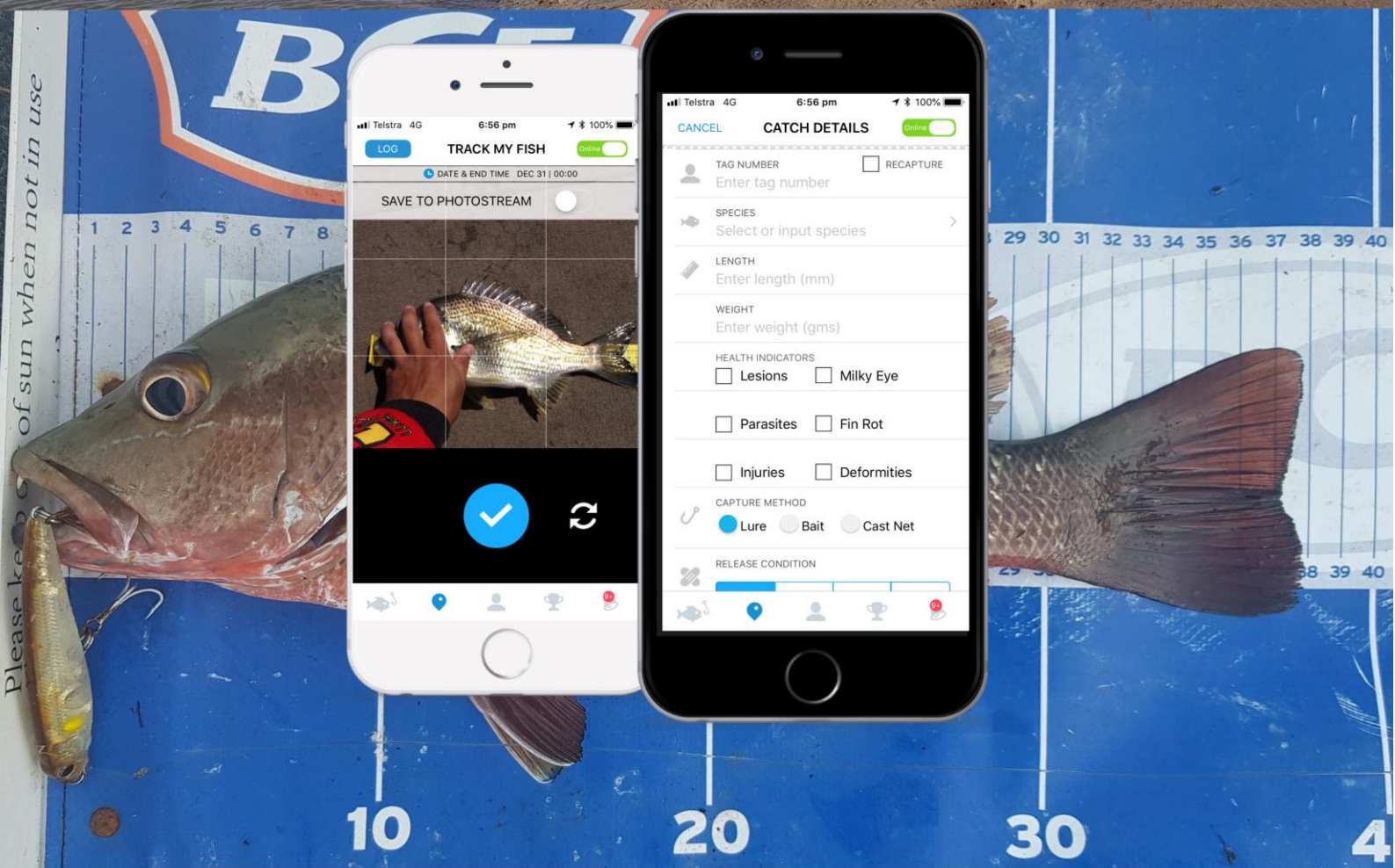


Visual fish health indicators for the Gladstone Harbour Report Card 2019



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SUMMARY

Fish images were collected throughout 2018 - 19 in the 13 GHHP monitoring zones in Gladstone Harbour and adjoining waterways to assess visual fish health. Collection of images was completed by a number of groups and individuals including members of Gladstone Sportfishing Club on fishing trips (317 images), members of the fishing public reporting recaptures of tagged fish (25 images), at the Boyne Tannum HookUp (BTHU) fishing competition (419 images) and by Infofish Australia (79 images) to boost numbers in zones where there were less than 25 images. In total 840 images were obtained.

Owing to fish movement fish health is scored at the harbour level. The single harbour score is warranted as fish are mobile and the health of target species cannot necessarily be attributed to individual monitoring zones. The harbour wide score is comprised of the individual fish scores.

Fish Body Condition (FBC) and Visual Fish Condition (VFC) were the 2 assessments made of fish health.

The Fish Body Condition (FBC) was assessed, based on length-weight data collected at the BTHU, where a Fulton's Fish Index (K) was calculated for each of the key species. FBC was not calculated for Barramundi as weights were not obtained for this species. The FBC was then converted to a 0-1 score on the GHHP scale.

The Visual Fish Condition (VFC) of 6 key species was assessed from images captured with the Trackmyfish app. These were Barred Javelin (219 images), Yellowfin Bream (183 images), Pikey Bream (143 images), Mangrove Jack (122 images), Dusky Flathead (80 images) and Barramundi (37 images). There were a further 62 images of other species.

The VFC was based on the following indicators being fins, skin, eyes, parasites and deformities. Visual fish health was assessed by both machine learning algorithms and human assessors. This year Microsoft Azure was used to undertake the machine assessment in preference to TensorFlow and Yolo previously used. There has been significant improvement in Azure, and it is now being used by a number of fisheries agencies including Queensland Fisheries.

There was close to 100% agreement between the human and machine assessment of each of the issues. The resulting level of detection for fins (12.5-31.1%) and skin (5.5-24.3%) was moderate, however the level of severity was low with VCI scores ranging from 0.96-0.98 on the GHHP 0-1 scale. The detection level for eyes, parasites and deformities was very low.

The FBC and VFC scores were then averaged to provide a species score that was converted to a GHHP grade from A-E. Barred Javelin and Barramundi were graded as A, Pikey Bream as B while Yellowfin Bream, Dusky Flathead and Mangrove Jack

were rated as C. The grading for Mangrove Jack needs to be viewed with caution due to the low sample numbers in the historic data.

The following table shows the VCI and FBC scores for the 6 key species, the species score on a 0-1 scale and the corresponding GHHP grade. No FBC was available for Barramundi as they were not weighed as part of the BTHU competition (photos only submitted). The all of harbour score was B.

Species	Visual Fish Condition Index (VCI)	Fish Body Condition (FBC)	Species Score	GHHP Species Grade
Yellowfin Bream	0.96 (183)	0.25 (192)	0.61	C
Pikey Bream	0.96 (133)	0.65 (85)	0.81	B
Barred Javelin	0.97 (219)	1.00 (110)	0.99	A
Dusky Flathead	0.98 (80)	0.05 (59)	0.52	C
Mangrove Jack	0.96 (122)	0.15 (36)	0.56	C
Barramundi	0.96 (37)	NA (0)	NA	NA
All of harbour			0.69	B

1. INTRODUCTION

The Gladstone Healthy Harbour Partnership (GHHP) was established in 2012 to assess the health of Gladstone Harbour. The GHHP produces an annual report on the health of the harbour that includes environmental, social, cultural and economic indicators. Fish recruitment and health were identified as important environmental indicators.

In 2018 GHHP and the Fisheries Research and Development Corporation (FRDC) commissioned Infofish Australia to undertake a trial of new tools to assess visual fish health. The objectives of the project were:

1. To deploy tools to automate data collection and assessment of fish health using data collected in Gladstone Harbour as a trial.
2. To undertake structured data collection of fish samples using Gladstone Healthy Harbour Partnership's reporting zones and the Boyne Tannum HookUp fishing competition.
3. To evaluate the potential to adapt the methods developed to monitor fish health in other estuaries and ports in Australia.

Over the course of the study two object detection algorithms were evaluated. The training of the machine learning models was focused on Bream and carried out in two parts. Initial training of the models was to recognise fish parts such as fins, tail, gills, eyes and mouth and fish health issues such as fin and tail damage, wounds and "redness" (e.g. lesions, scale damage).

A total of 1,242 images were assessed and machine and human agreement levels ranged from 50-86% for fin splitting, 60-93% for tail splitting, 78-93% for tail damage, 86% for redness while a wound model was unsuccessful in all instances. Images continue to be collected and those results will improve with more images for the training models, particularly for species other than Bream and for health issues where there were few images.

The project demonstrated that machine learning technology can be applied to assess visual health issues and that community members can be successfully involved in the collection of report card data.

That project resulted in 2 reports being "New Tools to Assess Visual Fish Health" (Sawynok W, Sawynok S and Dunlop A) (2018a) and "A Visual Condition Index" (Sawynok W, Sawynok S and Dunlop A) (2018b).

Following the completion of these projects GHHP decided to undertake a visual fish health assessment for 2018 - 19 and include a fish health indicator, score and grade in its 2019 report card.

2. OBJECTIVES

The objectives of this project were to:

1. Collect a minimum of 25 photographic samples in each of the 13 monitoring zones for all species.
2. Undertake a fish condition assessment from images collected at the Boyne Tannum HookUp fishing competition.
3. Provide visual fish health scores and grades for the 2019 report card.

Key species for the generation of report card grades and scores were identified as those with a minimum of 25 images in 2018 - 19. These were:

- Yellowfin Bream
- Pikey Bream
- Barred Javelin
- Dusky Flathead
- Mangrove Jack
- Barramundi

The GHHP Independent Scientific Panel (ISP) recommended that, owing to the potential for fish movement, fish health should be scored at the harbour level. The single harbour score is justifiable as fish are mobile and the health of the key species cannot necessarily be attributed to individual monitoring zones. However, except for Barramundi which can move large distances, the range of movements in the key species are suitable for the assessment of Gladstone Harbour as a whole (Flint et al 2018, Sawynok et al 2018a).

The key species for this project includes fish that are benthic feeders such as Dusky Flathead and those that feed higher in the water column such as Barramundi. As these species occupy a variety of trophic levels and habitats, they are differentially affected by any fish health issues. For example, demersal or benthic species are in closer contact with pollutants accumulated in sediments and as a result are more likely than pelagic species to present abnormalities (Cowled 2016). Fish health issues that affect a single species or group of species would be more readily apparent when aggregating by species.

3. GLADSTONE HARBOUR MONITORING ZONES

The Gladstone Harbour has been divided into 13 environmental monitoring zones for the GHHP Report Card (Figure 1).



