

BARRACADE

A fish survey in Corroboree Billabong, Mary River 2006

Fishery Report No. 86

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August 2007

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SUMMARY

The barramundi population at Corroboree Billabong in 2006 appears to be healthy.

Barracade 2006 estimated that there were 892 (standard error = 151) barramundi in the 450 m blocked-off section of the billabong. This value is higher than the average of 793 fish recorded during the previous 19 years since Barracade has been conducted.

Most fish (88.5%) were less than one year old and were 30 to 45 cm long. The total barramundi biomass within this 450 m section was approximately 746 kg. Overall 25% of barramundi were observed to be affected by red spot disease, which is less than in previous years.

Since crocodiles damaged nets during the trial, the estimate of the total number of barramundi had to be calculated using modified methods. Therefore, results must be interpreted with caution.

INTRODUCTION

The barramundi (*Lates calcarifer*) is a large perch that is widely distributed in the Indo-Pacific region and across northern Australia. It is valued by recreational fishers for its large size (Coleman 1998), flesh quality, fighting ability and readiness to take artificial lures. These qualities have made the barramundi an iconic species that supports important commercial and recreational fishing industries.

Research on barramundi in Northern Territory waters began in 1972 with sampling and tagging on the Mary River, and sampling on the Victoria and Roper River systems (Griffin 2007). Monitoring has continued to the present day using a mixture of methods such as commercial fishers' logbooks, on-board monitoring of commercial operations, surveying recreational fishers, mark and recapture experiments and depletion experiments such as Barracade.

A depletion experiment involves deliberately over-fishing an isolated population of fish and using the rate at which the catch decreases over time to estimate the number of individuals in that area. In the Barracade experiment, a length of billabong is closed off to prevent the movement of barramundi and large saratoga (*Scleropages jardinii*) into and out of the area. The area is then fished using gill nets with a range of mesh sizes to ensure that all sizes present are sampled equally. The Barracade experiment has been conducted on the Corroboree Billabong on the Mary River system every year since 1987. The year 2006 marks the 20th anniversary of this experiment.

The results of the annual Barracade studies provide a measure of barramundi recruitment into the billabong each year, which indicates the health of the barramundi stock in the system.

METHOD

From 11 to 14 September 2006, a 450 m long area of Corroboree Billabong (Figure 1), approximately 95 km Southeast of Darwin, was enclosed using two heavy-gauge, small mesh nets (stretch mesh length 45 mm, twine diameter 2.5 mm), one at each end of the study site. The study site was approximately 70 m wide. The nets that were used were designed to prevent the movement of barramundi into or out of the sampling area. The head ropes and floats of the two block-off nets were held above the water surface (with metal stakes in the northern net and styro-foam vegetable boxes in the southern net) to stop fish from jumping over the nets. Both nets were heavily weighted using lead line and 40 cm lengths of railway line (about 10 kg).

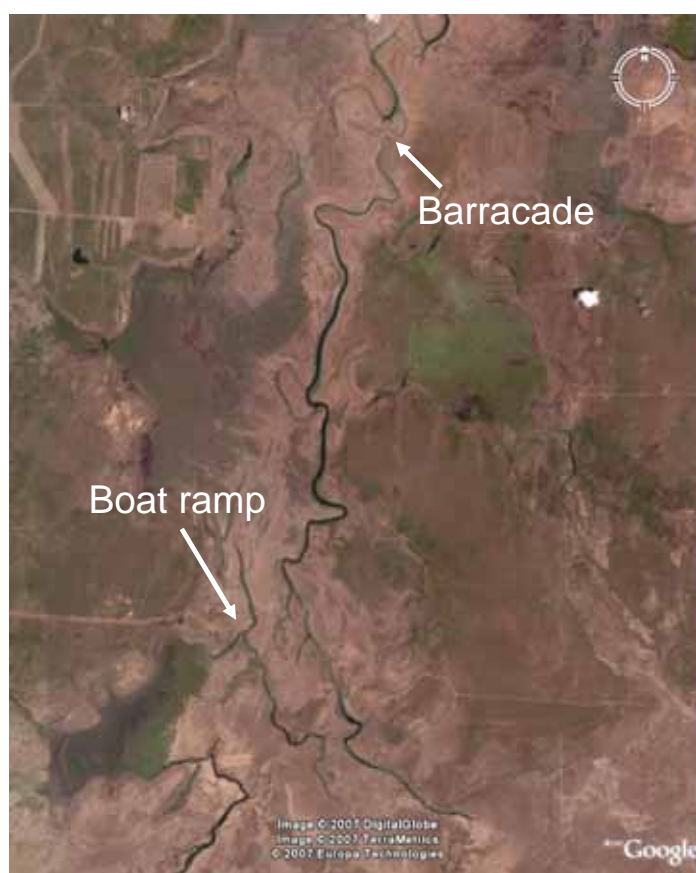


Figure 1. Corroboree Billabong showing the location of Barracade 2006. Adapted from *Google Earth*

Sampling gill nets of various sizes were set at selected locations within the enclosed area. The 450 m long area was fished intensively with gill nets (20 m long, 3.4 m deep) in six mesh sizes, from 76 mm (3 inch) to 203 mm (8 inch). Nets were first set at 6 p.m. on 11 September, and removed at 6 p.m. on 14 September (Table 1).

