BARRACADE

A FISH SURVEY IN CORROBOREE BILLABONG, MARY RIVER 2008

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SUMMARY

The barramundi (*Lates cacarifer*) supports important recreational and commercial fisheries in the Northern Territory (NT), Australia. Since 1987, a program called Barracade has annually monitored barramundi numbers, size, health and age in Corroboree Billabong in the Mary River system.

In September 2008 a fish survey using depletion methods estimated that there were 823 barramundi in a 660 m section of Corroboree Billabong, which was above the long-term average. Young fish dominated the catch (46% were less than one year old) and there were a smaller number of larger, older fish. The observed size distribution is typical of those years with good rainfall in the preceding wet season.

INTRODUCTION

Barramundi inhabits the Indo-Pacific region and northern Australia. It is valued by recreational fishers for its large size (Coleman 1998), readiness to take artificial lures, fighting ability and eating qualities. These features have made it an iconic species that supports substantial commercial and recreational fishing industries.

Barramundi stocks have been monitored in the NT using a range of methods, such as commercial fishers' logbooks, on board monitoring of commercial operations, recreational fishing surveys, mark and recapture experiments and depletion experiments such as Barracade. Barracade is an annual, long term (since 1987) fishery independent survey of barramundi abundance and population structure held at Corroboree Billabong on the Mary River system. Being independent of commercial and recreational fishers, the data is not subject to error or distortion that may arise through stakeholder participation.

The year 2008 marks the 22nd anniversary of the survey. Such long-term data sets are rare and valuable.

The results of the annual Barracade surveys provide a measure of barramundi recruitment into the billabong each year, which is an indication of the health of the barramundi stock in the system.

METHOD

The methods employed for Barracade 2008 were similar those used in preceding years (see de Lestang 2005, White and Grace 2007 and Grace 2008 for further details). A brief synopsis is given below.

The numbers of barramundi and saratoga were estimated using depletion methods. By preventing fish from entering or leaving an area, then fishing the area heavily, the number of fish originally present can be calculated by how quickly the catch rates decrease over time.

STUDY SITE

A section of Corroboree Billabong 12° 35' S 131° 40' E, on the Mary River system (Figure 1) was isolated using two heavy-gauge, small-mesh block-off nets, from 1 to 5 September 2008. This was the same section of the billabong that was sampled in 2007.

Figure 1. Location of the Barracade trial in 2008, adapted from Google Earth™

Water quality was examined at four randomly-chosen sites within the blocked-off area on 8 September 2008, three days after the fish survey was completed. Dissolved oxygen, temperature, electro-conductivity, turbidity and pH were all measured using a Horiba U-10 probe. Readings were taken near the surface, at 1 m deep and near the bottom.

The area of the blocked-off section was estimated by multiplying average channel width by the distance between the two block-off nets. Channel width within the section was measured at five sites using a Leupold RX-1 rangefinder. The length of the section was estimated by tracking a path with a GPS while travelling along the centre of the billabong. Water depth was measured at 20 sites, which were chosen in a stratified random manner.

FISH SAMPLING

Fish were sampled inside the blocked-off area using six gillnets, each with a different stretched mesh size ranging from 75 mm (3 inch) to 200 mm (8 inch). Nets were first set at 4 p.m. on 1 September 2008 and removed at 4 p.m. on 4 September 2008 (Table 1). Each gillnet was randomly set at one of six locations within the blocked-off area for a period of 24 hrs, then moved to another of the locations. All gillnets were brought ashore at 8 p.m. then redeployed at 6 a.m. the following morning to reduce interactions with crocodiles.

All barramundi caught were measured (total length) and tagged with a Hallprint™ dart tag (Figure 2) with a unique number for each fish. A scale was also removed from each individual from just behind the base of the pectoral fin, to allow fish to be aged. Saratoga were also measured but not tagged. Barramundi and saratoga were then placed in tubs of oxygenated water and released outside the block-off nets.

The severity of fungal lesions on each fish was scored (0-3) by the method of White and Grace (2007). Presence of red-spot was regressed against fish length using a logistic regression.

Table 1. Numbers of barramundi and saratoga caught during Barracade 2008

Sampling period	Net times	Barramundi	Saratoga
1	4 p.m. 1 Sept – 4 p.m. 2 Sept	229 (0)	3
2	4 p.m. 2 Sept – 4 p.m. 3 Sept	179 (0)	4
3	4 p.m. 3 Sept – 4 p.m. 4 Sept	112 (1)	0
4	6 p.m. 4 Sept – 6 p.m. 5 Sept	73 (1)	0
Total		**593**	**7**

Recaptures (shown in brackets) are fish that were caught in, tagged, released outside, and then caught again within the blocked-off area. Saratoga were not tagged, so recapture rates are not available.

