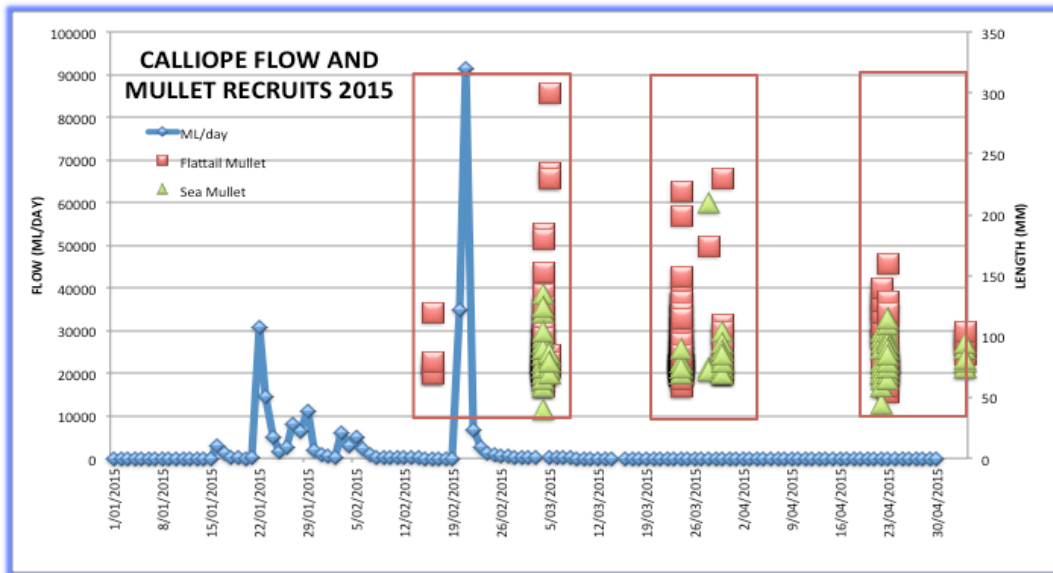


Figure 17: Calliope River daily flows and Mullet recruits showing survey periods each month (red boxes)