Table 1. Approximate times for setting and retrieving gill nets during Barracade 2006

Date	Times	Location
11 September 2006	6 p.m. – 11 p.m.	1
12 September 2006	6 a.m. – 6 p.m.	1
12 September 2006	6 p.m. – 11 p.m.	2
13 September 2006	6 a.m. – 6 p.m.	2
13 September 2006	6 p.m. – 11 p.m.	3
14 September 2006	6 a.m. – 6 p.m.	3

Nets were checked at least once an hour. Virtually continuous checking occurred when catch rates were high, such as on day one. The fish were gently removed from the nets and placed in a well-oxygenated holding tank. Nets were cut when required to remove fish with minimal physical damage.

The length of each fish caught was recorded and each fish was tagged using a dart tag lodged under the second leading dorsal fin ray, as described by Reynolds and Moore (1982). The fish were then examined for signs of red spot disease or other damage.

The severity of red spot disease, which is caused by a fungus (*Aphanomyces invadans*), was visually assessed using a simple scoring system (Table 2). In addition, pathologist Dr John Humphrey and parasitologist Dr Lois Small of the Berrimah Veterinary Laboratories of the Department of Primary Industry, Fisheries and Mines collected samples of fish over two days, both with and without red spot lesions. Those fish were checked for internal and external parasites.

At the time of tagging, an original scale was removed from the side of the body in the area just behind where the end of the pectoral fin touches the body, as these scales are less likely to be damaged or have been replaced (Quentin Allsop, NT Fisheries pers. comm.). The fish were then released outside the enclosure.

Table 2. Red spot lesion scoring system used during Barracade 2006

Category	Description
Frequency	
Single	One lesion
Occasional	Two to three lesions
Numerous	More than three lesions
Severity	
Mild	Flat red area with no scale loss
Moderate	Raised red area with no scale loss
Severe	Advanced ulceration causing scale loss and exposing underlying muscle
One eye	One eye affected causing blindness in affected eye
Two eyes	Both eyes affected, causing blindness in both eyes

Sampled barramundi were aged from collected scales, using a Leitz LaborLux S microscope, according to the proven technique of Davis and Kirkwood (1984). Scales show periods when fish growth is checked, typically between September and December, and periods of rapid growth between January and March. Only whole checks in the scale circuli (Figure 2) were counted. The scales removed from each fish were read independently by two fisheries staff and they were read again when the two initial readings differed by more than 20%.

In addition to the scale taken from each tagged fish, otoliths (ear bones) were also collected from 37 barramundi. The otoliths were air-dried for two weeks in the laboratory before being mounted in slow setting epoxy resin and sectioned at 400 microns. Each section was then washed in a bath of 3% hydrochloric acid, two baths of distilled water and then set under a cover slip using DPX Mountant. Otoliths were then aged using methods similar to those used with the scales (DPIF 2005).

