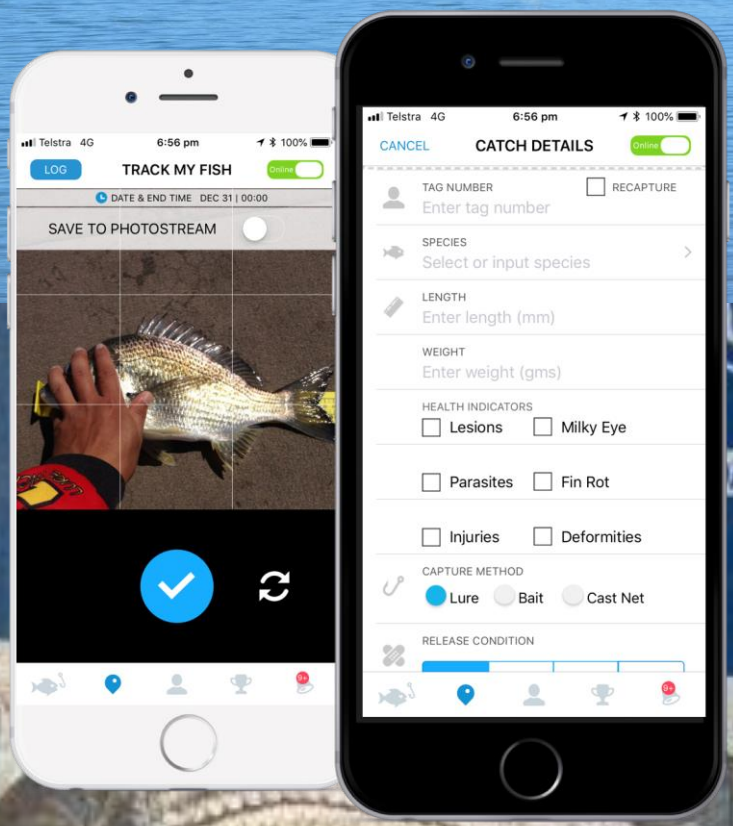
# Visual fish health indicators for the Gladstone Harbour Report Card 2020



# Visual fish health indicators for the Gladstone Harbour Report Card 2020

**Stefan Sawynok, Bill Sawynok, Aaron Dunlop and Phoenix Sawynok**

**Infofish Australia Pty Ltd**

**12 Mingoola Street Murarrie Qld 4172**

**Project ISP23b-2020**

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# SUMMARY

Fish health assessments in the Gladstone Harbour study area for the 2020 Report Card were based on Fish Condition (FC) which was a combination of Visual Fish Assessment (VFA) and Fish Body Condition (FBC). Owing to fish movement fish health is scored at the harbour level rather than at the individual monitoring zones level.

Fish images were used for visual fish assessment and length-weight data were obtained to assess fish body condition. Images were collected from:

- Suntag fishers using the Infofish Trackmyfish phone app and photos submitted by fishers recapturing tagged fish (July 2019-June 2020)
- Fishers in the ABT Bream fishing competition (September 2019)
- Infofish line fishing after cancellation of BTHU (June 2020)

Unfortunately, the Boyne Tannum HookUp (BTHU) fishing competition (May 2020) was cancelled due to restrictions imposed for dealing with Covid-19 so no images were collected there. As an alternative Infofish undertook limited line fishing to obtain data for assessing FBC for Bream species.

The Visual Fish Assessment (VFA) of 6 key species was made using 1,030 images mostly captured by the Trackmyfish app. The numbers of images for the key species were Barred Javelin (215), Yellowfin Bream (170), Pikey Bream (309), Mangrove Jack (109), Dusky Flathead (28) and Barramundi (115). There were a further 87 images of other species.

The VFA was based on the following indicators fins, skin, eyes, parasites and deformities. Visual fish health was assessed using both machine learning algorithms and human assessors. Microsoft Azure was used again this year to undertake the machine assessment. There was close to 100% agreement between the human and machine assessment on each parameter.

For the key species the resulting level of detection for fin damage was moderate ranging from 10.7% for Dusky Flathead to 39.8% for Mangrove Jack however the severity of the damage was low and assessed as light active erosion. Skin damage was low ranging from 0.9% for Barramundi to 2.4% for Pikey Bream with low severity of mild skin aberration. The detection level for eyes, parasites and deformities was very low to none. The resulting VFC scores are shown in the accompanying summary table.

To gauge how the Gladstone Harbour VFA compares with other locations images were assessed at 5 other locations. A total of 3,617 images were assessed. These were Baffle Creek (430), Hinchinbrook Channel (1,029), Sunshine Coast (1,246), Moreton Bay (480) and Lake Awoonga (369). For the key species Gladstone had the highest detection rate for fins at 26.1% however the severity was low. At all locations detections for skin, eyes, parasites and deformities was very low to none.

For the 2020 report card Fish body condition (FBC) was calculated using Relative Condition Factor (RCF) whereas Fulton's condition index (K) was used to assess FBC for the 2019 report card. The change was made following a meeting with the Independent Scientific Panel (ISP) as it was considered that Fulton's K did not adequately account for the different body shape of fish.

Length-weight data were proposed to be collected at the BTHU, however when it was cancelled Infofish collected 104 samples by line fishing. Sample numbers were Yellowfin Bream (27), Pikey Bream (70), Dusky Flathead (3) and other species (4). It was only possible to obtain a FBC score for the Bream species and the results are shown in the accompanying summary table.

The VFA and FBC scores were then averaged to provide a species FC score that was converted to a GHHP grade from A-E. Both Yellowfin Bream and Pikey Bream were graded as B and the all of harbour score was B.

No FBC data was available for Barred Javelin, Dusky Flathead, Mangrove Jack and Barramundi and these species were excluded from the calculation of the overall score.

| Species | Visual Fish Assessment (VFA) | Fish Body Condition (FBC) | Fish Condition (FC) score | GHHP Species Grade |
|---|---|---|---|---|
| Yellowfin Bream | 0.97 (170) | 0.44 (27) | 0.71 | B |
| Pikey Bream | 0.99 (309) | 0.48 (70) | 0.74 | B |
| Barred Javelin | 0.97 (215) | NA (0) | NA | NA |
| Dusky Flathead | 0.98 (28) | NA (3) | NA | NA |
| Mangrove Jack | 0.98 (108) | NA (0) | NA | NA |
| Barramundi | 0.98 (115) | NA (0) | NA | NA |
| All of harbour | 0.98 | 0.46 | 0.72 | 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 fish 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 using photographs and artificial intelligence algorithms 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).

Following the successful completion of that project GHHP decided to undertake a visual fish health assessment for 2018-19 and include a fish health indicator score in its 2019 report card using 6 key species. The results are contained in the report, Visual fish health indicators for the Gladstone Harbour Report Card 2019 (Sawynok et al. 2019).

Following the completion of the trial project and visual health assessment for the 2019 report card GHHP decided to undertake a further visual fish health assessment for 2019-20 and include a fish health indicator score in its 2020 report card.

# 2. OBJECTIVES

The objectives of the project were:

1. Produce visual fish condition scores and grades for the 2020 Gladstone Harbour Report Card. The required scores and grades are presented in Table 1 and the grading scale for the A to E grades is presented in Figure 1. The scores and grades to be calculated using the statistical methods developed in the 2019 visual fish condition project.

2. An updated visual fish condition project report.

**Table 1**: Required fish health scores and grades for the 2020 Gladstone Harbour Report Card.

| Species / Measure | Barramundi | Breams | Barred Javelin | Flathead | Mangrove Jack |
|---|---|---|---|---|---|
| **Skin** | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) |
| **Eyes** | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) |
| **Fins** | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) |
| **Parasites** | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) |
| **Deformities** | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) | Score (0 -1) |
| **Species score (Visual Fish Assessment VFA)** | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) |
| **Fish Body Condition** | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) | Grade A - E<br>Score (0 -1) |
| **Overall Harbour score** | Grade A - E<br>Score (0 -1) | | | | |


**Figure 1**: Grading scale for the 2020 Gladstone Harbour report card.

# 3. GLADSTONE HARBOUR MONITORING ZONES

The Gladstone Harbour has been divided into 13 environmental monitoring zones for the GHHP Report Card. However, owing to the potential for fish movement, fish health is 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.


**Figure 2***:* Gladstone monitoring zones for the GHHP Report Card (from 2018 Report Card Technical Report.pdf at https://dims.ghhp.org.au/repo/public/79fdb7).

# 4. METHODS

## 4.1 COLLECTING FISH SAMPLES

Data were collected from 1 July 2019 to 30 June 2020. The target was a minimum of 25 photographic samples of all species throughout the study area. There were 4 methods for collecting the field samples using the Infofish Trackmyfish (TMF) phone app or photos submitted by the general public.

1. SUNTAG - Photos collected by members of the Gladstone Sportfishing Club (GSFC) during normal fishing trips (July 2019 - June 2020) and photos provided by the general fishing public when reporting the recaptures of tagged fish (July 2019 - June 2020)
2. ABT BREAM TOURNAMENT - Photos collected at the ABT Bream tournament (September 2019)
3. BOYNE TANNUM HOOKUP - Photos and weights of fish were to be collected at the live weigh-in section of the Boyne Tannum HookUp (BTHU) fishing competition however it was cancelled due to Covid-19 (May 2020)
4. INFOFISH – Following the cancellation of the BTHU a limited number of photos and length-weight of fish (mostly Pikey and Yellowfin Bream) were obtained by Infofish by line fishing (June 2020) for assessing FBC

The data collected through TMF was:

- Photos of one side of the fish, preferably on a measuring ruler
- Tag number for fish that were tagged
- Total length of the fish to nearest half centimetre
- Weight of the fish in grams
- Check boxes to record visual health issues (lesions, milky eye, parasites, fin damage, injuries and deformities) (Infofish only)
- Date and GPS location of where the image was collected

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

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

Mangrove Jack were not included on the list of species to be assessed however sufficient photos were collected for it to be included. Whiting were not able to be assessed as those images were to be collected at the BTHU.

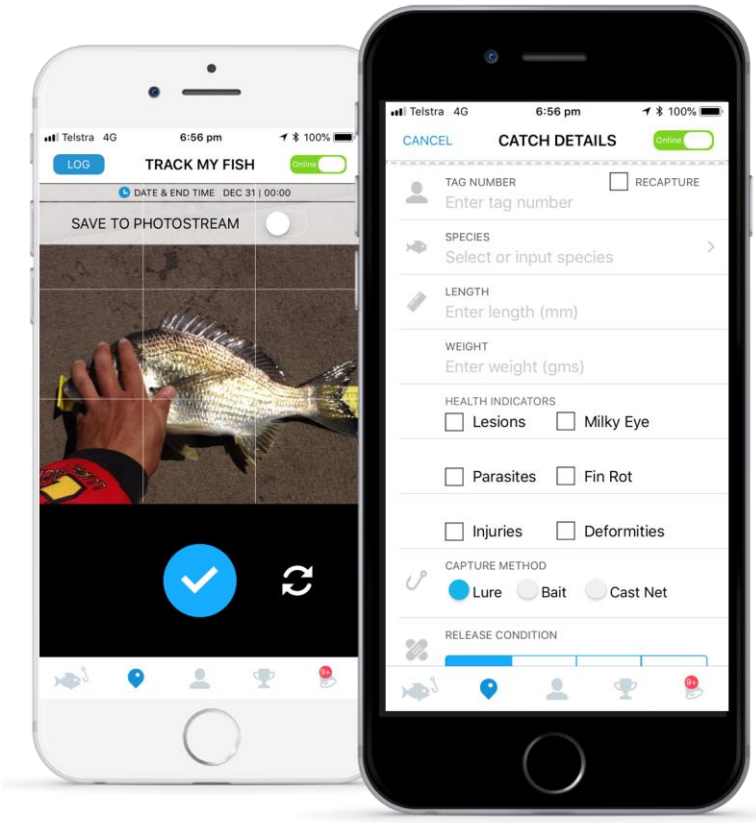


**Figure 3***:* Screen to capture fish image and collect details of the fish.

## 4.2 VISUAL FISH ASSESSMENT (VFA)

A simplified flow chart for Visual Fish Assessment (VFA) is presented in Figure 4 (Sawynok et al 2018a).

