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A 12-month survey of recreational boat-based fishing between Augusta and Kalbarri on the West Coast of Western Australia during 2005-06

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Contents

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Abstract

A 12-month survey of boat-based recreational fishing in the West Coast Bioregion (Augusta to Kalbarri) of Western Australia was conducted at boat ramps between 1st July 2005 and 30th June 2006. During the survey a total of 15,999 boat crews were interviewed, of which 13,185 (82%) had been undertaking some form of fishing activity and, of these, 10,382 (or 79%) of fishing boat crews had been ocean line fishing. The total annual recreational boat-based fishing effort for the West Coast Bioregion was estimated to be 1,557,000 fisher hours (95%CI: 1,495,000 – 1,620,000), which is a 15.5% increase in nominal fishing effort (i.e. this does not include increased efficiencies generated by technological improvements) compared to a similar survey conducted on the West Coast Bioregion in 1996/97. The survey estimated the highest catch (by number kept) was whiting (404,400, which includes a mixture of four species), Australian herring (288,400), squid (83,800), skipjack trevally (73,700) and King George whiting (48,400). The largest estimated catch by weight kept was Western Australian dhufish (186 tonnes), followed by the whiting (46 tonnes), pink snapper (40 tonnes), Australian herring (40 tonnes), skipjack trevally (34 tonnes) and baldchin groper (28 tonnes).

1.0 Introduction

The West Coast Bioregion extends from south of 27°S on the west coast to west of 115°30′E on the south coast, and includes approximately 900 kilometres of coastline between Kalbarri and Augusta (Figure 1). The coastline includes Western Australia's capital city Perth and several of the State's largest regional centres, Bunbury, Busselton and Geraldton. The West Coast Bioregion contains 81% of the Western Australian population of 1.98 million people (Trewin, 2006). Recreational fishing is a popular leisure activity in Western Australia, with an estimated 538,000 persons participating in recreational fishing at least once a year; 85% of these fish in the West Coast Bioregion (Baharthah, 2006).

Given that demersal fishing activities principally occur off the main residential areas of the West Coast Bioregion and that over the last decade there have been significant increases in both population size and fishing efficiency, such as through the use of Global Positioning Systems (GPS) and high quality colour echo sounders, increasing pressure is now being placed on the demersal species in this bioregion (Wise et al., 2007). Consequently, there has been growing concern from both the WA Department of Fisheries and stakeholder groups about the sustainability of these demersal scalefish stocks in the West Coast Bioregion.

Demersal fishing activities in the West Coast Bioregion covers a number of competing sectors including commercial fishing activities (the wetline fleet, the demersal gillnet and demersal longline ['shark'] fishery and, until recently, ancillary activities by the rock lobster fishery), plus significant recreational fishing activities (boat-based angling and the charter boat fishery) (Wise et al., 2007). Collectively these activities are known as the West Coast Demersal Scalefish Fishery (WCDSF), which is a multi-species fishery that lands over 100 different species with the key indicator species being WA dhufish, pink snapper and baldchin groper.

The West Coast Demersal Scalefish fishery extends over approximately 900 km of coastline and can be divided into the following main zones (Figure 1):

- Kalbarri zone (26°30′S – 28°S)
- Midwest zone (28°S – 31°S)
- Metropolitan (Metro) zone (31°S – 33°S)
- South zone (33°S – 115°30′E)
- Abrolhos Islands subregion

Information on the levels of catch, fishing effort and catch rates from all fishing sectors is required to evaluate the status of stocks. In Western Australia, the owners of commercial fishing licences are required to provide catch and effort returns as a condition of their licence. These returns provide landed weights for each species and effort as days fished by method. Similarly, tour operators (charter boat fishery) have been required to provide a daily trip return as a condition of their licence since September 2001, from which catch and fishing effort are estimated. Since there is no mandatory reporting system in place for recreational fishers, focused surveys must be conducted to provide catch and fishing effort estimates for this sector.

Following growing concerns about the sustainability of demersal species in the West Coast Bioregion, a recreational boat ramp creel survey was undertaken from the 1st July 2005 to 30th June 2006. The main objective for this survey was to provide estimates of total catch and fishing effort of recreational boat-based ocean line fishing for the West Coast Bioregion and

compare this to results from a similar survey conducted in 1996/97. Analysis of species such as western rock lobster and abalone, which are caught by boat based fishers, but are non-line fishing activities, have not been included in this report as the focus was on ocean line fishing. Estimates for these species would not, therefore, reflect their total catch.

2.0 Methods

2.1 Survey design

The recreational boat-based creel survey was designed to provide estimates of the total catch and fishing effort by boat-based angler's ocean line fishing in the West Coast Bioregion. This survey did not include estimates of catch and fishing effort of boats from yacht clubs, canals, private marina's and moorings not located near boat ramps[1].

In total, 61 boat ramps on the West Coast Bioregion that are used to launch boats into the ocean were included in the survey. The survey of boat ramps (questionnaire shown as Appendices A and B) was restricted to eight (8) hours, from 9:00am to 5:00pm from the 1st July 2005 to 30th June 2006.

A night based boat ramp survey was also undertaken to enable estimates of recreational night-based catch and fishing effort in Cockburn Sound. Cockburn Sound is an intensively used marine embayment south of Perth (Figure 1) and is also thought to represent an important spawning and nursery area for pink snapper (Wakefield, 2006). The night based boat ramp survey in Cockburn Sound was restricted to five hours (5) from 5:00pm until 10:00pm, from the 15th August 2005 to 28th February 2006 (but did not include the closed season from the 1st October to 15th December 2005).

The catch and fishing effort information gathered for recreational fishers at boat ramps was recorded in 5×5 nautical mile blocks. These blocks fit within the statistical blocks used for recording the commercial catch in Western Australia (60×60 nautical miles) and offer a finer resolution for reporting the recreational catch. Tour operators use the same 5×5 nautical mile blocks to report catch and fishing effort.

The survey design was similar to the previous survey conducted on the West Coast Bioregion in 1996/97 (Sumner and Williamson, 1999), with three notable differences:

- The 2005/06 survey was conducted from 9:00am to 5:00pm rather than 8:00am to 4:00pm, as was the case in 1996/97.
- The 2005/06 Cockburn Sound night based boat ramp survey was undertaken, which was not done in 1996/97.
- A limited survey of non-trailered boats was undertaken in 1996/97 (refer to Sumner and Williamson, 1999), but not in 2005/06.

The bus route method was used for this survey. This method requires that survey interviewers visit several boat ramps each day. Whilst at each ramp the count of boat trailers are recorded and interviews of recreational fishers are undertaken (Robson and Jones 1989, Jones *et al*. 1990). When the interviewers are at each boat ramp, they try to interview as many recreational boat crews as possible. When several boats return to the ramp at the same time, the survey interviewers randomly choose which of the boat crews will be interviewed. To increase the percentage of crews interviewed, two interview staff were used at each of the busy Perth metropolitan boat ramps during August 2005-April 2006.

1 In the previous survey (1996/97) the level of effort by this sector was found to be relatively small but may now have increased. This sector has been included in the phone diary survey completed in 2005/06 (Wise et al., 2007).

2.2 Spatial and temporal stratification

The 12-month recreational boat-based creel survey commenced on the 1st July 2005 and concluded on the 30th June 2006.

The West Coast Bioregion was divided into a number of districts so that survey interviewers could visit all the boat ramps within a district during a scheduled day. A district thus constituted the base sampling unit, with boat ramps within a district constituting the sub-sampling units. For the districts of Kalbarri and Dongara a single boat ramp represented the entire sampling unit. Thirteen (13) geographic districts were defined; boundaries were chosen to minimise travel time and hence cost. The districts and the number of boat ramps surveyed (in parentheses) for each zone was as follows:

Kalbarri zone:	Kalbarri (1)
Midwest zone:	Jurien Bay (5), Dongara (1), Geraldton (5), Port Gregory (2)
Metro zone:	Mandurah (8), Rockingham (6), South Metro (4), North Metro (3), Lancelin (4)
South zone:	Augusta (5), Busselton (9), Bunbury (8)
Additional Night Survey:	Cockburn Sound (6)

The results of the previous recreational survey conducted in 1996/97, showed that recreational fishers ventured out more frequently on weekends and public holidays (Sumner and Williamson, 1999). Consequently, a higher level of sampling was conducted on weekend and public holidays during the 2005/06 survey.

The combination of districts and day-type divisions resulted in an experimental design with 26 strata (thirteen districts × two for weekdays and non-weekdays). The days each district was surveyed was chosen randomly. For each survey day, randomised schedules were then set up for each district. The schedules specified the order in which to visit the boat ramps and the amount of time to spend at each ramp. The amount of time spent at a particular boat ramp was based on prior information on ramp usage obtained during the 1996/97 survey (Sumner and Williamson, 1999).

For example, a survey interviewer's schedule in the North Metro district may be allocated to each boat ramp as follows:

- Ocean Reef - 9:00am to 11:10am (2 hours and 10 minutes)
- Hillarys Marina - 11:28am to 3:05pm (3 hours and 37 minutes)
- Mindarie Keys - 3:34pm to 5:00pm (1 hour and 26 minutes)

The survey interviewers spent more time at busy boat ramps to maximise the amount of recreational data collected.

2.3 Estimation of ocean line fishing effort

This report focuses on the catch and fishing effort for anglers line fishing in the ocean. The fishing effort in fisher hours was estimated (Appendices C and D) from:

1) Number and duration (i.e. hours) of boats on the water

2) Proportion of boats participating in ocean line fishing[2]

3) Average number of anglers per boat participating in ocean line fishing

The initial count of trailers at the boat ramp and the times that boats were launched and retrieved provided an estimate of the total number of boats on the water and the time period for which those boats were on the water[3]. Boat crews were interviewed to determine whether they participated in ocean line fishing and to determine the number of anglers involved. The number of boats line fishing in the ocean was estimated by multiplying the total number of boats on the water by the proportion of boats line fishing in the ocean (e.g. not including those fishing in estuaries). The ocean-line fishing effort (in fisher hours) was estimated by multiplying the average effort in boat hours (which can be thought of as the average number of boats fishing in any given hour of the daily survey period) by the average number of anglers line fishing per boat.

Line fishing effort by boats that were launched before the start of shift (9.00am) and returned after the start of the shift was included in the estimates. The launch time for these boats was obtained when the crews were interviewed. 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 5:00pm can not be accounted for by a correction factor, as these crew were not interviewed.