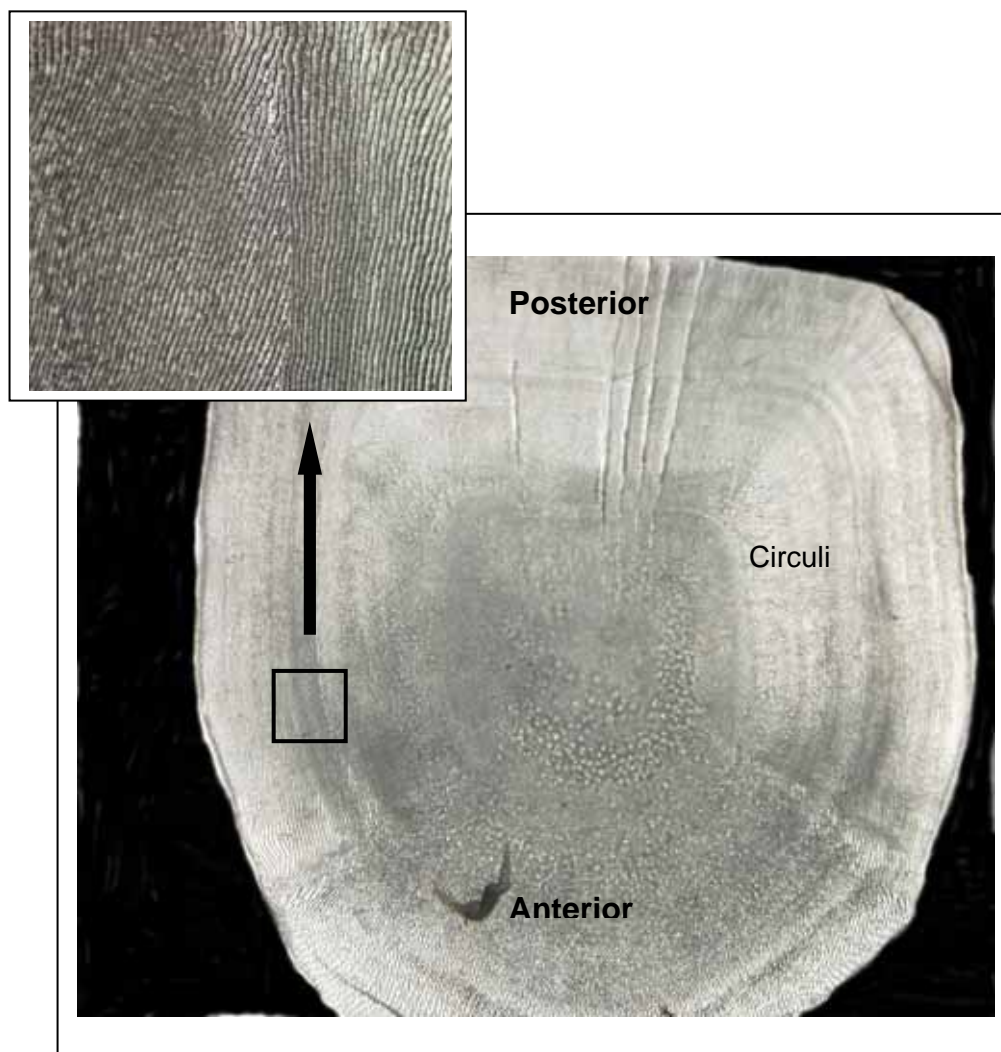


Figure 2. Photograph of a scale taken from a 59 cm barramundi that shows two annual growth checks. The insert is an enlarged section of an annual check of this scale.

RESULTS AND DISCUSSION

BARRAMUNDI

In total 573 barramundi were caught over the three days of fishing; 483 were tagged and released and 37 (7%) were taken for otolith or disease assessment. A total of 51 barramundi (9.2%) died during capture or from crocodile-related incidents, and two released fish were found dead outside the study site.

The barramundi caught ranged in size from 24 cm to 78 cm total length. Only 7% were longer than the legal length of 55 cm (Figure 3).

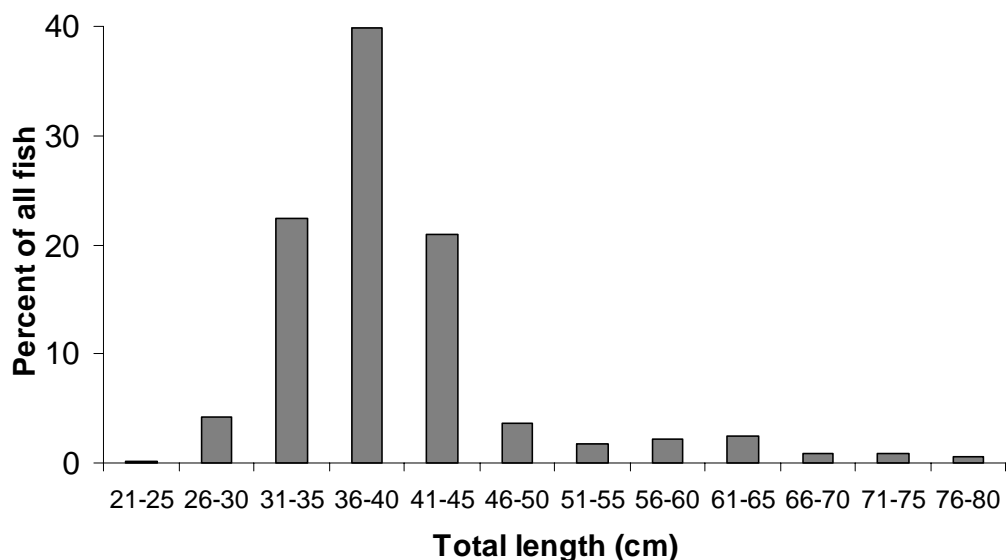


Figure 3. Length frequency distribution of barramundi collected during Barracade 2006

Age

Most fish (88.5%) were less than one year old as indicated by the size (Figure 3) and age (Figure 4) distributions. These barramundi were recruited to the billabong population during the previous wet season. The two people who determined ages from scales independently agreed 88% of the time, suggesting reasonable consistency (DPIF 2005).