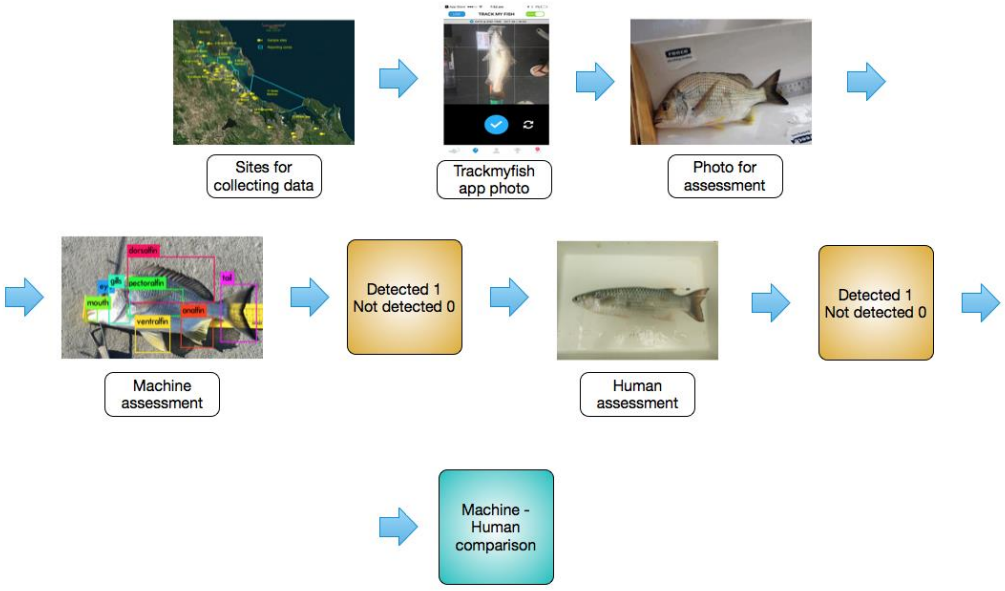


**Figure 4***:* Simplified flow chart of the process from field collection of data to the comparison of the machine and human assessment.

Two assessment methods were used, human and machine (Sawynok et al 2018a). Microsoft Azure was again used as the machine learning tool as this has been adopted by a number of fisheries agencies including Fisheries Queensland. Figure 5 shows a typical fish sample collected at the ABT Bream Tournament.

The 5 visual condition factors assessed were:

- Fins
- Skin
- Eyes
- Parasites
- Deformities

For all images the Visual Fish Assessment (VFA) was calculated based on the methods of Adams et al 1993 as a measure of visual condition. Each factor was provided a designation and score according to Table 2 and an overall score was generated for each individual fish wuth low scores reflecting healthier fish. The overall score was then converted to a 0-1 score using the following formula with high VFA scores reflecting healthier fish.

$$VFA = \frac{maximum\ score - fish\ score}{maximum\ score}$$


**Figure 5***:* Pikey Bream with minor tail fin damage

**Table 2**: 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 |

## 4.3 ASSESSING FISH BODY CONDITION (FBC)

Fish body condition (FBC) was calculated using Relative Condition Factor (RCF) whereas in the 2019 report card Fulton's condition index (K) was used (Sawynok S et al. 2019). The change was made following a meeting with the GHHP Independent Science Panel (ISP) as it was considered that Fulton's K did not adequately account for the different body shape of fish. The change in methodology necessitated the recalculation of the historic length- weight data collected at the BTHU from 2003-2019.

Length-weight data for the 2020 report card were proposed to be collected at the BTHU, however that event was cancelled due to Covid-19 restrictions. As a late alternative Infofish undertook line fishing in June 2020 to obtain length-weight

data. Due to the limited time available the focus was on collecting data on the Bream species, however data were also collected on other species that were caught. These data were collected from a representative but limited number of locations that were Gladstone Harbour/ Calliope River, Graham Creek, Boyne River, Wild Cattle Creek and South Trees Inlet.

The length-weight relationship is a key measure of fish used by fisheries agencies across Australia and internationally (Schneider 2000, King 2007). This relationship is calculated from the length–weight curve of best fit (Le Cren 1951) for each of the key species using data recorded in 2003-2019 during the BTHU and is described by the following formula:

$$W = a \times L^b$$

Where $W$ is the calculated weight and $L$ is the total length of the fish. Values of $W$ have been calculated from the logarithmic (base 10) equivalent:

$$\log W = \log a + b \cdot \log L$$

The Relative Condition Factor ($Kn$) (Le Cren 1951, Koushlesh 2017) is calculated as the proportion of the observed weight ($w$) to the calculated weight from the length-weight relationship ($W$) where a condition factor $Kn$ = 1 is consistent with a fish of average condition, $Kn$ >1 being above average and $Kn < 1$ below average.

$$Kn = \frac{w}{W}$$

The minimum ($Kn_{min}$) and maximum ($Kn_{max}$) condition factors for the species were determined from the historical minimum and maximum conditions. Each fish is scored ($S_{FISH}$) by normalising the Condition Factor, relative to the historical minimum and maximum.

$$S_{FISH} = \frac{Kn - Kn_{min}}{Kn_{max} - Kn_{min}}$$

The final score for the species in the current year is calculated as the average score for the species (where $n$ is the number of fish being assessed): The mean of the species ($S_{FISH}$) is shown in table 3. Other numerical summaries of the final score for each species are also in table 3.

$$S_{FINAL} = \frac{\sum_{i=1}^{n} S_{FISH}}{n}$$

Final grades are calculated using the standard GHHP cut-off scores as shown in Table 4.

**Table 3:** Values calculated for Fish Body Condition

| Species | number | Relative Condition Factor score | | | | |
|---|---|---|---|---|---|---|
| | | Mean | Median | Min | Max | Std dev |
| **Species 1** | | value | value | value | value | value |
| **Species 2** | | value | value | value | value | value |

**Table 4:** GHHP cut-off bands for grades

| SCORES | E | D | C | B | A |
|---|---|---|---|---|---|
| **Species** | 0-0.24 | 0.25-0.49 | 0.50-0.64 | 0.65-0.84 | 0.85-1 |

## 4.4 INFLUENCE OF RIVER FLOW

To provide some context to the assessment of VFC there was a need to examine some 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 FC score was generated for each key species by averaging VFA and FBC (Table 5) and these were aggregated to provide a single harbour wide score for fish health. Only those species with a VFA and FBC were included in the overall report card score and grade. 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 (VFA only)
- Dusky Flathead (VFA only)
- Mangrove Jack (VFA only)
- Barramundi (VFA only)

**Table 5**: Generating scores and grades for key species.

| Species | Visual Fish Assessment (VFA) | Fish Body Condition (FBC) | Fish Condition (FC) 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 | | Score (0 – 1) | Grade (A – E) |
| Dusky Flathead | 0 – 1 | | Score (0 – 1) | Grade (A – E) |
| Barramundi | 0 – 1 | | Score (0 – 1) | Grade (A – E) |
| Mangrove Jack | 0 – 1 | | Score (0 – 1) | Grade (A – E) |


**Figure 6**: The grading scale and the scores used in the GHHP 2020 report card.

## 4.6 GENERATING HARBOUR SCORES AND GRADES

In theory, a harbour-wide score would be generated by averaging over the individual species scores:

$$All\ of\ harbour\ score = \frac{YBream\ score + P\ Bream\ score + Javelin\ score + Flathead\ score + M\ Jack\ score}{5}$$

However due to the cancellation of the BTHU this limited the overall score to the Bream species:

$$All\ of\ harbour\ score = \frac{YBream\ score + P\ Bream\ score}{2}$$

## 4.7 COMPARISON WITH OTHER LOCATIONS

To provide a comparison to the scores and grades 5 locations were selected to provide a VFA comparison with Gladstone Harbour for the key species. Images were obtained from fishing competitions undertaken at each location. Lake Awoonga was added as it has been identified as a likely source of fish health issues in the Gladstone area in the past.

At each location all images, including 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 5 locations selected were:

- Baffle Creek
- Hinchinbrook Channel
- Sunshine Coast
- Moreton Bay
- Lake Awoonga

# 5. RESULTS

## 5.1 SUMMARY OF IMAGES

A total of 1,117 images were collected from 1 July 2019 to 30 June 2020. Suntag supplied 541 images, 472 were from the ABT Bream Tournament and 104 from Infofish (Figure 7).

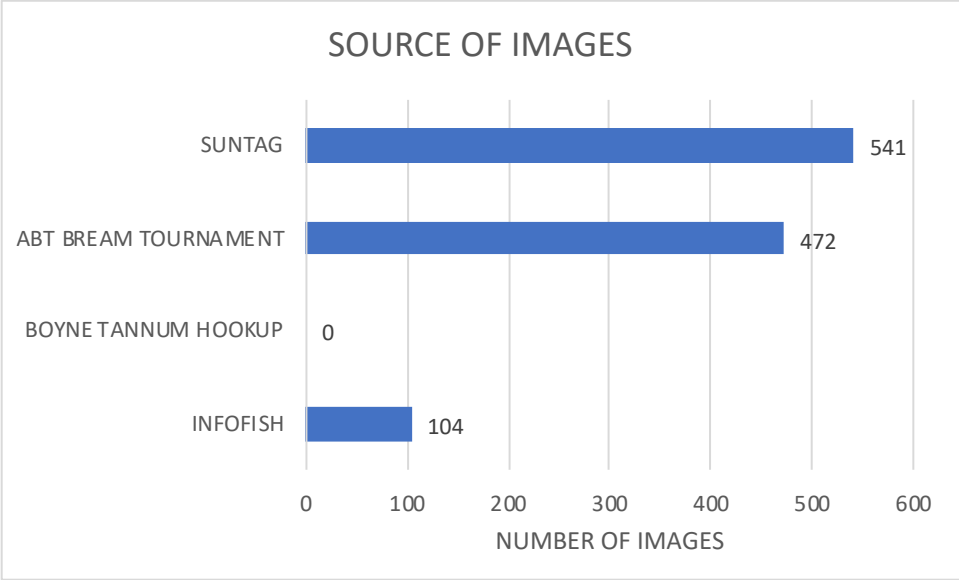


**Figure 7:** Sources of images for Visual Fish Condition (VFC) assessment.

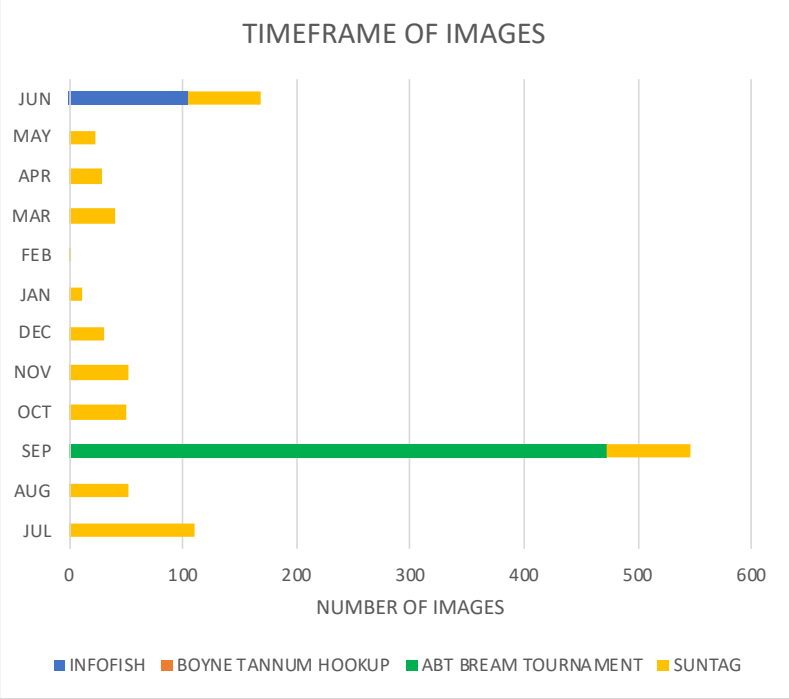


**Figure 8:** Timeframe for when images were obtained in 2019-2020.

Figure 8 shows the months in which the images were collected. There were 472 images obtained in September at the ABT Bream Tournament. There were 541 images collected through Suntag over the year and 104 images collected by Infofish in June.