Estimates of ocean line fishing effort were made for each of the 26 strata. These estimates were then aggregated to obtain the total recreational boat-based ocean line fishing effort for the West Coast and zones within the bioregion.

Estimation of ocean line fishing catch rates

Catch rates were calculated from information on the time a boat was on the water (i.e. the difference between launch and retrieval times) and catch obtained by interviewing fishers when they returned to the boat ramp. An average catch per boat is calculated for all species for each of the 26 strata and used to estimate catch (Appendices C and D). The boat crews that were interviewed are assumed to be representative of all boat crews for that stratum.

Estimation of ocean line fishing catch

To estimate the total catch, the estimated total ocean line fishing effort (fisher hours) was multiplied by the average daily catch rate (Appendices C and D). Separate estimates of total catch were made for each of the 26 strata. As each district constitutes a sampling unit, effort and catch rate data for individual boat ramps within a district, for which survey times covered only part of the 8-hour day, were used to estimate catch and effort for the whole district based on the full 8 hour day. The estimates for each stratum were then aggregated to obtain the total recreational boat-based ocean line fishing catch for each zone and the West Coast Bioregion.

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2 Boats crews that did not use a line, but participated in other activities (such as pulling lobster pots, crabbing, diving or snorkelling) were not included in the estimation of ocean line fishing effort.

3 Trailers belonging to jet skis and tenders for commercial rock lobster boats were not included.

The survey interviewers were not able to identify all species of whiting accurately. Consequently whiting species were grouped together as "combined whiting". This category comprised a mixture of four whiting species: southern school whiting (*Sillago bassensis*), western school whiting (*Sillago vittata*), yellow-finned whiting (*Sillago schomburgkii*) and trumpeter whiting (*Sillago maculata*).

Estimation of spatial ocean line fishing effort and catch

The catch and effort estimates for each district were apportioned to the 5x5 nautical mile blocks using the spatial information provided by anglers during the interviews. The survey design allowed only one block to be designated for a fishing trip.

Weight estimation

Measured lengths of kept species were converted to weights, using the species length/weight relationships (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 per fish species. The weight of fish kept has been reported for only the most common species, as weights could not be estimated for some species due to the small sample size of measured lengths.

Cockburn Sound Methods

The methods used to calculate the estimated total catch and fishing effort for the Cockburn Sound night based survey, follow the same methods described above.

3.0 Results

3.1 Number of interviews

During the survey a total of 15,999 boat crews were interviewed, of which 13,185 (82%) had been undertaking some form of fishing activity. Of these boats that had been fishing, 10,382 (79%) were ocean line fishing.

3.2 Recreational ocean line fishing effort

The estimated total annual recreational ocean line fishing effort on the West Coast Bioregion during 2005/06 was 1,557,000 fisher hours (95%CI: 1,495,000 – 1,620,000). Boats crews not angling but participating in other activities (such as pulling lobster pots crabbing, diving or snorkelling) were not included in the analysis.

The ocean line fishing effort was higher in the more populated areas such as the Metro zone, where an estimated 64% of the fishing effort was expended during 2005/06. (Table 2 and see Appendix E). The spatial distribution of boat-based ocean line fishing effort has radiated further from the large regional centres and expanded considerably offshore between the 1996/97 and 2005/06 surveys.

Trailer counts indicated that most ocean line fishing effort occurred during the period of the day surveyed (9:00am to 5:00pm), however, some fishing occurred before and after the survey period, as indicated by the boat launch and retrieval times. The mean number of trailers counted at boat ramps in the 2005/06 survey decreases towards the end of the day (Figure 2). Approximately 7% of all trailers counted at the end of scheduled shift remained at the boat ramps past 5:00pm in the 2005/06 survey, similar to the 6.3% remaining past 4:00pm in 1996/97 survey. This represents additional missing effort and catch.

Night fishing effort in Cockburn Sound between 15th August 2005 and 28th February 2006 (excluding the closed season from 1st October to 15th December 2005) was estimated at 15,000 fisher hours (95%CI: 12,000 - 18,000).

3.3 Recreational ocean line fishing catch

The estimated total retained ocean line fishing catch from recreational boats launched from boat ramps on the West Coast during 2005/06 was 1,234,300 individuals with 732,500 released.

The total numbers of fish both kept and released for all species are shown in Appendices F and G. The highest catches by boat-based recreational ocean line anglers in the West Coast Bioregion were (by number kept) estimated to be whiting (404,400 comprising a mixture of four species), Australian herring (*Arripis geogianus*) (288,400), squid (Cephalopodidae) (83,800), skipjack trevally (*Pseudocaranx dentex*) (73,700) and King George whiting (*Sillaginodes punctata*) (48,400) (Appendix F). The estimated weights of species kept were Western Australian dhufish (*Glaucosoma hebracium*) (186 tonnes), whiting (46 tonnes), pink snapper (*Pagrus auratus*) (40 tonnes), Australian herring (*Arripis geogianus*) (40 tonnes), skipjack trevally (*Pseudocaranx dentex*) (34 tonnes) and baldchin groper (*Choerodon rubescens*) (28 tonnes) (Table 3). The proportion of the total catch released ranged from between 9% for Australian herring, to 29% for pink snapper (Appendix G).

The estimated total weight kept (tonnes) for the main species retained by zone are listed in Table 4. In both 2005/06 and 1996/97, the Mid West zone had the highest catches of both WA dhufish (71 and 60 tonnes) and baldchin groper (19 and 11 tonnes) respectively. For pink snapper, the highest catch in 2005/06 was taken in the South zone (15 tonnes) but the highest catch in 1996/97 was 10 tonnes in the Metro zone. The highest catches of whiting (36 and 47 tonnes), Australian herring (32 and 38 tonnes) and skipjack trevally (23 and 22 tonnes) in both 2005/06 and 1996/97 respectively, occurred in the Metro zone.

The night based boat ramp survey in Cockburn Sound conducted between 15th August 2005 and 28th February 2006 (excluding the closed season from 1st October to 15th December 2005) estimated that the catch of pink snapper by this activity was 0.5 tonnes. The catch also included small quantities of Australian herring, squid, yellowtail scad, tailor and King George whiting and other species.

The estimated spatial distribution of the catch (numbers of fish kept per spatial block) of the key recreational species are presented in Appendices H to O. It is important to note that some of the spatial distributions of inshore species (e.g. Australian herring) show wider distribution offshore than expected for inshore species because the survey design only allowed for one block location to be recorded per interview. Thus, because fishing trips often expend effort at multiple locations on a given day, the attribution of a whole day's fishing effort to a single spatial block does not allow a comprehensive understanding of changes in location of the catch of individual species.

4.0 Discussion

Survey overview

It is important to note that the techniques used in this survey do not require every recreational fisher in the West Coast Bioregion to be interviewed; nonetheless, a total of 15,999 boat crews were interviewed, of which 10,544 different boat crews were interviewed (this equates to approximately 13% of boats registered in Western Australia, DPI, 2007). 13,185 (82% of boats interviewed) had been undertaking some form of fishing activity, of which 10,382 (or 79%) had been ocean line fishing. Night based fishing was only surveyed in Cockburn Sound, a location expected to have a relatively high proportion of night fishing, however night fishing at this location constituted only a small fraction of the total effort in the West Coast Bioregion. Finally, estimates of catches of these species taken whilst diving and not line fishing were not included in this report.

A separate phone diary survey of registered boats owners (including boats kept in yacht clubs, marinas, canals and moorings) was conducted during the same period as the recreational boat ramp creel survey, which provides an alternate method of estimating recreational catch. The phone diary survey includes catch landed outside the times boat ramps were surveyed such as at night. Secondly, the phone-diary survey potentially included larger boats kept in canals, marinas, yacht clubs and on moorings that were not included in the survey of boat ramps. Summary results from this survey can be found in Wise et al. (2007); a full report on this study is currently being prepared.

The Abrolhos Islands zone (Figure 1) was not fully covered by the survey since boats fishing at these offshore islands are typically too large to be 'trailer' boats, so they were not always encountered at boat ramps. Some trailer boats were encountered that reported activity in the Abrolhos Islands zone, plus information for the larger recreational boats was included in the phone diary survey (refer to Wise et al., 2007). Finally, a separate but dedicated recreational survey was conducted in the Abrolhos Islands for the 2006 calendar year (i.e. not 2005-06) the results of which are reported in (Sumner, 2008).

Total effort for ocean line fishing in the West Coast Bioregion

The earlier survey by Sumner and Williamson (1999) provided estimates of the total fishing effort for the West Coast Bioregion covering all recreational fishing activities including angling, pulling lobster pots, crabbing, diving and snorkelling. Data from this 1996/97 survey were reanalysed to provide a more precise estimate of recreational scalefish fishing effort to be comparable with the current survey. It is recognised that the estimates for these two surveys are based on different survey time periods (i.e. 8am – 4pm in 1996/97 vs 9am – 5pm in 2005/06), but the increased knowledge of fisher behaviour gained since the first survey, through consultation with stakeholders, indicates that the adjusted survey period obtained data more representative of boat-based ocean line fishers targeting scalefish.

The 2005/06 ocean line fishing effort of 1,557,000 fisher hours (95%CI: 1,495,000 – 1,620,000) represents a 15.5% increase over the ocean line fishing effort of 1,348,000 fisher hours (95%CI: 1,277,000 – 1,419,000) expanded during 1996/97. It is important to recognise that this increase is for nominal effort and does not take increases in fishing efficiency into account. The increased uptake of modern technology such as global positioning systems, colour echo sounders, braided line and chemically sharpened hooks are likely to have increased the efficiency of effort targeting demersal scalefish.

Total catch for ocean line fishing in the West Coast Bioregion

Despite that nominal effort (in fisher hours) increase of 15.5% over the nine years between the surveys, the retained weights of the key demersal indicator species in the West Coast Bioregion increased by 49-63%, while numbers caught increased by 15-58%. From 1996/97 to 2005/06 the weight of the retained catch of pink snapper increased 63%; however, the number of fish kept only increased 15%. This was due to the average weight per fish for pink snapper increasing from 1.58kg to 2.25kg.

There has been some notable declines in the catches of the main recreational species between the 1996/97 and 2005/06 surveys. These species include whiting (mixture of four whiting species), Australian herring and King George whiting.

