

**Boat-based Recreational Fishing
Catch and Effort in Cockburn Sound
and Owen Anchorage during
1996/97, 2001/02 and 2005/06**

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1.0 Executive Summary

The Department of Fisheries Western Australia has conducted a range of surveys to estimate the catch and effort of recreational fishers. The spatial coverage of such surveys has varied according to the management questions being addressed, from individual estuaries to entire bioregions. A 12-month survey of boat-based recreational fishing in the West Coast Bioregion (approximately Kalbarri to Augusta) was being planned for 2005/06 year to provide catch estimates over the entire bioregion. The sampling design for this bioregional level survey would have precluded the ability to confidently provide spatial resolution of catch estimates at finer scales than for the whole bioregion.

At that time, there was a need to better understand the levels of recreational catches in Cockburn Sound due to its recognized importance as recreational fishing destination combined with the fact that parts of Cockburn Sound and its foreshore have substantial industrial activities and infrastructure, including sand dredging in some areas conducted by Cockburn Cement Ltd. Consequently, Cockburn Cement Ltd contributed funds to enable an increased level of sampling in Cockburn Sound within the broader West Coast Bioregional survey of boat-based recreational fishing, so that catches specific to Cockburn Sound could be estimated. As a previous survey in 2001/02 had included a specific focus on Cockburn Sound (and Geographe Bay), the aim of the additional sampling in Cockburn Sound in 2005/06 was to conduct a level of sampling that matched the 2001/02 survey to enable direct comparison to be made between catch and effort levels during the two periods.

This report provides the recreational fishing estimates for Cockburn Sound from the comparable 2001/02 and 2005/06 surveys, and also provides the estimated catch and effort attributable to this embayment from a survey of the entire West Coast Bioregion in 1996/97. Although the estimates from this earlier survey could not be as accurately attributed to Cockburn Sound as those from the other two surveys, they have been included in this report to provide an indication of the quantum of catches from an earlier period.

The total recreational crabbing effort (with 95% confidence intervals shown) was 23,000 ($\pm 6,000$) hours during 1996/97, 32,000 ($\pm 10,000$) hours in 2001/02 and 14,000 ($\pm 3,000$) hours during 2005/06. The total recreational angling (line fishing) effort was 68,000 ($\pm 11,000$) hours during 1996/97, 135,000 ($\pm 23,000$) hours in 2001/02 and 128,000 ($\pm 8,000$) during 2005/06.

The main species caught by recreational fishers were

- blue swimmer crabs (1996/97 – 24 tonnes; 2001/02 – 25 tonnes; 2005/06 – 4 tonnes),
- Australian herring (1996/97 – 8 tonnes; 2001/02 – 17 tonnes; 2005/06 – 16 tonnes),
- King George whiting (1996/97 – 4 tonnes; 2001/02 – 9 tonnes; 2005/06 – 4 tonnes), and,
- other whiting species (1996/97 – 2 tonnes; 2001/02 – 5 tonnes; 2005/06 – 5 tonnes).

The marked decline in the crab catch to only 4 tonnes in 2005/06 was caused by a significant decline in recruitment levels of this species within Cockburn Sound during this period. This crab stock has subsequently recovered.

2.0 Introduction

This report was commissioned by the Perth-based consultants Oceanica Pty Ltd on behalf of Cockburn Cement Ltd to provide information on recreational fishing catch and effort in Cockburn Sound. The main objective was to compile available information from three recreational fishing surveys which included coverage of Cockburn Sound and Owen Anchorage (hereafter collectively referred to as “Cockburn Sound”). Cockburn Cement Ltd provided funding to increase the level of sampling in a broader 2005/06 survey, thus permitting estimation of comparable catches with a detailed survey of Cockburn Sound recreational catches undertaken in 2001/02.

The relatively protected, nearshore waters of Cockburn Sound provide a safe location for marine-based recreational boat-based fishing in the Perth metropolitan region. Consequently, this area is very popular for such recreational fishing and also supports a significant commercial fishery and aquaculture of blue mussels. The area is more highly productive than adjacent open marine waters in the Perth region, another factor that contributes to its popularity with fishers.