Figure 1: Gladstone monitoring zones for the GHHP Report Card (from 2018 Report Card Technical Report.pdf at <https://dims.ghhp.org.au/repo/public/79fdb7>)

The 13 Gladstone Harbour monitoring zones are:

- | | |
|---------------------|----------------------|
| 1. The Narrows | 8. Mid Harbour |
| 2. Graham Creek | 9. South Trees Inlet |
| 3. Western Basin | 10. Boyne Estuary |
| 4. Boat Creek | 11. Outer Harbour |
| 5. Inner Harbour | 12. Colosseum Inlet |
| 6. Calliope Estuary | 13. Rodds Bay |
| 7. Auckland Creek | |

4. METHODS

4.1 COLLECTING FISH SAMPLES

Data were collected from 1 July 2018 to 30 June 2019. The target was a minimum of 25 photographic samples of all species in each of the 13 monitoring zones. There were 4 methods for collecting the field samples using the Infofish Trackmyfish (TMF) phone app.

1. Photos collected by members of the Gladstone Sportfishing Club (GSFC) during normal fishing trips
2. Photos provided by the general fishing public when reporting the recaptures of tagged fish
3. Photos collected at the live weigh-in section of the Boyne Tannum HookUp (BTHU) fishing competition held from 3 - 5 May 2019
4. Photos collected by Infofish in monitoring zones where the minimum of 25 samples was not achieved by the above 3 methods

The data collected through TMF was:

- Photos of one side of the fish, preferably on a measuring ruler
- For photos collected by Infofish both sides of the fish were recorded and assessed
- Tag number for fish that were tagged
- Total length of the fish to nearest half centimetre
- Weight of the fish at the BTHU in grams
- Check boxes to record visual health issues (lesions, milky eye, parasites, fin damage, injuries and deformities)
- GPS location of where the sample was collected

For fish presented by fishing competitors at the BTHU the monitoring zone in which the fish was captured was recorded as it was not possible to obtain a GPS location for the point of capture. Figure 2 shows the TMF version used for collecting data at the BTHU.

Target species were the following however samples were collected from all species recorded:

- Yellowfin Bream (*Acanthopagrus australis*)
- Pikey Bream (*Acanthopagrus berda*)
- Barred Javelin (*Pomadasys kaakan*)
- Dusky Flathead (*Platycephalus fuscus*)
- Mangrove Jack (*Lutjanus argentimaculatus*)
- Barramundi (*Lates calcarifer*)

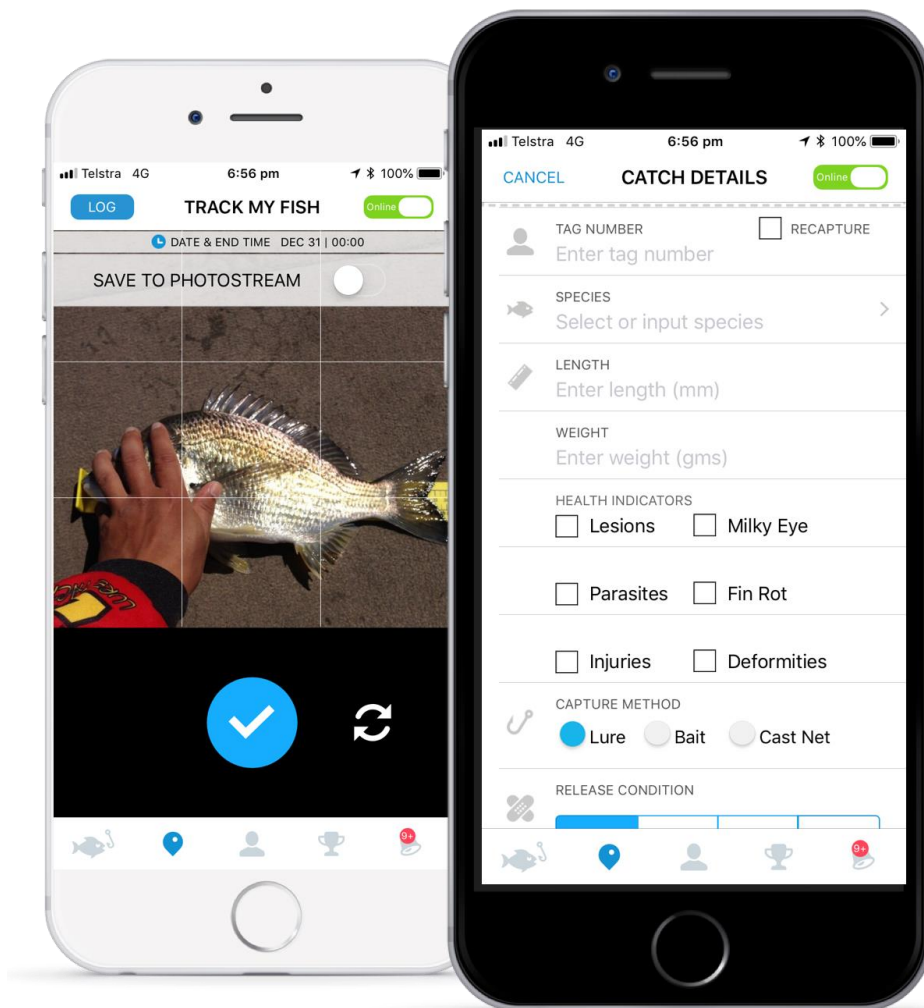


Figure 2: Screens to capture fish image and collect details of the fish

4.2 ASSESSING FISH BODY CONDITION (FBC)

Fish body condition (FBC) was based on fish presented at the BTHU where fish were weighed as well as the overall length recorded. FBC was assessed for Yellowfin and Pikey Bream, Barred Javelin, Dusky Flathead and Mangrove Jack using Fulton's condition index (K) rather than relative condition factor as used previously.

Fulton's condition index has a grading system that is used for salmonids by Fisheries Victoria (Barnham and Baxter 2003) and is used by Fisheries Queensland (DAFF 2013). The following Fulton's formula was used.

$$\text{Fulton's condition index } K = \frac{WEIGHT \times 10^3}{LENGTH \times 10^3}$$

K values were calculated for each species for all years and the mean, minimum and maximum values calculated as shown in Table 1. Scores were generated for each species for each year (excluding the current year) by the following formula:

$$score = \frac{mean([FI\ species\ | \ year]) - \min(FI\ species)}{\max([FI\ species]) - \min(FI\ species)}$$

Summaries were extracted for all years (excluding the current year) and quartile cutoffs generated based on the mean per species as bands that reflect the ceiling score cutoffs – 0.25 (E), 0.5 (D), 0.65 (C), 0.85 (B) and 1 (A). K values for each species were converted to a GHHP 0-1 score to assess condition as shown in Table 2.

Table 1: Values calculated for Fulton’s K condition index

Species	number	Fulton’s Condition (Kn)			GHHP score
		Min	Max	Mean	
Species 1					0-1
Species 2					0-1

Table 2: Cutoff bands for grades by species

SCORES	E	D	C	B	A
BARRED JAVELIN	0.32	0.66	0.71	0.91	1
DUSKY FLATHEAD	0.11	0.31	0.39	0.46	1
MANGROVE JACK	0.12	0.29	0.34	0.44	1
PIKEY BREAM	0.49	0.62	0.64	0.78	1
YELLOWFIN BREAM	0.20	0.29	0.38	0.78	1

4.3 ASSESSING VISUAL FISH CONDITION (VFC)

A simplified flow chart for the assessment of visual fish condition is presented in Figure 3 (Sawynok et al 2018a).

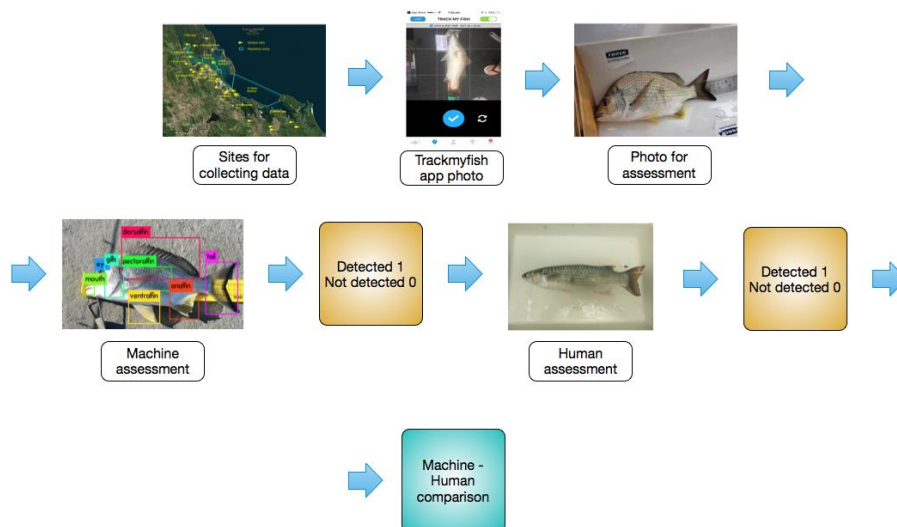


Figure 3: Simplified flow chart of the process from field collection of data to the comparison of the machine and human assessment

Two assessment methods were used, human and machine assessment using the methods adopted in 2018 (Sawynok et al 2018a). Microsoft Azure was used as the machine learning tool as this has been adopted by a number of fisheries agencies including Fisheries Queensland. Previously TensorFlow and Yolo were used. Figure 4 shows a typical fish sample collected at the BTHU.

The 5 visual condition factors assessed were:

- Fins
- Skin
- Eyes
- Parasites
- Deformities

For all images the Visual Fish Condition (VFC) was calculated based on the methods of Adams et al 1993 as a measure of visual condition. Each condition was provided a designation and score according to Table 3 and a score generated for each individual fish.

All fish were given a VFC score calculated as:

$$\text{VFC} = (\text{maximum score} - \text{fish score}) / \text{maximum score}$$



Figure 4: BTHU Yellowfin Bream with a small lesion on its side

Table 3: Designation and score for the conditions assessed

Fins		
Variable Condition	Designation	Score
No Active Erosion	0	0
Light Active Erosion	1	10
Moderate Active Erosion with Some haemorrhage	2	20
Severe Active Erosion with Some haemorrhage	3	30

Skin		
Variable Condition	Designation	Score
Normal no aberrations	0	0
Mild skin aberrations	1	10
Moderate skin aberrations	2	20
Severe skin aberrations	3	30

Eyes		
Variable Condition	Designation	Score
No aberrations	0	0
Opaque/Milky Eye	1	10
Swollen Eye	2	20
Haemorrhaging or bleeding Eye	3	30
Missing Eye	3	30

Parasites		
Variable Condition	Designation	Score
No parasites	0	0
Observed parasites	1	10

Deformities		
Variable Condition	Designation	Score
No deformity	0	0
Observed Deformity	3	30

4.4 INFLUENCE OF ENVIRONMENTAL CONDITIONS

To provide some context to the assessment of VCI there was a need to examine environmental conditions. Fish health can be influenced by river flow and rainfall. Skin aberrations such as red spot disease are often associated with freshwater flows. While there can be considerable variation in flows and rainfall throughout the study area the following were used as measures of relevant environmental conditions.