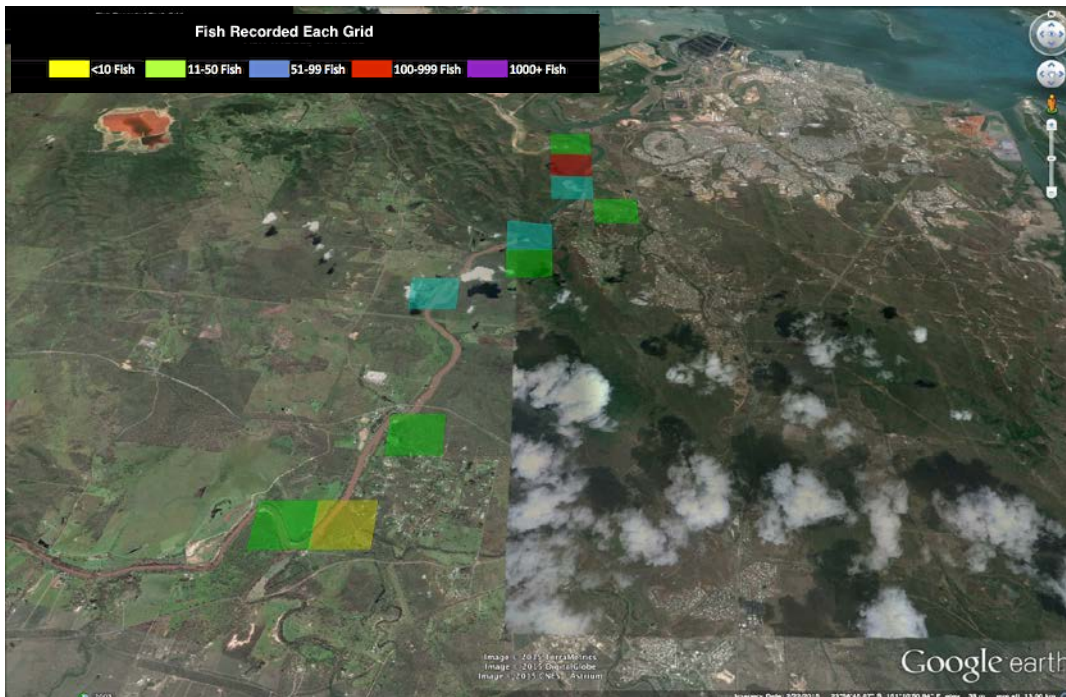


Figure 18: Locations where Flattail Mullet recruits were recorded Feb-Apr 2015

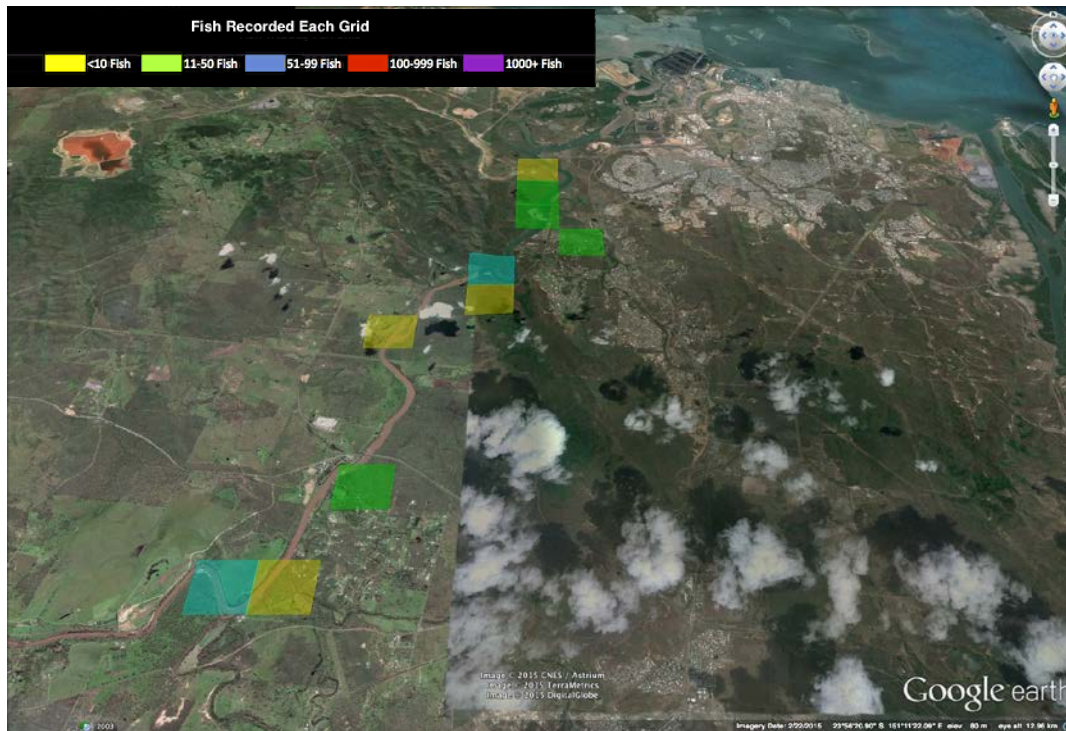


Figure 19: Locations where Sea Mullet recruits were recorded Feb-Apr 2015

OTHER SPECIES

There were 6 other species of recreational, commercial or indigenous interest that were recorded during recruitment surveys in the Calliope River as shown in *table 2*. There is a significant commercial Banana Prawn fishery in the region with a catch of 134.42t in 2014 in Gladstone Harbour (commercial fish grid S30).² *Figure 20* shows a Mangrove Jack recruit recorded at the Historical Village (site 59).

Table 2: Other species of recreational, commercial and indigenous interest

SPECIES	SITES	NUMBER
FLATHEAD - DUSKY	3	4
JAVELIN - BARRED	1	1
JAVELIN - SPECKLED	1	1
MANGROVE JACK	1	1
PRAWN - BANANA	10	118
WHITING - SAND	4	30

² From <http://qfish.daff.qld.gov.au/>



Figure 20: Mangrove Jack recruit at the Historical Village

HISTORICAL BARRAMUNDI TAGGED IN CALLIOPE RIVER

From 1985-2014 fish, including Barramundi, were tagged in the Calliope River under the Suntag program. Results of that tagging have been included in the Gladfish reports. Of relevance to this study is the timeline of Barramundi tagged in the Calliope River over that time.

Figure 21 shows the timeline of lengths of tagged Barramundi in the Calliope River from 1985-2014 and river flows. This indicates a number of recruitment events where recruits were recorded following above wet season average flows in Jan-Feb in 1996, 2003, 2004, 2005, 2008, 2009 and 2010.

In 2011 there was a significant increase in large Barramundi numbers following the spilling of fish from Lake Awoonga when it overflowed the spillway due to extensive flooding. *Figure 22* shows the numbers and locations where Barramundi were tagged in the Calliope River from 1985-2014. Locations were recorded within 1km² grids on Suntag grid map CR02 and there were 60 grids where Barramundi were tagged. There were 14 grids where over 100 fish were tagged with the most tagged at CR02/D10, the hot water outlet at the power station.

In the lower Calliope there were 48 grids with an average of 69.5 fish tagged. In the upper Calliope there were 12 grids with an average of 156.3 tagged. This shows that most Barramundi were tagged in the upper Calliope River and in the lower reaches of the lower Calliope River including at the hot water outlet at the power station.

Figure 23 shows where and the time of year first year Barramundi recruits were recorded in the Calliope River from 1985-2015 from both recruitment surveys and tagging. There were 18 grids in map CR02 where recruits were tagged. This shows that recruits have been recorded throughout much of the river

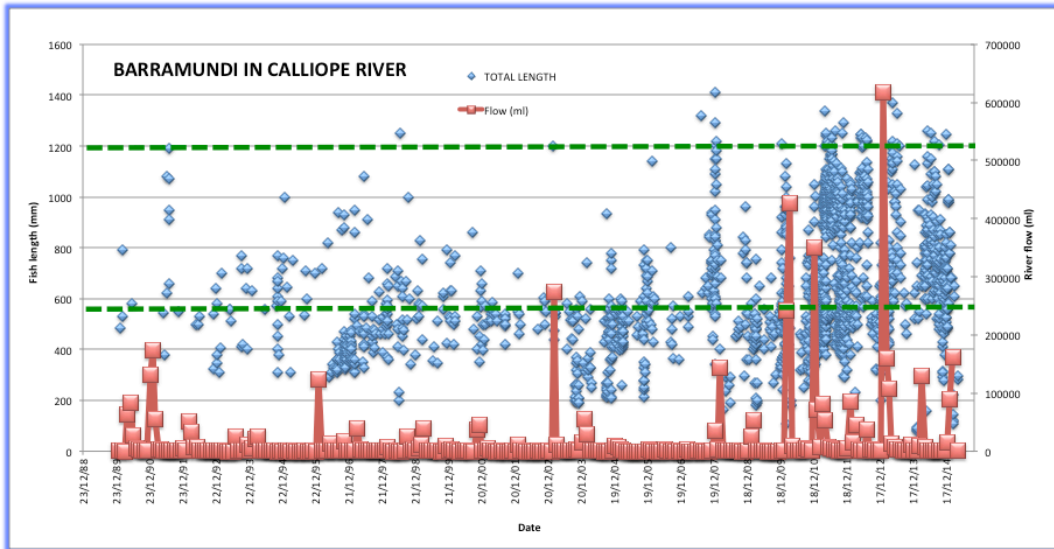


Figure 21: Timeline of Barramundi in the Calliope River 1985-2014 (green lines show minimum and maximum legal lengths)