CALCULATING FISH NUMBERS

The numbers of barramundi and saratoga in the blocked-off section of the billabong were estimated from the captures in each sampling period (Table 1). Assuming that no fish entered the blocked-off area, and none died from natural causes within this area, then it is possible to estimate how many fish would have to be caught and removed until no fish were caught (Hilborn and Walters 1992).

BARRAMUNDI AGE AND WEIGHT

Barramundi scales show rings or checks when the fish is stressed, which typically occurs during the 'build-up' (September to December). The number of checks on each scale was counted by Fisheries staff with prior experience in the procedure. Each scale was given a rating for readability (0 – 3), and only those scales of the highest readability rating were used in further analyses. At the time of printing, scales from 201 fish (caught during the first and second sampling periods and evenly sub-sampled from the different sized gillnets) had been read, representing 34% of total number of fish caught.

Barramundi weights were calculated using the equation

$$Weight = 0.0000106 \times Total\ Length^{3.02}$$

where *Total Length* is in cm and *Weight* is in kg (Reynolds 1978).

RESULTS AND DISCUSSION

STUDY SITE

The 660 m section of Corroboree Billabong that was examined had an average width of 37 m (range 30 - 57 m) giving an area estimate of 24 600 m^2. The block-off area had an average depth of 1.7 m (range 0.1 – 3.0 m). Lilies (mainly Lotus (*Nelumbo nucifera*)) covered an estimated 24% of the study area.

Dissolved oxygen levels were suitable for fish survival and were typical for Corroboree Billabong in the dry season (e.g. Grace et al. 2007). The water was reasonably soft (little calcium or magnesium) and turbid (Table 2). The water was stratified (layered) with temperature, dissolved oxygen and pH, with all the highest near the surface and the lower towards the bottom (Figure 2) as Powell and Townsend (1997) found for other billabongs on the Mary River system.

Importantly, the water was more turbid, or muddy, in 2008 (118 Nephelometric turbidity units (NTU)) than it was in 2007 with 70 NTU and higher than previously reported for the Mary River system (Schultz et al. 2002, Powel and Townsend 1997). This agrees with numerous anecdotal reports that the water was muddier in 2008 than in previous years. The cause of this higher turbidity is not known, although several factors may be involved: increases in the number of boats using the billabong and erosion as a result of fire and grazing (Schultz et al. 2002). An increase in turbidity may result in less photosynthesis in algae (Jewson and Taylor 1978), which may possibly reduce the overall productivity of the system. Increased turbidity may also encourage the water to become more stratified.

Table 2. Water quality parameters in the blocked-off area at midday on 8 September 2008

Water quality parameter	Average ± s.e.m.
Dissolved oxygen (mg/L)	2.9 ± 0.3
Temperature (°C)	28.1 ± 0.3
Electro conductivity (mS/cm)	0.82 ± 0.001
Turbidity (NTU)	118 ± 14
pH	6.56 ± 0.1