Monthly flows recorded at the Castlehope recording station 132001A on the Calliope River were considered indicative of flows in the rivers and creeks in the study area.

The exception is the Boyne River where flows are related to water releases and overtopping of Awoonga dam. Overtopping has been associated with fish health issues since 2011, particularly in Barramundi in the Boyne River. Data on the dam level were obtained from the Gladstone Area Water Board.

4.5 GENERATING SPECIES SCORES AND GRADES

A species score was generated for each key species (Table 4) and these were aggregated to provide a single harbour wide score for fish health. Key species were identified as those with a minimum of 25 images. This also allowed historic length-weight data to be assessed for FBC.

Key species for which there were sufficient data:

- Yellowfin Bream
- Pikey Bream
- Barred Javelin
- Dusky Flathead
- Mangrove Jack
- Barramundi (VCI only)

Table 4: Generating scores and grades for key species

Species	Visual Fish Condition Index (VCI)	Fish Body Condition (FBC)	Species Score	Species Grade
Yellowfin Bream	0 – 1	0 – 1	Score (0 – 1)	Grade (A – E)
Pikey Bream	0 – 1	0 – 1	Score (0 – 1)	Grade (A – E)
Barred Javelin	0 – 1	0 – 1	Score (0 – 1)	Grade (A – E)
Dusky Flathead	0 – 1	0 – 1	Score (0 – 1)	Grade (A – E)
Mangrove Jack	0 – 1	0 – 1	Score (0 – 1)	Grade (A – E)
Barramundi	0 – 1		Score (0 – 1)	Grade (A – E)



Figure 5: The grading scale and the scores used in the GHHP 2019 report card

4.6 GENERATING HARBOUR SCORES AND GRADES

A harbour wide score was generated by summing the individual species scores (excluding Barramundi), then calculating the average score. Zones scores will equal the all of harbour score.

$$\text{All of Harbour score} = (\text{Yellowfin Bream score} + \text{Pikey Bream score} + \text{Barred Javelin score} + \text{Dusky Flathead score} + \text{Mangrove Jack score})/5$$

4.7 COMPARISON WITH OTHER LOCATIONS

To provide a comparison to the scores and grades 3 locations in various stages of urban development and habitat modification (high, moderate, low) were selected to provide a VCI comparison with Gladstone Harbour for the key species.

At each location all images of the key species were assessed and the number of detections and severity of fins, skin, eyes, parasites and deformities recorded. To provide a comparison between locations the percentage of detections of each health issue were calculated. Comparisons were made where there was a minimum of 25 images.

The 3 locations selected were:

- Moreton Bay
- Sunshine Coast
- Hinchinbrook Channel

5. RESULTS

5.1 SUMMARY OF IMAGES

A total of 840 images were collected from 1 July 2018 to 30 June 2019. The BTHU supplied 419 images, 317 were from the GSFC, 79 from Infofish and 25 from recaptures from the fishing public (Figure 6).

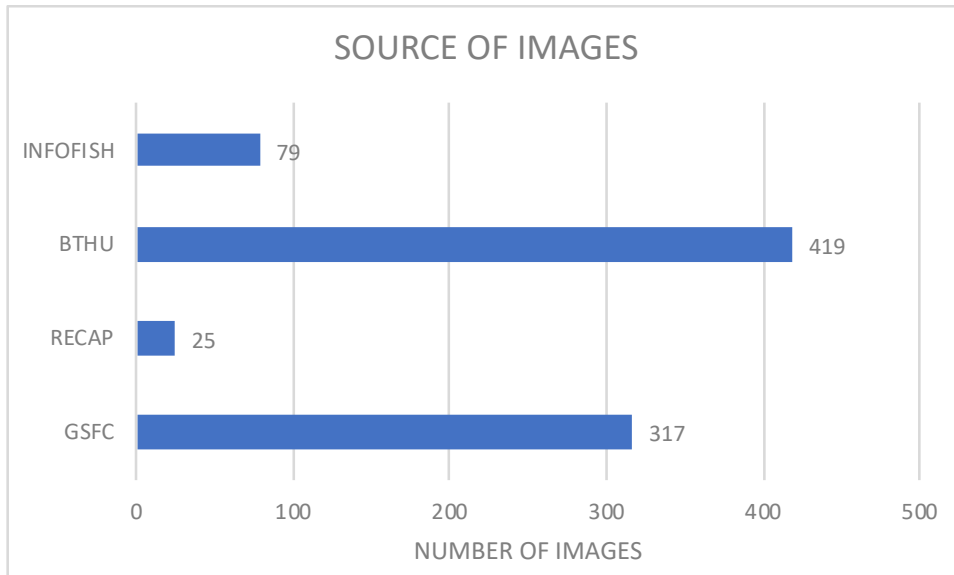


Figure 6: Sources of images for visual fish condition assessment

Figure 7 shows the months in which the images were collected. There were 434 images collected in May, mostly at the BTHU (419) and 79 images collected in June by Infofish that was aimed at boosting the numbers in zones where there were less than 25 images.

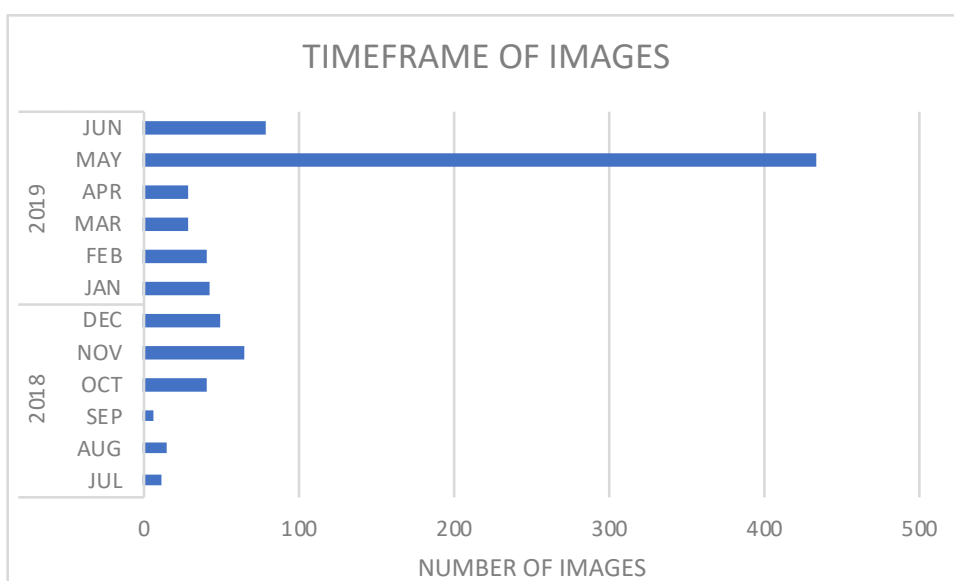


Figure 7: Timeframe for when images were obtained

Figure 8 shows the number of images based on species. Key species with images were Barred Javelin 219, Yellowfin Bream 183, Pikey Bream 143, Mangrove Jack 122 and Barramundi 37.

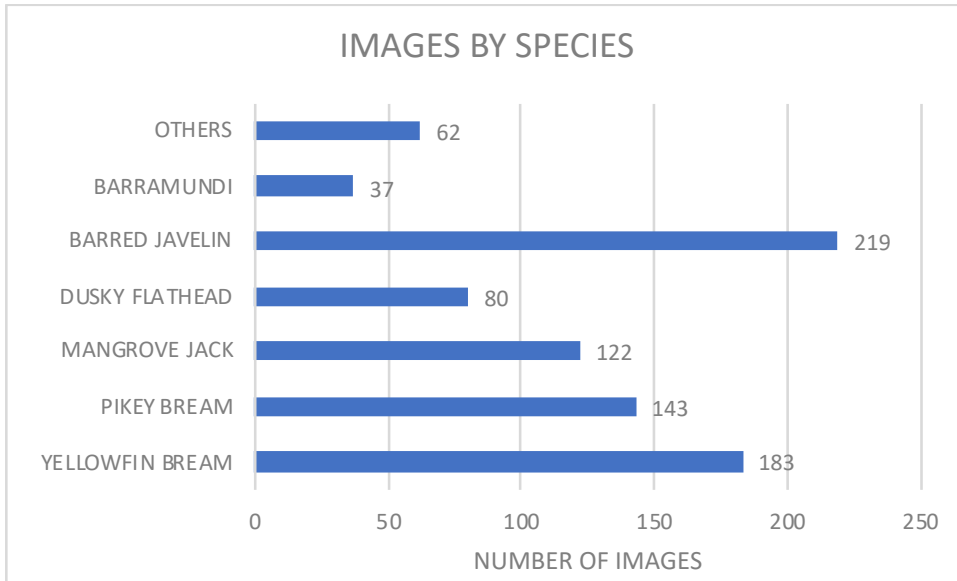


Figure 8: Number of images for each of the key species

Figure 9 shows the number of images used for each of the key species at each of the comparison sites in the calculation of a VCI. At each of the 4 sites all images for the key species were assessed. Total images were Gladstone (784), Moreton Bay (263), Sunshine Coast (150) and Hinchinbrook (163).