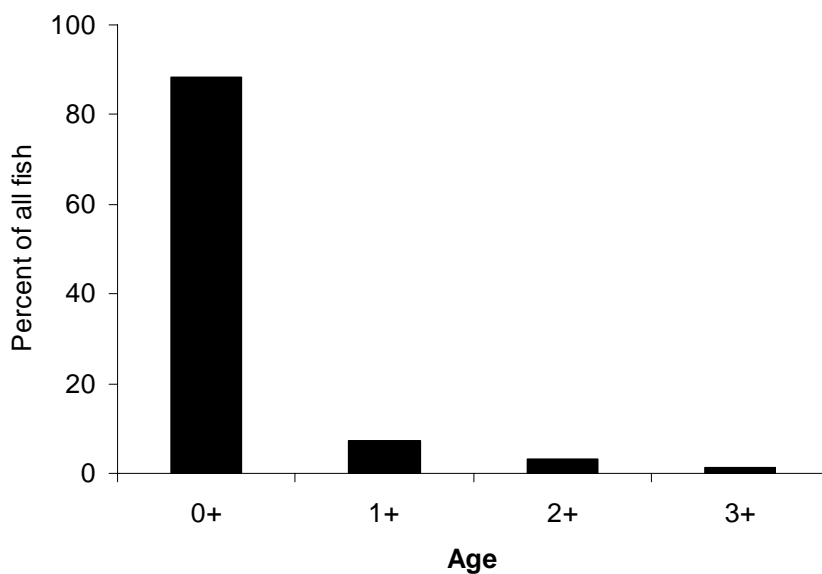


Figure 4. Age distribution of barramundi captured during Barracade 2006, determined by scale readings

In addition to the scales removed from each barramundi, sagittal otoliths and an additional scale were taken from a sub-sample of 37 fish, ranging in length between 24 and 74 cm. The ages as read from scales corresponded well with the ages as read from growth checks in otoliths (Figure 5). However, in four of the 37 fish (11.5%), the otolith contained a ring, or annulus, that corresponded to an incomplete check in the scale, rather than a whole check. Otoliths may have several rings deposited in one year, possibly as a result of spawning (DPIF 2005) or other stresses, or alternatively, a favourable dry season may result in an incomplete check in a scale.

The damage to the block-off nets was unlikely to affect the age structure data, as the holes in the nets were large enough to allow fish of all sizes to enter the site.