Numbers presented are averages of 10 readings ± standard error

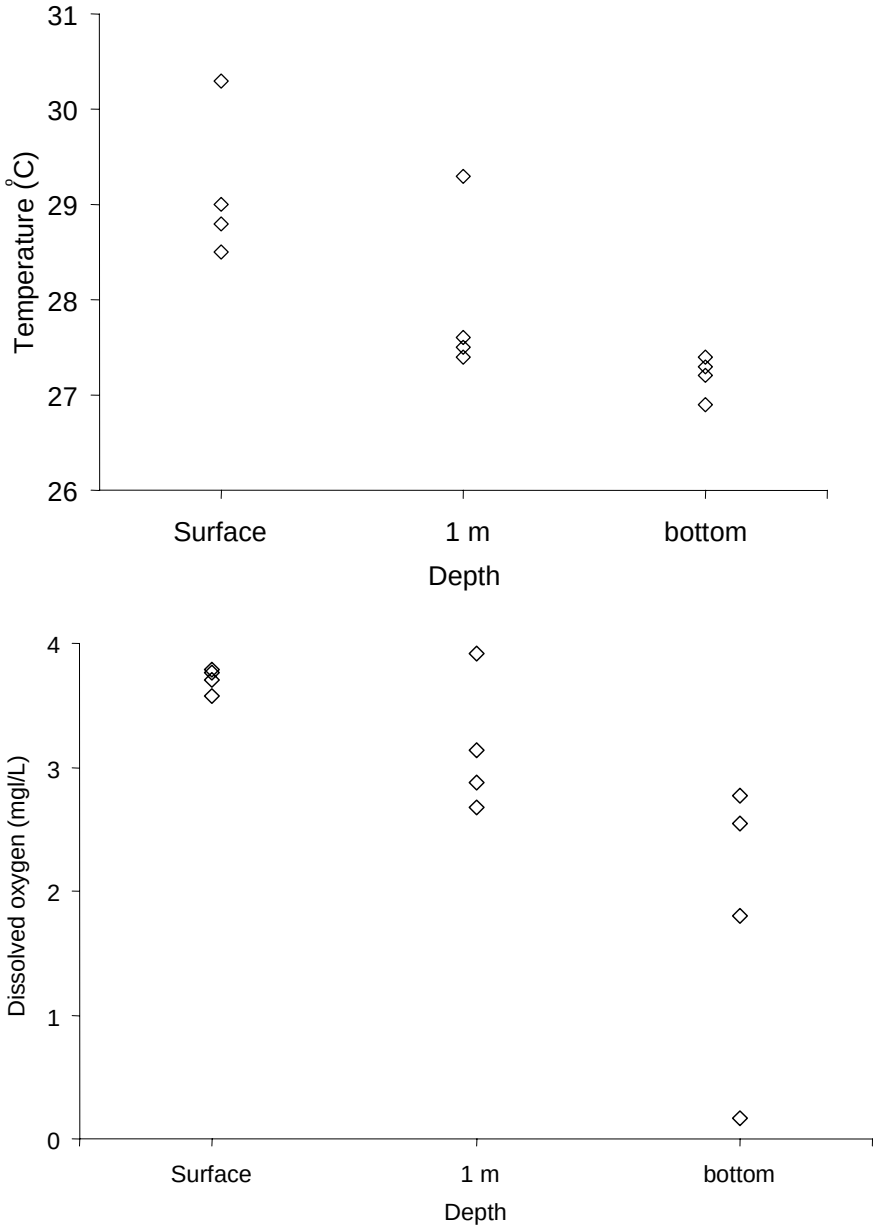


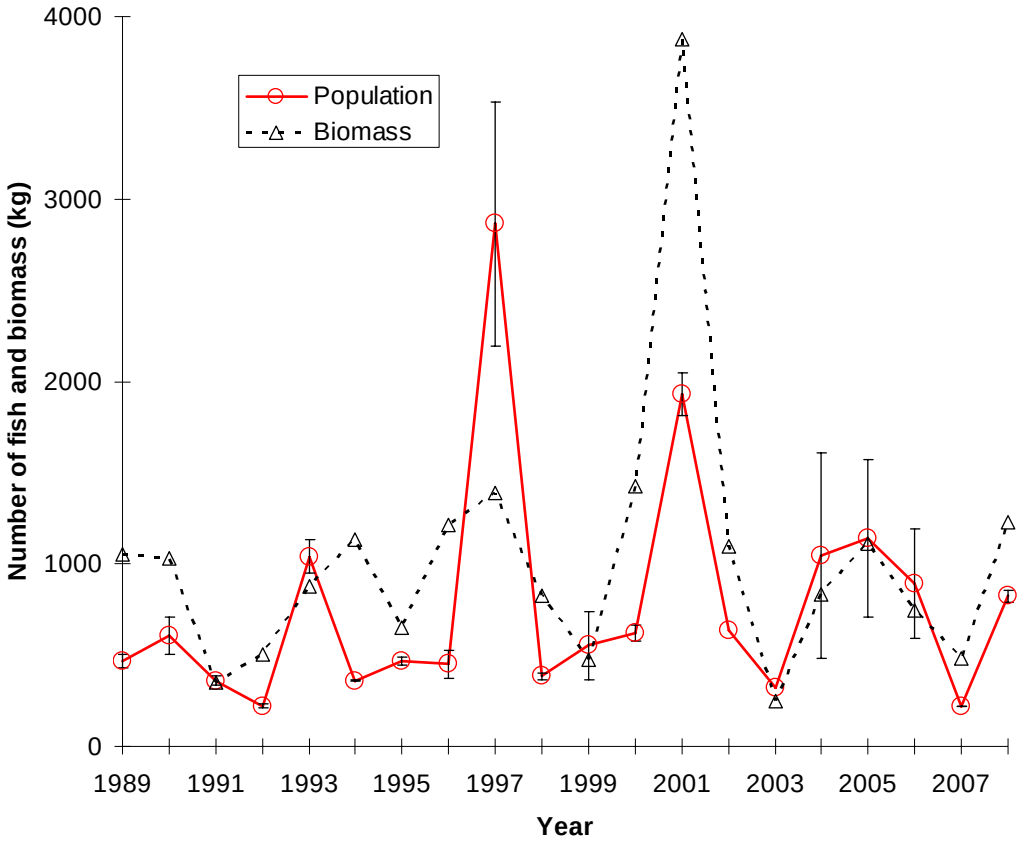
Figure 2. Water temperature (top) and dissolved oxygen (bottom) for four sites within the blocked-off area