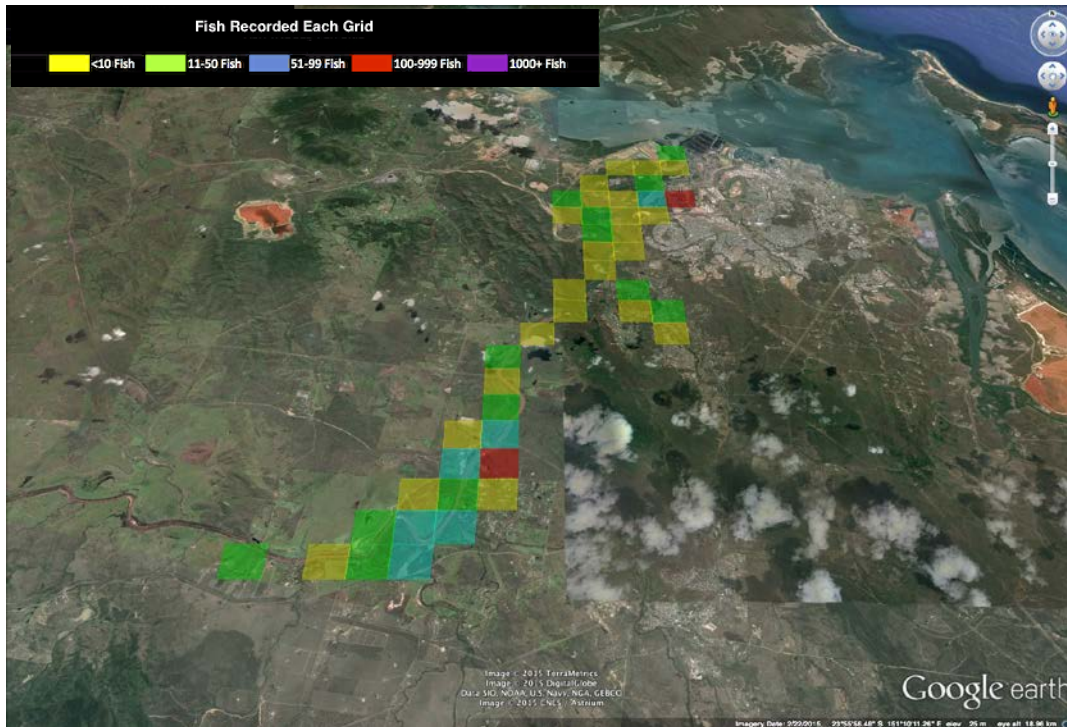


Figure 22: Locations Barramundi tagged in the Calliope River 1985-2014

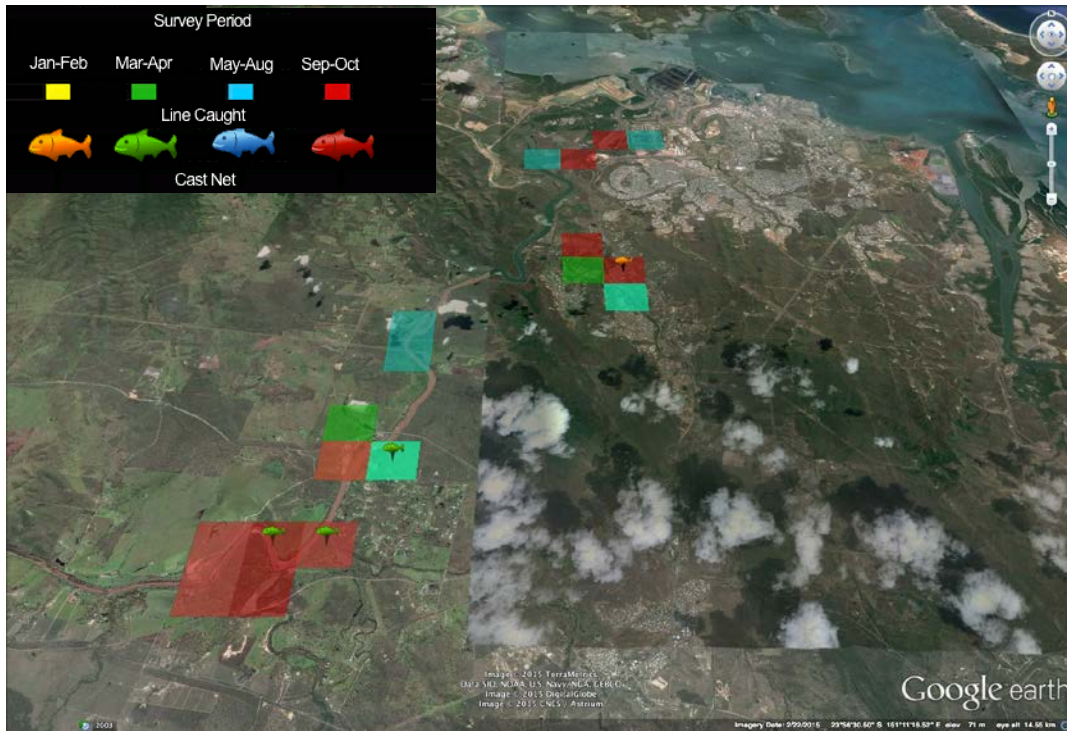


Figure 23: Locations first year Barramundi recorded in the Calliope River 1985-2015

HISTORICAL RECRUITMENT SURVEYS IN CALLIOPE RIVER

From 2000-2004 recruitment surveys were undertaken, using the same methods as used in the current project, at Beecher Creek (site 6). From 2012-2014 further recruitment surveys were carried out at Beecher Creek (site 6). In 2014 there were 2 surveys at Historical Village (site 59).