The night fishing catch of pink snapper in Cockburn Sound was estimated as 0.5 tonnes with length ranges for this catch of between 455mm and 760mm. Given this size range, these fish are not likely to be only from the spawning aggregations that form annually in Cockburn Sound. These aggregations are usually comprised of larger fish with lengths between 700mm and 950mm (Wakefield, 2006).

Spatial and temporal variations

The spatial distribution of boat-based ocean line fishing effort has radiated further from the large regional centres and expanded considerably offshore between the 1996/97 and 2005/06 surveys. This likely reflects the overall increase in effort as well as a change in fishing behaviour whereby some fishers now travel further to partake in fishing. However, note that the spatial distributions of recreational fishing effort depicted for this survey may not always be indicative of where particular species were caught. Discussions with some recreational anglers indicated that those who were going to target demersal species offshore often undertook some fishing in shallower inshore waters on the outward or return trip (e.g. depending on weather conditions on a particular day), specifically to target inshore species. Because the survey design asked the question "where was most time spent fishing", such anglers would therefore have indicated that they had spent most time fishing offshore, leading to an underestimate of the amount of effort expended inshore, and to misidentification of catch-location for inshore species.

The highest effort occurred in the Metro zone in both surveys. The spatial variations between catches of the key demersal scalefish were consistent between 1996/97 and 2005/06 and reflect their natural distribution. Pink snapper and WA dhufish are distributed throughout the West Coast Bioregion while baldchin gropers are more abundant in the Midwest zone of the West Coast Bioregion.

WA dhufish was the dominant key demersal species by weight (tonnes), and together with the other key offshore demersal species (pink snapper and baldchin groper) comprised the major component of the retained catch by weight by recreational anglers in the 2005/06 survey, this is also reflected in the 1996/97 survey.

What was apparent in the 1996/97 survey, and again found to be the case in 2005/06, was that many boat crews interviewed had not caught the key demersal species but had caught what have traditionally been thought of as inshore species. Indeed, many anglers (20% in 2005/06) were targeting Australian herring, whiting species, and skipjack trevally, hence the high prevalence of these species in the retained catch. Any potential changes to management measures designed to reduce the catch of demersal species may divert additional effort to inshore species. Under conditions of increasing total fishing effort between the two surveys the catches of the key

smaller inshore species have all declined, while the catches of each of the demersal species have increased. This may in part be related to a greater proportion of the total fishing effort being expended in more offshore waters seeking to target the larger demersal species. It may also indicate declines in abundance of these inshore species.

5.0 Conclusions

The recreational catch and fishing effort has been estimated for trailered boats ocean line fishing in the West Coast Bioregion during 2005/06. A 15.5% nominal increase in ocean line fishing effort occurred between 1996/97 and 2005/06. However, this does not take into account increases in efficiency by the recreational sector. There was an increase in the retained catches of all the key demersal species by the recreational sector from 1996/97 to 2005/06. This survey did not include estimates of catch and fishing effort of boats launching from yacht clubs, marina's, canals and moorings not located near boat ramps.

Apart from WA Dhufish, on the basis of both numbers and weight of the retained catch, the West Coast Bioregion recreational boat-based fishery in 2005/06 can be considered primarily a fishery for smaller, and predominantly inshore, scalefish species such as whiting species, Australian herring and skipjack trevally. This is very similar to the situation in 1996/97 when the same group of species dominated a major component of the recreational boat-based catch.

Any management measures designed to reduce the catch of demersal species may divert additional effort to Australian herring, whiting species, and skipjack trevally. For this reason the recreational catch of these inshore species will also need to be monitored in the future.

Consideration for the future management of recreational fishing on the West Coast Bioregion must include that many of the inshore species caught by boat-based fishers are also targeted by shore based fishers. There are, however, no estimates of effort and catch for shore based fishing in this bioregion. It is unknown what level of risk that this poses to inshore stocks.

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8.0 Tables and figures

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

Common name	Length-weight relationship	Source for length-weight relationship
Western Australian dhufish	Female: $W=4.17x10^{-5}L^{2.859}$ Male: $W=3.22x10^{-5}L^{2.898}$ Unknown: $W=4.83x10^{-5}L^{2.837}$	Hesp et al, 2002
Pink snapper	$W=0.0467727((L-0.7)/11.79)^{2.781}$	Moran & Burton, 1990
Australian herring	$W=1.44x10^{-5}L^{2.94}$	Gaughan *et al.*, 2006
Skipjack trevally	LnW=2.992LnL-11.331	Farmer *et al*., 2005
Baldchin groper	$W=0.012132(L/10)^{3.15867}$	Nardi *et al*., 2006
Samson fish	$W=0.017234949(0.092TL)^{2.92134}$	Mackie, M. (unpublished data)
Southern school whiting	$W=6.30x10^{-6}L^{3.05}$	Brown, J. (Fisheries WA, unpublished data)
King George whiting	$W=1.10x10^{-6}L^{3.29}$	Gaughan *et al*., 2006
Breaksea cod	$W=33.938e^{(0.0085L)}$	Eastman, 2001
Australian salmon	$W=1.30x10^{-6}L^{3.36}$	Gaughan *et al.*, 2006
Queen snapper	$W=3.808x10^{-6}L^{3.175}$ (Blue Morwong equation)	Taylor & Willis, 1998
Sand/general whiting	$W=6.30x10^{-6}L^{3.05}$	Brown, J. (Fisheries WA, unpublished data)
Western school whiting	$W=7.74x10^{-6}L^{3.01}$	Brown, J. (Fisheries WA, unpublished data)
Snook	$W=0.0035(L/10)^{3.05}$	Bertoni (unpublished data)
Narrow-barred spanish mackerel	$W(kg)=3.3992e\text{-}9((L-42.74)/1.06)^{3.1207}$	Mackie *et al*., 2005
Sweetlip emperor	$W=9.15x10^{-6}L^{3.09}$	Ayvazian *et al*., 2004
Sea sweep	$W=7.626x10^{-6}L^{3.136}$ (Silver Sweep equation)	Taylor & Willis, 1998
Coral trout	$W=0.0079(FL/10)^{3.157}$ FL=0.97TL	Ferreira & Russ, 1993
Tailor	$W=1.15x10^{-5}L^{2.97}$	Gaughan *et al*., 2006
Yellow-finned whiting	$W=2.02x10^{-6}L^{3.24}$	Gaughan *et al*., 2006
Western foxfish	LnW=2.986LnL-10.857	Cossington, 2006
Flatheads	$W=4.35x10^{-6}L^{3.05}$	Brown, J. (Fisheries WA, unpublished data)
Oriental bonito	$W=0.0217(FL/10)^{2.87}$ FL=0.9025TL	Torres, 1991
Southern sea garfish	$W=1.94x10^{-6}L^{3.09}$	Brown, J. (Fisheries WA, unpublished data)
Banded sweep	$W=7.626x10^{-6}L^{3.136}$ (Silver Sweep equation)	Taylor & Willis, 1998
Southern blue-spotted flathead	$W = 4.35x10^{-6}L^{3.05}$	Brown, J. (Fisheries WA, unpublished data)
Western butterfish	logW=log0.0000122+3.06logFL TL=-2.347+1.11FL	Mant *et al*., 2006
Redfish	$W=6.495x10^{-5}L^{2.761}$	Williamson, P.C. (unpublished data)
Sergeant baker	$W=1.264x10^{-5}L^{3.012}$	McAuley & Simpfendorfer (2003)
Silver bream	$W=2.14x10^{-5}L^{2.932}$	Hesp (2003)

Note: W is weight in g; L is total length in mm; FL is fork length in mm

Table 2. Recreational line fishing effort by zone.

Zones	2005/06		1996/97	
	Effort (fisher hours)	SE (fisher hours)	Effort (fisher hours)	SE (fisher hours)
Kalbarri	24,000	1,000	25,000	5,000
Mid West	195,000	12,000	161,000	9,000
Metro	1,003,000	22,000	926,000	32,000
South	336,000	18,000	236,000	14,000
Total	**1,557,000**	**32,000**	**1,348,000**	**36,000**

Table 3. Estimated total recreational retained catch by weight for major species caught in West Coast Bioregion.

Common name	Scientific Name	2005/06		1996/97	
		Kept (tonnes)	SE (tonnes)	Kept[1] (tonnes)	SE (tonnes)
Western Australian dhufish	*Glaucosoma hebraicum*	186	9	125	26
Combined whiting spp.	Sillaginidae	46	3	58	9
Pink snapper	*Pagrus auratus*	40	3	25	7
Australian herring	*Arripis georgianus*	40	2	46	7
Skipjack trevally	*Pseudocaranx dentex*	34	4	38	10
Baldchin groper	*Choerodon rubescens*	28	2	19	6
Samson fish	*Seriola hippos*	24	3	35	12
King George whiting	*Sillaginodes punctata*	19	1	28	4
Breaksea cod	*Epinephelides armatus*	16	1	17	4
Australian salmon	*Arripis truttaceus*	17	3	12	5
Queen snapper	*Nemadactylus valenciennesi*	10	1.5	19	7
Snook	*Sphyraena novaehollandiae*	9	2	23	11
Narrow-barred spanish mackerel	*Scomberomorus commerson*	7	1.5	12	4
Sweetlip emperor	*Lethrinus miniatus*	6	1	0.4	0.2
Redfish[2]	*Centroberyx* spp.	5	0.6	1	0.4
Sea sweep	*Scorpis aequipinnis*	3	0.5	3	1
Tailor	*Pomatomus saltatrix*	3	0.7	14	4
Sergeant baker	*Aulopus purpurissatus*	3	0.3	2	1
Flathead, general	Platycephalidae	3	0.3	-	-
Coral trout	*Plectropomus maculatus*	2	0.6	2	1
Western foxfish	*Bodianus frenchii*	2	0.3	2	1
Oriental bonito	*Sarda orientalis*	2	0.4	0	0
Garfish, general	Hemiramphidae	2	0.2	7	2
Silver bream	*Rhabdosargus sarba*	1	0.1	2	0.6
Banded sweep	*Scorpis georgianus*	1	0.2	1	0.4
Western butterfish	*Pentapodus vitta*	1	0.5	-	-

1 Weight could not be estimated for some species due to the small sample size of measured lengths.

2 Note that this “redfish” group consists of 2-3 species, which were mainly referred to locally as red snapper. The dominant species was likely to be bight redfish (*Centroberyx gerrardi*), with lesser numbers of swallowtail redfish (*Centroberyx lineatus*). These are different to some tropical species also known as red snapper.