This report presents catch and effort estimates from three surveys of boat-based fishers. Recreational anglers used lines with bait or lures to catch fish. Boat-based crabbers either use drop nets or catch crabs by hand whilst diving or snorkelling. Surveys of recreational fishing activities that included coverage of Cockburn Sound were conducted during 1996/1997 (Sumner and Williamson, 1999), in 2001/02 (Sumner and Malseed, 2004) and in 2005/06 (Sumner *et al.*, 2008). The 1996/97 and 2005/06 surveys covered the entire West Coast Bioregion of Western Australia, which includes Cockburn Sound. There was a need to re-analyse data collected during the 1996/97 and 2001/02 surveys so the boundaries used for Cockburn Sound and methods used for all surveys matched as closely as possible.

For the 2005/06 survey, Cockburn Cement Ltd provided funds to increase the intensity of survey sampling in Cockburn Sound above that which would have otherwise occurred as part of the overall experimental design for the entire West Coast Bioregion. The 2001/02 survey had a particular focus on blue swimmer crab (*Portunus pelagicus*) fisheries of the lower west coast region of Western Australia due to concerns over resource allocation between the recreational and commercial sectors. Consequently, this survey also included coverage of Geographe Bay to the south. For comparability with the 1996/97 and 2005/06 surveys, however, only the boat-based catch and effort estimates from Cockburn Sound in 2001/02 have been included in this particular report.

3.0 Methods

3.1 Boat Ramp Surveys

An onsite survey employing interviews of fishers returning to boat ramps (i.e. a creel survey) was used to estimate the recreational boat-based effort and catch for all species. The 1996/97 survey (September 1996 to August 1997) was conducted at boat ramps from 8:00 am to 4:00 pm. The 2001/02 survey (September 2001 to August 2002) was conducted at boat ramps between 7:00 am and 8:00 pm during spring and summer, 8:00 am and 7:00 pm in autumn and 9:00 am to 6:00 pm during winter. The 2005/06 survey (July 2005 to June 2006) was conducted at boat ramps from 9:00 am to 5:00 pm. Due to concerns about recreational fishers targeting pink snapper (*Pagrus auratus*), an evening boat ramp survey from 5:00 pm until 10:00 pm was conducted in Cockburn Sound from August 15, 2005 to February 28, 2006 (not including the closed season for this species from October 1, 2005 to December 15, 2005).

Reiterating from above, the 1996/97 and 2005/06 surveys were part of larger surveys of boat-based recreational fishing in the West Coast Bioregion (between Augusta and Kalbarri) of Western Australia. The 2001/02 survey focused on the recreational catch and effort from only Cockburn Sound and Geographe Bay.

Each of the surveys included the Leeuwin, Woodman's Point, Sutton Road, Kwinana Beach, Palm Beach and Causeway boat ramps (Figure 1). The Fremantle Sailing Club boat ramp was subsequently included in the 2005/06 survey. The bus route method was used for these surveys (Robson and Jones 1989; Jones *et al.*, 1990).

The data collected during the 1996/97 and 2005/06 surveys were re-analysed in this study to estimate the catch and effort specifically for Cockburn Sound. The boundaries used for Cockburn Sound were matched as closely as possible despite the larger block sized used during the 1996/97 survey (see 3.1.5). The same methods for estimating catch and effort were used for all surveys. The 2001/02 Cockburn Sound data were also re-analysed in this study to estimate the catch and effort for angling (i.e. finfish) since, previously, only the crab catch from this survey was reported (Sumner and Malseed, 2004).

3.1.1 Spatial and temporal stratification

The experimental design consisted of interview schedules that specified the order in which to visit the boat ramps and the amount of time to spend at each ramp. For the 2001/02 and 2005/06 surveys, the allocation of the times spent at particular boat ramps was determined based on ramp usage data recorded during the 1996/97 survey (Sumner and Williamson, 1999). In general, survey interviewers spent more time at busy boat ramps to maximise the amount of recreational data collected so that it was more representative of overall recreational effort. Furthermore, as recreational fishers in the West Coast Bioregion tend to fish more frequently on weekends and public holidays (Sumner and Williamson, 1999), a higher level of sampling was conducted at these times.