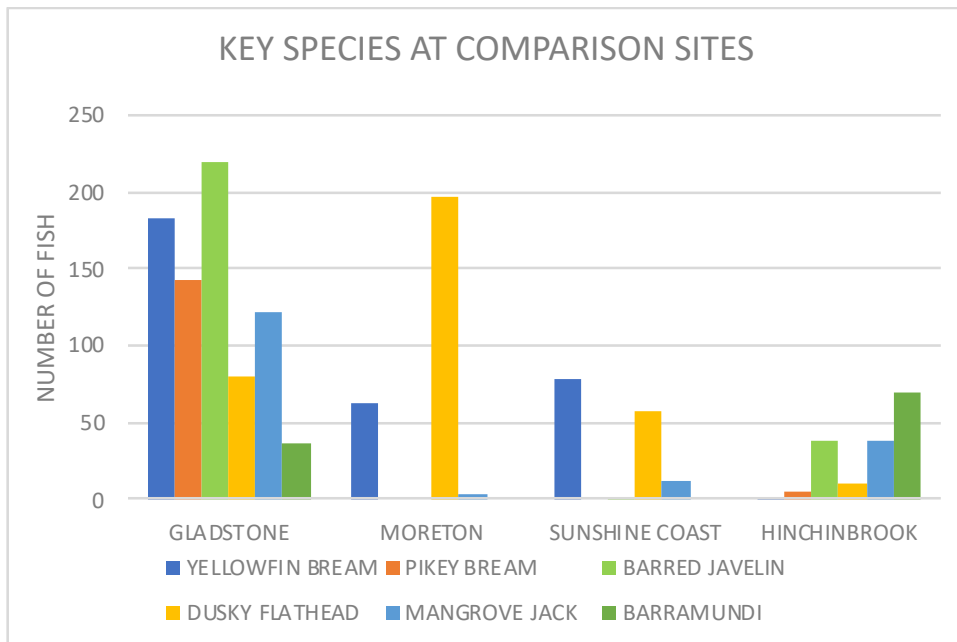


Figure 9: Images assessed at each of the comparison sites

5.2 FISH BODY CONDITION (FBC)

Fish body condition was calculated for fish presented at the BTHU live weigh-in where weight (grams) and total length (mm) were recorded. Fulton's K values were calculated for each of the key species except Barramundi as fish were not weighed. There was a total of 482 fish where weight and length were recorded:

- Yellowfin Bream (192)
- Pikey Bream (85)
- Barred Javelin (110)
- Dusky Flathead (59)
- Mangrove Jack (36)
- Barramundi (0 photos only submitted)

A plot of length-weight was generated for all species as shown in Figure 10. Fulton's K was calculated as shown in Table 5 and converted to GHHP scores based on Table 2.

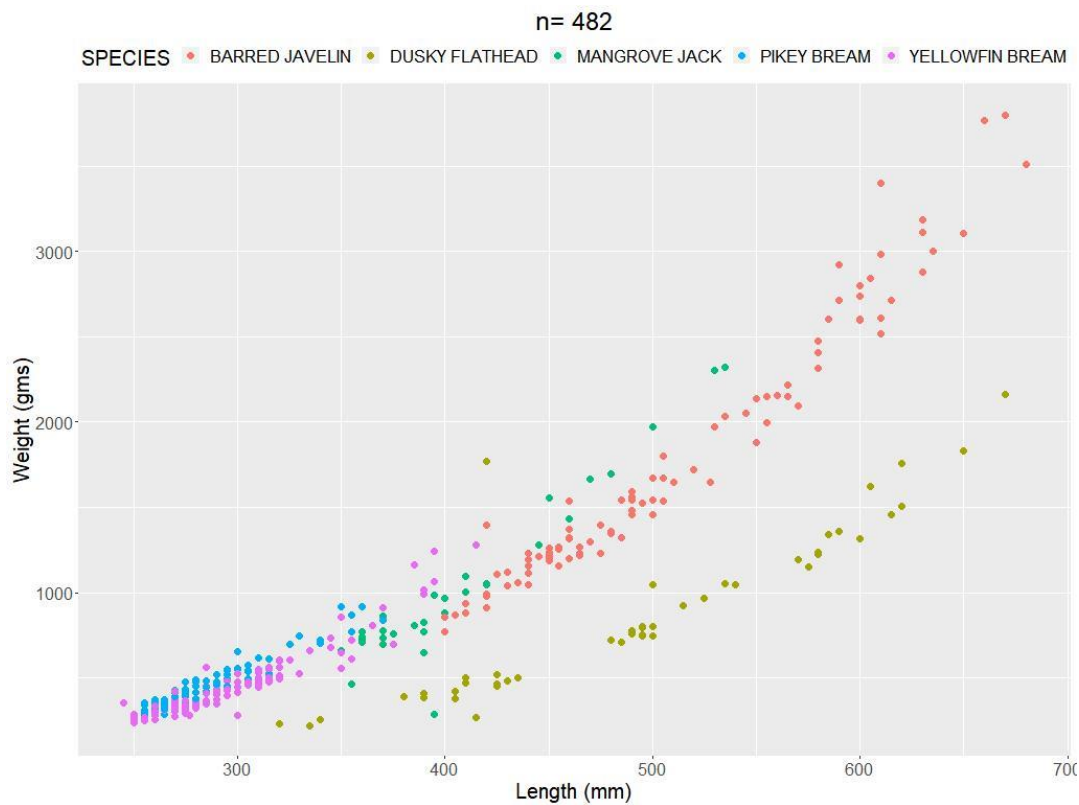


Figure 10: Length-weight plot for Key species from the BTHU 2019 samples

Table 5: Fulton’s condition factor (K) and GHHP score for key species from the 2019 BTHU samples

Species	number	Fulton’s Condition (Kn)			Historic Mean	GHHP score
		Min	Max	Mean		
Yellowfin Bream	192	0.93	3.15	1.45	1.45	0.25
Pikey Bream	85	1.09	2.63	1.65	1.58	0.65
Barred Javelin	110	1.94	5.71	3.40	2.58	1.00
Dusky Flathead	59	0.65	4.21	1.72	1.75	0.06
Mangrove Jack	36	1.31	4.35	2.47	2.59	0.15

For 4 of the key species there was historical length-weight data available from the BTHU from 2003 - 2018 where Fulton’s K was calculated, noting data were not available for 2009 and 2011. There were some data for Mangrove Jack however the sample sizes for years 2003 - 2010 and 2013 were too small to provide a reliable figure and there were no data available for 2016. FBC calculated using Fulton’s K is shown in Figures 11 – 15 for all species with a line showing the overall mean for K.

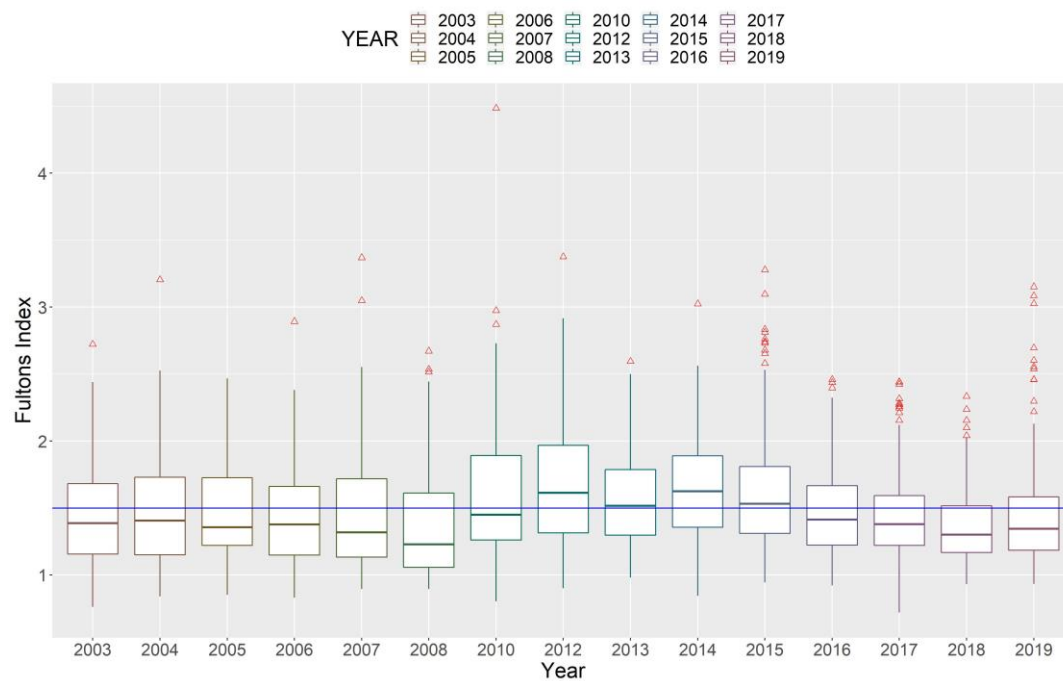


Figure 11: Plot of Fulton’s condition index (K) for Yellowfin Bream from 2003 – 2019 (see Appendix 3 for summary statistics)