Table 4. Estimated total catch (tonnes) for the main recreational species retained by zone (standard errors are shown in parenthesis).

Common name	Kalbarri		Mid West		Metro		South	
	2005/06	1996/97	2005/06	1996/97	2005/06	1996/97	2005/06	1996/97
WA Dhufish	2 (0.3)	1 (0.5)	71 (7)	60 (6)	58 (4)	48 (5)	55 (5)	16 (3)
Whiting (Mixture of four species)	0 (0)	0 (0)	4 (1)	2 (1)	36 (4)	47 (5)	6 (1)	8 (2)
Pink Snapper	2 (0.4)	1 (0.4)	10 (1)	9 (2)	13 (1)	10 (1)	15 (2)	5 (1)
Australian Herring	0 (0)	0 (0)	3 (1)	4 (1)	32 (3)	38 (4)	5 (1)	4 (1)
Skipjack Trevally	0 (0)	0 (0)	3 (1)	4 (1)	23 (6)	22 (4)	8 (1)	12 (5)
Baldchin Groper	1 (0.2)	0.3 (0.2)	19 (2)	11 (2)	8 (1)	7 (1)	0.1 (0.1)	0 (0)
Samson Fish	0 (0)	0 (0)	3.8 (1)	6.6 (1.5)	13.1 (1.8)	19.2 (3.1)	7 (1.7)	8.4 (2.5)
King George Whiting	0 (0)	0 (0)	0.04 (0.02)	0 (0)	14.4 (0.9)	17.5 (2.2)	4.7 (0.7)	10.1 (1.8)
Breaksea Cod	0.2 (0.03)	0.2 (0.1)	2 (0.3)	2.1 (1)	9.9 (0.5)	11.3 (1)	4.2 (0.5)	3.3 (0.6)
Australian Salmon	0 (0)	0 (0)	0 (0)	0 (0)	12 (2.1)	5.7 (1.9)	4.7 (1.6)	6.4 (3.3)

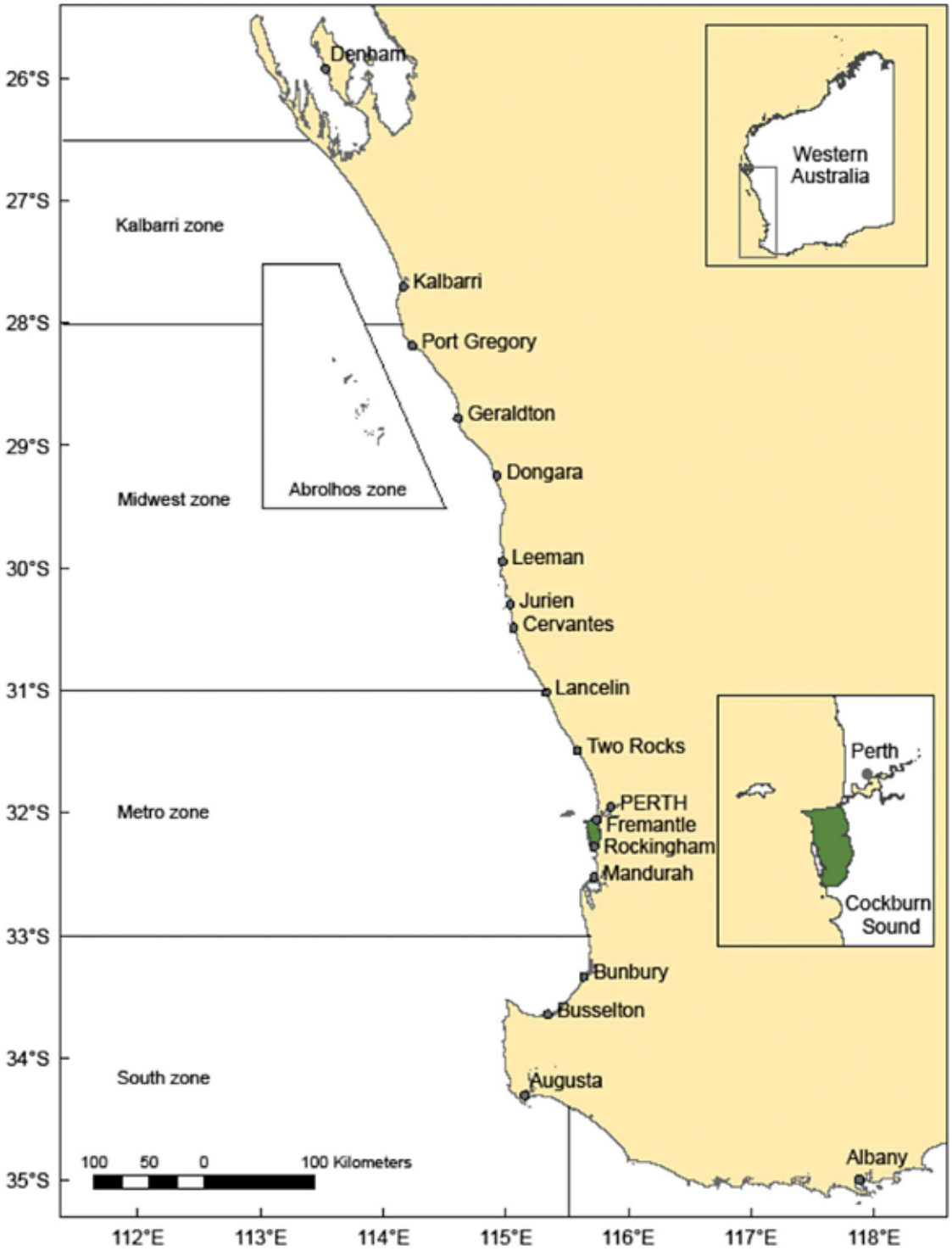


Figure 1. West Coast Bioregion showing the Kalbarri, Abrolhos, Midwest, Metro, Cockburn Sound and South zones.

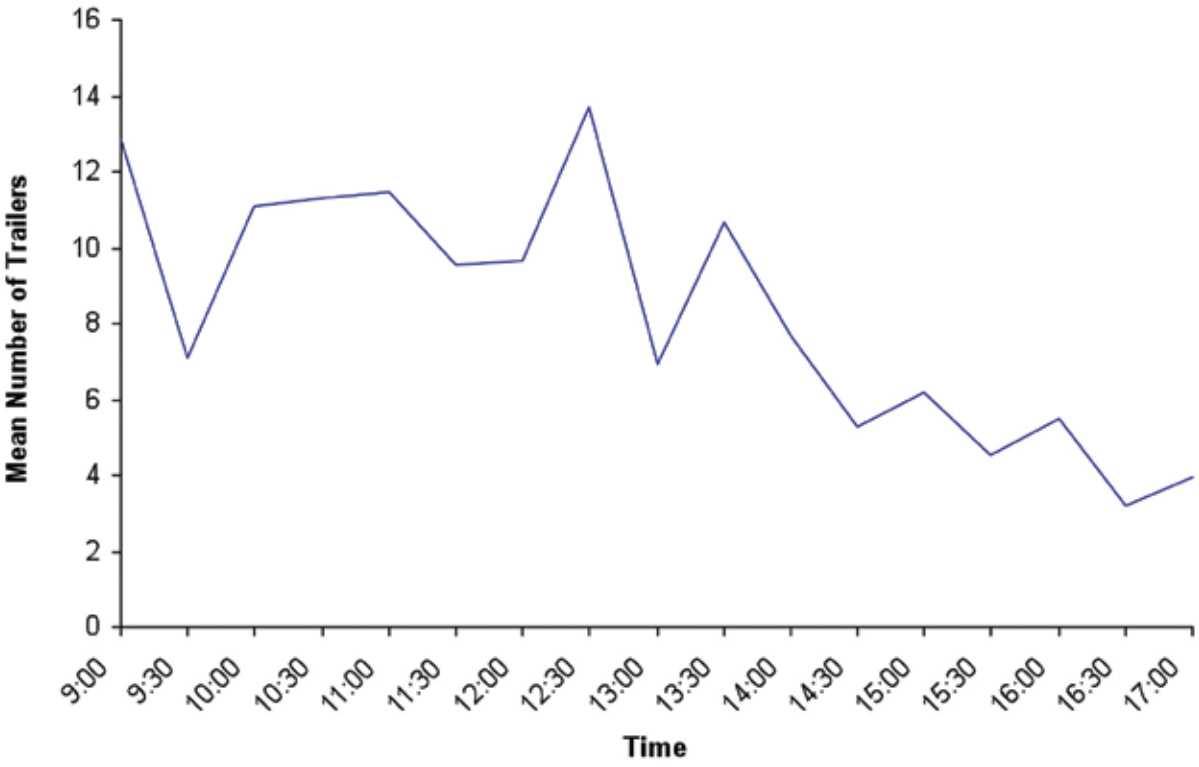


Figure 2. Mean number of trailers counted at boat ramps in the West Coast Bioregion for various times of the day.