The experimental design (i.e. when boat ramps were visited and for how long) ensured that the boat crews interviewed were randomly selected in a manner that ensured the overall sample was representative of the entire population of recreational boat fishers for Cockburn Sound.

Estimates of fishing effort and catch were made for each of the strata (weekdays and non-weekdays). These estimates were then aggregated to estimate the total recreational boat-based

fishing effort and catch for Cockburn Sound. A detailed description of the analytical methods is provided in Wise and Fletcher (in press). A summary of the methods employed is provided below.

3.1.2 Estimation of effort

The fishing effort in hours was estimated from:

1. the number and duration (i.e. hours) of boats on the water, and
2. the proportion of boats fishing in the study area.

The initial count of boat trailers at ramps and the times that boats were launched and retrieved provided an estimate of the total number of boats and the time period for which those boats were on the water. Boat crews were interviewed to determine whether they had been fishing in Cockburn Sound. The number of boats with people fishing was estimated by multiplying the total number of boats on the water (trailer/launch counts) by the proportion of boats fishing (interview data) in the study area.

Fishing effort for boat anglers who launched before the start of shift (9.00am) and returned after the start of the shift was included in the estimates. The launch times for these boats were determined by interviewing fishing crews. The ratio of effort occurring prior to the start of a shift to that occurring after the start of a shift was estimated and a correction factor (f) applied to the effort estimate for each stratum. The effort from boats returning to the ramp after survey interviewers had left at the end of the day could not be accounted for by a correction factor, as these crew were not interviewed.

Estimates of fishing effort were made for each strata (weekdays and non-weekdays). These estimates were then aggregated to obtain the total recreational boat-based fishing effort for Cockburn Sound.

3.1.3 Estimation of catch rates

Catch rates were calculated from information on the duration a fishing boat was on the water (i.e. the difference between launch and retrieval times) and catch data (in numbers) obtained by interviewing fishers when they returned to the boat ramp. An average catch rate per hour was calculated for all species for each of the strata and used to estimate catch.

3.1.4 Estimation of catch

To estimate the total catch, the estimated total fishing effort (boat hours) was multiplied by the average daily catch rate (fish per hour). Separate estimates of total catch were made for each strata. Effort and catch rate data for individual boat ramps for which survey times covered only part of the 8-hour day were expanded to estimate catch and effort for the full 8 hour day. The estimates for each temporal stratum were then aggregated to obtain the total recreational boat-based fishing catch.

The survey interviewers were not able to identify all species of whiting accurately, except for King George whiting (*Sillaginodes punctata*). Consequently, the other whiting species were grouped together as a “combined whiting” category. This category comprised a mixture of four whiting species, namely southern school whiting (*Sillago bassensis*), western school whiting (*Sillago vittata*), yellow-finned whiting (*Sillago schomburgkii*) and trumpeter whiting (*Sillago maculata*).

3.1.5 Attribution of fishing effort and catch to Cockburn Sound

The 1996/97 survey recorded recreational catch and fishing effort for blocks on a 5 x 5 nautical mile grid. For this reason it was not possible to accurately attribute the catch and fishing effort to Cockburn Sound for that period from the data collected during this survey. Because the 2001/02 and 2005/06 surveys used a finer spatial resolution (1.7 x 1.7 nautical mile blocks) for Cockburn Sound, the data from these latter studies were better suited to separating catch and effort for Cockburn Sound from the surrounding areas. Note, however, the nature of the experimental design of the surveys does not permit catch and effort for these smaller spatial blocks within Cockburn Sound to be individually reported in a statistically robust manner.