Figure 9 shows the number of images based on species. There was a total of 1,030 images for the key species. Key species with images were Pikey Bream (370), Barred Javelin (216), Yellowfin Bream (193), Barramundi (115), Mangrove Jack (108) and Dusky Flathead (28). There were 87 images of other species.

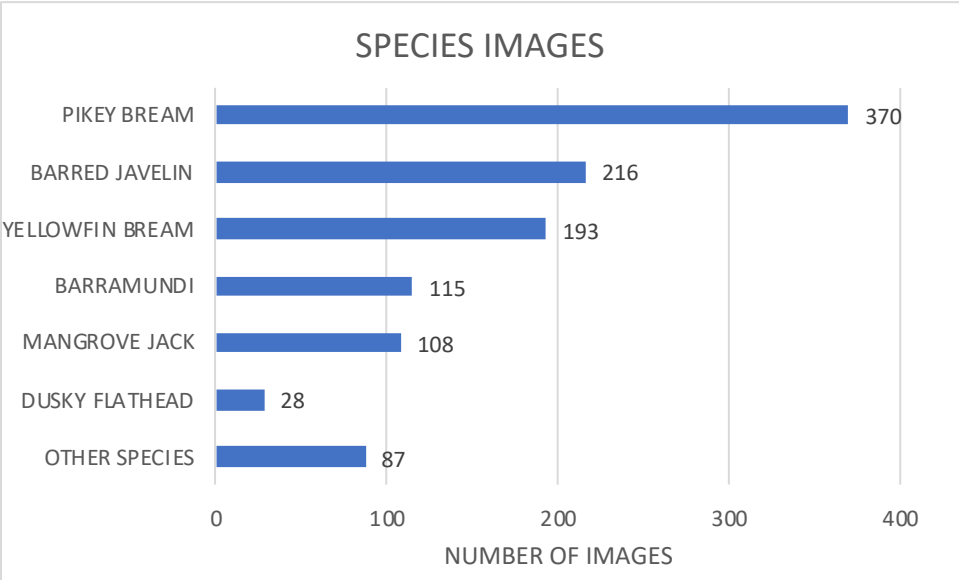


**Figure 9:** Number of images for each of the key species.

Figure 10 shows the number of images used for each of the key species at Gladstone and each of the comparison locations in the calculation of VFA. At the 6 sites a total of 4,734 images for all species were assessed.

For the key species there was a total of 2,833 images assessed. Total images for the key species were Gladstone (1,030), Baffle Creek (258), Hinchinbrook (429), Sunshine Coast (399), Moreton Bay (368) and Lake Awoonga (369).

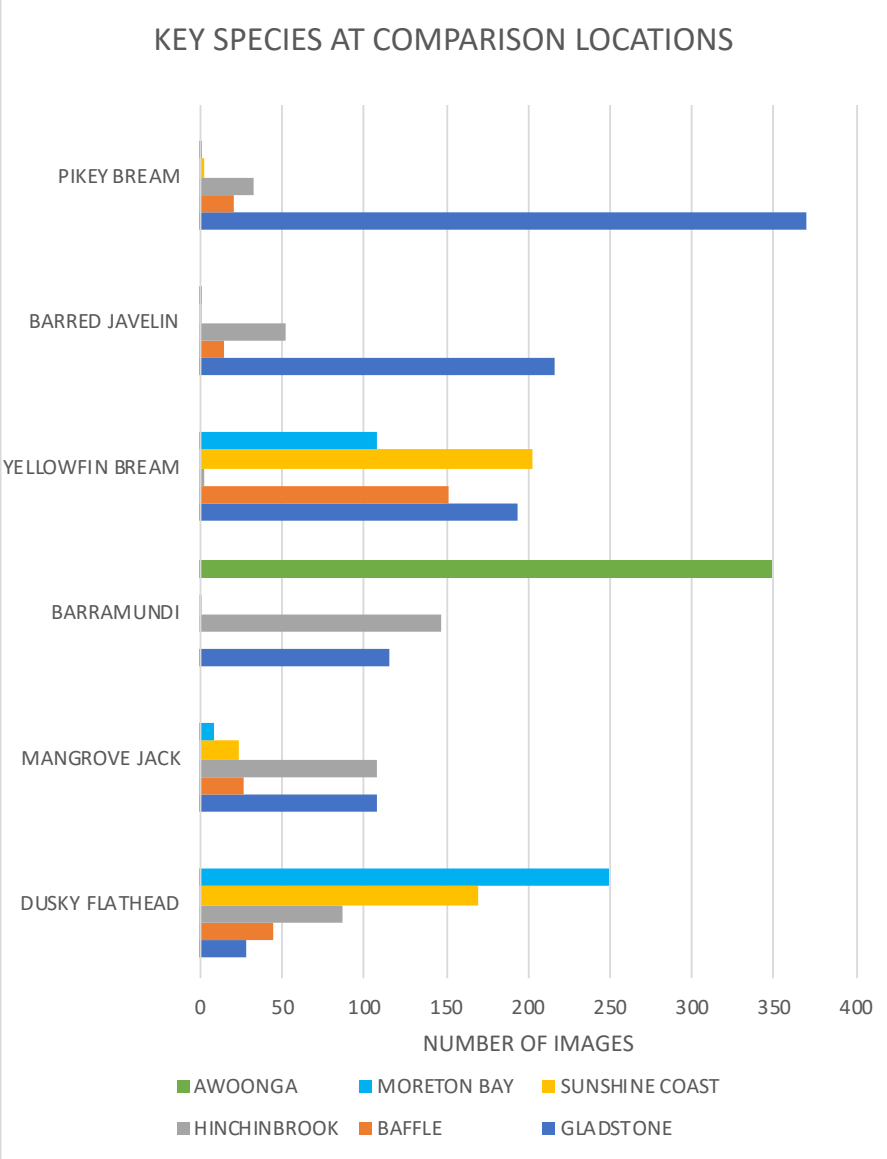


**Figure 10:** Images obtained at Gladstone and each of the comparison locations

## 5.2 VISUAL FISH ASSESSMENT (VFA)

VFA was assessed based on 1,030 images of the key species. Human and machine assessments 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. There was just one eye issue recorded in a Barramundi while there were no issues recorded for parasites or deformities.

Tables 7 and 8 provide the severity of detection for fin and skin damage for the key species. The level of severity was mostly light active erosion for fins and mild skin aberrations for skin.

**Table 6:** Detection of Visual Fish Assessment issues in key species in 2019 – 2020.

| Species | Number | Fins | Skin | Eyes | Parasites | Deform-ities | GHHP score | GHHP grade |
|---|---|---|---|---|---|---|---|---|
| Yellowfin Bream | 193 | 55 (28.5%) | 2 (1.0%) | 0 | 0 | 0 | 0.96 | A |
| Pikey Bream | 370 | 68 (18.4%) | 9 (2.4%) | 0 | 0 | 0 | 0.97 | A |
| Barred Javelin | 216 | 83 (38.4%) | 0 | 0 | 0 | 0 | 0.98 | A |
| Dusky Flathead | 28 | 3 (10.7%) | 0 | 0 | 0 | 0 | 0.99 | A |
| Mangrove Jack | 108 | 43 (39.8%) | 0 | 0 | 0 | 0 | 0.97 | A |
| Barramundi | 115 | 22 (19.1%) | 1 (0.9%) | 1 (0.9%) | 0 | 0 | 0.98 | A |
| All species | 1030 | 292 (26.1%) | 12 (1.1%) | 1 (0.1%) | 0 (0.0%) | 0 (0.0%) | | |

**Table 7:** Severity score of variable conditions for key species (eg YB = Yellowfin Bream) for fins and the number of detections.

| Variable Condition Fins | Design-ation | Score | YB | PB | BJ | DF | MJ | B |
|---|---|---|---|---|---|---|---|---|
| No Active Erosion | 0 | 0 | 138 | 302 | 133 | 25 | 65 | 93 |
| Light Active Erosion | 1 | 10 | 50 | 62 | 76 | 3 | 43 | 22 |
| Moderate Active Erosion with some haemorrhage | 2 | 20 | 5 | 6 | 6 | 0 | 0 | 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 (eg YB = Yellowfin Bream) for skin and the number of detections.

| Variable Condition Skin | Design-ation | Score | YB | PB | BJ | DF | MJ | B |
|---|---|---|---|---|---|---|---|---|
| Normal no aberrations | 0 | 0 | 191 | 361 | 216 | 28 | 108 | 114 |
| Mild skin aberrations | 1 | 10 | 2 | 8 | 0 | 0 | 0 | 1 |
| Moderate skin aberrations | 2 | 20 | 0 | 1 | 0 | 0 | 0 | 0 |
| Severe skin aberrations | 3 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |

## 5.3 FISH BODY CONDITION (FBC)

Fish Body Condition (FBC) was assessed using a Relative Condition Factor (RCF) whereas previously Fulton's K measure was used.

There was a total of 104 fish of the target species and others where weight and length were recorded:

- Yellowfin Bream (27)
- Pikey Bream (70)
- Barred Javelin (0)
- Dusky Flathead (3)
- Mangrove Jack (0)
- Barramundi (0)
- Tarwhine (2)
- Goldspotted Rockcod (2)

In 2020 length-weight data were obtained by Infofish and included both legal and undersized fish. Data from 2003-2019 were collected from the BTHU and was only from legal fish. Figure 11 shows the average, minimum and maximum lengths recorded each year for Pikey Bream and Figure 12 shows the lengths for Yellowfin Bream. The lower average lengths in 2020 resulted from the inclusion of undersize fish. Length-weight data for the other species were only available for 2003-2019 and are contained in Appendix 2.

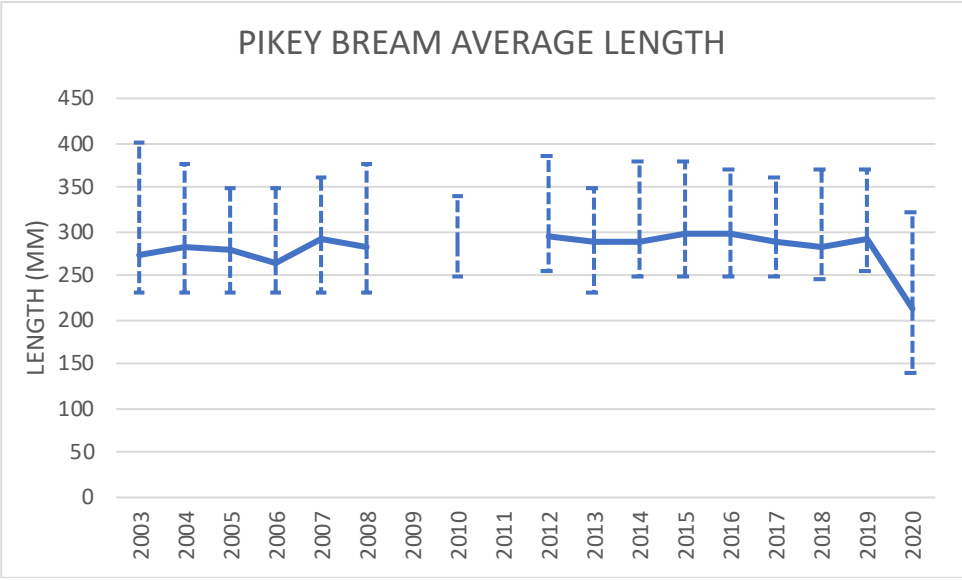


**Figure 11:** Average length of Pikey Bream each year from 2003-2020 (bars show the minimum and maximum lengths recorded)