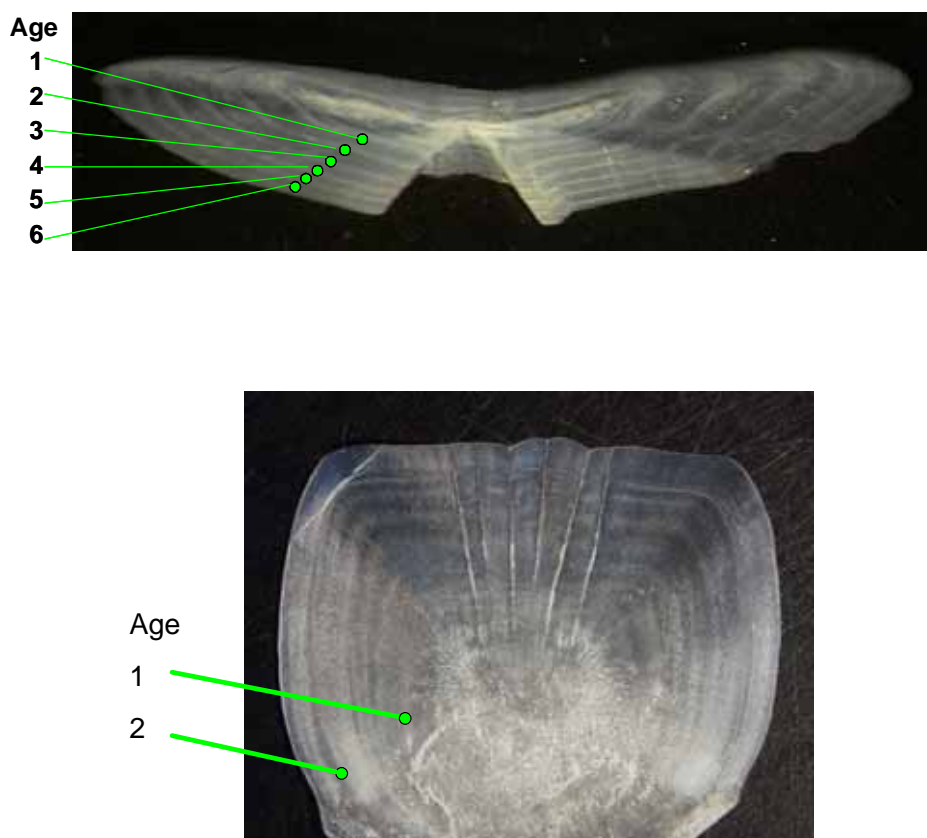


Figure 5. A sectioned barramundi otolith (top) and scale (bottom) showing growth checks that indicate age. Otolith photo courtesy of Ian Halliday, Qld Department of Primary Industries and Fisheries.

Population

The 2006 Barracade experiment did not successfully deplete the barramundi population within the netted area. The catch per unit of effort (CPUE) within the study site declined rapidly between the first and second fishing days, but increased during the third day (Table 3). This increase corresponded with previously tagged fish being recaptured within the block-off area (Table 3), indicating that the block-off nets had lost their integrity.

Table 3. Barramundi and saratoga captures and CPUE during the 2006 Barracade depletion experiment

Period	Barramundi		Saratoga	
	Catch (recaptures)	CPUE (fish/hour)	Catch	CPUE (fish/hour)
6 p.m. 11 September – 6 p.m. 12 September	284 (0)	2.84	5	0.050
6 p.m. 12 September – 6 p.m. 13 September	102 (1)	1.023	2	0.019
6 p.m. 13 September – 6 p.m. 14 September	187 (4)	1.845	0	0.000
Total	573 (5)		7	

Recaptures are fish that were caught in the block-off area, tagged, released outside and then caught again within the blocked-off area.

Large crocodiles damaged block-off nets. Such damage was observed on the first morning of sampling. As a result, an unknown number of barramundi entered the “block-off” area during the experiment, explaining why tagged fish were recaptured in this area and why CPUE increased between the second and third sampling periods (Table 3).

In addition to the block-off nets being compromised, a 3 inch net was destroyed by large crocodiles on the second day, which was mistakenly replaced with a 4 inch net.

The compromised integrity of block-off nets and accidental replacement of the 3 inch net with a larger 4 inch net meant that the use of calculations based on declining CPUE over time to estimate the number of barramundi present, as in most previous years, was not appropriate.

Populations were estimated from CPUE for the first night of fishing, and combined with records from previous years (Griffin 2002). There is a correlation between CPUE for the first night fishing and estimates of total population (Figure 6). The population in 2006 was estimated using the equation:

$$\text{Population} = 33.8 \times \text{CPUE}_{\text{night 1}} + 127$$

This produced an estimate of 892 barramundi within the blocked-off area, with a 95% confidence interval between 596 and 1190. This suggests there were approximately 0.028 fish per m², or one fish every 35 m².

The total barramundi biomass in the 450 m section in 2006 was calculated to be 746 kg, with a 95% confidence interval between 677 and 815 kg (calculated by Monte-Carlo simulation). This was calculated from the weight of individual fish, using the formula

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

where Length is the total length of the barramundi in cm and Weight is in kg (Reynolds 1978). The weight was calculated for each fish that was measured using this formula and these calculated weights were then averaged. Average weight was then multiplied by the estimated number of fish to give the biomass of barramundi in the 450-m length of the billabong. The average weight of individual fish was calculated to be 0.84 kg.