BARRAMUNDI NUMBERS

Based on the depletion survey, we estimate there were 823 (s.e.m. = 16) fish in the blocked-off area in 2008. This being the case, approximately 72% of all the barramundi in the area were caught. The fact that only two tagged barramundi were recaptured means that the block-off nets provided an effective barrier and that the technique used is a valid means of estimating fish abundance.

The freshwater section of the lower catchment of the Mary River (north of the Arnhem Highway) contained roughly 87 000 barramundi in 2008, assuming there is 70 km of freshwater billabong in this area (Shultz et al. 2002). The average weight was calculated to be 1.49 kg, giving a total biomass of 1226 kg of barramundi in the blocked-off area (Figure 3).

The estimate of 823 barramundi is above the average of 767 fish for the preceding 21 years of Barracade and considerably higher than the 220 recorded in 2007. Such large inter-annual variation is normal for barramundi in this system (Figure 3).



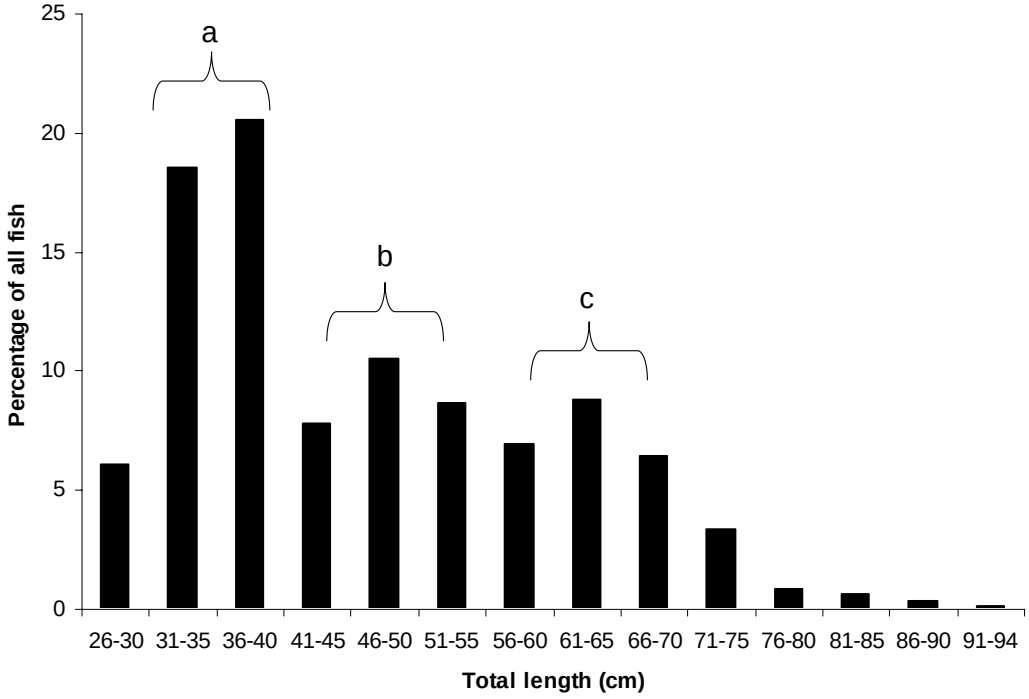
Error bars for fish numbers show 95% confidence intervals, calculated using methods of Carl and Strub (1978).