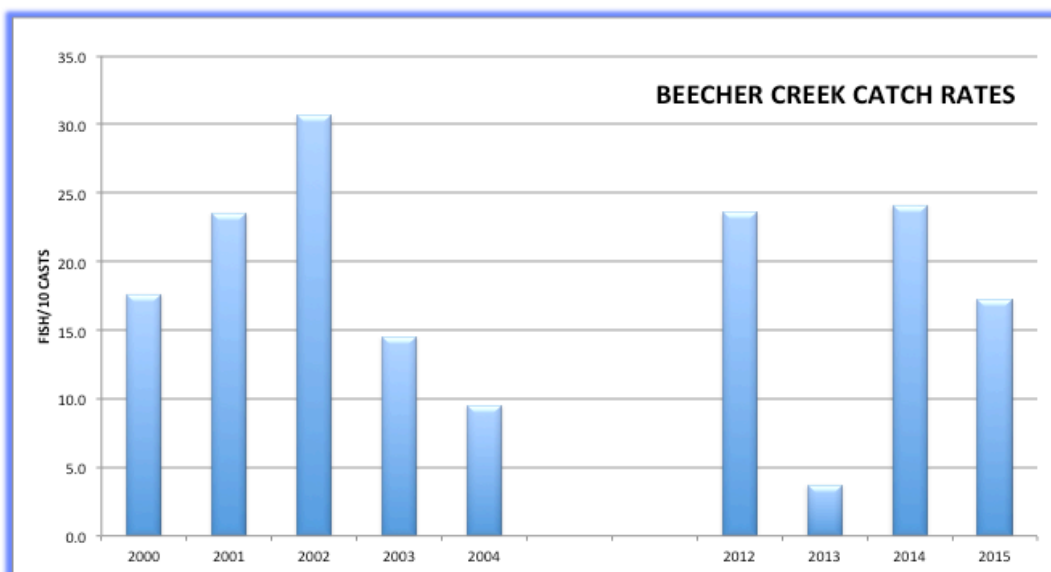


Figure 24: Catch rates (10 casts) for Beecher Creek recruitment surveys 2000-2015

From 2000-2014 there were 36 surveys with 700 casts at Beecher Creek with 36 species and 1,430 individuals recorded. Of those species there were 27 that were also recorded in 2015 and 9 that were not recorded. A summary of surveys is in Appendix 3.

Figure 24 shows the catch rates for each year. It should be noted that the catch rates for 2003 and 2004 were from 1 survey in each year. In 2013 Cyclone Oswald resulted in record rainfall in the area during the period when recruitment surveys were undertaken and influenced the low catch rate. This was mainly due to the dispersal of fish by the flooding away from the survey site.

Figure 25 shows the numbers of Barramundi recruits recorded during recruitment surveys and tagging trips in Beecher Creek, in the area of site 6, from 2000-2015. There were 18 recruits recorded in 2003 and 22 in 2004. In 2012 there were 5 recruits recorded and 1 recruit each year in 2013 and 2014. No recruits were recorded in 2015. This indicates that Beecher Creek is an important habitat for Barramundi recruits even though they were not recorded there in all years.

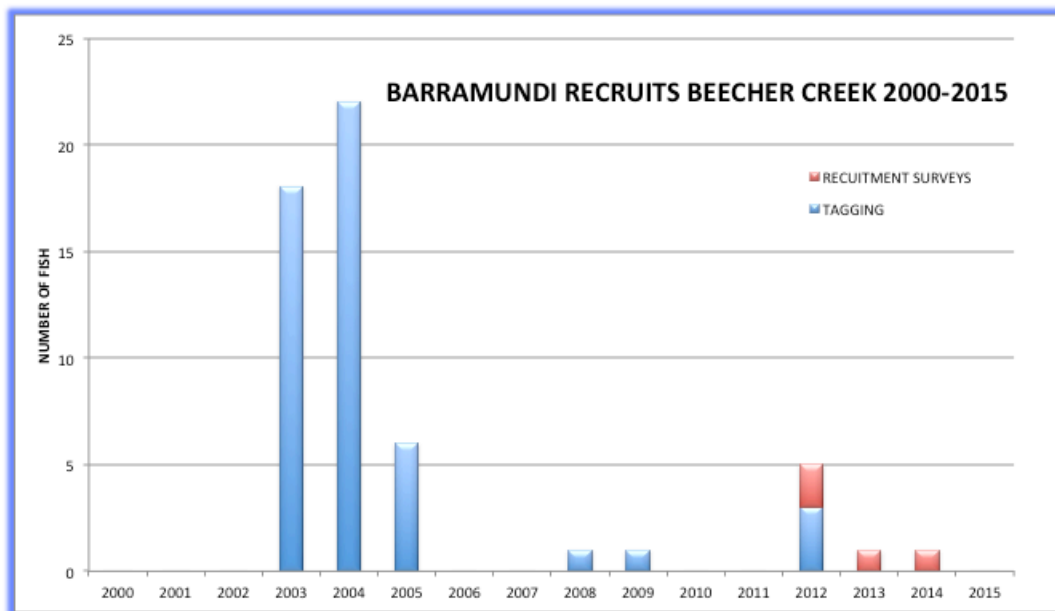


Figure 25: Barramundi recruits recorded in Beecher Creek from 2000-2015

In 2014 there were 2 surveys with 30 casts at Historical Village with 5 species and 65 individuals, including 4 Barramundi recorded. A summary of surveys is in Appendix 3.