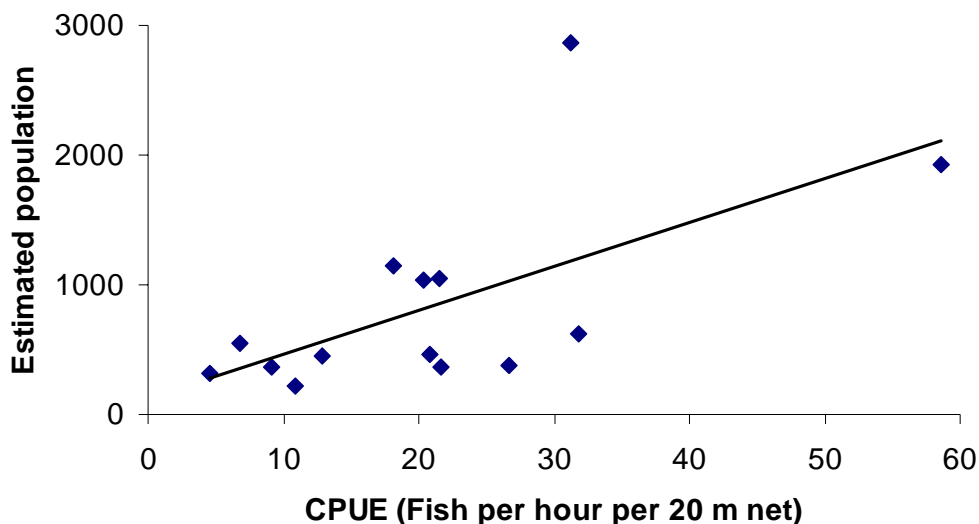


Figure 6. Estimated population versus CPUE for the first night of fishing at Barracade from 1991 to 2005 (excludes 2002 which was calculated using a similar correlation). Line shows the equation: Population = 33.8 x CPUE + 127 (r² = 0.4).

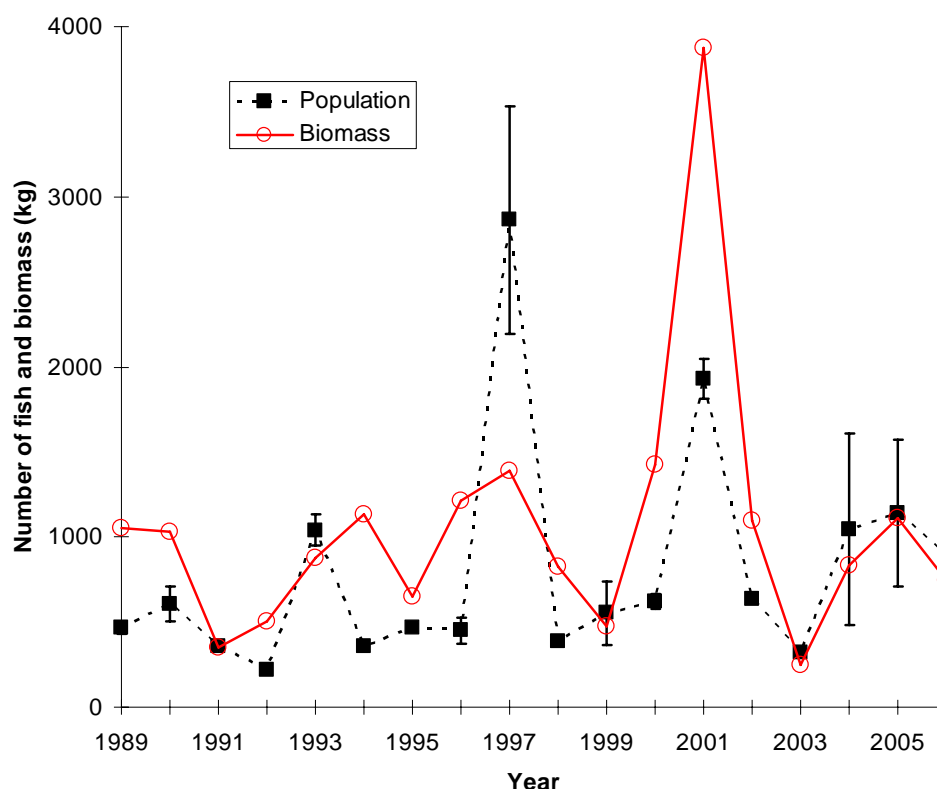


Figure 7. Estimated number of barramundi and their biomass within the Barracade depletion site from 1989 to 2006. Error bars show 95% confidence intervals for number of barramundi

Disease

Pathology work confirmed that skin and eye lesions were caused by the red spot fungus (*Aphanomyces invadans*). This disease was first recorded in the Northern Territory in mullet (*Liza* sp.) in the Mary River system in 1986 and has been recorded in 17 fish species since (Humphrey and Pearce 2004). The proportion of fish that were affected has been recorded during each Barracade since 1989. During the 2006 Barracade, 25% of barramundi and 28% of saratoga were observed to have lesions.

The frequency of the disease in barramundi has varied from year to year with a long-term average of about 27% of fish observed to be infected (Table 4). There has been no overall increase or decrease in frequency since red spot disease was first recorded as part of Barracade ($p = 0.4$, Figure 8). Pathologists have commented however, that eye lesions were uncommon in the 1980s (John Humphrey, pers. comm.). Barramundi in Corroboree Billabong therefore do not appear to be developing immunity to red spot disease, as indicated by the frequency of the disease. In fact, the frequency of the disease increased with an increase in population ($p = 0.002$, Figure 9). This shows that red spot disease may be worse when fish are overcrowded, which is possibly related to

poor water quality. There is no relationship between the size of a fish and the likelihood of it having red spot disease ($p = 0.5$, Table 5).