Figure 3. Numbers of barramundi and their estimated biomass (kg) for Barracade from 1989 to 2008

BARRAMUNDI SIZE AND AGE

The patterns of barramundi sizes reflect fish ages. A large proportion of barramundi caught were smaller than 40 cm total length (Figure 4) because 46% of fish were less than one year old, with a smaller number of fish (28%) between one and two years old (Figure 5).

Only 28% of the fish caught were of legal length (i.e. 55 cm or above).



The group of fish 26 cm to 40 cm long (a) are less than one year old, fish 41 cm to 55 cm long (b) are mainly one year old, and 56 cm to 70 cm fish are mainly three years old.

Figure 4. Size distribution of barramundi caught during Barracade 2008

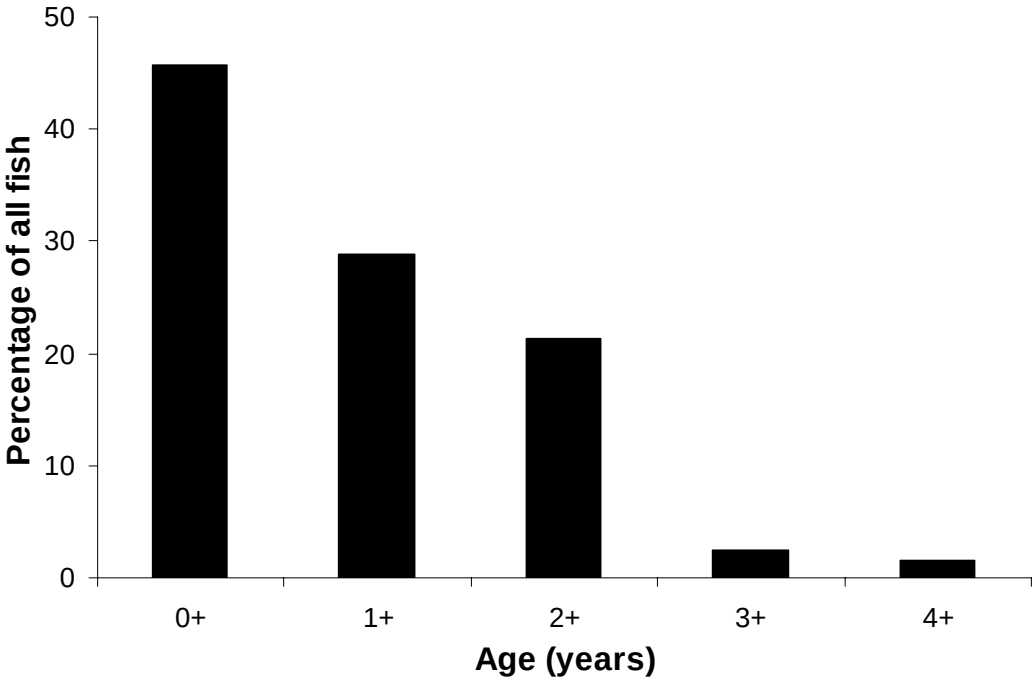


Figure 5. Age distribution of barramundi that could be aged with confidence from Barracade 2008

Although numbers of barramundi were above average and populations appeared quite healthy, there were fewer young fish than expected. Population models (see Box 1) predicted that 603 young barramundi, less than one year old, would be caught in Barracade 2008 (as opposed to our estimate of 380 young barramundi for 2008).

Box 1. A barramundi recruitment model

By investigating the number of fish of various ages that were caught in previous Barracade surveys, it is possible to predict the number of barramundi less than one year old with some accuracy ($R^2 = 0.42$) using the equation

$$Recruits = 0.517 * Rainfall - 0.5 * Recruits_{t-1} - 377$$

where *Recruits* are the number of fish less than one year old for any year, $Recruits_{t-1}$ is the number of barramundi less than one year old in the previous year, and *Rainfall* is the total rainfall for Darwin Airport between July in the previous year and June that year. This model is currently being further refined.

This model agrees with our current understanding of the lifecycle of barramundi. More rainfall means a larger area of floodplain is inundated for longer, giving young fish access to more areas to feed and escape larger fish. However, barramundi are cannibals and compete aggressively with each other, so the young fish are less likely to survive until September if there are more fish in the system from the previous year.