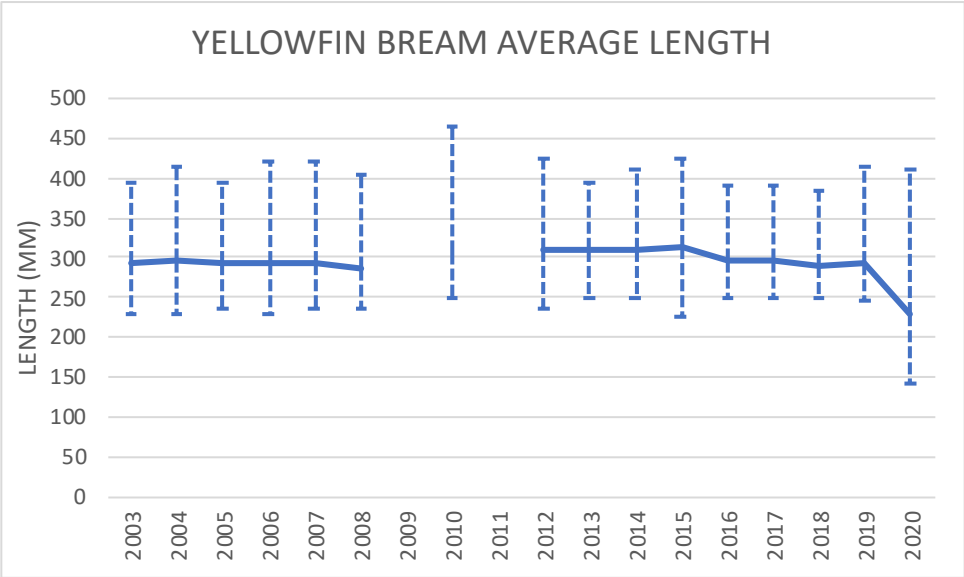


**Figure 12:** Average length of Yellowfin Bream each year from 2003-2020 (bars show the minimum and maximum lengths recorded)

For each of the key species historic data recorded during the BTHU competition from 2003-2019 were used to generate the length-weight curve of best fit and subsequently to generate the parameters for each of the key species. Figure 13 shows the length-weight scatterplot for each of the key species.

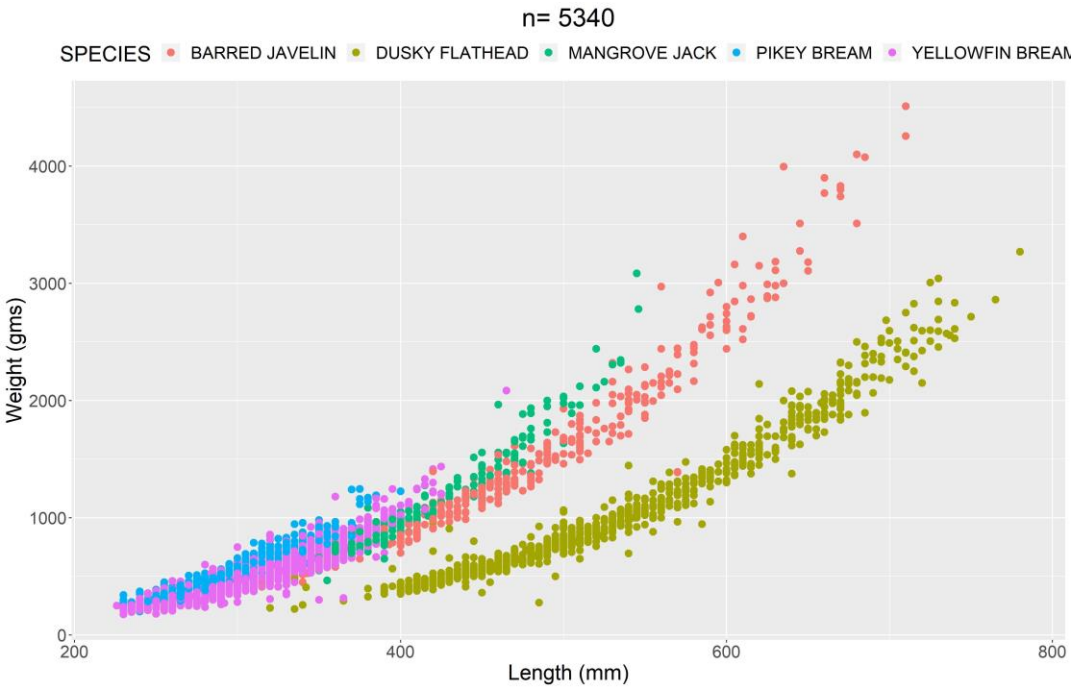


**Figure 13:** Length-weight data for the key species using the historic data from the BTHU from 2003-2019.

Table 9 shows the RCF parameters calculated for the key species using the historic data from the BTHU from 2003-2019. Tables 10-11 show the mean, median, minimum and maximum RCF from the historic data from 2003-2019 and for 2020. Table 12 shows the RCF scores for 2020.

**Table 9:** Relative Condition Factor parameters (see equation 1) for the key species using the historic data from the BTHU from 2003-2019.

| SPECIES | Number Samples | a | b | $R^2$ |
|---|---|---|---|---|
| **YELLOWFIN BREAM** | 2791 | 0.0000343 | 2.871 | 0.917 |
| **PIKEY BREAM** | 991 | 0.0000280 | 2.937 | 0.906 |
| **BARRED JAVELIN** | 401 | 0.0000560 | 2.763 | 0.973 |
| **MANGROVE JACK** | 207 | 0.00000695 | 3.128 | 0.950 |
| **DUSKY FLATHEAD** | 950 | 0.00000320 | 3.112 | 0.959 |

**Table 10:** Mean, median, minimum and maximum condition factors for the key species from the historic data from the BTHU for 2003-2019.

| SPECIES | Mean Condition Factor | Median Condition Factor | Minimum Condition Factor | Maximum Condition Factor |
|---|---|---|---|---|
| **YELLOWFIN BREAM** | 1.004 | 0.999 | 0.571 | 1.475 |
| **PIKEY BREAM** | 1.005 | 1.005 | 0.608 | 1.409 |
| **BARRED JAVELIN** | 1.004 | 1.004 | 0.570 | 1.405 |
| **MANGROVE JACK** | 1.003 | 0.997 | 0.705 | 1.327 |
| **DUSKY FLATHEAD** | 0.999 | 0.994 | 0.625 | 1.471 |

**Table 11:** Mean, median, minimum, maximum and standard deviation of condition factors for the key species for 2020.

| Species | Mean Condition | Median Condition | Min Condition | Max Condition | Standard Deviation Condition |
|---|---|---|---|---|---|
| **YELLOWFIN BREAM** | 0.973 | 0.958 | 0.804 | 1.221 | 0.097 |
| **PIKEY BREAM** | 0.993 | 0.991 | 0.807 | 1.428 | 0.096 |
| **BARRED JAVELIN** | NA | NA | NA | NA | NA |
| **MANGROVE JACK** | NA | NA | NA | NA | NA |
| **DUSKY FLATHEAD** | NA | NA | NA | NA | NA |

**Table 12:** Mean, median, minimum, maximum and standard deviation scores for the key species for 2020.

| Species | Mean Score | Median Score | Min Score | Max Score | Standard Deviation Score |
|---|---|---|---|---|---|
| **YELLOWFIN BREAM** | 0.45 | 0.43 | 0.26 | 0.72 | 0.11 |
| **PIKEY BREAM** | 0.48 | 0.48 | 0.25 | 1.00 | 0.12 |
| **BARRED JAVELIN** | NA | NA | NA | NA | NA |
| **MANGROVE JACK** | NA | NA | NA | NA | NA |
| **DUSKY FLATHEAD** | NA | NA | NA | NA | NA |

FBC was recalculated using RCF for all years with the results for each species shown in Figures 14-18 with a line showing the overall mean. For each year box plots show the mean RCF, 25$^{th}$ and 75$^{th}$ percentiles, range and outliers. RCF=1 means average condition.