3.1.6 Estimation of catch by weight

In Western Australia, reporting of fishing activities is normally based on weights of catches, not numbers of fish caught. The catch estimates in numbers were therefore converted to weights. Measured lengths of individuals of kept species, as recorded by the survey interviewers, were converted to weights using the length/weight relationships for each species (Table 1). The total weight, in tonnes, for each species kept was estimated by multiplying the total number of retained fish by the average weight of the individuals of each species. The total weights of fish kept have been reported for only the most common species, as average weights could not confidently be estimated for infrequently-caught species due to the small sample size of measured lengths.

Table 1. Length-weight relationship used to estimate weight of fish

Common name	Length-weight relationship	Source for length-weight relationship
Australian herring	$W=2.05 \times 10^{-6} L^{3.32}$	Mc Glennon, D. (unpublished data)
Skipjack trevally	$\ln W=2.992 \ln L-11.331$	Farmer <i>et al.</i> , 2005
King George whiting	$W=1.10 \times 10^{-6} L^{3.29}$	Hyndes (1996)
Southern school whiting	$W=6.30 \times 10^{-6} L^{3.05}$	Fisheries WA, (unpublished data)
Western school whiting	$W=8.32 \times 10^{-6} L^{2.98}$	Fisheries WA, (unpublished data)
Trumpeter whiting	$W=8.32 \times 10^{-6} L^{2.98}$	Fisheries WA, (unpublished data)
Yellow-finned whiting	$W=2.02 \times 10^{-6} L^{3.24}$	Fisheries WA, (unpublished data)
General whiting	$W=8.32 \times 10^{-6} L^{2.98}$	Brown, J. (Fisheries WA, unpublished data)
Blue swimmer crab	$\log W=\log 2.56 \times 10^{-5}+3.260 \log CW$	Potter <i>et al.</i> , 1983

Note: W is weight in g; L is total length in mm; CW is carapace width.



Figure 1. Cockburn Sound and Owen Anchorage

4.0 Results

4.1 Fishing Effort

The boat-based recreational fishing effort for Cockburn Sound and Owen Anchorage during 1996/97 was estimated to be 91,000 hours (Table 2). This was the second most intensive area for recreational fishing in the state at the time (following the area adjacent to the Hillary's marina) (Sumner and Williamson, 1999). In 2001/02, the boat-based recreational fishing effort for Cockburn Sound was estimated to be 167,000 hours. The coverage of Cockburn Sound by this survey was more extensive and more detailed than that in 1996/97, including both early morning and evening fishing activities. The similarly intensive survey in 2005/06 estimated the total effort as 142,000 hours. This later survey included evening fishing from 15 August 2005 to 28 February 2006.

Table 2. Estimated boat-based recreational fishing effort for Cockburn Sound and Owen Anchorage from surveys using different sampling periods (with 95% confidence intervals shown).

Method	1996/97 Effort (Hours)	2001/02 Effort (Hours)	2005/06 Effort (Hours)
Angling	68,000 (±11,000)	135,000 (±23,000)	128,000 (±8,000)
Crabbing (Nets & Diving)	23,000 (±6,000)	32,000 (±10,000)	14,000 (±3,000)
Total angling and crabbing	91,000 (±13,000)	167,000 (±25,000)	142,000 (±9,000)

4.1.1 Finfish

Boat-based anglers fishing in Cockburn Sound targeted a range of species such as King George whiting, Australian herring and pink snapper (Sumner and Malseed, 2004).

The estimated boat-based angling effort within Cockburn Sound was 135,000 hours in 2001/02 and 128,000 hours in 2005/06 (Table 2), i.e. virtually the same. The estimated level of fishing effort for these periods was approximately double that estimated for 1996/97. This difference is due, in part, to the different times at which sampling at boat ramps was conducted and the different spatial resolution of the survey data for different periods.

4.1.2 Blue Swimmer Crabs

The estimated total annual recreational boat-based crabbing effort for Cockburn Sound during 1996/97 was 23,000 (±6,000) hours. The estimated total annual recreational boat-based crabbing effort increased to 32,000 (±10,000) hours during 2001/02 and subsequently declined to 14,000 (±3,000) hours in 2005/06. It is likely that Cockburn Sound was less attractive to recreational crabbers during 2005/06 due to low catch rates, resulting from poor recruitment in this embayment during this period (Bellchambers *et al.*, 2006) with the fishery for crabs in this region being closed for the following two seasons (Johnston *et al.*, 2011).