9.0 Appendices

Appendix A Boat ramp trailer count form

WEST COAST RECREATIONAL BOAT SURVEY

BOAT RAMP FORM 2005 / 06

Interviewers Name: _____

Date: _____ **Start Time (24hr):** _____ **Finish Time(24hr):** _____

District _____ **Boat Ramp:** _____

ENVIRONMENTAL DATA

Wind:	**Calm** 1	**Light** 2	**Mod** 3	**Strong** 4	**Gale** 5	**Direction**

Water:	**Calm** 1	**Slight** 2	**Mod** 3	**Rough** 4	**V. Rough** 5

Cloud Cover:	**Cloud %**	**Rainfall:**	**Nil** 1	**Light** 2	**Mod** 3	**Heavy** 4

Boat Launches				**Boat Retrievals**			
Time	**Type**	**Time**	**Type**	**Time**	**Type**	**Time**	**Type**

Total Number of Trailers in carpark	
At Start	**At Finish**
Number of Boats from Moorings / Shore	
At Start	**At Finish**
Final Count	
At Start	**At Finish**

Boat Types

P: Power boat

Y: Yacht

O: Other

Appendix B Boat ramp interview questionnaire form

WEST COAST RECREATIONAL FISHING SURVEY 2005/6
INTERVIEW QUESTIONNAIRE

Date: _____ **Location:** _____ **Boat Reg. No.:** _____

Retrieval Time	Launch Time (include date if different from Today)	Boat (Pwr / Yacht / Other)	Fishing (Yes / No)	Dive / Snorkel / Water Ski / Other	Number of Persons Fishing / Number in Party	Number of Aboriginal or Torres Strait Islanders Descent	Home Postcode of Interviewee	Lenght of Boat (ft / m)	Block Number or Estuary	Crabbing (Yes / No)	Time Spent Fishing (Decimal Hrs)	Number of Lines Used	Number and type of nets - Crab / Gill / cAst / Scoop / Pot

FISHERS ONLY

Species (Record Sex for Lobsters and any Tag Numbers for Fish)	Number Kept	Number Released	Number taken by Sharks	Number of Break-offs	Number of Undersize or Oversize Kept	Species Targeted 1._____ 2._____ Measurements (mm)
W.A. Dhufish (male)						
W.A. Dhufish (female)						
Pink Snapper						
Breaksea Cod						
Baldchin Groper						
Herring						

1) What is the bag limit for _____ *targeted/predominant species from catch?*

CORRECT	INCORRECT	DONiT KNOW

2) What is the size limit for _____ *targeted/predominant species from catch?*

CORRECT	INCORRECT	DONiT KNOW

Appendix C Catch and effort calculations for boats launched from public boat ramps

Estimation of total effort

The fishing effort for a day (hours) was estimated by the method of Jones and Robson (1991) as follows:

$$e = fT\sum_i \left[\left(\frac{1}{w_i} \right) \sum_j X_{ij} \right] \tag{1}$$

where T=8 is the time taken to complete the bus route, w_i is the interviewer wait time at site i and X_{ij} is the time trailer j spends at site i. A correction factor $f \geq 1$ was used to adjust the effort for fishing that occurred before the morning shift commenced at time t.

$$f = \frac{\sum_j (r_j - \ell_j)}{\sum_j b_j} \tag{2}$$

where

$$b_j = \begin{cases} r_j - t, & \ell_j < t \\ r_j - \ell_j, & \ell_j \geq t \end{cases}$$

r_j is the retrieval time for boat j and ℓ_j is the launch time for boat j. The fishing effort was estimated for a random sample of days in each stratum (see Section 2.2). The estimated variance within stratum k is (Pollock et al., 1994)

$$s_k^2 = \frac{1}{n_k - 1} \sum_{m=1}^{n_k} \left(e_{km} - \bar{e}_k \right)^2 \tag{3}$$

where n_k is the sample size (days) for stratum k, e_{km} the effort for stratum k on day m and $\bar{e}_k$ the mean daily fishing effort for stratum k. The variance associated with the estimate of the mean, with finite population correction (Neter et al., 1988), is calculated as

$$Var(\bar{e}_k) = \frac{s_k^2}{n_k} \left(\frac{N_k - n_k}{N_k} \right) \tag{4}$$

where N_k is the total number of days in stratum k. The total effort for stratum k is estimated as

$$\hat{E}_k = \frac{N_k}{n_k} \sum_{m=1}^{n_k} e_{km} \tag{5}$$

The variance associated with $\hat{E}_k$ is estimated by

$$Var(\hat{E}_k) = N_k^2 \, Var(\bar{e}_k) \tag{6}$$

The standard error is calculated by the usual method

$$SE(\hat{E}_k) = \sqrt{Var(\hat{E}_k)} \tag{7}$$

The total effort is estimated by summing the effort for the strata as follows

$$\hat{E} = \sum_{k=1}^{n} \hat{E}_k \tag{8}$$

where n is the number of strata. Similarly the variance of $\hat{E}$ is estimated from the independent variances for the strata

$$Var(\hat{E}) = \sum_{k=1}^{n} Var(\hat{E}_k) \tag{9}$$

The standard error of $\hat{E}$ is calculated by the usual method

$$SE(\hat{E}) = \sqrt{Var(\hat{E})} \tag{10}$$

Estimation of total catch

The catch rate for each stratum k is estimated by (Crone and Malvestuto, 1991) since the probability of sampling a boat is independent of trip length

$$\hat{R}_k = \frac{\bar{c}_k}{\bar{L}_k} = \frac{\sum_{j=1}^{n_k} c_{kj} / n_k}{\sum_{j=1}^{n_k} L_{kj} / n_k} \tag{11}$$

where n_k is the number of boats where the catch was recorded, c_{kj} the catch for boat j and L_{kj} the effort, in hours, for boat j. The variances for $\bar{c}_k$ and $\bar{L}_k$ can be calculated by the usual method (see (3) and (4) without the finite population correction factor). The variance for $\hat{R}_k$ can be estimated using the formulae described in Kendall and Stuart (1969)

$$Var(\hat{R}_k) \approx \hat{R}_k^2 \left(\frac{Var(\bar{c}_k)}{\bar{c}_k^2} + \frac{Var(\bar{L}_k)}{\bar{L}_k^2} - \frac{2Cov(\bar{c}_k, \bar{L}_k)}{\bar{c}_k \bar{L}_k} \right) \tag{12}$$

The covariance term was assumed to be zero.

The total catch for stratum k is estimated as

$$\hat{C}_k = \hat{E}_k \hat{R}_k \tag{13}$$

The variance was estimated using the formulae described in Kendall and Stuart (1969)

$$Var(\hat{C}_k) \approx \hat{C}_k^2 \left(\frac{Var(\hat{E}_k)}{\hat{E}_k^2} + \frac{Var(\hat{R}_k)}{\hat{R}_k^2} + \frac{2Cov(\hat{E}_k, \hat{R}_k)}{\hat{E}_k \hat{R}_k} \right) \tag{14}$$

where the covariance term was assumed to be zero. The total catch is estimated by summing the catch for each strata as follows

$$\hat{C} = \sum_{k=1}^{n} \hat{C}_k \tag{15}$$

The variance of $\hat{C}$ is estimated as

$$Var(\hat{C}) = \sum_{k=1}^{n} Var(\hat{C}_k) \tag{16}$$

The standard error of $\hat{C}$ is calculated by the usual method

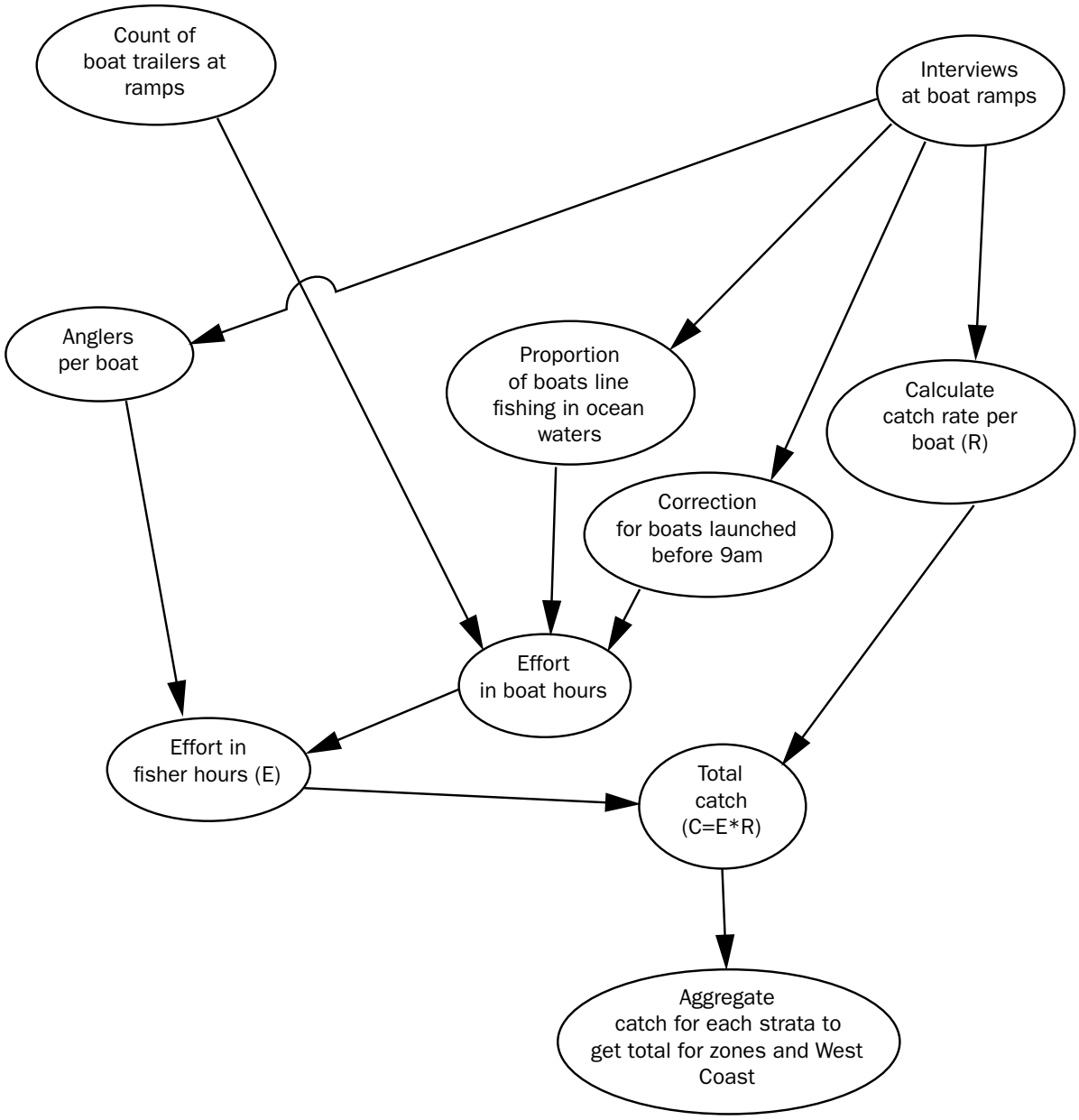
$$SE(\hat{C}) = \sqrt{Var(\hat{C})} \tag{17}$$

The standard error associated with the estimate of the number of fish kept $SE(\hat{c})$ was calculated for each species. Assuming a student t distribution, the (1-α) percent confidence interval for the number kept ($\hat{c}$) was calculated from the standard error as follows:

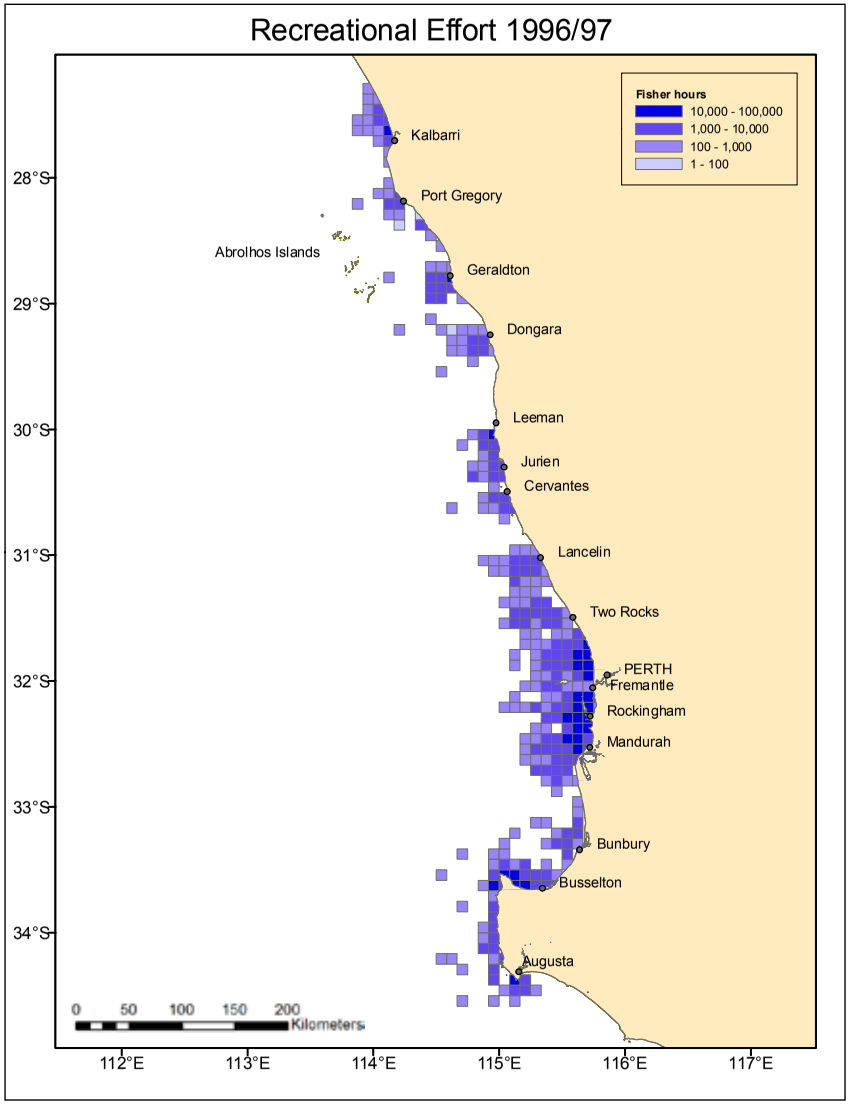
$$\hat{c} \pm t(1-\alpha/2; n-1)SE(\hat{c})$$
$$\hat{c} \pm 1.96\ SE(\hat{c})$$

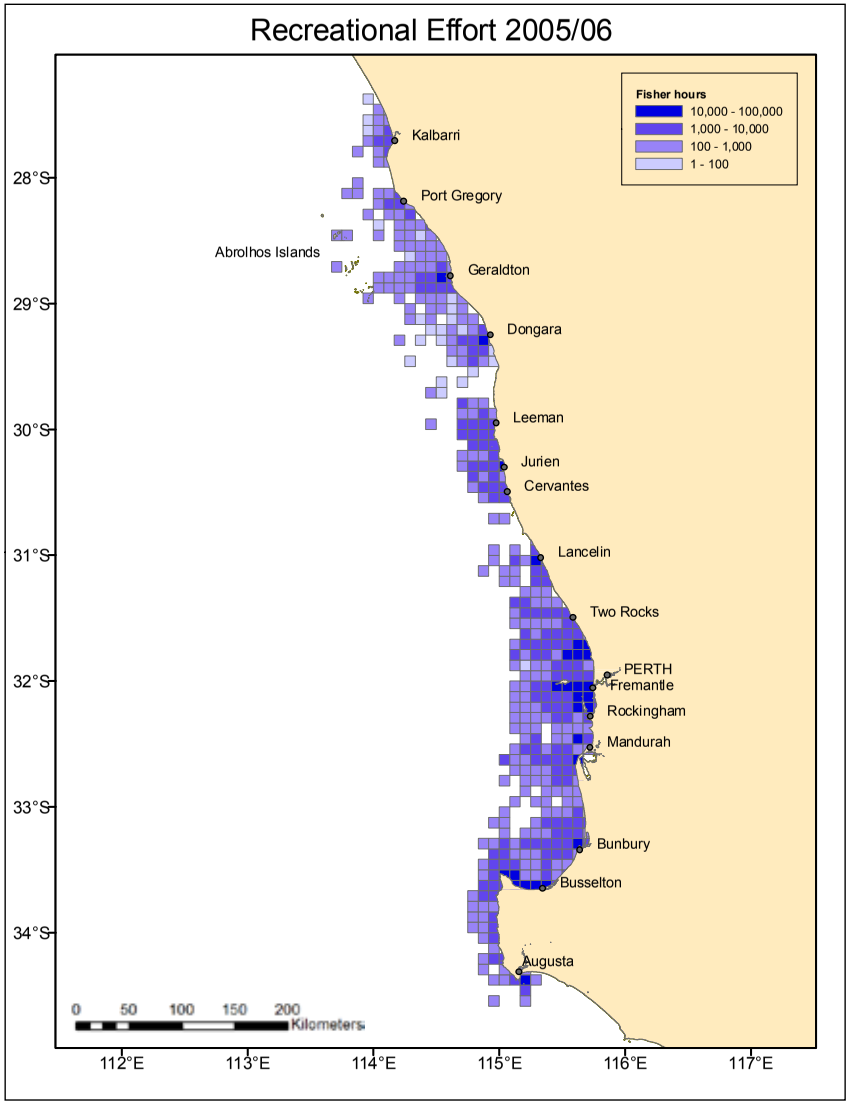
where $\alpha = 0.05$ for the 95% confidence interval and n is the number of boats surveyed (sample size). The estimates reported in the results have been rounded to reflect the level of precision.

Appendix D Schematic representation of calculations to estimate catch and fishing effort



Appendix E Spatial distribution of estimated recreational ocean line fishing effort in the West Coast Bioregion for boats launched from public ramps





Appendix F Estimated total number of fish retained by recreational ocean line fishing in the West Coast Bioregion for boats launched from public ramps

Common Name	Scientific name	Total Kept 05/06	SE Kept 05/06	Total Kept 96/97	SE Kept 96/97
Combined whiting spp.	Sillaginidae	404,376	16,638	506,343	33,755
Herring, Australian	*Arripis georgianus*	288,392	14,658	364,932	23,099
Squids, general	Cephalopodidae	83,791	4,295	77,425	7,925
Trevally, Skipjack/Silver	*Pseudocaranx* spp.	73,693	8,334	105,593	14,221
Whiting, King George	*Sillaginodes punctata*	48,362	2,921	87,001	8,870
Dhufish, Western Australian	*Glaucosoma hebraicum*	35,222	1,799	23,982	1,773
Wrasse/Gropers, general	Labridae	30,736	2,408	58,543	4,817
Garfish, general	Hemiramphidae	22,161	2,310	67,356	7,478
Cod, Breaksea (Black-arse Cod)	*Epinephelides armatus*	18,008	875	13,803	1,245
Snapper, Pink	*Pagrus auratus*	17,808	1,237	15,546	1,538
Groper, Baldchin	*Choerodon rubescens*	9,933	861	6,286	943
Seapikes/Barracuda/Snook, general	*Sphyraena* spp.	8,711	1,989	25,048	6,929
Emperor, Sweetlip (Red Throat)	*Lethrinus miniatus*	7,513	1,023	564	193
Butterfish, Western	*Pentapodus vitta*	5,900	2,678	9,419	2,140
Flatheads, general	Platycephalidae	5,882	648	7,481	1,098
Scad, Yellowtail	*Trachurus novaezelandiae*	5,251	894	7,351	2,127
Tailor	*Pomatomus saltatrix*	4,826	690	24,251	3,749
Trumpeters/Grunters, General	Teraponidae	4,313	871	6,949	2,477
Snapper, Queen (Blue Morwong)	*Nemadactylus valenciennesi*	4,252	382	6,105	1,072
Samson Fish/Sea Kingfish	*Seriola hippos*	4,117	296	4,947	610
Blowfish, Common	*Torquigener pleurogramma*	4,052	1,085	1,035	492
Sergeant Baker	*Aulopus purpurissatus*	3,997	379	1,896	368
Salmon, Australian	*Arripis truttaceus*	3,891	619	2,740	859
Redfish[1]	*Centroberyx* spp.	3,875	646	1,119	249
Cuttlefish	Sepiidae	3,803	390	1,503	465
Leatherjackets, general	Monacanthidae	3,324	326	2,718	514
Mackerel, Blue	*Scomber australasicus*	2,788	543	22,169	3,456
Sweep, Sea	*Scorpis aequipinnis*	2,774	365	4,326	917
Foxfish, Western	*Bodianus frenchii*	2,434	275	1,463	396
Shark, general		2,321	306	2,234	313
Bonitos, general	*Scombridae* spp.	2,033	385	442	170
Harlequin Fish	*Othos dentex*	1,989	220	1,256	266
Bream, Silver (Tarwhine)	*Rhabdosargus sarba*	1,732	227	5,337	1,103
Goatfish, general	Mullidae	1,706	376	2,410	659
Sweep, Banded	*Scorpis georgianus*	1,697	238	2,716	519
Flounders, general	Pleuronectidae & Bothidae	1,106	173	2,439	495
Dart, Common	*Trachinotus botla*	818	414		
Mackerel, Narrow-Barred Spanish	*Scomberomorus commerson*	812	150	1,721	458
Pike, Long-finned	*Dinolestes lewini*	808	348	215	95