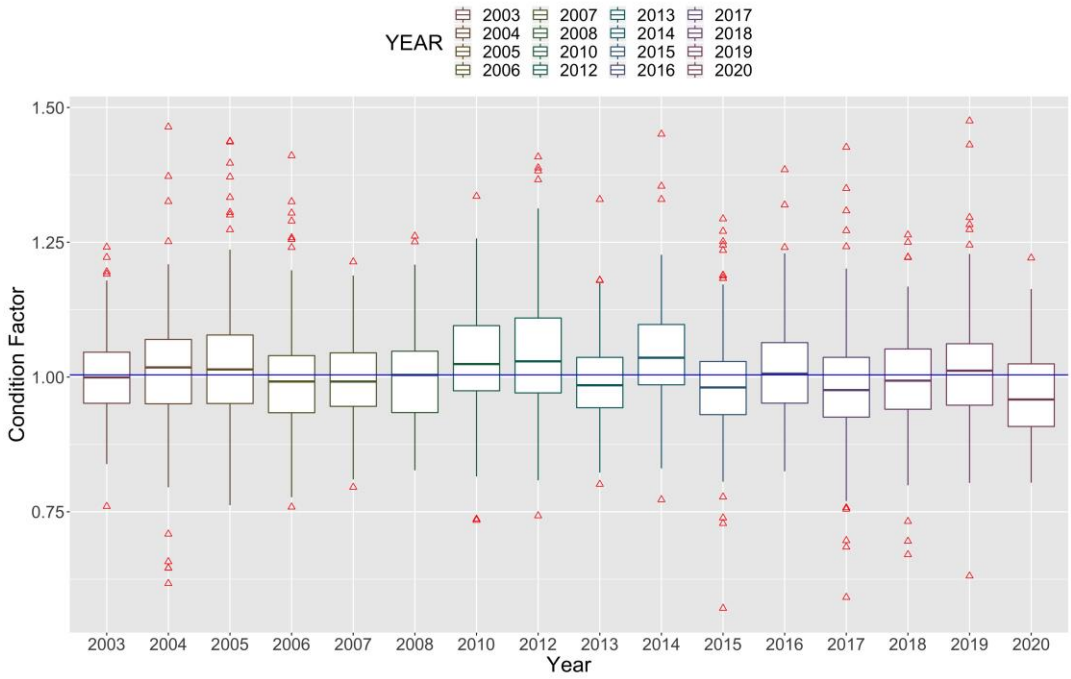


**Figure 14:** Plot of mean Condition Factor for Yellowfin Bream from 2003 – 2020.

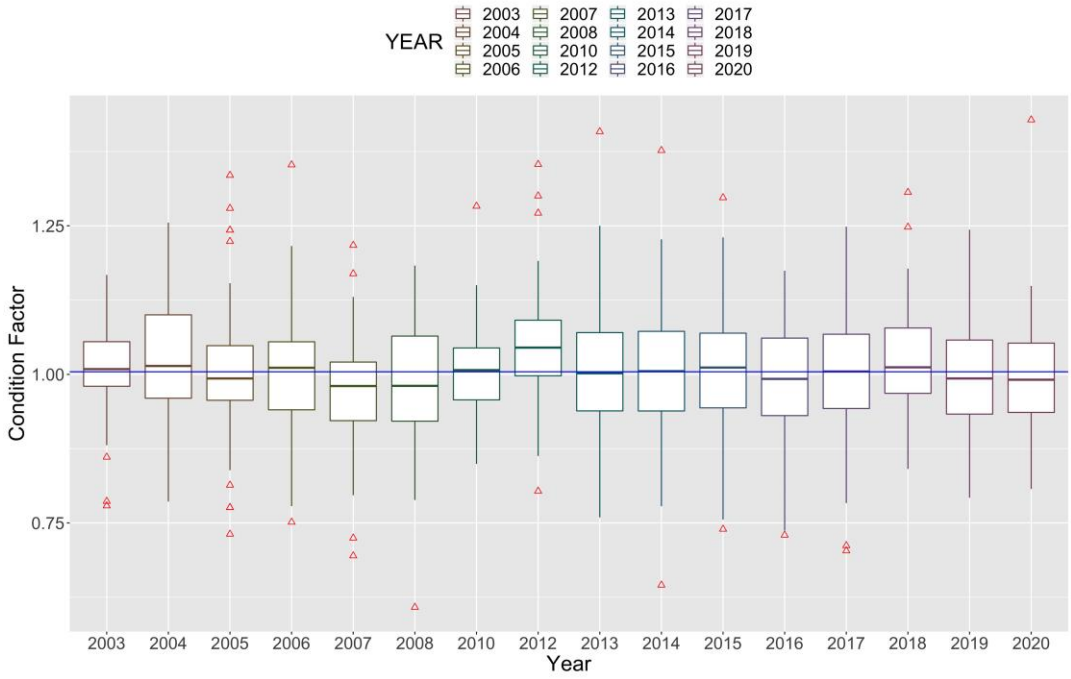


**Figure 15:** Plot of Condition Factor for Pikey Bream from 2003 – 2020.

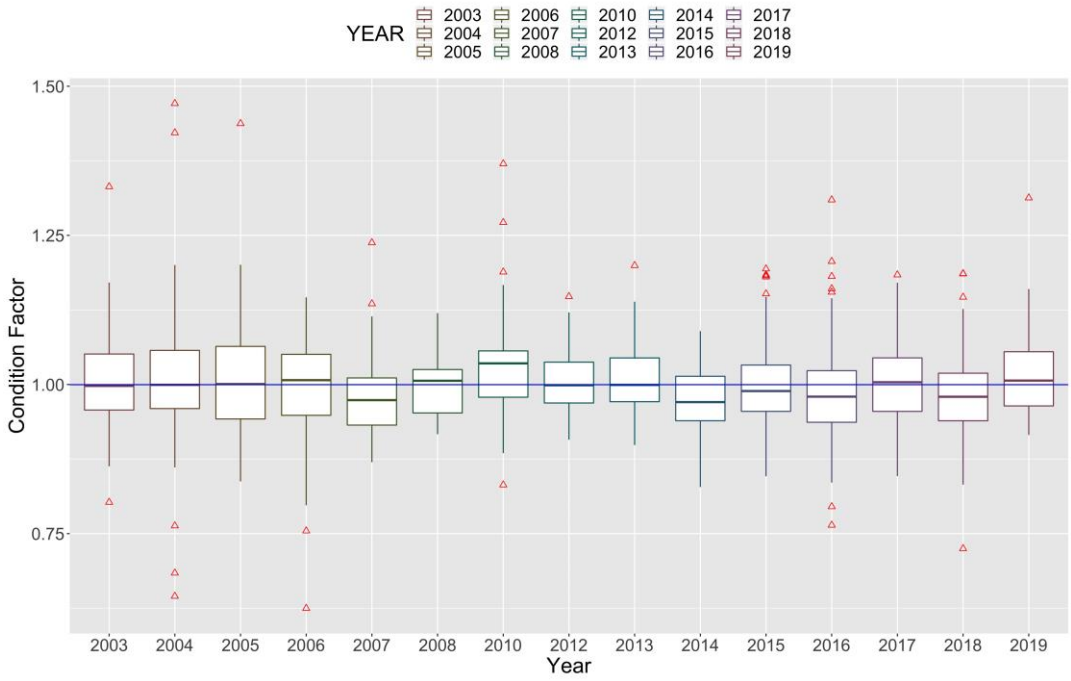


**Figure 16:** Plot of Condition Factor for Dusky flathead from 2003 – 2019.

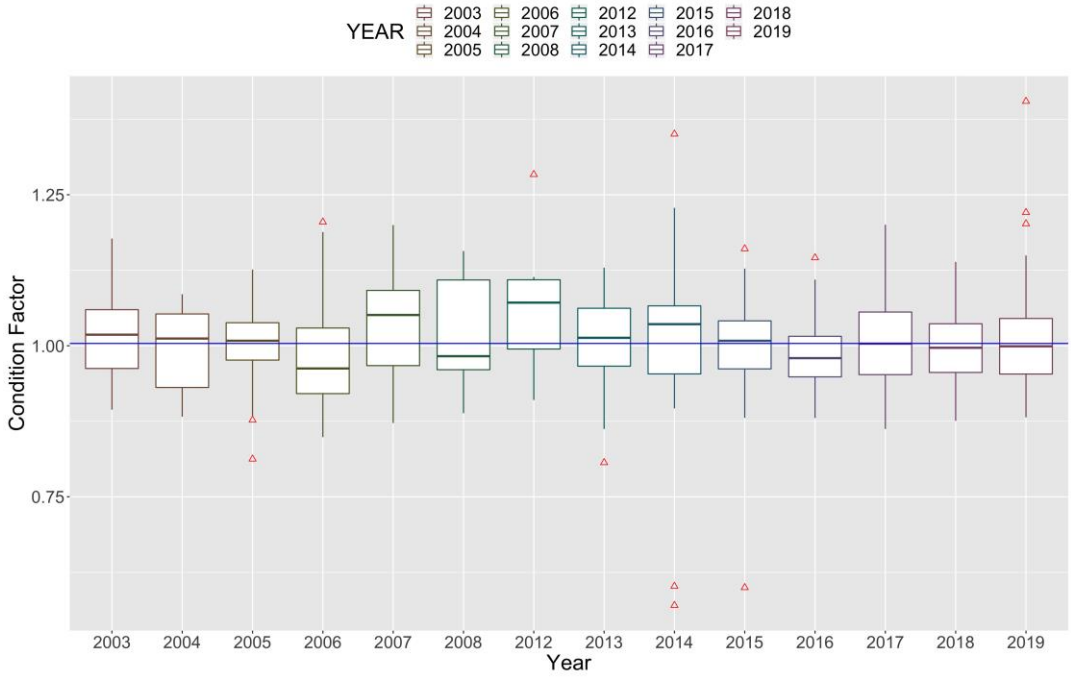


**Figure 17:** Plot of Condition Factor for Barred Javelin from 2003 – 2019.

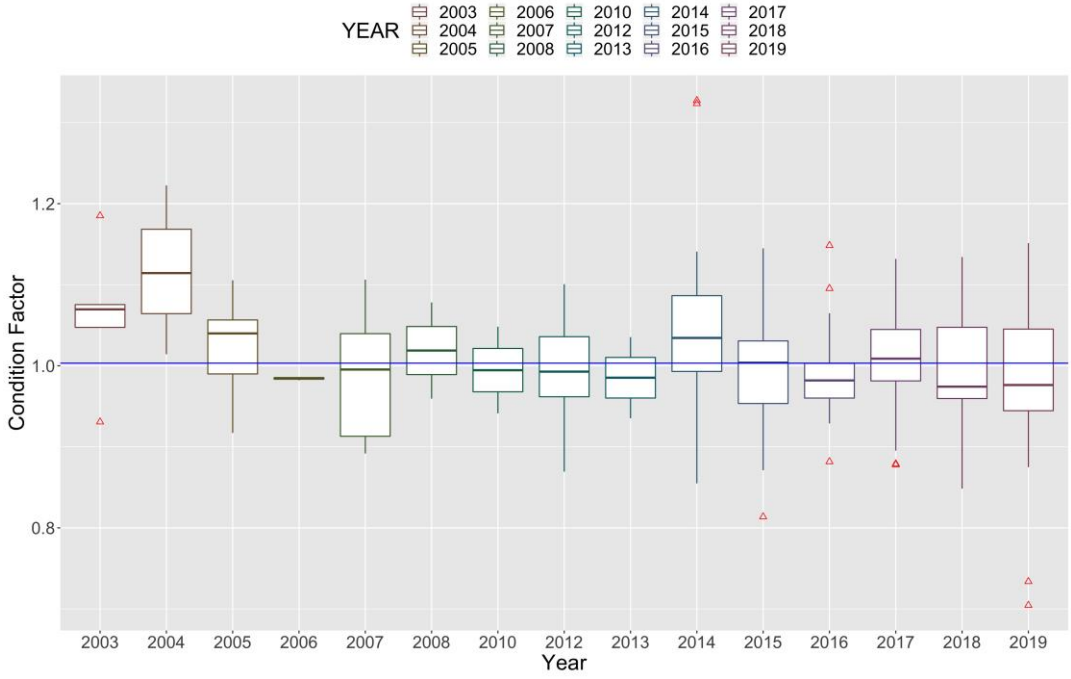


**Figure 18:** Plot of Condition Factor for Mangrove Jack from 2003 - 2019 (small sample sizes 2003 - 2013).

## 5.4 RIVER FLOW CONDITIONS

Figure 17 shows the monthly flow and the mean monthly flow in the Calliope River at Castlehope from 1 July 2018 – 30 June 2020. There was very little flow in the river in 2019 with below average flows during the 2020 wet season. The highest flow was in February with 32,745ML compared with a mean flow of 52,682 ML for that month.

Figure 18 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 37.06m on 1 July 2019 to 35.42m on 30 June 2020 was recorded. There was an inflow in February but there was no overtopping of the dam.

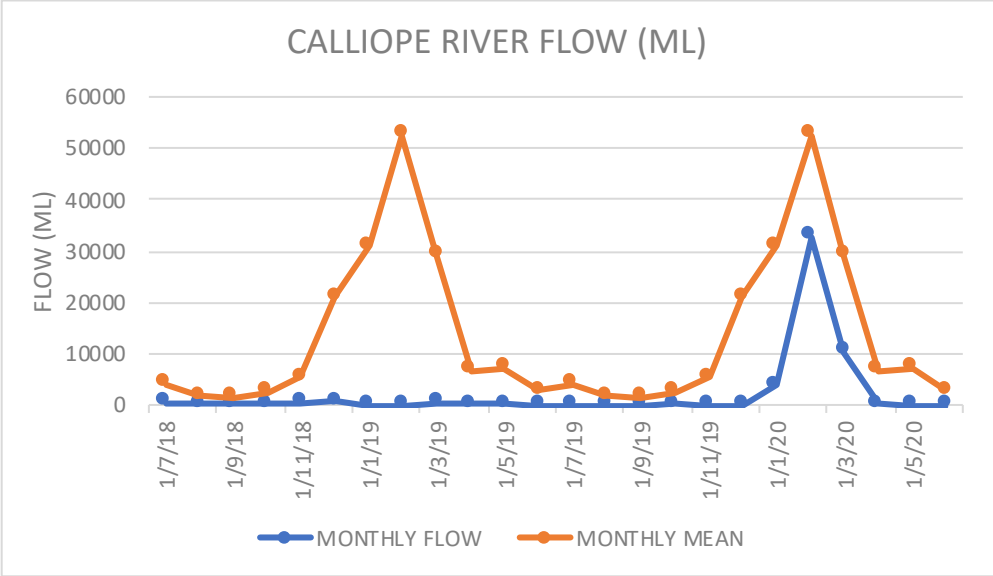


**Figure 19:** Calliope River flows and mean monthly flows (ML) July 2018 – June 2020.

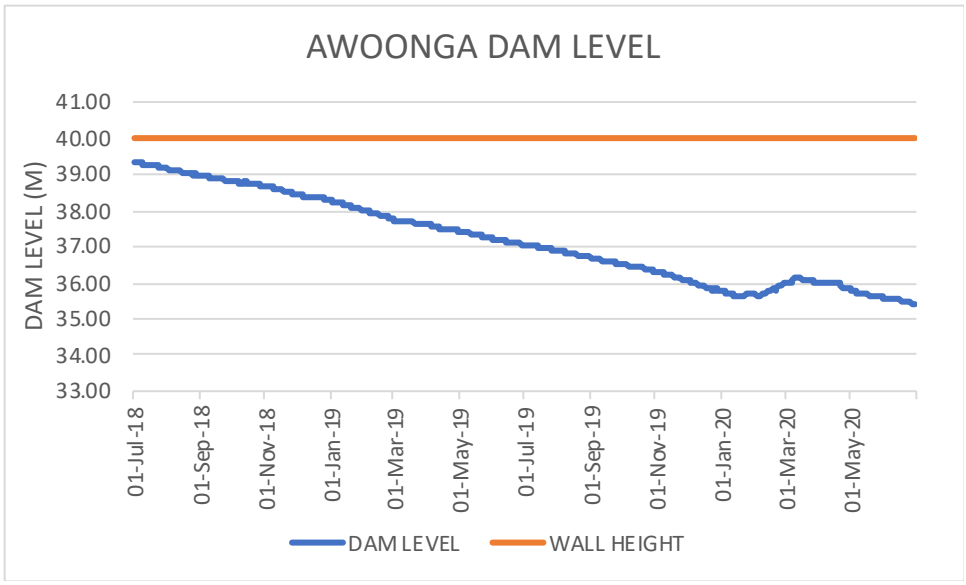


**Figure 20:** Awoonga lake levels and dam wall heights (m).

## 5.5 SPECIES SCORES AND GRADES

Table 13 shows the VFA and FBC scores for the 6 key species, the species score on a 0-1 scale and the corresponding GHHP grade. The GHHP grade for Yellowfin and Pikey Bream was B. No FBC was available for species other than the Breams. The all of harbour grade was B.