WATER QUALITY

Water quality parameters of temperature, salinity, pH, total dissolved solids (TDS), conductivity, dissolved oxygen and turbidity were measured. During surveys a total of 29 water quality readings were taken at 12 sites. Readings are shown in Appendix 4. No readings were taken at site 81 Old Bruce Highway Bridge as this was adjacent to site 59 Historical Village and readings would be similar. Also readings at site 65 Calliope Gravelbar and site 78 Beecher Creek Mouth were considered to be similar. No readings were taken at site 6 Beecher Creek as these surveys were undertaken at a different time

when the equipment was not available. Water quality parameters were considered to be within an acceptable range.

Salinity was affected by freshwater flows in Jan-Feb with salinity in the upper Calliope (0.1-05%) and lower Calliope being mostly low in early Mar (2-5%) except at the 2 sites in the lowest reaches (18%). Later in Mar-Apr salinity was significantly higher (18-34%) in the lower Calliope than in the upper Calliope (0.1-3%). Salinity in the upper Calliope remained low throughout the survey period (0.1-3%).

Water temperatures ranges from a high of 31.5°C in early Mar at Farmers Island to a low of 23.4°C in late Apr at Calliope Split Channel.

DISCUSSION

While there were only 6 Barramundi recruits recorded during recruitment surveys data from historic surveys and tagging indicate that recruits use most areas of the proposed FHA. Recruits in 2015 were only recorded in the upper Calliope with 5 fish recorded in the Calliope Backwater, which is within the boundary of the area of interest. This is considered to be some of the most suitable habitat for juvenile Barramundi in the proposed FHA based on the survey data. From the historic data Beecher Creek is also suitable habitat for Barramundi recruits.

Barramundi catch rates of recruits in the Calliope River were similar to that in the Gladstone area but significantly lower than in the Fitzroy River, however this was consistent with historic recruitment patterns.

Cyclone Marcia was responsible for the flooding in the river on 20-21 Feb. This coincided with the largest spring tides for the year from 18-21 Feb. These conditions allowed recruits to move up the river into nursery areas at the upper areas of the tidal limit and into the freshwater reaches. These conditions are likely to have allowed recruits to move upstream well beyond the upper limit of the proposed FHA resulting in fewer recruits in the proposed area. In years when these conditions don't occur there are likely to be more recruits in the upper areas of the proposed FHA.

It was not possible to determine growth rates of Barramundi recruits during the study period. The size range of fish suggests that there were a number of successful spawning events during the spawning period from Oct-Jan. The size of recruits recorded during the 3 survey periods were consistent with the size of fish recorded in the Gladstone area and in the Fitzroy River.

The Calliope River and the Gladstone area are of local importance for Barramundi recruits whereas the Fitzroy River is of regional importance.

The Old Bruce Highway Bridge provides an artificial barrier that divides the lower and upper parts of the river. The barrier only allows fish to access the upper river around the high tide period of larger tides. This limits the opportunity for recruits to move into the upper Calliope. This is supported by the lower catch rates for the upper Calliope. While not significantly different it is likely to be why there were no Pikey Bream recruits recorded in the upper reaches of the river. It may also be related to the low salinity levels in the upper Calliope from Feb-Apr.

While for species other than Barramundi there were fewer recruits in the upper Calliope River this may only relate to the survey period and it is likely that in other years there may be more recruits of other species.

Yellowfin Bream were recorded throughout the proposed FHA while Pikey Bream were only recorded from the lower Calliope. Bream recruits of both species were also recorded at most sites in the Gladstone area. This indicated widespread distribution of Bream recruits throughout the entire area and supports the value of the Calliope River for Bream recruits. While the catch rates for Bream were lower in the Calliope River than in the Gladstone area that was not significant.

Mullet are important for commercial fishers, recreational fishers for bait and a food fish for the higher end predatory fish such as Barramundi and Mangrove Jack so their wide distribution is important for stocks of those fish. Both Flattail and Sea Mullet were the most numerous and widespread species recorded in the Calliope River and also in the Gladstone area utilising the widest range of habitats. The catch rates for Mullet were slightly higher in the Calliope River than in the Gladstone area but the differences were not significant.

The Calliope River and the Gladstone area are of local importance to Barramundi, Bream, Mullet, Banana Prawn and a range of other species of commercial, recreational and indigenous importance. They are also important for a range of species not considered being of commercial, recreational or indigenous significance but are important from an overall ecological perspective.

REFERENCES


- Brown G (2007): Age of Bream: AusBream Forum <http://www.ausbream.com.au/>
- Cowden K (1995): Induced Spawning and Culture of Yellowfin Bream, Yellowfin Bream, *Acanthopagrus australis* (Gunther) and Mangrove Jack, *Lutjanus argentimaculatus*, (Forsskal, 1775): PhD thesis, James Cook University
:<http://eprints.jcu.edu.au/24101/>
- Davis TLO (1986): Biology of wildstock *Lates calcarifer* in Northern Australia: Management of Wild and Cultured Sea Bass – Barramundi (*Lates calcarifer*): Proceedings on an International Workshop in Darwin 24-30 June 1986 (38-43)
- Davis TLO and Kirkwood GP (1984): Age and Growth Studies on Barramundi *Lates calcarifer* (Bloch), in Northern Australia: Aust Journal of Marine and Freshwater Research 35 (673-689)
- Moore R (1979): Natural sex inversion in Giant Perch (*Lates calcarifer*): Aust Journal of Marine and Freshwater Research 30 (803-813)
- Moore R (1982): Spawning and Early Life History of barramundi (*Lates calcarifer*), in Papua New Guinea: Aust Journal of Marine and Freshwater Research 33 (647-661)
- Pollock BR (1982a): Movement and migration of Yellowfin Bream, *Acanthopagrus australis* (Gunther), In Moreton Bay, Queensland as determined by tag recoveries: Journal of Fish Biology 20 (245-252)
- Pollock BR (1982b): Spawning period and growth of Yellowfin Bream, *Acanthopagrus australis* (Gunther), in Moreton Bay, Australia: Journal of Fish Biology 21 (349-355)
- Pollock BR (2011): Bream Biology: AusBream Forum www.sqafca.com.au
- Sawynok (2002): Barramundi Nursery Areas in Central Queensland: www.crystal-bowl.com/barramundi-nursery-areas-in-central-queensland-2002
- Sawynok W, Platten J, Parsons W and Sawynok S (2015): Gladfish 2014 www.info-fish.net/gladfish