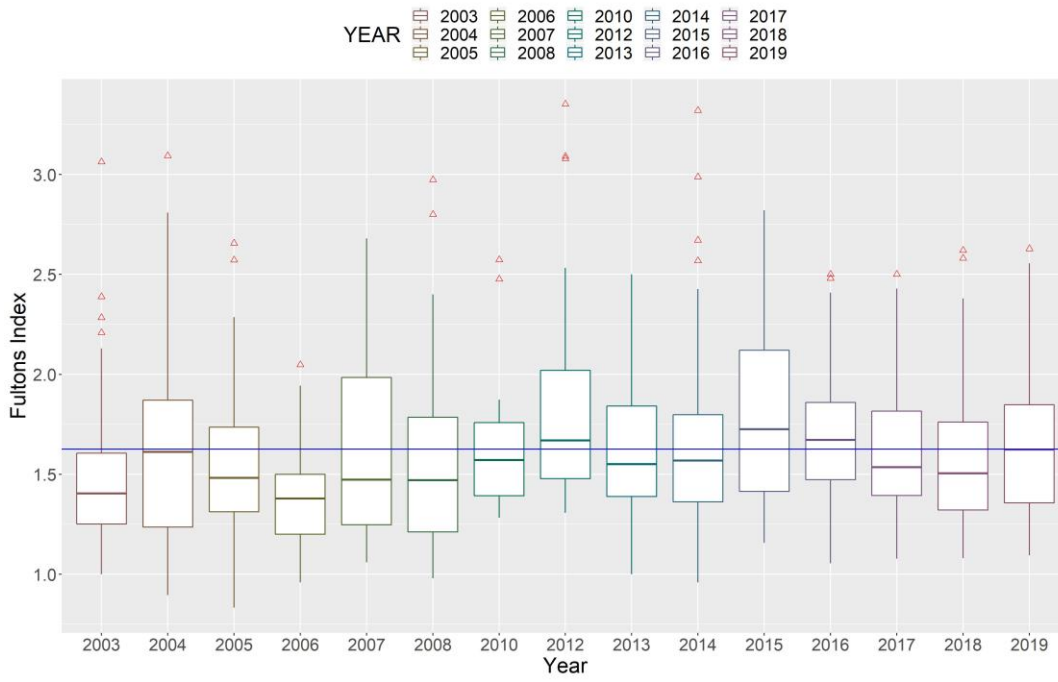


Figure 12: Plot of Fulton's condition index (K) for Pikey Bream from 2003 - 2019

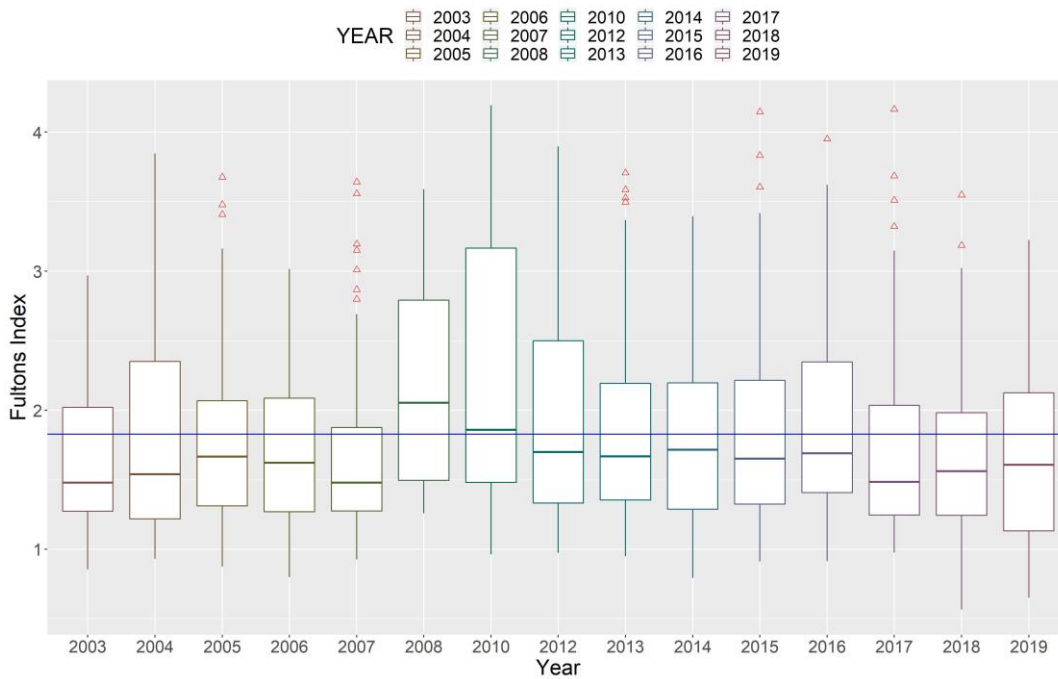


Figure 13: Plot of Fulton's condition index (K) for Dusky flathead from 2003 – 2019 (see Appendix 3 for summary statistics)

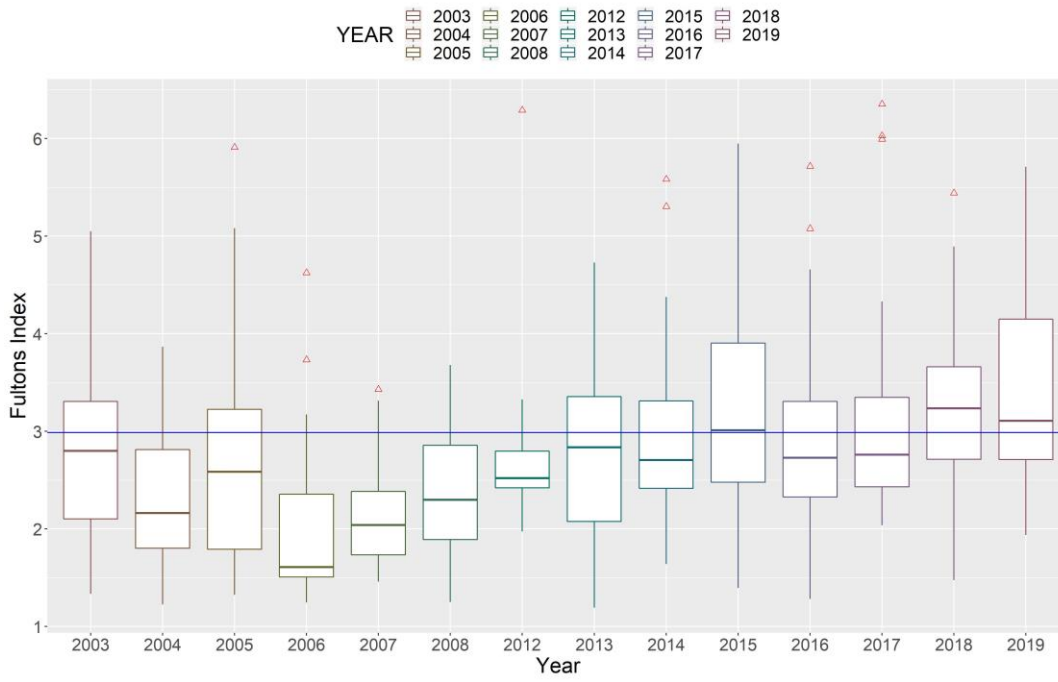


Figure 14: Plot of Fulton's condition index (K) for Barred Javelin from 2003 – 2019 (see Appendix 3 for summary statistics)

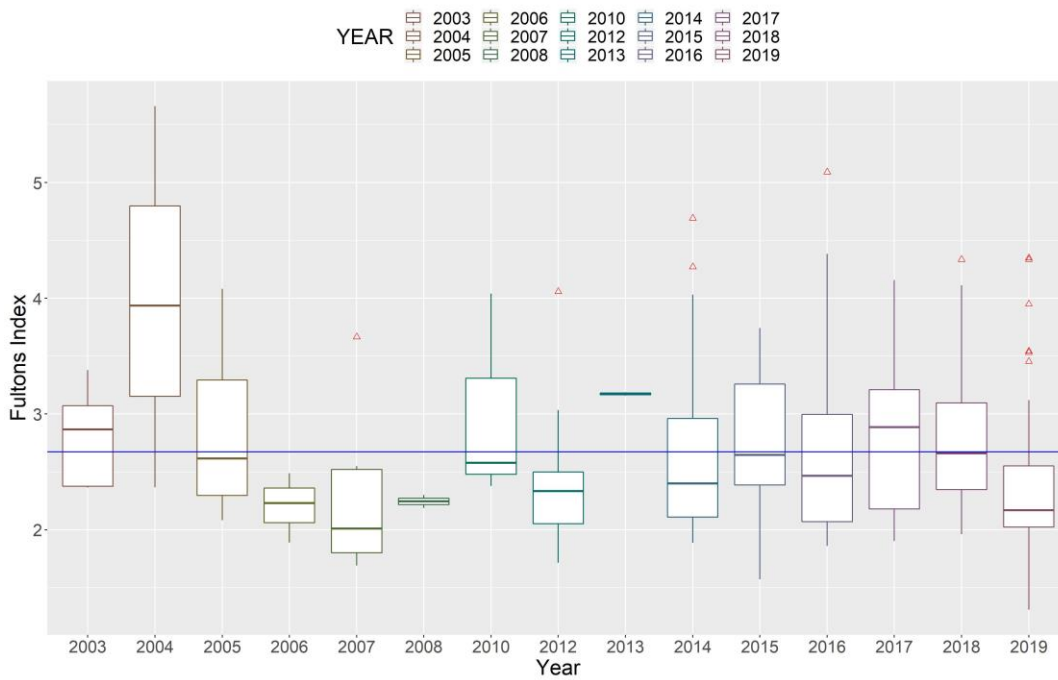


Figure 15: Plot of Fulton's condition index (K) for Mangrove Jack from 2003 - 2019 (small sample sizes 2003 - 2013) (see Appendix 3 for summary statistics)

5.3 VISUAL FISH CONDITION (VFC)

VFC was assessed based on 784 images of the key species. Human and machine VCI were undertaken for each condition and the overall result was close to 100% agreement between the 2 methods.

Table 6 shows the number of detections in images of the key species however this does not refer to the severity of the issue. Fin damage was the most detected issue followed by skin damage. The incidence of eye damage (3 detections) and parasites (1 detection on a Goldspotted Rockcod however this was not a key species) were at very low levels and no deformities were recorded.

Table 7 provides the severity of detection for fin damage for the key species while Table 8 provides the severity of detection of skin aberrations for the same species. This shows that the level of severity was mostly light active erosion for fins and mild skin aberrations for skin resulting in high GHHP scores.

Table 6: Detection of visual fish condition issues in key species in 2018 - 2019

Species	Number	Fins	Skin	Eyes	Parasites	Deformities	GHHP score	GHHP grade
Yellowfin Bream	183	57 (31.1%)	10 (5.5%)	1 (0.5%)	0	0	0.97	A
Pikey Bream	143	34 (23.8%)	22 (15.4%)	2 (1.4%)	0	0	0.96	A
Barred Javelin	219	42 (19.2%)	37 (16.9%)	0	0	0	0.97	A
Dusky Flathead	80	10 (12.5%)	8 (10.0%)	0	0	0	0.98	A
Mangrove Jack	122	34 (27.9%)	24 (19.7%)	0	0	0	0.96	A
Barramundi	37	10 (27.0%)	9 (24.3%)	0	0	0	0.96	A

Table 7: Severity score of variable conditions for key species for fins and the number of detections

Variable	Condition	Designation	Score	YB	PB	BJ	DF	MJ	B
Fins									
No Active Erosion		0	0	126	109	177	70	88	27
Light Active Erosion		1	10	51	26	38	10	29	9
Moderate Active Erosion with Some haemorrhage		2	20	6	8	4	0	5	0
Severe Active Erosion with Some haemorrhage		3	30	0	0	0	0	0	0

Table 8: Severity score of variable conditions for key species for skin and the number of detections

Variable Skin	Condition	Designation	Score	YB	PB	BJ	DF	MJ	B
Normal no aberrations		0	0	173	121	182	72	98	28
Mild skin aberrations		1	10	9	22	33	6	24	8
Moderate skin aberrations		2	20	1	0	4	2	0	1
Severe skin aberrations		3	30	0	0	0	0	0	0

5.4 ENVIRONMENTAL CONDITIONS

Figure 16 shows the monthly flow and the mean monthly flow in the Calliope River at Castlehope. There was very little flow in the river with the highest flow being 597.8 ML in December. During the “normal” wet season months of January to March there was very little flow with just a maximum of 360.6 ML in March. The February flow was just 1.4 ML compared with a mean flow of 52,682 ML.

Figure 17 shows the Awoonga lake level at the dam wall. There was no overtopping of the dam during the year and a steady decline in the lake level from 39.47m on 1 July 2018 to 37.24m on 31 May 2019. The steady decline in the water level indicates there was little or no input to the lake. This supports the flows in the Calliope River.