**Table 13:** GHHP Scores and grades for the 6 key species (figures in brackets are sample size).

| Species | Visual Fish Assessment (VFA) | Fish Body Condition (FBC) | Fish Condition (FC) score | GHHP Species Grade |
|---|---|---|---|---|
| Yellowfin Bream | 0.97 (170) | 0.44 (27) | 0.71 | B |
| Pikey Bream | 0.99 (309) | 0.48 (70) | 0.74 | B |
| Barred Javelin | 0.97 (215) | NA (0) | NA | NA |
| Dusky Flathead | 0.98 (28) | NA (3) | NA | NA |
| Mangrove Jack | 0.98 (108) | NA (0) | NA | NA |
| Barramundi | 0.98 (115) | NA (0) | NA | NA |
| All of harbour | 0.98 | 0.46 | 0.72 | B |

## 5.6 VFA COMPARISON BY LOCATION

To gauge how VFA compares with other locations images were assessed at 5 other locations using the same methods as used in Gladstone. A total of 3,617 images were assessed. These were Baffle Creek (430), Hinchinbrook Channel (1,029), Sunshine Coast (1,246), Moreton Bay (480) and Lake Awoonga (369). For the key species

Table 14 shows the number of images of each key species at the comparison locations. Comparisons were made where there was a minimum of 25 images. Table 15 is a summary of the detections for the key and all species and the resulting score for the key species. Table 16 shows the number and percentage of each health issue detected in key species at each location and the total number of images assessed at each location for the key species.

Gladstone had the highest detection rate for fins at 26.1% however the severity was low. At all sites detections of skin, eyes, parasites and deformities was very low to none.

**Table 14:** Number of images for the key species at Gladstone and each of the comparison locations.

| Species | Gladstone | Baffle Creek | Hinchin-brook | Sunshine Coast | Moreton Bay | Awoonga |
|---|---|---|---|---|---|---|
| **Yellowfin Bream** | 193 | 151 | 2 | 202 | 108 | 0 |
| **Pikey Bream** | 370 | 21 | 33 | 2 | 1 | 0 |
| **Barred Javelin** | 216 | 15 | 52 | 1 | 1 | 0 |
| **Dusky Flathead** | 28 | 44 | 87 | 170 | 249 | 0 |
| **Mangrove Jack** | 108 | 27 | 108 | 23 | 9 | 0 |
| **Barramundi** | 115 | 0 | 147 | 1 | 0 | 349 |
| **Total key species** | 1030 | 258 | 429 | 399 | 368 | 349 |
| **Total all species** | 1117 | 430 | 1092 | 1246 | 480 | 369 |

**Table 15:** Summary of number of detections for key species and all species by location and score for key species.

| Location | Fins | Skin | Eyes | Parasites | Deformities | Images | Score |
|---|---|---|---|---|---|---|---|
| **Key species** | | | | | | 2408 | |
| **Gladstone** | 274 | 12 | 1 | 0 | 0 | 1002 | 0.98 |
| **Baffle Creek** | 15 | 0 | 0 | 0 | 0 | 258 | 0.99 |
| **Hinchinbrook** | 80 | 3 | 0 | 0 | 0 | 429 | 0.99 |
| **Sunshine Coast** | 41 | 7 | 4 | 1 | 0 | 399 | 0.98 |
| **Moreton Bay** | 66 | 2 | 1 | 0 | 0 | 368 | 0.98 |
| **Awoonga** | 81 | 5 | 0 | 0 | 2 | 349 | 0.98 |
| **All species** | | | | | | 4734 | |
| **Gladstone** | 292 | 12 | 1 | 0 | 0 | 1117 | |
| **Baffle Creek** | 29 | 0 | 1 | 0 | 1 | 430 | |
| **Hinchinbrook** | 166 | 12 | 2 | 1 | 0 | 1092 | |
| **Sunshine Coast** | 112 | 55 | 7 | 1 | 53 | 1246 | |
| **Moreton Bay** | 110 | 5 | 1 | 0 | 4 | 480 | |
| **Awoonga** | 82 | 7 | 0 | 0 | 2 | 369 | |

**Table 16:** Number of detections of health issues at Gladstone and at each of the comparison locations (percentages of species samples).

| Fins | Gladstone | Baffle Creek | Hinchin-brook | Sunshine Coast | Moreton Bay | Awoonga |
|---|---|---|---|---|---|---|
| **Yellowfin Bream** | 55 (28.5%) | 15 (9.9%) | NA | 40 (19.8%) | 31(28.7%) | NA |
| **Pikey Bream** | 68 (18.4%) | NA | 11 (33.3%) | NA | NA | NA |
| **Barred Javelin** | 83 (38.4%) | NA | 6 (11.5%) | NA | NA | NA |
| **Dusky Flathead** | 3 (10.7%) | 0 (0.0%) | 3 (3.4%) | 1 (0.6%) | 35(14.1%) | NA |
| **Mangrove Jack** | 43 (39.8%) | NA | 25 (23.1%) | NA | NA | NA |
| **Barramundi** | 22 (19.1%) | NA | 35 (23.8%) | NA | NA | 81(23.2%) |
| **Total** | 274(27.3%) | 15 (7.6%) | 80 (18.9%) | 41 (11.0%) | 66(18.5%) | 81(23.2%) |

| Skin | Gladstone | Baffle Creek | Hinchin-brook | Sunshine Coast | Moreton Bay | Awoonga |
|---|---|---|---|---|---|---|
| **Yellowfin Bream** | 2 (1.0%) | 0 (0.0%) | NA | 6 (3.0%) | 2 (1.9%) | NA |
| **Pikey Bream** | 9 (2.4%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barred Javelin** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Dusky Flathead** | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (0.6%) | 0 (0.0%) | NA |
| **Mangrove Jack** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barramundi** | 1 (0.9%) | NA | 3 (2.0%) | NA | NA | 5 (1.4%) |
| **Total** | 12 (0.8%) | 0 (0.0%) | 3 (0.7%) | 7 (1.9%) | 2 (0.8%) | 5 (1.4%) |
| **Eyes** | **Gladstone** | Baffle Creek | Hinchin-brook | Sunshine Coast | Moreton Bay | Awoonga |
| **Yellowfin Bream** | 0 (0.0%) | 0 (0.0%) | NA | 4 (5.1%) | 0 (0.0%) | NA |
| **Pikey Bream** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barred Javelin** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Dusky Flathead** | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (0.4%) | NA |
| **Mangrove Jack** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barramundi** | 1 (0.9%) | NA | 0 (0.0%) | NA | NA | 0 (0.0% |
| **Total** | 1 (0.1%) | 0 (0.0%) | 0 (0.0%) | 4 (1.1%) | 1 (0.3%) | 0 (0.0%) |
| **Parasites** | **Gladstone** | **Baffle Creek** | **Hinchin-brook** | **Sunshine Coast** | **Moreton Bay** | **Awoonga** |
| **Yellowfin Bream** | 0 (0.0%) | 0 (0.0%) | NA | 1 (2.0%) | 0 (0.0%) | NA |
| **Pikey Bream** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barred Javelin** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Dusky Flathead** | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | NA |
| **Mangrove Jack** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barramundi** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | 0 (0.0%) |
| **Total** | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (0.3%) | 0 (0.0%) | 0 (0.0%) |
| **Deformities** | **Gladstone** | **Baffle Creek** | **Hinchin-brook** | **Sunshine Coast** | **Moreton Bay** | **Awoonga** |
| **Yellowfin Bream** | 0 (0.0%) | 0 (0.0%) | NA | 0 (0.0%) | 0 (0.0%) | NA |
| **Pikey Bream** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barred Javelin** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Dusky Flathead** | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | NA |
| **Mangrove Jack** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | NA |
| **Barramundi** | 0 (0.0%) | NA | 0 (0.0%) | NA | NA | 2 (0.6%) |
| **Total** | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 2 (0.6%) |

# 6. DISCUSSION

The overall grade for Gladstone Harbour was B (0.72) with Yellowfin and Pikey Bream both receiving a B grade. Unfortunately, the cancellation of the BTHU due to Covid-19 restrictions, meant it was not possible to obtain length-weight samples for the other key species. This limited the overall grade of fish health however the grade for VFA for all key species was A.

The results were in line with expectations based on the river flow conditions. During the year there was a flow in the Calliope River in February however this was below the long-term average flow for the month and followed very dry conditions in 2019. This is also reflected in the small inflow into Lake Awoonga at that time. 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 the low level of skin aberrations reflects the drier conditions.

For Gladstone the level of detection of fin issues was 26.1% and for skin was 1.1%. This detection of fin issues was higher than at the comparison locations however the level of severity was low. The level of detection for eyes and parasites was low at all locations. While there were no deformities detected in Gladstone there was a high level of deformities at 43.2% recorded for Snapper on the Sunshine Coast.

There was no spilling from Lake Awoonga in either 2019 or 2020. In previous years there were regular reports of dead Barramundi in the Boyne River below Awoonga dam however there were no reports received during this year.

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# APPENDIX 1: FISH HEALTH DETECTIONS AT GLADSTONE AND REFERENCE LOCATIONS

**Table 17:** Visual detections for all species at Gladstone.

| Species | Fins | Skin | Eyes | Parasites | Deformities | Images |
|---|---|---|---|---|---|---|
| BARRAMUNDI | 22 | 1 | 1 | 0 | 0 | 115 |
| BARRED JAVELIN | 83 | 0 | 0 | 0 | 0 | 216 |
| BLACKSPOTTED ROCKCOD | 1 | 0 | 0 | 0 | 0 | 10 |
| BLUE THREADFIN | 0 | 0 | 0 | 0 | 0 | 2 |
| DUSKY FLATHEAD | 3 | 0 | 0 | 0 | 0 | 28 |
| FORKTAIL CATFISH | 0 | 0 | 0 | 0 | 0 | 3 |
| GARFISH | 1 | 0 | 0 | 0 | 0 | 1 |
| GIANT TREVALLY | 0 | 0 | 0 | 0 | 0 | 1 |
| GOLDEN SNAPPER | 3 | 0 | 0 | 0 | 0 | 6 |
| GOLDSPOTTED ROCKCOD | 11 | 0 | 0 | 0 | 0 | 44 |
| GREY MACKEREL | 0 | 0 | 0 | 0 | 0 | 1 |
| MANGROVE JACK | 43 | 0 | 0 | 0 | 0 | 108 |
| MOSES SNAPPER | 0 | 0 | 0 | 0 | 0 | 3 |
| PERMIT | 0 | 0 | 0 | 0 | 0 | 1 |
| PIKEY BREAM | 68 | 9 | 0 | 0 | 0 | 370 |
| QUEENFISH | 0 | 0 | 0 | 0 | 0 | 3 |
| QUEENSLAND GROPER | 0 | 0 | 0 | 0 | 0 | 2 |
| RED EMPEROR | 0 | 0 | 0 | 0 | 0 | 2 |
| SOUTHERN SARATOGA | 0 | 0 | 0 | 0 | 0 | 1 |
| TARPON | 0 | 0 | 0 | 0 | 0 | 2 |
| TARWHINE | 2 | 0 | 0 | 0 | 0 | 2 |
| VENUS TUSKFISH | 0 | 0 | 0 | 0 | 0 | 1 |
| YELLOWFIN BREAM | 55 | 2 | 0 | 0 | 0 | 170 |
| **TOTAL** | **292** | **12** | **1** | **0** | **0** | **1002** |