During 2001/02, blue swimmer crabs were targeted by 18% of the recreational boat-based fishers interviewed in Cockburn Sound. In 2001/02, the recreational boat-based crabbing effort was greatest in summer with 63% of the annual crabbing effort occurring during this period (December to February) (Sumner and Malseed, 2004). Autumn was the next most popular

season for boat-based crabbing followed by spring, whereas no crabbing took place during winter. The majority of boat-based crabbing took place in the morning.

4.2 Catch

4.2.1 Finfish

The main finfish species caught from Cockburn Sound were Australian herring (*Arripis georgianus*), combined whiting species (*Sillago* spp.), King George Whiting (*Sillaginodes punctata*) and skipjack trevally (*Pseudocaranx dentex*).

The boat-based recreational catch of Australian herring and “other whiting” in 2001/02 and 2005/06 were similar (Tables 3 & 4). The reduction in the catch of King George whiting from 2001/02 to 2005/06 can, in part, be attributed to the increase in minimum size limit from 250mm to 280mm during that period. There is also anecdotal evidence of a large recruitment-pulse of King George whiting in south-western Western Australia around 2001 and this may have contributed to higher catches of this species in 2001/02. The catch of skipjack trevally (“skippy”) doubled from 2001/02 to 2005/06, but the large uncertainty associated with these estimates precludes any confidence that there was in fact a difference. There was also catches of other fish species that have not been reported due to the low numbers recorded at boat ramps, thus precluding calculation of a reliable estimates for the individual species. This includes yellowtail scad, tailor, pink snapper, garfish, trumpeters, scaly mackerel, silver bream and other species which, when combined, attributed further catches as high as 30,000 – 60,000 individual fish per year.

In addition to the quantity of fish kept by recreational fishers there was also fish caught and released (Table 5).

Table 3. Estimated boat-based recreational numbers of abundant finfish species and crabs caught and retained from Cockburn Sound (with 95% confidence intervals shown).

Species	1996/97	2001/02	2005/06
Australian herring	62,000 (±24,000)	110,000 (±46,000)	104,000 (±16,000)
Whiting other than King George	34,000 (±14,000)	47,000 (±30,000)	53,000 (±13,000)
King George whiting	24,000 (±12,000)	58,000 (±34,000)	20,000 (±4,000)
Skipjack trevally	9,000 (±5,000)	8,000 (±6,000)	17,000 (±15,000)
Blue swimmer crabs	110,000 (±36,000)	104,000 (±48,000)	18,000 (±5,000)

Table 4. Estimated boat-based recreational weights of abundant fish species and crabs caught and retained from Cockburn Sound (with 95% confidence intervals shown).

Species/Group	1996/97 (tonnes)	2001/02 (tonnes)	2005/06 (tonnes)
Australian herring	8 (±3)	17 (±7)	16 (±2)
Whiting other than King George	2 (±1)	5 (±3)	5 (±1)
King George whiting	4 (±2)	9 (±5)	4 (±1)
Skipjack trevally	n/a	2 (±1)	5 (±4)
Blue swimmer crabs	24 (±8)	25 (±11)	4 (±1)

Table 5. Estimated boat-based recreational numbers of abundant fish species and crabs caught and released from Cockburn Sound (with 95% confidence intervals shown).