SARATOGA

Seven saratoga were caught in 2008, giving an estimate of eight saratoga in the blocked-off area (Figure 6). This is below the long-term average of 31 fish. Numbers of saratoga at Corroboree Billabong have varied greatly between years and this is thought to be related to the amount of water lilies present. However, there were 36 saratoga in Barracade 2007 and only 9% lily cover, whereas we estimated there were eight saratoga and 24% lily cover in 2008. The relationship between saratoga and lilies is clearly not as straightforward as was first thought. In future, combining Barracade data sets with aerial photography may improve our understanding of the saratoga populations.

The length of saratoga caught in 2008 ranged from 46 to 63 cm, with an average of 55 cm, which is slightly longer than the average for 2007, which was 53 cm. This difference is not significant ($F_{1, 13} = 0.1$, $P = 0.7$).

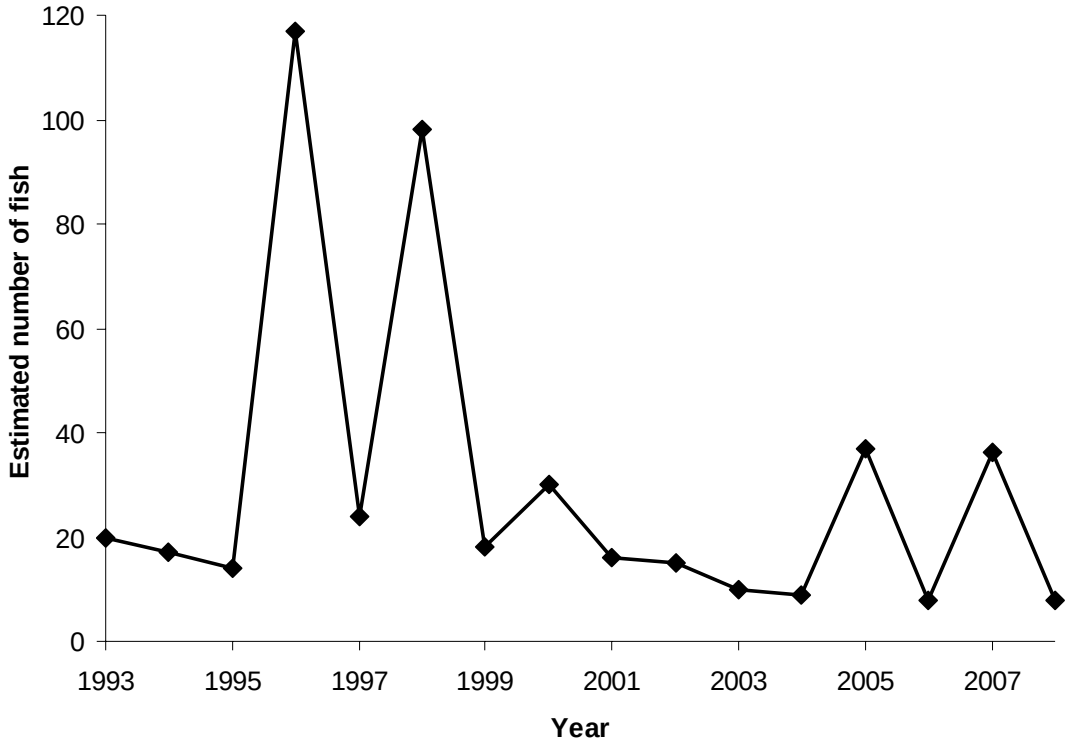


Figure 6. Numbers of saratoga in blocked-off areas of Barracade, from 1993 to 2008

OTHER FISH

After barramundi, bony bream were the most commonly caught fish during Barracade 2008 (Table 3). The two-banded grunters which were caught were near the maximum size reported for this species of 18 cm (Allen et al. 2002). Although not all other fish were recorded, there are clearly good numbers of other fish present in the billabong. Bony bream in particular are known to be a common food for barramundi.

Table 3. Other fish caught during Barracade 2008.