The extent to which red spot disease affects survival of barramundi in Corroboree Billabong is not known. However, fish with severe multiple ulcers and/or severe eye damage would have a lower life expectancy than unaffected fish.

In general, all fish had high levels of parasites, especially gill flukes and internal protozoa. A number of new species of parasites have been identified as a result of samples collected during Barracade 2006 (John Humphrey, pers. comm.).

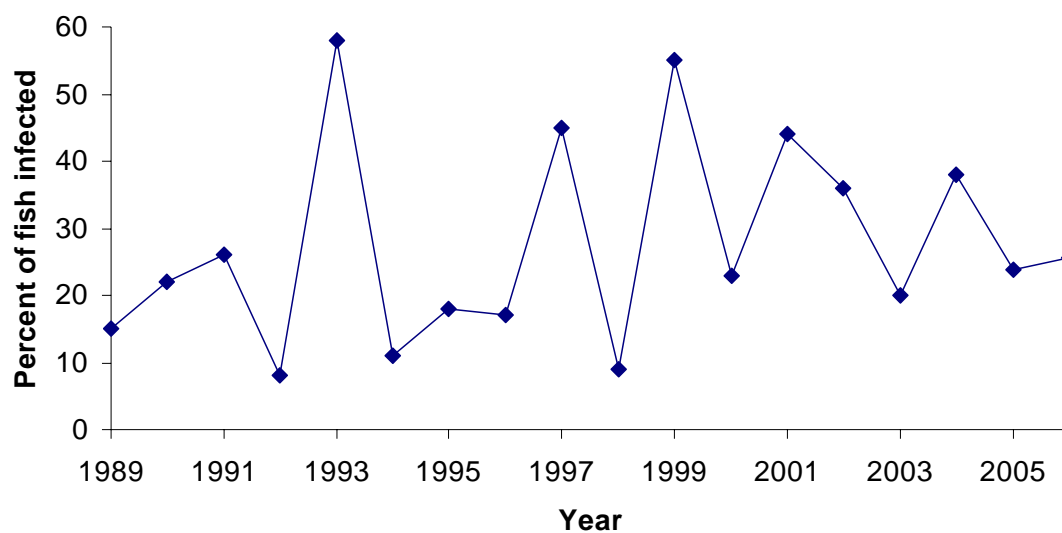
Table 4. Numbers of fish affected and severity of red spot disease recorded during Barracade 2006

Disease Category	Barramundi	Saratoga
Number of lesions		
Single lesion	33 (5.8%)	2 (28%)
Two to three lesions	35 (6.1%)	0
More than three lesions	68 (11.9%)	0
Severity		
Mild	94 (16.4%)	0
Moderate	31 (5.4%)	2 (28%)
Severe	11 (1.9%)	0
One eye blind	41 (7.2%)	0
Both eyes blind	6 (1%)	0
Numbers		
Fish assessed	573	7
Affected fish	145 (25.5%)	2 (28%)

Figures in brackets show percentage of fish affected out of all fish that were observed.