APPENDIX 1 – SURVEY SITES

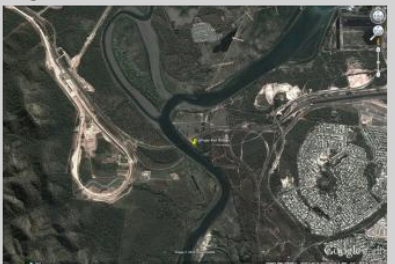
Site details, as stored in the Infofish 2015 database, along with a more detailed description of the habitat and how surveyed.

Site Id: 75
 Location: CALLIOPE RAIL BRIDGE
 Map: CR02
 Grid: F7
 Lat: -23.874
 Long: 151.19

Description: Under southern railway bridge over the Calliope River on east side


Image: 
 Image


Second Image: 
 Image

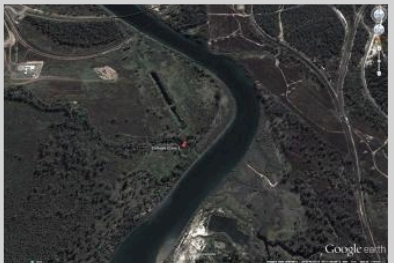
Third Image: 
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Site Id: 71
 Location: CALLIOPE DRAIN 1
 Map: CR02
 Grid: G7
 Lat: -23.882
 Long: 151.19

Description: Tidal limit in small stoney drain downstream for Beecher Creek on western side to river

Image: 
 Image

Second Image: 
 Image


Third Image: 
 Image


The site is on the lower boundary of the proposed FHA and is under the western rail bridge over the Calliope River. It is mostly a gravel bank with small mud drains either side of the bridge. Along the bank on either side is a thin ribbon of mangroves.
 Survey timing: Around high tide
 Standard number of casts: 10

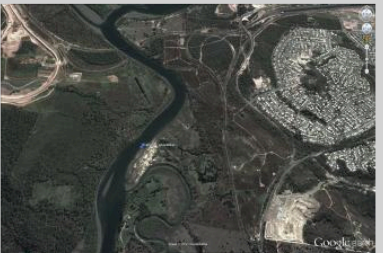
This site is at the upper tidal limit of a small creek that drains into the Calliope River on the western side about 1km upstream from the rail bridges. The creek bed is mostly coarse gravel and there are a number of small pools formed as the tide recedes. There are a small number of mangroves along the bank.
 Survey timing: Around high tide
 Standard number of casts: 10

Site Id: 65
 Location: CALLIOPE GRAVELBAR
 Map: CR02
 Grid: G7
 Lat: -23.887
 Long: 151.189

Description: Gravel/Sandbar in Calliope River downstream of mouth of Beecher Creek


Image: 


Second Image: 

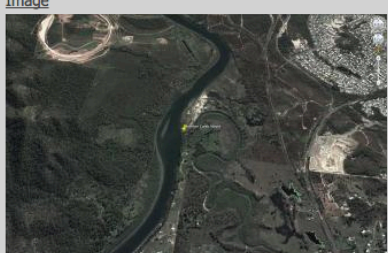
Third Image: 

Site Id: 78
 Location: BEECHER CREEK MOUTH
 Map: CR02
 Grid: H7
 Lat: -23.89
 Long: 151.189

Description: Gravel and mud bank on north side of mouth of Beecher Creek

Image: 


Second Image: 


Third Image: 

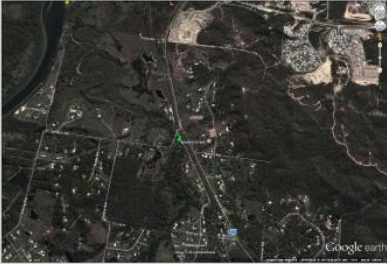
<p>The site is a gravel and sand bar about 100-200m long that is exposed at low tide and is about 2km upstream from the rail bridge. The bar is undulating with many small gutters and channels up to 1m in depth. Survey timing: Around low tide Standard number of casts: 10</p>	<p>This site is on the northern bank at the mouth of Beecher Creek. It is a combination of sand, mud and gravel with small undulations. Survey timing: From low tide to high tide Standard number of casts: 10</p>
--	--

Site Id: 6
 Location: BEECHER CREEK
 Map: CR02
 Grid: I8
 Lat: -23.923
 Long: 151.207

Description: Hole at top end of Beecher Creek and freshwater hole above tidal limit


Image: 


Second Image: 


Third Image: 

Site Id: 77
 Location: DEVILS ELBOW DRAIN
 Map: CR02
 Grid: K6
 Lat: -23.917
 Long: 151.179

Description: Small drain on south side bank at Devils Elbow

Image: 

Second Image: 

Third Image: 

The site is at the upper tidal limit of Beecher Creek above the causeway on Beecher Creek Road. There are 2 large pools above the causeway. The first one is immediately above the causeway and is about 150m long. This pool has a base of solid rock with gravel areas. A series of shallow riffles and runs extends for about 150m to the second pool that is 100m long. The second pool has a coarse gravel base.


Survey timing: Most times except high tide
 Standard number of casts: 20 (10 in each pool)


This site is a very small mud drain on the southern side of the river just downstream from Devils Elbow on the Calliope River. There is a small gravelbar on the river side of the drain. The site was surveyed once only on an opportunity basis.