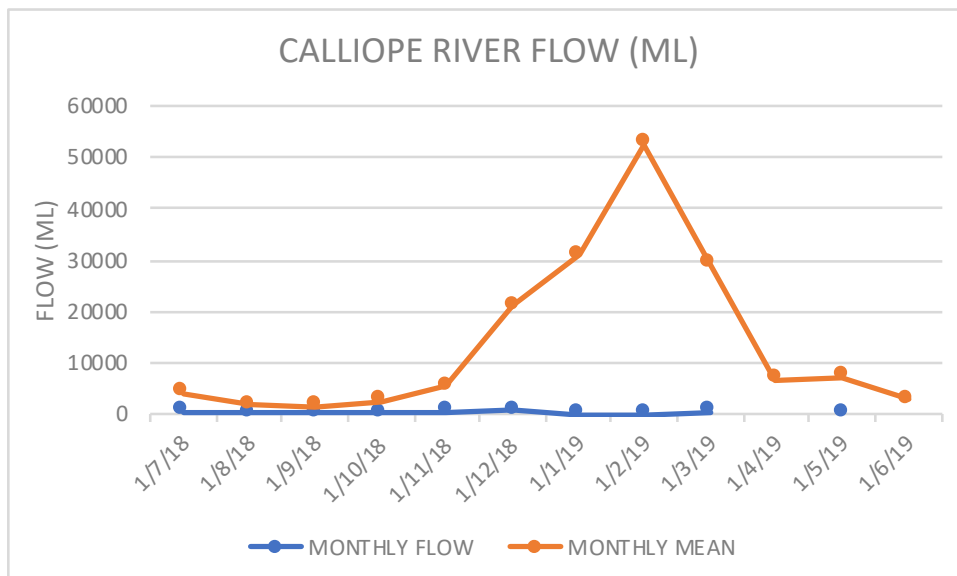


Figure 16: Calliope River flows and mean monthly flows (ML)

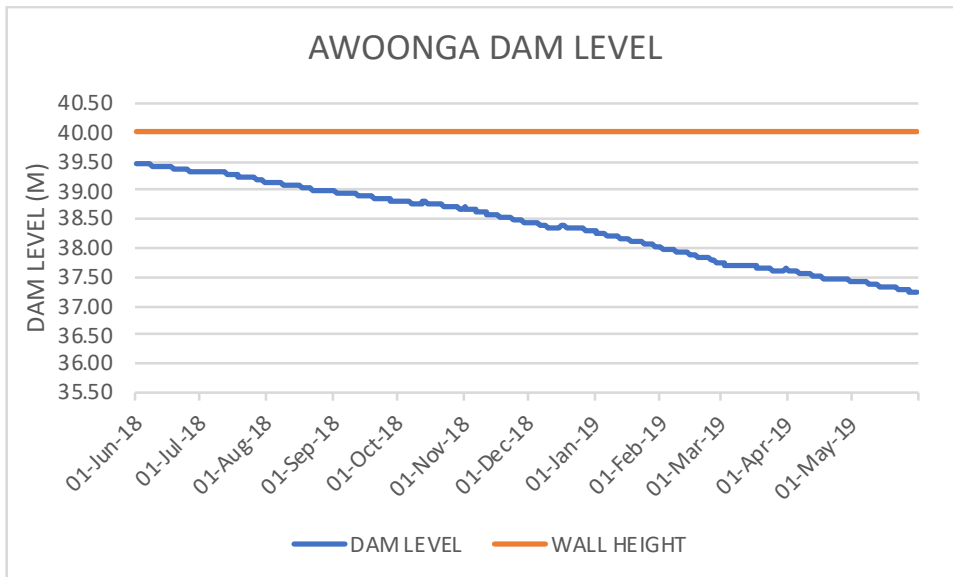


Figure 17: Awoonga lake levels and dam wall heights (m)

5.5 SPECIES SCORES AND GRADES

Table 9 shows the VCI and FBC scores for the 6 key species, the species score on a 0-1 scale and the corresponding GHHP grade. No FBC was available for Barramundi as they were not weighed as part of the BTHU competition (photos only submitted). The All of Harbour score was B. The full list of species and their VFC scores are contained in Appendix 1.

Table 9: GHHP Scores and grades for the 6 key species (figures in brackets are sample size)

Species	Visual Fish Condition Index (VCI)	Fish Body Condition (FBC)	Species Score	GHHP Species Grade
Yellowfin Bream	0.96 (183)	0.25 (192)	0.61	C
Pikey Bream	0.96 (133)	0.65 (85)	0.81	B
Barred Javelin	0.97 (219)	1.00 (110)	0.99	A
Dusky Flathead	0.98 (80)	0.05 (59)	0.52	C
Mangrove Jack	0.96 (122)	0.15 (36)	0.56	C
Barramundi	0.96 (37)	NA (0)	NA	NA
All of harbour			0.69	B

5.6 VCI COMPARISON BY LOCATION

For each location all images for the key species were assessed for VCI using the same methods as used in Gladstone. Table 10 shows the number of images of each key species at the comparison locations. Comparisons were only made where there was a minimum of 25 images. Table 11 shows the number and percentage of each health issue detected in images at each location. Table 12 is a summary of the detections and the resulting score.

Gladstone had the highest rate of detections for fins and skin while the rates for eyes, parasites and deformities were low at all locations.

Table 10: Number of each key species at each of the comparison locations

Species	Gladstone	Moreton	Sunshine Coast	Hinchinbrook
Yellowfin Bream	183	62	79	1
Pikey Bream	143	0	0	5
Barred Javelin	219	0	1	38
Dusky Flathead	80	197	58	10
Mangrove Jack	122	4	12	39
Barramundi	37	0	0	70
Total	784	263	150	163

Table 11: Number of detections of health issues at each of the comparison locations

Fins	Gladstone	Moreton	Sunshine Coast	Hinchinbrook
Yellowfin Bream	57 (31.1%)	7 (11.2%)	11 (13.9%)	NA
Pikey Bream	34 (23.8%)	NA	NA	NA
Barred Javelin	42 (19.2%)	NA	NA	8 (21.1%)
Dusky Flathead	10 (12.5%)	5 (2.5%)	0 (0.0%)	NA
Mangrove Jack	34 (27.9%)	NA	NA	8 (20.5%)
Barramundi	10 (27.0%)	NA	NA	10 (14.3%)
Total	187 (23.9%)	12 (4.5%)	11 (7.3%)	26 (16.0%)
Skin	Gladstone	Moreton	Sunshine Coast	Hinchinbrook
Yellowfin Bream	10 (5.5%)	1 (1.6%)	4 (5.1%)	NA
Pikey Bream	22 (23.8%)	NA	NA	NA
Barred Javelin	37 (16.9%)	NA	NA	2 (5.3%)
Dusky Flathead	8 (10.0%)	1 (0.5%)	2 (3.5%)	NA
Mangrove Jack	24 (19.7%)	NA	NA	5 (12.8%)
Barramundi	9 (23.4%)	NA	NA	3 (4.3%)
Total	110 (14.0%)	2 (0.8%)	6 (4.0%)	10 (6.1%)

Eyes	Gladstone	Moreton	Sunshine Coast	Hinchinbrook
Yellowfin Bream	1 (0.5%)	1 (1.6%)	1 (1.3%)	NA
Pikey Bream	2 (1.4%)	NA	NA	NA
Barred Javelin	0 (0.0%)	NA	NA	0 (0.0%)
Dusky Flathead	0 (0.0%)	0 (0.0%)	0 (0.0%)	NA
Mangrove Jack	0 (0.0%)	NA	NA	24
Barramundi	0 (0.0%)	NA	NA	1 (1.4%)
Total	3 (0.04%)	1 (0.4%)	1 (0.7%)	1 (0.6%)
Parasites	Gladstone	Moreton	Sunshine Coast	Hinchinbrook
Yellowfin Bream	0 (0.0%)	0 (0.0%)	0 (0.0%)	NA
Pikey Bream	0 (0.0%)	NA	NA	NA
Barred Javelin	0 (0.0%)	NA	NA	0 (0.0%)
Dusky Flathead	0 (0.0%)	0 (0.0%)	1 (1.3%)	NA
Mangrove Jack	0 (0.0%)	NA	NA	0 (0.0%)
Barramundi	0 (0.0%)	NA	NA	0 (0.0%)
Total	0 (0.0%)	0 (0.0%)	1 (0.7%)	0 (0.0%)
Deformities	Gladstone	Moreton	Sunshine Coast	Hinchinbrook
Yellowfin Bream	0 (0.0%)	0 (0.0%)	0 (0.0%)	NA
Pikey Bream	0 (0.0%)	NA	NA	NA
Barred Javelin	0 (0.0%)	NA	NA	0 (0.0%)
Dusky Flathead	0 (0.0%)	0 (0.0%)	0 (0.0%)	NA
Mangrove Jack	0 (0.0%)	NA	NA	0 (0.0%)
Barramundi	0 (0.0%)	NA	NA	1 (1.4%)
Total	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)

Table 12: Summary of detections by location and score

Location	Fins	Skin	Eyes	Parasites	Deformities	Score
Gladstone	187	110	3	0	0	0.96
Moreton Bay	12	2	1	0	0	0.98
Sunshine Coast	11	6	1	1	0	0.98
Hinchinbrook	26	10	1	0	1	0.97

6. DISCUSSION

The overall grade for Gladstone Harbour was B (0.69) with 1 species recording an A, 1 a B and 3 a C. For FBC Barred Javelin had a grade of A, Pikey Bream a B and Yellowfin Bream, Dusky Flathead and Mangrove Jack was C. The grading for Mangrove Jack needs to be treated with caution due to the low sample sizes in the historic data from 2003 – 2010 and 2013. The VCI was A for all species.

The results were in line with expectations based on the climatic conditions. During the year there was little or no freshwater flow in the river and creeks as demonstrated by the flows in the Calliope River and lake levels in Awoonga. These conditions are likely to have influenced food supply and consequently FBC. A number of fish conditions, such as red spot disease, are associated with freshwater flows and this is reflected in the low level of skin aberrations.

For Gladstone the level of detection of fin issues was 23.9% and for skin was 14.0%, which were higher than the comparison locations, however the levels of severity were low. There were very few detections of eyes, parasites and deformities. The levels for fins and skin at Gladstone is likely to be influenced by fish being brought into the weigh in station at the BTHU in a variety of containers including eskies and buckets. These fish were transported from various locations in the region and may have spent several hours in their containers making them more susceptible to fin and skin damage.