Table 5. Percentage of fish affected by red spot disease in six size classes

Size (cm)	Fish affected (%)
21-30	8
31-40	26
41-50	33
51-60	9
61-70	21
71-80	0

**Figure 8.** The percentage of barramundi affected by red spot disease during Barracade between 1989 and 2006

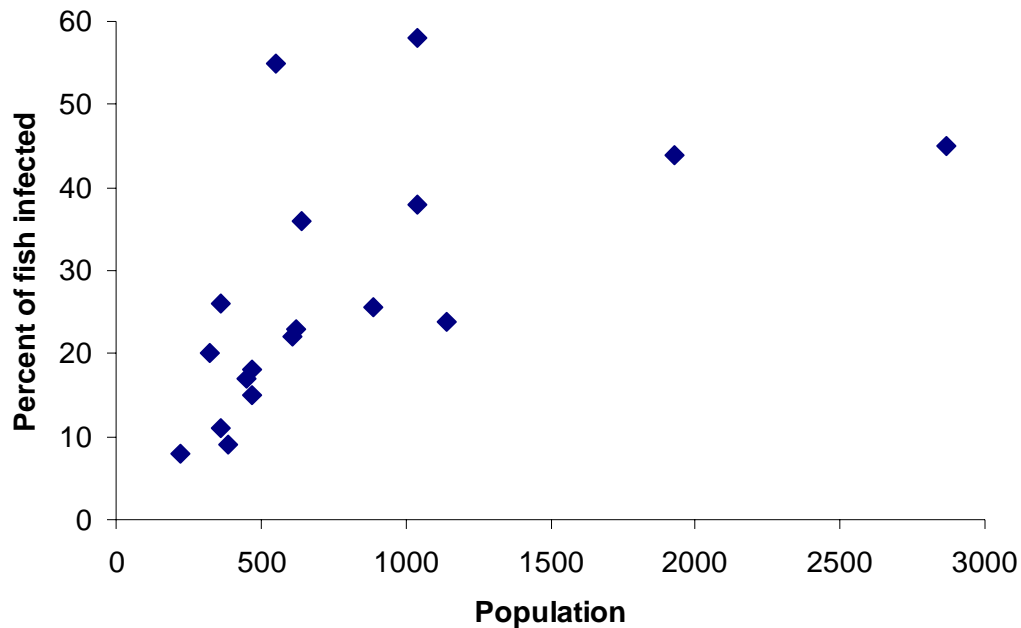


Figure 9. The percentage of barramundi affected by red spot disease versus barramundi population measured at Barracade between 1989 and 2006

SARATOGA

The number of saratoga captured within the block-off site has been recorded each year since 1993. In 2006, seven saratoga were caught, the lowest recorded total to date and well below average (mean = 30.9, standard error = 19.6).

The number of saratoga caught within the block-off site has varied considerably from year to year (Figure 10). The reasons for these fluctuations in numbers are not clear and any number of factors could be important. However, there were virtually no lotus lilies and water lilies within the site in 2006, which may have contributed to the low saratoga numbers in 2006.

It must be noted that Barracade is run primarily to monitor barramundi. The net sizes and sampling area used may not be ideal for estimating saratoga numbers.

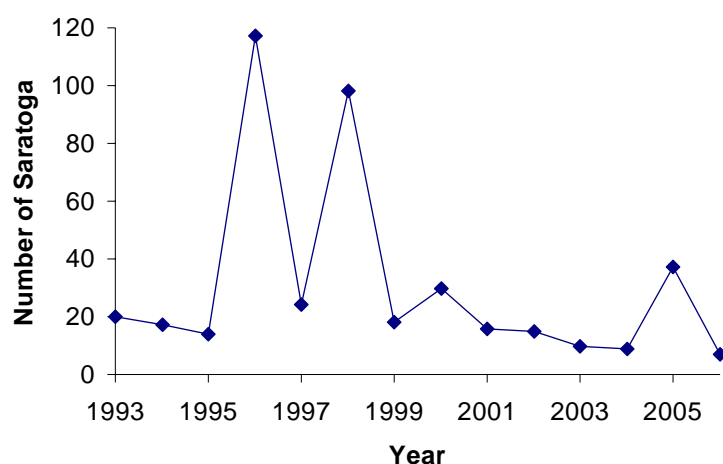


Figure 10. The number of saratoga captured during Barracade from 1993 to 2006

CONCLUSIONS

In 2006 there were about 892 fish with a biomass of 745 kg within the 450 m section of Corroboree Billabong. These figures should be used with some caution as the methods used to calculate these values were not ideal.

The majority of fish caught were less than one year old. Recruitment of barramundi into billabongs is known to be influenced by freshwater flows associated with flooding events as well as predation by larger barramundi (Staunton-Smith et al. 2004; Griffin and Walters (in press)). A large research project is being conducted in cooperation with NT Fisheries to determine the effects of large versus small freshwater flows and timing of these flows on barramundi populations.

Results from previous depletion experiments strongly suggest that young fish are eaten by older fish, which causes cycles in barramundi populations (Griffin and Walters (in press)). This cycle of strong recruitment one year, followed by fewer recruits in the following year has been observed at Corroboree Billabong as well as at Yellow Waters, in Kakadu National Park (Griffin and Walters (in press)). A big recruitment event can occur when there are few large fish, but a smaller recruitment events occur in the following year because the previous year's recruits cannibalise the new recruits. The 2006 barramundi population of Corroboree Billabong had a large number of young fish and fewer older fish.

The closed area depletion technique has again proved to be an effective method for obtaining detailed information on fish populations in the billabong. It is recommended that the operation be repeated on an annual basis using standardised methods because they currently provide the best data available on barramundi populations in the Mary River. Problems of crocodile damage to nets will need to be addressed.

ACKNOWLEDGEMENTS

The Barracade depletion experiment is a labour-intensive activity, which requires members of the team to work from 6 am to midnight, every day, to tend nets and to record and release caught fish. The members of the team for the 2006 Barracade were Quentin Allsop, Kane Dysart, Chris Errity, Poncie Kurnoth, Mark Hearnden, Nick Niedermeyer and Peter Zeroni.

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