**Table 18:** Visual detections for all species at Baffle Creek reference location.

| Species | Fins | Skin | Eyes | Parasites | Deformities | Images |
|---|---|---|---|---|---|---|
| BARRED JAVELIN | 0 | 0 | 0 | 0 | 0 | 15 |
| BIGEYE TREVALLY | 0 | 0 | 0 | 0 | 0 | 2 |
| BLACK BREAM | 0 | 0 | 0 | 0 | 0 | 1 |
| BLACKSPOTTED ROCKCOD | 0 | 0 | 0 | 0 | 0 | 1 |
| CATFISH | 0 | 0 | 0 | 0 | 0 | 11 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **COMMON PONYFISH** | 0 | 0 | 0 | 0 | 0 | 26 |
| **DIAMONDFISH** | 0 | 0 | 0 | 0 | 0 | 3 |
| **DUSKY FLATHEAD** | 0 | 0 | 0 | 0 | 0 | 44 |
| **EEL** | 0 | 0 | 0 | 0 | 0 | 1 |
| **FLOUNDER** | 1 | 0 | 0 | 0 | 0 | 3 |
| **GIANT TREVALLY** | 0 | 0 | 0 | 0 | 0 | 14 |
| **GOLDEN TREVALLY** | 2 | 0 | 0 | 0 | 0 | 12 |
| **GOLDSPOTTED ROCKCOD** | 4 | 0 | 0 | 0 | 0 | 14 |
| **GRASSE EMEPEROR** | 0 | 0 | 0 | 0 | 0 | 1 |
| **LONGTOM** | 0 | 0 | 0 | 0 | 0 | 4 |
| **MANGROVE JACK** | 2 | 0 | 0 | 0 | 0 | 27 |
| **MILKFISH** | 0 | 0 | 0 | 0 | 0 | 2 |
| **MOSES SNAPPER** | 1 | 0 | 0 | 0 | 0 | 17 |
| **MUD CRAB** | 0 | 0 | 0 | 0 | 0 | 3 |
| **PARROTFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **PIKE EEL** | 0 | 0 | 0 | 0 | 0 | 3 |
| **PIKEY BREAM** | 3 | 0 | 0 | 0 | 0 | 21 |
| **QUEENFISH** | 0 | 0 | 0 | 0 | 0 | 3 |
| **SAND WHITING** | 0 | 0 | 0 | 0 | 0 | 33 |
| **SICKLEFISH** | 1 | 0 | 0 | 0 | 0 | 4 |
| **TARPON** | 0 | 0 | 1 | 0 | 0 | 3 |
| **UNKNOWN?** | 0 | 0 | 0 | 0 | 0 | 1 |
| **YELLOWFIN BREAM** | 15 | 0 | 0 | 0 | 0 | 151 |
| **TOTAL** | **29** | **0** | **1** | **0** | **1** | **430** |

**Table 19:** Visual detections for all species at Hinchinbrook reference location.

| Species | Fins | Skin | Eyes | Parasites | Deformities | Images |
|---|---|---|---|---|---|---|
| **ARCHERFISH** | 1 | 0 | 0 | 0 | 0 | 4 |
| **BARRACUDA** | 11 | 1 | 0 | 0 | 0 | 36 |
| **BARRAMUNDI** | 35 | 3 | 0 | 0 | 0 | 147 |
| **BARRED JAVELIN** | 6 | 0 | 0 | 0 | 0 | 52 |
| **BATFISH** | 0 | 1 | 0 | 0 | 0 | 2 |
| **BIGEYE TREVALLY** | 2 | 0 | 0 | 0 | 0 | 12 |
| **BLACKSPOTTED ROCKCOD** | 29 | 1 | 1 | 1 | 0 | 219 |
| **BLUDGER TREVALLY** | 0 | 0 | 0 | 0 | 0 | 4 |
| **BLUE THREADFIN** | 2 | 0 | 0 | 0 | 0 | 6 |
| **DOUBLESPOTTED QUEENFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **DUSKY FLATHEAD** | 3 | 0 | 1 | 0 | 0 | 87 |
| **FORKTAIL CATFISH** | 0 | 0 | 0 | 0 | 0 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **GIANT TREVALLY** | 7 | 0 | 0 | 0 | 0 | 107 |
| **GOLDEN SNAPPER** | 7 | 1 | 0 | 0 | 0 | 36 |
| **GOLDSPOTTED ROCKCOD** | 19 | 3 | 0 | 0 | 0 | 161 |
| **GRINNER** | 0 | 0 | 0 | 0 | 0 | 1 |
| **LONGTOM** | 0 | 0 | 0 | 0 | 0 | 1 |
| **MANGROVE JACK** | 25 | 0 | 0 | 0 | 0 | 108 |
| **MOSES SNAPPER** | 0 | 0 | 0 | 0 | 0 | 11 |
| **PACIFIC BARRACUDA** | 0 | 0 | 0 | 0 | 0 | 6 |
| **PAINTED SWEETLIPS** | 0 | 0 | 0 | 0 | 0 | 2 |
| **PIKEY BREAM** | 11 | 0 | 0 | 0 | 0 | 33 |
| **PUFFERFISH** | 0 | 0 | 0 | 0 | 0 | 2 |
| **QUEENFISH** | 1 | 0 | 0 | 0 | 0 | 15 |
| **QUEENSLAND GROPER** | 0 | 0 | 0 | 0 | 0 | 1 |
| **REDTHROAT EMPEROR** | 1 | 0 | 0 | 0 | 0 | 3 |
| **REMORA** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SADDLETAIL SNAPPER** | 0 | 0 | 0 | 0 | 0 | 2 |
| **SAND WHITING** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SCHOOL MACKEREL** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SICKLEFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SPANISH MACKEREL** | 0 | 0 | 0 | 0 | 0 | 1 |
| **STONEFISH** | 0 | 0 | 0 | 0 | 0 | 3 |
| **TALANG QUEENFISH** | 0 | 1 | 0 | 0 | 0 | 1 |
| **TARPON** | 5 | 1 | 0 | 0 | 0 | 19 |
| **TOADFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **YELLOWFIN BREAM** | 1 | 0 | 0 | 0 | 0 | 2 |
| **TOTAL** | **166** | **12** | **2** | **1** | **0** | **1092** |

**Table 20:** Visual detections for all species at Sunshine Coast reference location.

| Species | Fins | Skin | Eyes | Parasites | Deformities | Images |
|---|---|---|---|---|---|---|
| **AMBERJACK** | 0 | 0 | 0 | 0 | 0 | 15 |
| **AUSTRALIAN BASS** | 6 | 2 | 0 | 0 | 0 | 30 |
| **BARCHEEK CORAL TROUT** | 0 | 0 | 0 | 0 | 0 | 3 |
| **BARRAMUNDI** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BARRED JAVELIN** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BATFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BIGEYE TREVALLY** | 1 | 1 | 1 | 0 | 0 | 24 |
| **BLACK TREVALLY** | 0 | 0 | 0 | 0 | 0 | 2 |

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|---|---|---|---|---|---|---|
| **BLACKSPOT TUSKFISH** | 0 | 3 | 0 | 0 | 0 | 5 |
| **BLACKSPOTTED ROCKCOD** | 1 | 3 | 0 | 0 | 0 | 26 |
| **BLACKSPOTTED ROváKCOD** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BLACKTIPPED ROCKCOD** | 0 | 0 | 0 | 0 | 0 | 5 |
| **BLUEBARRED PARROTFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BLUE SWIMMER CRAB** | 0 | 0 | 0 | 0 | 0 | 2 |
| **BLUEBARRED PARROTFISH** | 0 | 1 | 0 | 0 | 0 | 4 |
| **BLUELINED EMPEROR** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BLUESPOTTED FLATHEAD** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BLUESPOTTED CORAL TROUT** | 0 | 0 | 0 | 0 | 0 | 1 |
| **BONITO** | 0 | 1 | 0 | 0 | 0 | 5 |
| **BROWNSTRIPE SEAPERCH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **COBIA** | 1 | 0 | 0 | 0 | 0 | 9 |
| **COLLARED SEA BREAM** | 0 | 0 | 0 | 0 | 0 | 1 |
| **COMMON CORAL TROUT** | 0 | 0 | 0 | 0 | 0 | 2 |
| **DUSKY FLATHEAD** | 1 | 1 | 0 | 0 | 0 | 170 |
| **EASTERN RED SCORPIONFISH** | 1 | 0 | 0 | 0 | 0 | 1 |
| **EMBER PARROTFISH** | 0 | 1 | 0 | 0 | 1 | 1 |
| **FORKTAIL CATFISH** | 0 | 0 | 0 | 0 | 0 | 15 |
| **GIANT HERRING** | 0 | 0 | 0 | 0 | 0 | 1 |
| **GIANT TREVALLY** | 0 | 1 | 1 | 0 | 0 | 34 |
| **GOATFISH** | 0 | 1 | 0 | 0 | 0 | 3 |
| **GOLDEN TREVALLY** | 0 | 2 | 0 | 0 | 0 | 4 |
| **GOLDSPOTTED PIGFISH** | 0 | 0 | 0 | 0 | 0 | 2 |
| **GOLDSPOTTED ROCKCOD** | 2 | 1 | 0 | 0 | 0 | 38 |
| **GOLDSPOTTED TREVALLY** | 0 | 0 | 0 | 0 | 0 | 1 |
| **GRAPHIC TUSKFISH** | 0 | 0 | 0 | 0 | 0 | 2 |
| **GRASS EMPEROR** | 3 | 0 | 0 | 0 | 0 | 13 |
| **GREY MORWONG** | 0 | 1 | 0 | 0 | 0 | 3 |
| **GUDGEON** | 0 | 0 | 0 | 0 | 0 | 1 |
| **HERRING** | 0 | 0 | 0 | 0 | 0 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **HUSSAR** | 0 | 0 | 0 | 0 | 0 | 2 |
| **JACK MACKEREL** | 0 | 0 | 0 | 0 | 0 | 2 |
| **JOBFISH** | 0 | 0 | 0 | 0 | 0 | 2 |
| **LANCER EMPEROR** | 0 | 0 | 0 | 0 | 0 | 1 |
| **LOBSTER** | 0 | 0 | 0 | 0 | 0 | 16 |
| **LONGTOM** | 0 | 0 | 0 | 0 | 0 | 2 |
| **LONGFIN ROCKCOD** | 0 | 0 | 0 | 0 | 0 | 5 |
| **LONGNOSE TREVALLY** | 0 | 0 | 0 | 0 | 0 | 3 |
| **LONGTAIL TUNA** | 0 | 0 | 0 | 0 | 0 | 2 |
| **MACKEREL TUNA** | 0 | 2 | 0 | 0 | 0 | 18 |
| **MAHI MAHI** | 3 | 0 | 0 | 0 | 0 | 4 |
| **MANGROVE JACK** | 3 | 3 | 0 | 0 | 0 | 23 |
| **MAORI ROCKCOD** | 1 | 0 | 0 | 0 | 0 | 18 |
| **MINIFIN PARROTFISH** | 0 | 1 | 0 | 0 | 0 | 1 |
| **MOSES SNAPPER** | 0 | 0 | 0 | 0 | 0 | 12 |
| **MUD CRAB** | 0 | 0 | 0 | 0 | 0 | 26 |
| **MULLET** | 1 | 0 | 0 | 0 | 0 | 1 |
| **MULLOWAY** | 7 | 2 | 0 | 0 | 0 | 24 |
| **SPANISH MACKEREL** | 1 | 0 | 0 | 0 | 0 | 5 |
| **PEARL PERCH** | 3 | 0 | 0 | 0 | 0 | 40 |
| **PIKE EEL** | 0 | 0 | 0 | 0 | 0 | 3 |
| **PIKEY BREAM** | 1 | 0 | 0 | 0 | 0 | 2 |
| **PONYFISH** | 1 | 0 | 0 | 0 | 2 | 2 |
| **PUFFERFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **QUEENFISH** | 0 | 0 | 0 | 0 | 0 | 8 |
| **RED EMPEROR** | 0 | 0 | 0 | 0 | 0 | 27 |
| **REDFISH** | 0 | 1 | 0 | 0 | 0 | 1 |
| **REDTHROAT EMPEROR** | 2 | 0 | 0 | 0 | 0 | 4 |
| **REMORA** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SALMON CATFISH** | 1 | 1 | 0 | 0 | 0 | 5 |
| **SAND WHITING** | 7 | 14 | 1 | 0 | 0 | 52 |
| **SCHOOL MACKEREL** | 0 | 0 | 0 | 0 | 0 | 7 |
| **SHARK** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SHOVELNOSE RAY** | 0 | 0 | 0 | 0 | 0 | 3 |
| **SILVER TREVALLY** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SNAPPER** | 17 | 3 | 0 | 0 | 48 | 111 |
| **SOLE** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SPANGLED EMPEROR** | 2 | 0 | 0 | 0 | 0 | 3 |
| **SPECKLED JAVELIN** | 2 | 0 | 0 | 0 | 0 | 13 |
| **SPOTTED MACKEREL** | 0 | 0 | 0 | 0 | 0 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **STARGAZER** | 0 | 0 | 0 | 0 | 0 | 1 |
| **STINGRAY** | 0 | 0 | 0 | 0 | 1 | 34 |
| **STONEFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **STRIPED CATFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **STRIPED SCAT** | 0 | 0 | 0 | 0 | 0 | 1 |
| **STRIPEY SNAPPER** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SURGEONFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SWALLOWTAIL DART** | 0 | 0 | 0 | 0 | 0 | 12 |
| **SYDNEY CARDINALFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **TAILOR** | 0 | 0 | 0 | 0 | 0 | 3 |
| **TARPON** | 0 | 0 | 0 | 0 | 0 | 3 |
| **TARWHINE** | 0 | 0 | 0 | 0 | 0 | 4 |
| **TERAGLIN** | 1 | 0 | 0 | 0 | 0 | 19 |
| **TREVALLY** | 0 | 0 | 0 | 0 | 0 | 1 |
| **TRIGGERFISH** | 0 | 0 | 0 | 0 | 0 | 3 |
| **TRUMPETFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **VENUS TUSKFISH** | 2 | 3 | 0 | 0 | 0 | 39 |
| **WHIP RAY** | 0 | 0 | 0 | 0 | 0 | 1 |
| **WHIPTAIL** | 0 | 0 | 0 | 0 | 0 | 3 |
| **WHITING** | 0 | 0 | 0 | 0 | 0 | 1 |
| **WOBBEGONG SHARK** | 0 | 0 | 0 | 0 | 0 | 5 |
| **WOLF HERRING** | 1 | 0 | 0 | 0 | 0 | 6 |
| **YELLOWFIN BREAM** | 40 | 6 | 4 | 1 | 0 | 202 |
| **YELLOWFIN PIKE** | 0 | 0 | 0 | 0 | 0 | 2 |
| **YELLOWFIN TUNA** | 0 | 0 | 0 | 0 | 0 | 2 |
| **YELLOWTAIL KINGFISH** | 0 | 0 | 0 | 0 | 0 | 5 |
| **YELLOWTAIL PIKE** | 0 | 0 | 0 | 0 | 0 | 3 |
| **YELLOWTAIL SCAD** | 0 | 0 | 0 | 0 | 0 | 2 |
| **TOTAL** | **112** | **55** | **7** | **1** | **53** | **1246** |