From 2011 to early 2018 there were regular over-toppings of Awoonga dam with fish, mostly Barramundi, spilling from the lake into the Boyne River, Gladstone Harbour and adjacent waterways. This resulted in dead and injured fish from going over the spillway and subsequent fish health issues from abrasions and trauma. This year there was no overtopping of the dam however there were 9 dead Barramundi reported at Manns Weir in June. This could be due to fish health issues, a sudden drop in water temperature or a combination of both those factors. Appendix 6 has a summary of the incidences since 2011. These fish deaths have not been factored into the gradings however some further consideration needs to be given as to how these may be dealt with.

7. REFERENCES

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APPENDIX 1: ALL SPECIES VISUAL HEALTH CONDITION

Table 13: Visual Condition Index (VCI) for all species recorded

Species	Visual Fish Condition Index (VCI)	Fish Body Condition (FBC)	Species Score	GHHP Species Grade
Yellowfin Bream	0.96 (183)	0.25 (192)	0.61	C
Pikey Bream	0.96 (133)	0.65 (85)	0.81	B
Barred Javelin	0.97 (219)	1.00 (110)	0.99	A
Dusky Flathead	0.98 (80)	0.05 (59)	0.52	C
Mangrove Jack	0.96 (122)	0.15 (36)	0.56	C
Barramundi	0.96 (37)	NA (0)	NA	NA
Golden Snapper	0.94 (22)	NA		
Blackspotted Rockcod	0.96 (9)	NA		
Goldspotted Rockcod	0.96 (6)	NA		
Blue Threadfin	1.00 (3)	NA		
Bartail Flathead	0.97 (3)			
Barcheek Coral Trout	0.97 (3)	NA		
Speckled Javelin	0.96 (2)	NA		
Whiting	0.95 (2)	NA		
Black Jewfish	0.92 (1)	NA		
King Threadfin	0.85 (1)	NA		
Giant Trevally	0.85 (1)	NA		
Red Emperor	1.00 (1)	NA		
Sicklefish	0.92 (1)	NA		

APPENDIX 2: SPECIES BY NUMBERS IN ZONES

List of images by species recorded using standard name, scientific name, number of zones and number of fish images recorded in 2018 - 2019.

Table 14: Number of fish sampled and the number of zones

STANDARD NAME	SCIENTIFIC NAME	ZONES	NUMBER
Javelin – Barred	<i>Pomadasys kaakan</i>	11	219
Bream – Yellowfin	<i>Acanthopagrus australis</i>	12	183
Bream – Pikey	<i>Acanthopagrus berda</i>	13	143
Mangrove Jack	<i>Lutjanus argentimaculatus</i>	10	122
Flathead – Dusky	<i>Platycephalus fuscus</i>	12	80
Barramundi	<i>Lates calcarifer</i>	7	37
Snapper - Golden	<i>Lutjanus johnni</i>	10	22
Rockcod – Blackspotted	<i>Epinephelus malabaricus</i>	5	9
Flathead – Bartail	<i>Platycephalus indicus</i>	5	7
Rockcod – Goldspotted	<i>Epinephelus coioides</i>	3	3
Threadfin – Blue	<i>Eleutheronema tetradactylum</i>	2	3
Coral Trout – Barcheek	<i>Plectropomus maculatus</i>	2	3
Whiting – Goldenline	<i>Sillago analis</i>	1	1
Jewfish – Black	<i>Hyporthodus nigrurus</i>	1	1
Trevally – Giant	<i>Caranx ignobilis</i>	1	1
Threadfin – King	<i>Polydactylus macrochir</i>	1	1
Flounder – Largemouth	<i>Pseudorthombus spp</i>	1	1
Snapper – Moses	<i>Lutjanus russelli</i>	1	1
Emperor – Red	<i>Lutjanus sebae</i>	1	1
Sicklefish	<i>Drepane punctata</i>	1	1
Javelin – Speckled	<i>Pomadasys argenteus</i>	1	1
Total			840

APPENDIX 3: FISH BODY CONDITION RESULTS 2003 - 2019

Table 15: Fulton's Condition Index calculations for all species from 2003 - 2019

YELLOWFIN BREAM

Fulton's Condition Index K				
Year	Samples (n)	Mean	Min	Max
2003	153	1.44	0.76	2.72
2004	192	1.49	0.84	3.20
2005	188	1.47	0.85	2.47
2006	176	1.44	0.83	2.89
2007	126	1.44	0.90	3.37
2008	63	1.40	0.90	2.67
2009	0			
2010	137	1.62	0.80	4.48
2011	0			
2012	150	1.69	0.90	3.38
2013	179	1.57	0.98	2.59
2014	103	1.64	0.84	3.02
2015	361	1.59	0.94	3.28
2016	181	1.47	0.92	2.46
2017	451	1.43	0.72	2.44
2018	139	1.38	0.93	2.33
2019	192	1.45	0.93	3.15

PIKEY BREAM

Fulton's Condition Index K				
Year	Samples (n)	Mean	Min	Max
2003	56	1.49	1.00	3.06
2004	50	1.64	0.90	3.09
2005	71	1.54	0.83	2.66
2006	65	1.37	0.96	2.05
2007	75	1.63	1.06	2.68
2008	35	1.57	0.98	2.97
2009	0			
2010	23	1.64	1.28	2.57
2011	0			
2012	48	1.80	1.31	3.35
2013	82	1.64	1.00	2.50
2014	64	1.66	0.96	3.32

2015	89	1.78	1.16	2.82
2016	63	1.71	1.06	2.50
2017	87	1.62	1.08	2.50
2018	98	1.60	1.08	2.62
2019	85	1.65	1.09	2.63

BARRED JAVELIN

Fulton's Condition Index K				
Year	Samples (n)	Mean	Min	Max
2003	14	2.87	1.33	5.05
2004	13	2.33	1.23	3.87
2005	16	2.74	1.32	5.91
2006	25	1.99	1.25	4.62
2007	25	2.15	1.46	3.43
2008	11	2.35	1.25	3.68
2009	0			
2010	0			
2011	0			
2012	8	3.01	1.98	6.29
2013	14	2.81	1.19	4.73
2014	27	2.97	1.64	5.58
2015	25	3.28	1.39	5.95
2016	30	2.96	1.28	5.72
2017	40	3.12	2.04	6.35
2018	43	3.27	1.48	5.44
2019	110	3.40	1.94	5.71

MANGROVE JACK

Fulton's Condition Index K				
Year	Samples (n)	Mean	Min	Max
2003	5	2.81	2.36	3.38
2004	3	3.99	2.37	5.66
2005	8	2.84	2.08	4.08
2006	3	2.20	1.89	2.49
2007	8	2.25	1.69	3.67
2008	2	2.24	2.19	2.30
2009	0			
2010	3	3.00	2.38	4.04
2011	0			
2012	14	2.38	1.71	4.06
2013	2	3.17	3.16	3.19
2014	23	2.72	1.89	4.69

2015	15	2.71	1.57	3.74
2016	30	2.70	1.86	5.09
2017	26	2.77	1.90	4.16
2018	29	2.81	1.96	4.34
2019	36	2.47	1.31	4.35

DUSKY FLATHEAD

Fulton's Condition Index K				
Year	Samples (n)	Mean	Min	Max
2003	42	1.65	0.86	2.97
2004	48	1.82	0.93	3.85
2005	54	1.83	0.88	3.68
2006	46	1.72	0.80	3.02
2007	69	1.70	0.93	3.64
2008	13	2.11	1.26	3.59
2009	0			
2010	54	2.21	0.96	4.19
2011	0			
2012	75	1.90	0.98	3.90
2013	68	1.87	0.95	3.71
2014	63	1.80	0.79	3.39
2015	131	1.87	0.91	4.14
2016	100	1.90	0.91	3.95
2017	50	1.77	0.98	4.16
2018	79	1.69	0.57	3.55
2019	58	1.68	0.65	3.22

Table 16: Fulton’s Condition Index for 2003 - 2019 for all species and corresponding GHHP grades

YELLOWFIN BREAM

year	Samples (n)	Mean K	Species year min	Species year max	Score	Grade
2003	153	1.44	1.38	1.69	0.20	D
2004	192	1.49	1.38	1.69	0.35	C
2005	188	1.47	1.38	1.69	0.29	D
2006	176	1.44	1.38	1.69	0.19	E
2007	126	1.44	1.38	1.69	0.22	D
2008	63	1.40	1.38	1.69	0.09	E
2009	0					
2010	137	1.62	1.38	1.69	0.79	A
2011	0					
2012	150	1.69	1.38	1.69	1.00	A
2013	179	1.57	1.38	1.69	0.64	B
2014	103	1.64	1.38	1.69	0.86	A
2015	361	1.59	1.38	1.69	0.70	B
2016	181	1.47	1.38	1.69	0.30	C
2017	451	1.43	1.38	1.69	0.16	E
2018	139	1.38	1.38	1.69	0.00	E
2019	192	1.45	1.38	1.69	0.25	D

PIKEY BREAM

year	Samples (n)	Mean K	Species year min	Species year max	Score	Grade
2003	56	1.49	1.37	1.80	0.28	E
2004	50	1.64	1.37	1.80	0.63	C
2005	71	1.54	1.37	1.80	0.40	E
2006	65	1.37	1.37	1.80	0.00	E
2007	75	1.63	1.37	1.80	0.59	D
2008	35	1.57	1.37	1.80	0.47	E
2009	0		1.37	1.80		
2010	23	1.64	1.37	1.80	0.62	D
2011	0		1.37	1.80		
2012	48	1.80	1.37	1.80	1.00	A
2013	82	1.64	1.37	1.80	0.62	C
2014	64	1.66	1.37	1.80	0.68	B
2015	89	1.78	1.37	1.80	0.95	A
2016	63	1.71	1.37	1.80	0.79	A
2017	87	1.62	1.37	1.80	0.57	D
2018	98	1.60	1.37	1.80	0.52	D
2019	85	1.65	1.37	1.80	0.65	B

BARRED JAVELIN

year	Samples (n)	Mean K	Species year min	Species year max	Score	Grade
2003	14	2.87	1.99	3.40	0.62	D
2004	13	2.33	1.99	3.40	0.24	E
2005	16	2.74	1.99	3.40	0.53	D
2006	25	1.99	1.99	3.40	0.00	E
2007	25	2.15	1.99	3.40	0.11	E
2008	11	2.35	1.99	3.40	0.25	E
2009	0		1.99	3.40		
2010	0		1.99	3.40		
2011	0		1.99	3.40		
2012	8	3.01	1.99	3.40	0.72	B
2013	14	2.81	1.99	3.40	0.58	D
2014	27	2.97	1.99	3.40	0.70	C
2015	25	3.28	1.99	3.40	0.92	A
2016	30	2.96	1.99	3.40	0.69	C
2017	40	3.12	1.99	3.40	0.80	B
2018	43	3.27	1.99	3.40	0.91	B
2019	110	3.40	1.99	3.40	1.00	A