Fish	Number caught
Bony bream (*Nematalosa erebi*)	45
Eel tailed catfish (*Neosilurus ater*)	3
Mullet (*Liza* sp.)	3
Fork tailed catfish (*Arius* spp.)	3
Barred grunter (*Amniataba percoides*)	2

FISH HEALTH

In total, 203 barramundi (34%) were infected with the fungal disease red-spot (*Aphanomyces invadans*). This infection rate is just above the long term average of 27%, which is not surprising given that an individual barramundi is more likely to have red-spot lesions when

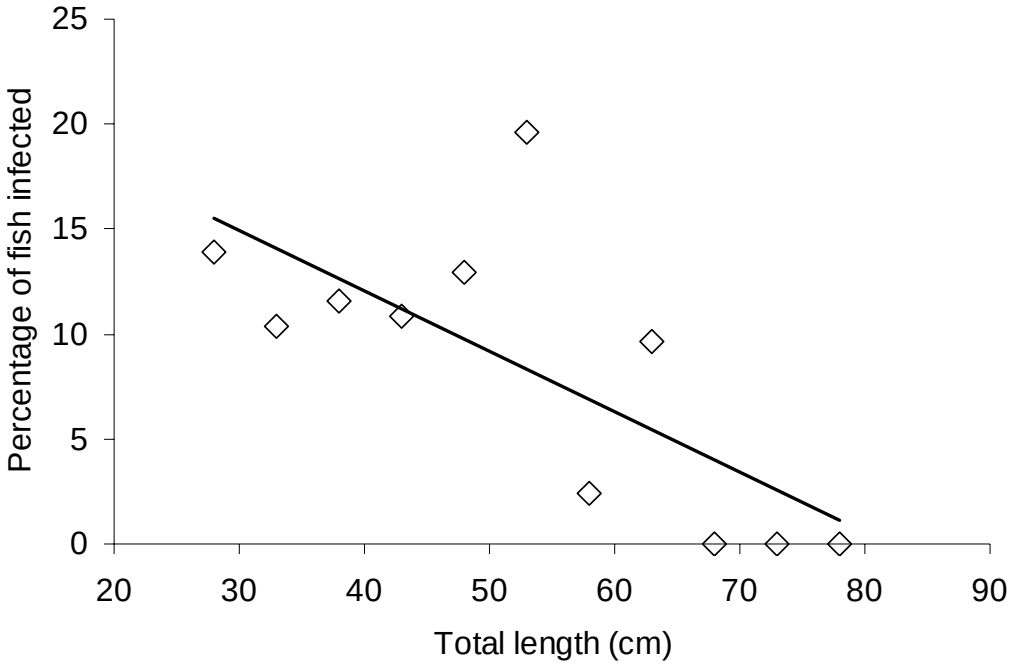
large numbers of barramundi are present (White and Grace 2007); barramundi numbers in 2008 were slightly above the long-term average.

Smaller fish were considerably more likely to have red-spot than larger fish ($F_{1, 586} = 29$, $P < 0.0001$). See Figure 7. Interestingly, in 2006 and 2007, when there was less red-spot, there was no correlation between red-spot presence and fish length (White and Grace 2007, Grace 2008). The epidemiology of this disease in Corroboree Billabong deserves further investigation, which may explain some of the complex interactions between small and large barramundi, and river flow.

Only 47 barramundi (8%) had eyes that were affected by red-spot (Table 4). There is little information on how eye damage affects the ability of a fish to survive, grow and reproduce (Arlinghause et al. 2007), although some of the fish with eye damage appeared to be otherwise healthy.

Table 4. Prevalence of red-spot on barramundi

Severity of red-spot	Percentage of all barramundi caught
No lesions	65%
One lesion	14%
Two to three lesions	8%
More than three lesions	12%
No eyes affected	92%
One eye affected	6%
Two eyes affected	2%



Data was grouped into 5 cm increments before plotting

Figure 7. The proportion of barramundi with red-spot lesions decreases as fish become larger

FUTURE PRIORITIES

Barracade has provided a long-term dataset of fish sizes, abundance and health. A more thorough examination of the data should improve our understanding of barramundi biology, population dynamics and diseases.

Data from the 21 years of Barracade is currently being examined to further determine how rainfall and flooding affects barramundi growth and recruitment. This will provide an interesting contrast to work done on barramundi in a very different environment in central Queensland (Robins et al. 2006).

There may be some merit in comparing cost and effectiveness of electro-fishing and gillnets for sampling barramundi populations in the future. Electro-fishing may not be straightforward – electro-fishing catch per unit effort may be a poor indicator of fish abundance and susceptibility to electro-fishing can vary with fish size (Pusey et al. 1998). The usefulness of broadband sonar for counting fish in Corroboree Billabong was also investigated.

A separate boat with a Lowrance LCX 112 sonar, fitted with broadband capabilities was taken through the area repeatedly while the gillnets were in the water. The graphical output, GPS readings and time were all saved electronically and are currently being read and recorded by experienced operators.

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