**Table 21:** Visual detections for all species at Moreton Bay reference location.

| Species | Fins | Skin | Eyes | Parasites | Deformities | Images |
|---|---|---|---|---|---|---|
| **AUSTRALIAN BASS** | 0 | 0 | 0 | 0 | 0 | 3 |
| **BARRED JAVELIN** | 1 | 0 | 0 | 0 | 0 | 1 |
| **BIGEYE TREVALLY** | 2 | 0 | 0 | 0 | 0 | 5 |
| **BLACKSPOTTED ROCKCOD** | 0 | 0 | 0 | 0 | 0 | 1 |
| **COBIA** | 0 | 0 | 0 | 0 | 0 | 1 |
| **DUSKY FLATHEAD** | 35 | 0 | 1 | 0 | 0 | 249 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **GIANT TREVALLY** | 7 | 0 | 0 | 0 | 0 | 25 |
| **GOLDEN TREVALLY** | 0 | 0 | 0 | 0 | 0 | 2 |
| **GOLDSPOTTED ROCKCOD** | 2 | 0 | 0 | 0 | 0 | 11 |
| **KING THREADFIN** | 5 | 1 | 0 | 0 | 0 | 9 |
| **MANGROVE JACK** | 2 | 0 | 0 | 0 | 0 | 9 |
| **MAORI ROCKCOD** | 0 | 0 | 0 | 0 | 0 | 2 |
| **MULLOWAY** | 4 | 1 | 0 | 0 | 0 | 14 |
| **PIKEY BREAM** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SILVER JEWFISH** | 0 | 0 | 0 | 0 | 0 | 1 |
| **SNAPPER** | 11 | 1 | 0 | 0 | 4 | 21 |
| **SPECKLED JAVELIN** | 0 | 0 | 0 | 0 | 0 | 1 |
| **TAILOR** | 10 | 0 | 0 | 0 | 0 | 14 |
| **THREADFIN** | 0 | 0 | 0 | 0 | 0 | 2 |
| **YELLOWFIN BREAM** | 31 | 2 | 0 | 0 | 0 | 108 |
| **TOTAL** | **110** | **5** | **1** | **0** | **4** | **480** |

**Table 22:** Visual detections for all species at Lake Awoonga reference location.

| Species | Fins | Skin | Eyes | Parasites | Deformities | Images |
|---|---|---|---|---|---|---|
| **BARRAMUNDI** | 81 | 5 | 0 | 0 | 2 | 349 |
| **FORKTAIL CATFISH** | 1 | 1 | 0 | 0 | 0 | 17 |
| **SOOTY GRUNTER** | 0 | 1 | 0 | 0 | 0 | 2 |
| **TILAPIA** | 0 | 0 | 0 | 0 | 0 | 1 |
| **TOTAL** | **82** | **7** | **0** | **0** | **2** | **369** |

# APPENDIX 2: AVERAGE LENGTHS OF KEY SPECIES RECORDED FOM 2003-19

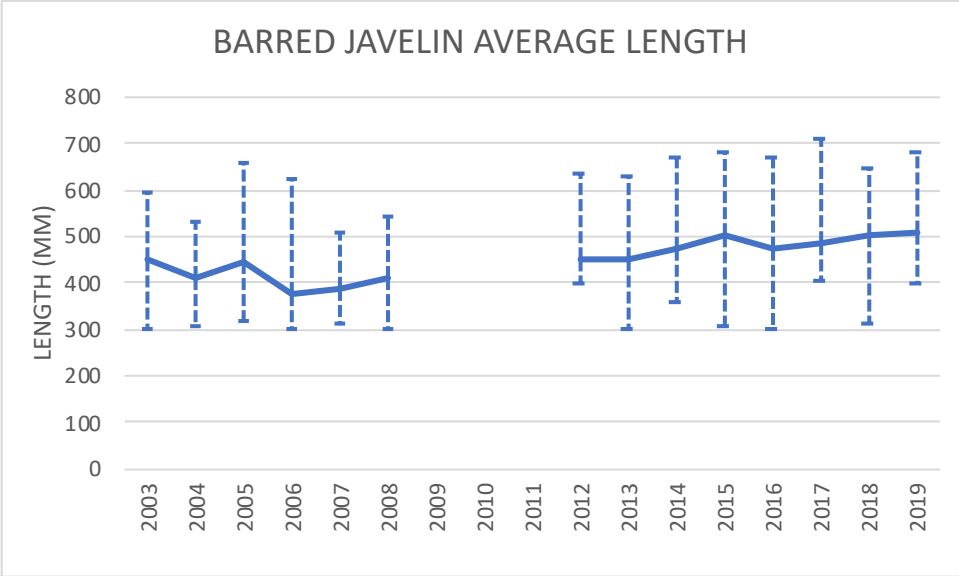


**Figure 21:** Average length of Barred Javelin each year from 2003-2020 (bars show the minimum and maximum lengths recorded)

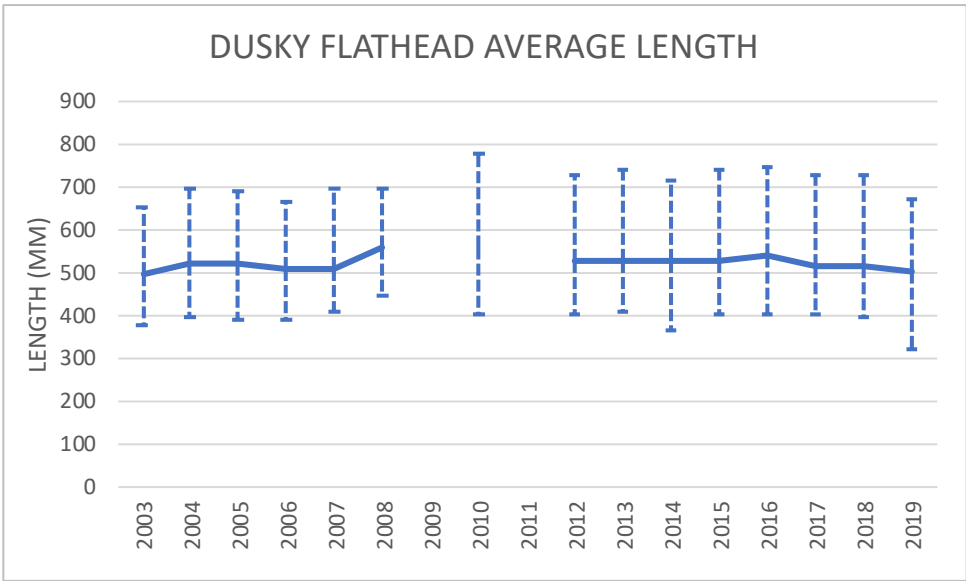


**Figure 22:** Average length of Dusky Flathead each year from 2003-2020 (bars show the minimum and maximum lengths recorded)

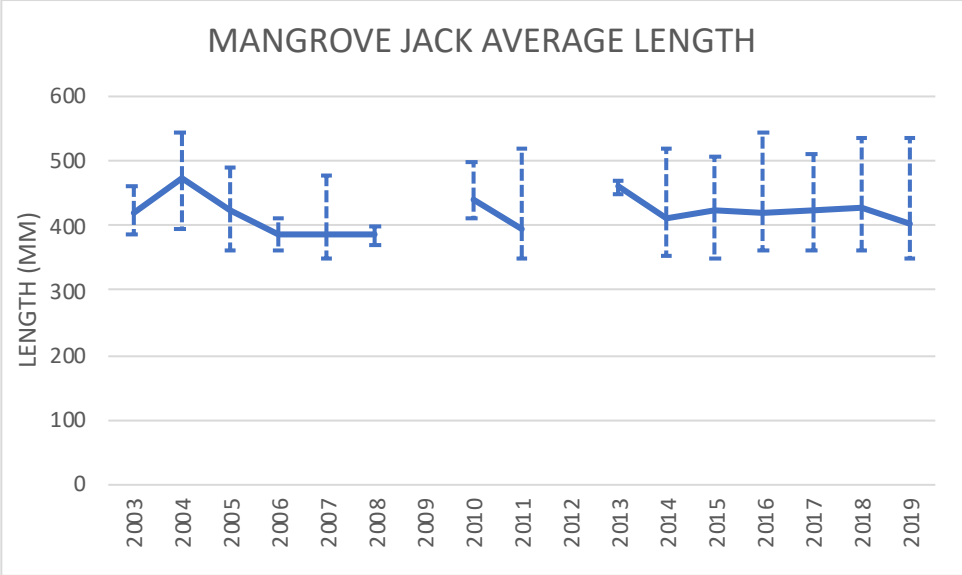


**Figure 23:** Average length of Mangrove jack each year from 2003-2020 (bars show the minimum and maximum lengths recorded)