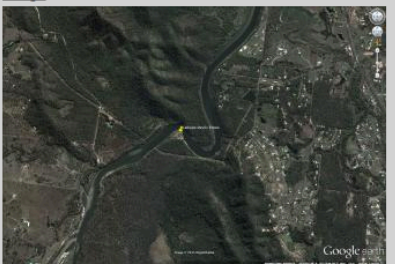
Survey timing: Around low tide
 Standard number of casts: 5

Site Id: 76
 Location: CALLIOPE DEVILS ELBOW
 Map: CR02
 Grid: J6
 Lat: -23.915
 Long: 151.176

Description: Sandbank at Devils Elbow draining off flat

Image: 
[Image](#)

Second Image: 
[Image](#)

Third Image: 
[Image](#)

Site Id: 69
 Location: FARMERS ISLAND
 Map: CR02
 Grid: L4
 Lat: -23.93
 Long: 151.16

Description: Gravelbar and small drain that cuts through Farmers Island in Calliope River

Image: 
[Image](#)

Second Image: 
[Image](#)

Third Image: 
[Image](#)

The site is at Devils Elbow on the Calliope River. It is a sandbar on the southern bank right on the elbow. A small drain that drains an area of dead mangroves runs across the sandbar. At the upstream end of the sandbar there is a small mud and gravel patch.
 Survey timing: Half tide up or down to low tide
 Standard number of casts: 20

This site is at Farmers Island in the Calliope River. At the southern end of the island there is an extensive gravelbar. There is also a small drain that bisects the island from half tide up to half tide down. The drain is mostly sand and mud.
 Survey timing gravelbar: Around low tide
 Survey timing drain: Around high tide
 Standard number of casts gravelbar: 20
 Standard number of casts drain: 10

Site Id: 81
 Location: OLD BRUCE HIGHWAY BRIDGE
 Map: CR02
 Grid: P4
 Lat: -23.964
 Long: 151.154

Description: Below old Bruce Highway bridge on Calliope River

Image: 

Second Image: 

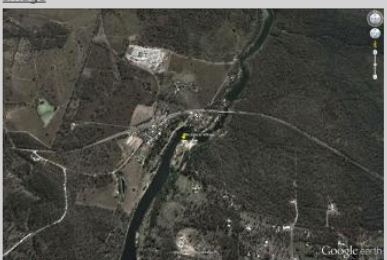
Third Image: 

Site Id: 59
 Location: HISTORICAL VILLAGE
 Map: CR02
 Grid: P4
 Lat: -23.963
 Long: 151.152

Description: Upstream of the Old Bruce Highway bridge on the Calliope River

Image: 

Second Image: 

Third Image: 

<p>The site is on the downstream side of the old Bruce Highway bridge on the Calliope River. The bridge has a causeway below it that holds back water above the bridge. Big tides push up above the bridge. On the outgoing tide there is a rapids like effect. The area is mostly base rock and gravel. Survey timing: Falling tide towards low Standard number of casts: 10</p>	<p>This site is immediately above the old Bruce Highway bridge. It is along the southern shoreline and a small backwater on the northern side. Area is mostly gravel with some sand patches. Survey timing: Anytime other than high tide Standard number of casts: 20</p>
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Site Id: 80
 Location: OPPOSITE LIEXLIP CREEK
 Map: CR02
 Grid: R3
 Lat: -23.98
 Long: 151.147

Description: Sandbank opposite Liexlip Creek

Image: 

Image: 

Second Image: 

Third Image: 

Site Id: 79
 Location: CALLIOPE BACKWATER
 Map: CR02
 Grid: R2
 Lat: -23.985
 Long: 151.141

Description: Backwater old channel near junction of Calliope River and Double Creek

Image: 

Image: 

Second Image: 

Third Image: 

<p>The site is opposite Leixlip Creek in the Calliope River above the old Bruce Highway bridge. It is a section of open shoreline with a gravel and sand base. Survey timing: Anytime other than high tide Standard number of casts: 10</p>	<p>This site is a backwater near the junction of Double Creek with the Calliope River. It is an overflow channel when the river is in flood. Its base is mostly sand and small gravel with a grass-lined bank with a few small mangroves on the southern side and gravel on the northern side. This is one of the better habitat areas suitable for Barramundi. Survey timing: Anytime other than high tide Standard number of casts: 20</p>
---	--

Site Id:	72
Location:	CALLIOPE SPLIT CHANNEL
Map:	CR02
Grid:	R1
Lat:	-23.983
Long:	151.135
Description	Calliope River above old Bruce Highway bridge where river splits into 2 channels for a short distance around a small island
Image:	
Second Image:	
Third Image:	

The site is at a small island in the Calliope River about 1km upstream from Double Creek. An extensive rockbar is in the eastern channel and the western channel has a rock and gravel base. The western channel flows on big tides or when there is a fresh.

Survey timing: Anytime other than high tide

Standard number of casts: 20

APPENDIX 2 - SPECIES

List of species recorded using standard names, scientific name, number of sites, and number of fish recorded in 2015.