MANGROVE JACK

year	Samples (n)	Mean K	Species year min	Species year max	Score	Grade
2003	5	2.81	2.20	3.99	0.34	B
2004	3	3.99	2.20	3.99	1.00	A
2005	8	2.84	2.20	3.99	0.35	B
2006	3	2.20	2.20	3.99	0.00	E
2007	8	2.25	2.20	3.99	0.03	E
2008	2	2.24	2.20	3.99	0.02	E
2009	0		2.20	3.99		
2010	3	3.00	2.20	3.99	0.45	A
2011	0		2.20	3.99		
2012	14	2.38	2.20	3.99	0.10	E
2013	2	3.17	2.20	3.99	0.54	A
2014	23	2.72	2.20	3.99	0.29	D
2015	15	2.71	2.20	3.99	0.29	D
2016	30	2.70	2.20	3.99	0.28	D
2017	26	2.77	2.20	3.99	0.32	C
2018	29	2.81	2.20	3.99	0.34	C
2019	36	2.47	2.20	3.99	0.15	D

DUSKY FLATHEAD

year	Samples (n)	Mean K	Species year min	Species year max	Score	Grade
2003	42	1.65	1.65	2.21	0.00	E
2004	48	1.82	1.65	2.21	0.31	D
2005	54	1.83	1.65	2.21	0.33	C
2006	46	1.72	1.65	2.21	0.13	D
2007	69	1.70	1.65	2.21	0.09	E
2008	13	2.11	1.65	2.21	0.82	A
2009	0		1.65	2.21		
2010	54	2.21	1.65	2.21	1.00	A
2011	0		1.65	2.21		
2012	75	1.90	1.65	2.21	0.46	A
2013	68	1.87	1.65	2.21	0.40	B
2014	63	1.80	1.65	2.21	0.27	D
2015	131	1.87	1.65	2.21	0.39	C
2016	100	1.90	1.65	2.21	0.46	B
2017	50	1.77	1.65	2.21	0.21	D
2018	79	1.69	1.65	2.21	0.08	E
2019	58	1.68	1.65	2.21	0.06	E

APPENDIX 4: FISH HEALTH DETECTIONS AT GLADSTONE AND REFERENCE LOCATIONS

Table 17: Fish health detections at Gladstone

Species	Fins	Skin	Eyes	Parasites	Deformities	Samples
BARCHEEK CORAL TROUT	1	0	0	0	0	3
BARRAMUNDI	10	9	0	0	0	37
BARRED JAVELIN	42	37	0	0	0	219
BARTAIL FLATHEAD	0	1	0	0	0	3
BLACKSPOTTED ROCKCOD	2	3	0	0	0	9
BLACK JEWFISH	0	1	0	0	0	1
BLUE THREADFIN	0	0	0	0	0	3
DUSKY FLATHEAD	10	8	0	0	0	80
GIANT TREVALLY	1	0	0	0	0	1
GOLDEN SNAPPER	6	9	0	0	0	22
GOLDENLINE WHITING	0	1	0	0	0	1
GOLDSPOTTED ROCKCOD	1	1	0	1	0	6
KING THREADFIN	1	0	0	0	0	1
MANGROVE JACK	34	24	0	0	0	122
MOSES SNAPPER	0	0	0	0	0	1
PIKEY BREAM	34	22	2	0	0	143
RED EMPEROR	0	0	0	0	0	1
SICKLEFISH	0	1	0	0	0	1
SPECKLED JAVELIN	1	0	0	0	0	2
STEELBACK	0	1	0	0	0	1
YELLOWFIN BREAM	57	10	1	0	0	183
TOTAL	200	128	3	1	0	840

Table 18: Fish health detections at Moreton Bay reference location

Species	Fins	Skin	Eyes	Parasites	Deformities	Samples
AMBERJACK	0	0	0	0	0	1
AUSTRALIAN BASS	1	1	0	0	0	13
BARRACUDA	0	0	0	0	0	1
BIGEYE TREVALLY	0	0	0	0	0	2
BLACKSPOTTED ROCKCOD	1	0	0	0	0	3
COBIA	0	0	0	0	0	1
DUSKY FLATHEAD	5	1	0	1	0	197

GIANT TREVALLY	1	0	0	0	1	12
GOLDEN PERCH	1	0	0	0	0	3
GOLDSPOTTED ROCKCOD	0	0	0	0	0	8
GRASS EMPEROR	0	0	0	0	0	9
GRINNER	1	0	0	0	0	2
KING THREADFIN	1	1	0	0	0	12
MANGROVE JACK	2	0	0	0	0	4
MOSES SNAPPER	0	0	0	0	0	1
MUD CRAB	0	0	0	0	0	4
MULLOWAY	3	0	0	0	0	11
MURRAY COD	0	0	0	0	0	1
PONYFISH	0	0	0	0	1	1
PUFFERFISH	0	0	0	0	0	1
SNAPPER	1	1	1	0	0	10
SPANGLED EMPEROR	0	0	0	0	0	1
SPECKLED JAVELIN	0	0	0	0	0	3
TAILOR	1	8	0	0	0	21
WHIPTAIL	0	0	0	0	0	3
YELLOWFIN BREAM	7	1	1	0	0	62
TOTAL	22	18	2	0	3	387

Table 19: Fish health detections at Sunshine Coast reference location

Species	Fins	Skin	Eyes	Parasites	Deformities	Samples
AUSTRALIAN BASS	2	0	0	0	0	12
BARRACUDA	0	0	0	0	0	2
BARRED JAVELIN	0	0	0	0	0	1
BIGEYE TREVALLY	2	3	1	0	0	17
BLACKSPOTTED ROCKCOD	1	0	0	0	0	6
BLUDGER TREVALLY	0	1	0	0	0	2
BLUE TUSKFISH	0	0	0	0	0	1
BULL SHARK	0	0	0	0	0	1
COWTAIL RAY	0	0	0	0	0	2
DUSKY FLATHEAD	0	2	0	1	0	58
EAGLE RAY	0	0	0	0	0	1
FORKTAIL CATFISH	0	1	0	0	0	3
GIANT HERRING	0	0	0	0	0	1
GIANT TREVALLY	0	0	0	0	0	9
GOLDEN TREVALLY	0	0	0	0	0	1
GOLDSPOTTED ROCKCOD	1	0	0	0	0	3

GRASS EMPEROR	0	1	0	0	0	6
GREY MORWONG	0	0	0	0	0	1
HAIRTAIL	0	0	0	0	0	1
LONGNOSE TREVALLY	1	0	0	0	0	1
MACKEREL TUNA	0	0	0	0	0	3
MANGROVE JACK	1	5	0	0	0	12
MAORI ROCKCOD	0	0	0	0	0	8
MOSES SNAPPER	1	1	0	0	0	5
MULLOWAY	2	0	0	0	0	14
PEARL PERCH	0	0	0	0	0	6
PONYFISH	0	0	0	0	1	1
PUFFERFISH	0	0	0	0	0	2
PUTTYNOSE PERCH	1	0	0	0	0	1
QUEENFISH	0	0	0	0	0	1
RED EMPEROR	0	0	0	0	0	2
SALMON CATFISH	0	0	0	0	0	2
SAND WHITING	3	2	0	0	0	18
SCHOOL MACKEREL	0	1	0	0	0	1
SHARK	0	0	0	0	0	1
SHOVELNOSE RAY	0	0	0	0	0	2
SNAPPER	1	3	0	0	0	15
SPANGLED EMPEROR	0	0	0	0	0	1
SPECKLED JAVELIN	1	2	0	0	0	8
STINGRAY	1	0	0	0	0	3
STRIPED TUNA	0	1	0	0	0	1
TAILOR	1	0	0	0	0	4
VENUS TUSKFISH	2	2	0	0	0	12
YELLOWFIN BREAM	11	4	1	0	2	79
YELLOWSPOTTED ROCKCOD	0	0	0	0	0	1
YELLOWTAIL KINGFISH	0	0	0	0	0	1
TOTAL	32	29	2	1	3	334

Table 20: Fish health detections at Hinchinbrook reference location

Species	Fins	Skin	Eyes	Parasites	Deformities	Samples
ARCHERFISH	0	0	0	0	0	2
BARRACUDA	9	4	0	0	0	44
BARRAMUNDI	10	3	1	0	1	70
BARRED JAVELIN	8	2	0	0	0	38
BIGEYE TREVALLY	0	0	0	0	0	4

BLACK JEWFISH	0	0	0	0	0	1
BLACKSPOTTED ROCKCOD	5	2	0	0	0	69
BLUE THREADFIN	1	7	1	0	0	23
COMMON CORAL TROUT	2	0	0	0	0	4
CRIMSON SNAPPER	1	0	0	0	0	1
DARKTAIL SNAPPER	0	0	0	0	0	2
DUSKY FLATHEAD	0	0	0	0	0	10
GIANT TREVALLY	2	4	0	0	0	34
GOLDEN SNAPPER	7	4	1	0	1	32
GOLDSPOTTED ROCKCOD	12	2	0	0	0	55
GRINNER	0	0	0	0	0	1
LONGFIN ROCKCOD	0	0	0	0	0	8
MANGROVE JACK	8	5	0	0	0	38
MOSES SNAPPER	0	0	0	0	0	1
PIKEY BREAM	3	1	0	0	0	5
QUEENFISH	0	0	0	0	0	5
SILVER JEWFISH	5	4	0	0	0	16
STARGAZER	1	0	0	0	0	1
STRIPED SCAT	1	1	0	0	0	1
STRIPEY SNAPPER	0	0	0	0	0	2
TARPON	1	1	0	0	0	2
WOLF HERRING	0	0	0	0	0	1
YELLOWFIN BREAM	0	0	0	0	0	1
TOTAL	76	41	4	0	2	475

APPENDIX 5: REPORTS OF DEAD FISH IN THE BOYNE RIVER

Based on Infofish documented reports by fishers of dead, dying or sick Barramundi the following estimates in Table 22 were made of the numbers in the Boyne River each year since 2011. These estimates are crude however they do provide some sense of the scale of the issue.

Table 21: Estimated numbers of dead, dying or sick Barramundi reported by fishers from 2011 - 2019

Year	Number of fish
2011	2,000+
2012	160+
2013	40+
2014	40+
2015	5+
2016	none reported
2017	400+
2018	5+
2019	9