Species	1996/97	2001/02	2005/06
Australian herring	6,000 (±5,000)	20,000 (±11,000)	11,000 (±3,000)
Whiting other than King George	10,000 (±5,000)	19,000 (±10,000)	8,000 (±3,000)
King George whiting	1,000 (±1,000)	27,000 (±18,000)	4,000 (±2,000)
Skipjack trevally	7,000 (±5,000)	13,000 (±12,000)	6,000 (±2,000)
Blue swimmer crabs	16,000 (±11,000)	27,000 (±12,000)	4,000 (±2,000)

4.2.2 Blue Swimmer Crabs

An estimated ~ 25 tonnes of blue swimmer crabs (*Portunus pelagicus*) were caught and retained in both 1996/97 and 2001/02. There was a large reduction in the retained recreational catch of blue swimmer crabs to 4 (±1) tonnes in 2005/06 (Tables 3 and 4). The pattern for captured but released crabs was similar with 16,000 (±11,000) crabs released in 1996/97, 27,000 (±12,000) in 2001-02 and only 4,000 (±2,000) in 2005/06 (Table 5).

The reduced catch of crabs in 2006/07 was due to a combination of low catch rates and a reduction in recreational effort targeting blue swimmer crabs. The average recreational catch rates for blue swimmer crabs dropped from 4.3 crabs per fisher day in 2001/02 to 2.3 crabs per fisher day during 2005/06. This is consistent with similar reductions in commercial catch rates and catches during the same period (Bellchambers *et al.*, 2006), which was followed by closure of the Cockburn Sound crab fishery in December 2006 (Johnston *et al.*, 2011).

5.0 Discussion

This report provides the recreational fishing estimates for Cockburn Sound from comparable surveys conducted in 2001/02 and 2005/06, as well as providing the estimated catch and effort attributed to Cockburn Sound from a survey of the entire West Coast Bioregion in 1996/97.

Each of recreational fishing surveys conducted in 1996/97, 2001/02 and 2005/06 had different objectives. The 1996/97 survey was designed to provide estimates of catch and fishing effort for the entire West Coast Bioregion rather than an individual embayment. It was therefore not possible to clearly delineate catch and effort from Cockburn Sound and Owen Anchorage from the surrounding areas in this 1996/97 survey due to the larger spatial block size that was used. For this reason, the spatial resolution and the catch and effort estimates of the 1996/97 survey are less precise than the later surveys. Despite that the estimates from this earlier survey could not be as accurately attributed to Cockburn Sound as those from the two more recent surveys, these data were included to provide an indication of the quantum of catches from that earlier period.

The 2001/02 survey specifically focused on Cockburn Sound (and Geographe Bay) as part of a study on blue swimmer crabs in the lower west coast of WA. The 2005/06 survey was initially designed to provide estimates of catch and fishing effort for the entire West Coast Bioregion between Augusta and Kalbarri, but additional sampling was conducted in Cockburn Sound to match that undertaken in the 2001/02 survey. The latter two surveys provide the most comparable datasets. The revised catch and effort estimates, particularly for 1996/97 and 2001/02 enabled more meaningful comparisons to be made between years.

The surveys show that Cockburn Sound is a major recreational fishing area, with one of the highest levels of angling effort in the West Coast Bioregion between Augusta and Kalbarri (Sumner and Williamson, 1999). Due to the design and logistical limitation of the surveys, whereby sampling was predominantly undertaken during daylight hours, the catch and effort data presented underestimates the actual total amounts. Therefore, the catches of the main species shown and the other species will be higher than were estimated from these surveys. For example, pink snapper (*Pagrus auratus*), which is a very popular targeted species in Cockburn Sound, attracts considerable angling attention during early- to late-evening at certain times of the year, but there were only small amounts of snapper recorded in these surveys. This outcome also applied to the 2005/06 survey despite the addition of limited night-time sampling specifically undertaken to try and account for snapper fishing. Similarly, squid is also a popular target species in Cockburn Sound, but the experimental designs employed, which were focused on finfish for the 1996/97 and 2005/06 bioregional surveys and on crabs in the 2001/02 survey, were not able to also provide explicit estimates of the effort directed towards squid (i.e. squid jigging). In addition to these recognized reasons that cause the estimates provided from these surveys to be under-estimates of true catch in Cockburn Sound, this embayment is also a focal area for land-based fishing. Consequently, catches of some species that are also targeted from the shore, such as Australian herring, are likely to be considerably higher than those provided here.

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