Common Name	Scientific name	Total Kept 05/06	SE Kept 05/06	Total Kept 96/97	SE Kept 96/97
Trout, Coral	*Plectropomus maculatus*	804	153	1,433	405
Octopus, general	*Octopus* spp.	679	174	1,464	614
Tuna, Southern Bluefin	*Thunnus maccoyii*	612	174		
Gurnard Perch	*Neosebastes pandus*	527	157	263	100
Wirrah, Western	*Acanthistius serratus*	489	188	359	
Sweetlips, Gold-Spotted	*Plectorhinchus flavomaculatus*	469	87	526	166
Sweetlips, Painted	*Diagramma labiosum*	436	113	84	48
Wobbegongs/Catsharks, general	*Orectolobus* spp.	392	115	530	159
Parrotfish, General	Scaridae	385	97	614	267
Emperor, Blue-Lined (Black Snapper)	*Lethrinus laticaudis*	368	88		
Scorpioncod, Western Red	*Scorpaena sumptuosa*	340	108	273	120
Trevallies, general		323	154	54	33
Groper, Western Blue	*Achoerodus gouldii*	282	96	108	81
Emperor, Spangled	*Lethrinus nebulosus*	279	94	163	89
Cod, Estuary/Slimy Cod	*Epinephelus coioides*	278	68		
Kingfish, Yellowtail	*Seriola lalandi*	268	87	673	384
Mulloway	*Argyrosomus hololepidotus*	260	120	56	40
Mackerel, Scaly	*Sardinella lemuru*	243	125	429	241
Gurnards, general	Triglidae	188	56	767	255
Pilchard (Mullie)	*Sardinops neopilchardus*	176	101	162	133
Morwong, Dusky	*Dactylophora nigricans*	161	54	17	17
Dolphinfish, Common/Mahi Mahi	*Coryphaena hippurus*	159	83	255	136
Cods - General		149	55	12,510	2,704
Scorpionfishes, general	Scorpaenidae	145	53		
Tuna, Yellowfin	*Thunnus albacares*	113	31	289	126
Eels, General	*Gymnothorax spp.*	107	73		
Threadfin-Breams/ Butterfishes/Monocle Breams	Nemipteridae	103	75		
Other Species (n = 72 species)		2,910		14,611	

1 Note that this “redfish” group consists of 2-3 species, which were mainly referred to locally as red snapper. The dominant species was likely to be bight redfish (*Centroberyx gerrardi*), with lesser numbers of swallowtail redfish (*Centroberyx lineatus*). These are different to some tropical species also known as red snapper.

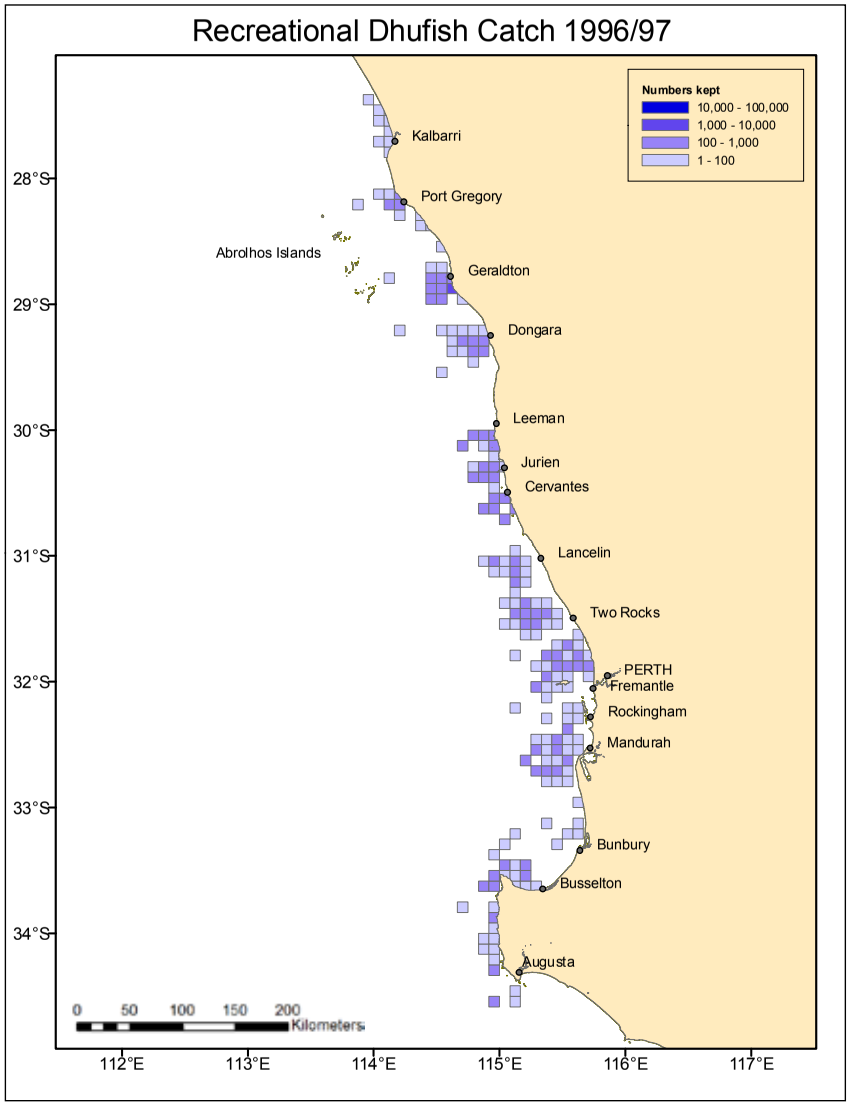
Appendix G Estimated total number of fish (by species) released by recreational ocean line fishing in the West Coast Bioregion for boats launched from public ramps

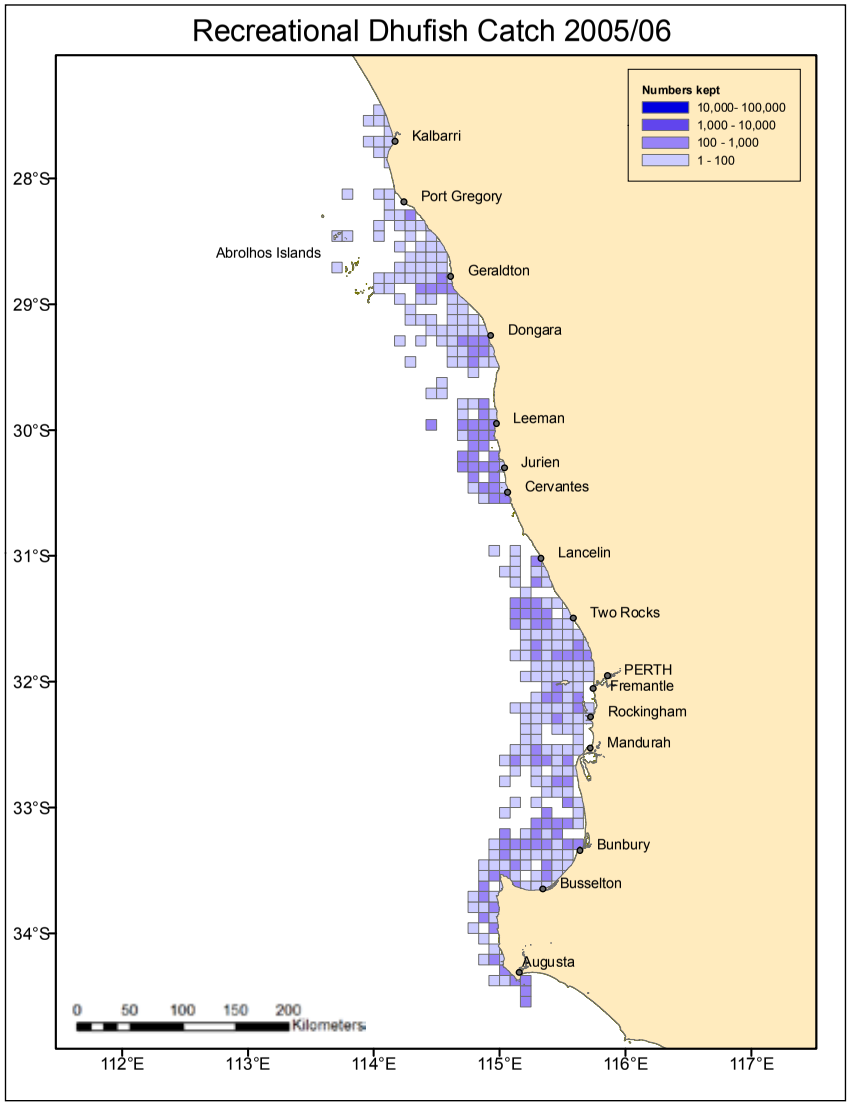
Common Name	Scientific Name	Total Released 05/06	SE Released 05/06	Total Released 96/97	SE Released 96/97
Wrasse/Gropers, general	Labridae	143,367	6,736	71,728	5,068
Blowfish, Common	*Torquigener pleurogramma*	96,027	5,819	19,545	3,821
Combined whiting spp.	Sillaginidae	62,305	4,385	102,243	11,189
Flatheads, general	Platycephalidae	48,928	5,635	37,217	5,084
Trumpeters/Grunters, General	Teraponidae	45,816	4,998	10,037	2,324
Herring, Australian	*Arripis georgianus*	38,299	3,236	17,018	2,930
Trevally, Skipjack/Silver	*Pseudocaranx* spp.	37,017	3,025	26,520	4,249
Dhufish, Western Australian	*Glaucosoma hebraicum*	16,766	974	11,801	974
Snapper, Pink	*Pagrus auratus*	13,693	1,112	8,298	1,459
Leatherjackets, general	Monacanthidae	10,758	2,155	2,914	808
Cod, Breaksea (Black-arse Cod)	*Epinephelides armatus*	9,900	807	1,924	440
Whiting, King George	*Sillgainodes punctata*	9,002	1,338	16,625	3,088
Samson Fish/Sea Kingfish	*Seriola hippos*	8,429	933	2,543	684
Emperor, Sweetlip (Red Throat)	*Lethrinus miniatus*	7,063	1,279		
Salmon, Australian	*Arripis truttaceus*	6,583	1,624	1,095	584
Sergeant Baker	*Aulopus purpurissatus*	6,407	614	961	246
Scad, Yellowtail	*Trachurus novaezelandiae*	5,877	1,319	2,890	754
Rays, general		5,810	478	2,295	413
Butterfish, Western	*Pentapodus vitta*	5,298	766	2,264	831
Gurnard Perch	*Neosebastes scorpaenoides*	5,276	754	487	187
Goatfish, general	Mullidae	4,638	593	1,370	414
Shark, general		3,765	480	1,894	499
Tailor	*Pomatomus saltatrix*	3,586	855	3,314	1,099
Bream, Silver (Tarwhine)	*Rhabdosargus sarba*	3,497	754	5,057	1,215
Scorpioncod, Western Red	*Scorpaena sumptuosa*	3,493	450	262	142
Gurnards, general	Triglidae	2,390	367	2,441	633
Blowfish, Northwest (Silver Toadfish)	*Lagocephalus sceleratus*	2,358	367	5,591	1,175
Garfish, general	Hemiramphidae	2,252	448	3,847	1,562
Groper, Baldchin	*Choerodon rubescens*	1,963	276	518	203
Sweep, Sea	*Scorpis aequipinnis*	1,827	397	658	375
Squids, general	Cephalopodidae	1,746	295	1,164	734
Mackerel, Blue	*Scomber australasicus*	1,707	494	5,185	1,417
Parrotfish, General	Scaridae	1,675	370	341	174
Seapikes/Barracuda/ Snook, general	*Sphyraena* spp.	1,546	488	4,074	1,446
Sweep, Banded	*Scorpis georgianus*	1,206	232	141	82
Rays, Shovelnose, General		1,169	199	400	141