STANDARD NAME	SCIENTIFIC NAME	SITES	NUMBER
ANCHOVY - AUSTRALIAN	<i>Engraulis australis</i>	2	3
BARRAMUNDI	<i>Lates calcarifer</i>	2	6
BREAM - BONY	<i>Nematalosa erebi</i>	7	83
BREAM - PIKEY	<i>Acanthopagrus berda</i>	7	32
BREAM - YELLOWFIN	<i>Acanthopagrus australis</i>	12	58
BULLROUT	<i>Notesthes robusta</i>	1	1
DIAMONDFISH	<i>Monodactylus argenteus</i>	1	1
FLATHEAD - DUSKY	<i>Platycephalus fuscus</i>	3	4
GARFISH - SNUBNOSE	<i>Arrhamphus sclerolepis</i>	3	3
GLASSFISH - ESTUARY	<i>Ambassis marianus</i>	12	266
GRUNTER - BARRED	<i>Amniataba percoides</i>	4	12
GRUNTER - CRESCENT	<i>Therapon jarbua</i>	3	11
HERRING - SOUTHERN	<i>Herklotsichthys castelnaui</i>	6	96
JAVELIN - BARRED	<i>Pomadasys kaakan</i>	1	1
JAVELIN - SPECKLED	<i>Pomadasys argenteus</i>	1	1
LONGTOM - STOUT	<i>Tylosurus gavioloides</i>	1	2
MANGROVE JACK	<i>Lutjanus argentimaculatus</i>	1	1
MILKFISH	<i>Chanos chanos</i>	2	2
MOUTH ALMIGHTY	<i>Glossamia aprion</i>	1	1
MUDSKIPPER	<i>Periophthalmus spp</i>	1	2
MULLET - FLATTAIL	<i>Liza argentea</i>	13	454
MULLET - SEA	<i>Mugil cephalus</i>	12	243
PERCH - SPANGLED	<i>Leiopotherapon unicolor</i>	3	4
PONYFISH - COMMON	<i>Leiognathus equulus</i>	9	195
PRAWN - BANANA	<i>Fenneropenaeus indicus</i>	10	118
QUEENFISH - GIANT	<i>Scomberoides commersonnianus</i>	1	2
RABBITFISH - GOLDLINED	<i>Siganus lineatus</i>	1	5
RAINBOWFISH - EASTERN	<i>Melanotoenia splendida</i>	2	2
RAY - EASTERN SHOVELNOSE	<i>Aptychotrema rostrata</i>	1	1
SCAT - STRIPED	<i>Selenotoca multifasciata</i>	6	72
SCAT - SPOTTED	<i>Scatophagus argus</i>	4	54
SILVERBIDDY - COMMON	<i>Gerres subfasciatus</i>	6	32
SILVERBIDDY - THREADFIN	<i>Gerres filamentosus</i>	3	3
SNAPPER - MOSES	<i>Lutjanus russellii</i>	4	5
SWEETLIPS - BROWN	<i>Plectorhinchus gibbosus</i>	1	1
TOADFISH - COMMON	<i>Tetractenos hamiltoni</i>	3	7
WHITING - SAND	<i>Sillago ciliata</i>	4	30

APPENDIX 3 – HISTORIC RECRUITMENT SURVEYS

Summary of recruitment surveys in Beecher Creek (site 6) from 2000-2004, and 2012-2015 and at Historical Village (site 59) from 2014-2015.

BEECHER CREEK RECRUITMENT SURVEYS									
	2000	2001	2002	2003	2004	2012	2013	2014	2015
SURVEYS	8	11	4	1	1	3	4	4	4
CASTS	160	220	80	20	20	50	70	80	80
SPECIES	13	18	16	7	7	13	5	14	14
FISH	282	518	245	29	19	118	26	193	138
FISH/CAST	1.8	2.4	3.1	1.5	1.0	2.4	0.4	2.4	1.7
FISH/10 CASTS	17.6	23.5	30.6	14.5	9.5	23.6	3.7	24.1	17.3
BARRAMUNDI	0	0	0	0	0	2	1	1	0
YELLOWFIN BREAM	12	11	1	0	1	18	3	16	16
PIKEY BREAM	0	1	0	0	0	0	0	0	0
FLATTAIL MULLET	79	213	79	6	3	16	11	76	16
SEA MULLET	0	0	2	0	3	14	0	17	12

HISTORICAL VILLAGE RECRUITMENT SURVEYS		
	2014	2015
SURVEYS	2	3
CASTS	30	50
SPECIES	5	12
FISH	65	33
FISH/CAST	2.2	0.7
FISH/10 CASTS	21.7	6.6
BARRAMUNDI	4	0
YELLOWFIN BREAM	8	3
PIKEY BREAM	0	0
FLATTAIL MULLET	22	6
SEA MULLET	0	8

APPENDIX 4 – WATER QUALITY READINGS

SITE ID	TEMP °C	SALINITY %	pH	TDS ppm	COND µs/cm	DO mg/L	SECCHI mtre
4/03/2015							
75	30.3	18	7.16	900	875	4	0.65
71	30.3	18	7.16	950	850	4.15	0.65
77	30.5	5	7.15	950	890	5	1
69	31.5	2	6.15	975	850	4	0.65
77	31.2	2.5	7.85	950	950	0.15	0.5
65	31.1	5	7.15	950	875	4.8	0.65
5/03/2015							
72	28.8	0.18	7.15	377	754	4.11	1
79	30.1	0.1	7.15	411	822	1.7	1
80	30.3	0.1	7.1	400	800	1.4	1.4
59	31.3	0.5	7.3	485	866	1	1
23/03/2015							
65	29.3	25	7.16	980	850	11	0.49
78	29.3	25	7.16	990	875	11	0.5
77	29.5	25	7.15	975	850	5	0.5
69	29.3	26	7.16	875	860	6	0.4
71	31.3	25	7.15	950	950	4	0.5
75	31	25	7.15	989	850	5	0.75
24/03/2015							
72	27.7	0.2	7.16	437	963	4	1.1
79	28.4	0.1	7.16	526	1050	4	1.5
80	28.6	0.1	7.16	576	1310	11	0.8
59	28.7	0.3	7.16	802	1601	1.5	1.5
22/04/2015							
72	23.4	0.2	7.17	850	1263	5	1.5
79	24.7	0.2	7.15	1310	1385	8	3
80	26.1	0.25	7.17	985	1230	6	1.5
59	24.7	3	7.16	850	975	5	1.7
23/04/2015							
69	23.8	25	7.16	985	870	11	1
77	24.4	28	7.17	830	870	5.1	1.5
78	25	31	7.16	785	670	8.1	1.7
71	25.5	18	7.17	901	850	5.1	0.5
75	26.4	34	7.16	950	750	6	1