Common Name	Scientific Name	Total Released 05/06	SE Released 05/06	Total Released 96/97	SE Released 96/97
Cods - General	Serranidae	1,106	223	7,092	1,709
Sweep, Footballer	*Neatypus obliquus*	1,087	649	33	23
Foxfish, Western	*Bodianus frenchii*	936	183	17	17
Blue Devil, Western	*Paraplesiops sinclairi*	924	185	61	37
Trout, Coral	*Plectropomus maculatus*	855	299	276	132
Snapper, Queen (Blue Morwong)	*Mnemadactylus valenciennesi*	842	460		
Scorpionfishes, general	Scorpaenidae	796	157		
Bonitos, general	*Scombridae* spp.	785	245	230	204
Cod, Estuary/Slimy Cod	*Epinephelus coioides*	775	486		
Groper, Western Blue	*Achoerodus gouldii*	661	242		
Redfish[1]	*Centroberyx* spp.	656	161	202	131
Cuttlefish	Sepiidae	590	122	130	87
Wobbegongs/Catsharks, general	Orectolobus sp.	563	150	301	118
Emperor, Blue-Lined (Black Snapper)	*Lethrinus laticaudis*	543	176		
Eels, General	*Gymnothorax* spp.	460	133	33	24
Flounders, general		384	99	445	167
Harlequin Fish	*Othos dentex*	327	92	271	167
Knife Jaw	*Oplegnathus woodwardi*	325	192		
Whiting, Blue Weed	*Haletta semifasciata*	324	168		
Emperor, Spangled	*Lethrinus nebulosus*	316	107	154	95
Cod, Chinaman	*Epinephelus rivulatus*	287	170	174	81
Buffalo Bream, Western	*Kyphosus cornelii*	277	98	209	91
Kingfish, Yellowtail	*Seriola lalandi*	276	111	118	82
Old Wife	*Enoplosus armatus*	265	179		
Footballer/Stripey	*Microcanthus strigatus*	241	125		
Trevallies, general		226	178		
Pigfishes, general	*Bodianus* spp.	218	219		
Moonlighter	*Tilodon sexfasciatum*	217	122		
Cow Fish, Shaw's	*Aracana aurita*	210	97		
Buffalo Bream, Common (Silver Drummer)	*Kyphosus sydneyanus*	209	162		
Other Species (n = 71 species)		6,494		17,115	

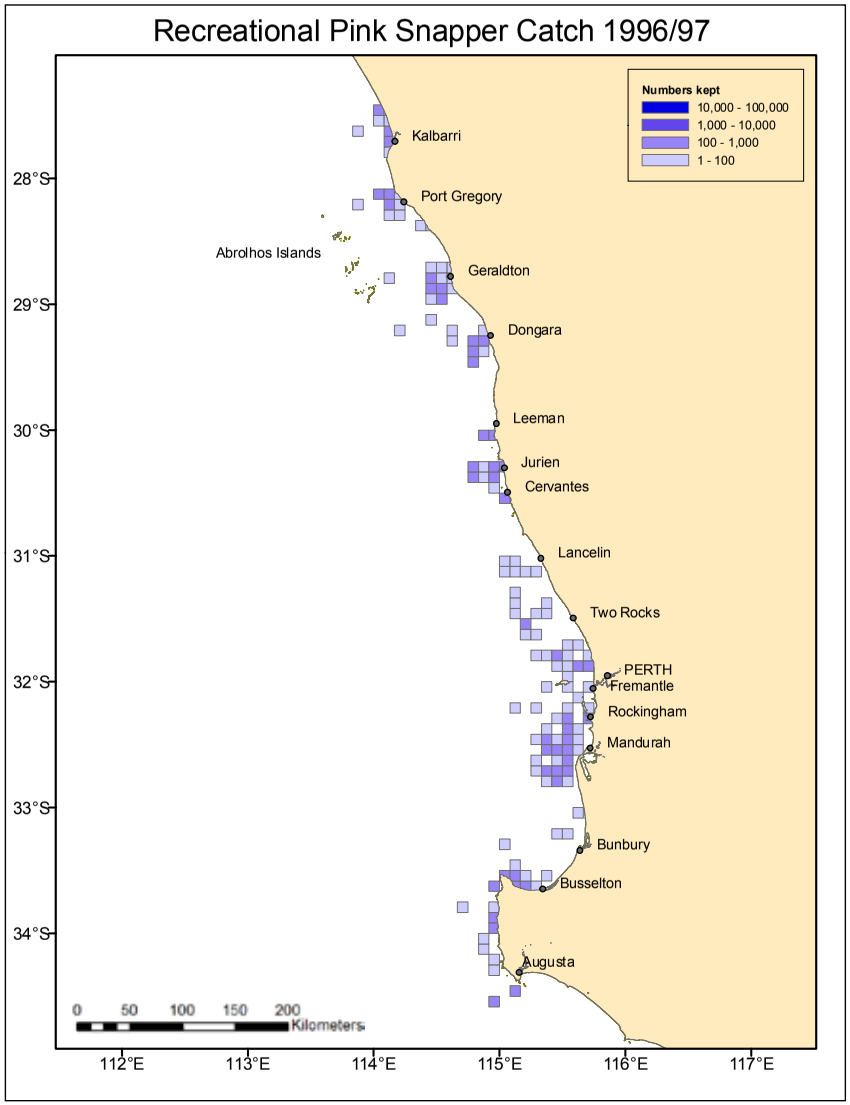
1 Note that this "redfish" group consists of 2-3 species, which were mainly referred to locally as red snapper. The dominant species was likely to be bight redfish (*Centroberyx gerrardi*), with lesser numbers of swallowtail redfish (*Centroberyx lineatus*). These are different to some tropical species also known as red snapper.

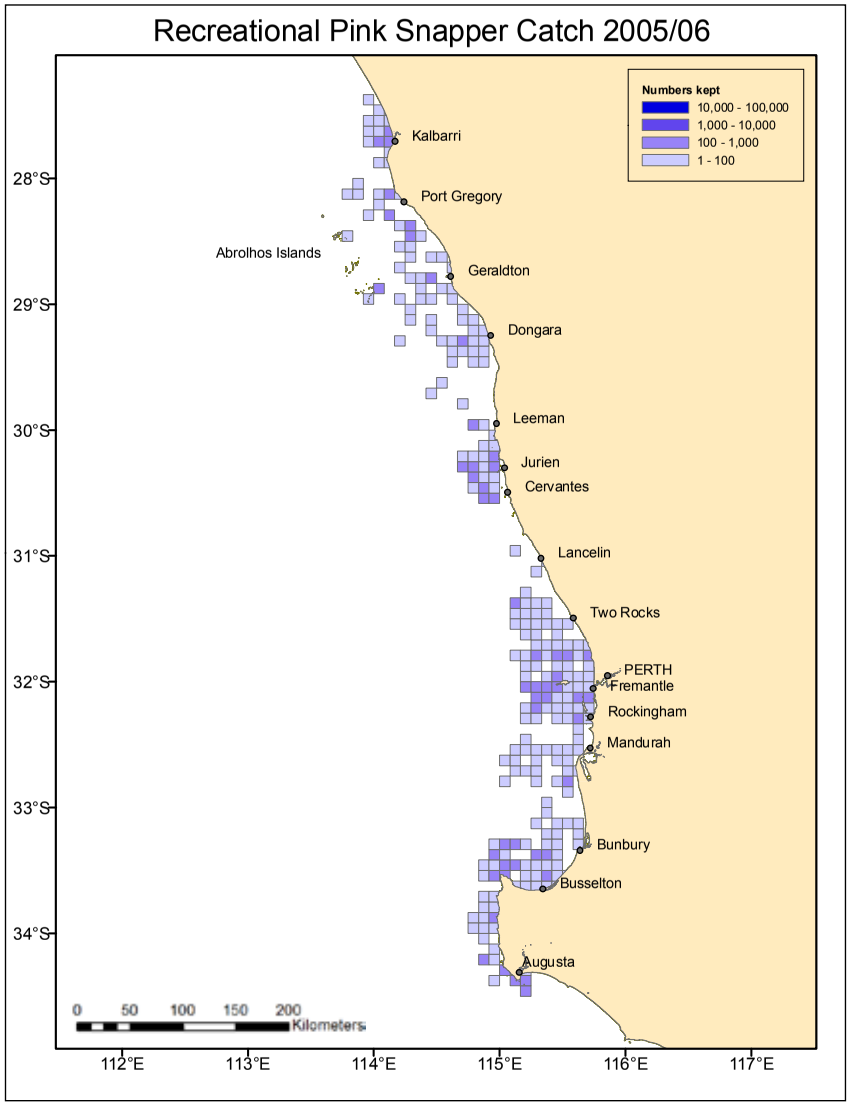
Appendix H Spatial distribution of the estimated recreational ocean line fishing catch of WA dhufish in the West Coast Bioregion for boats launched from public ramps



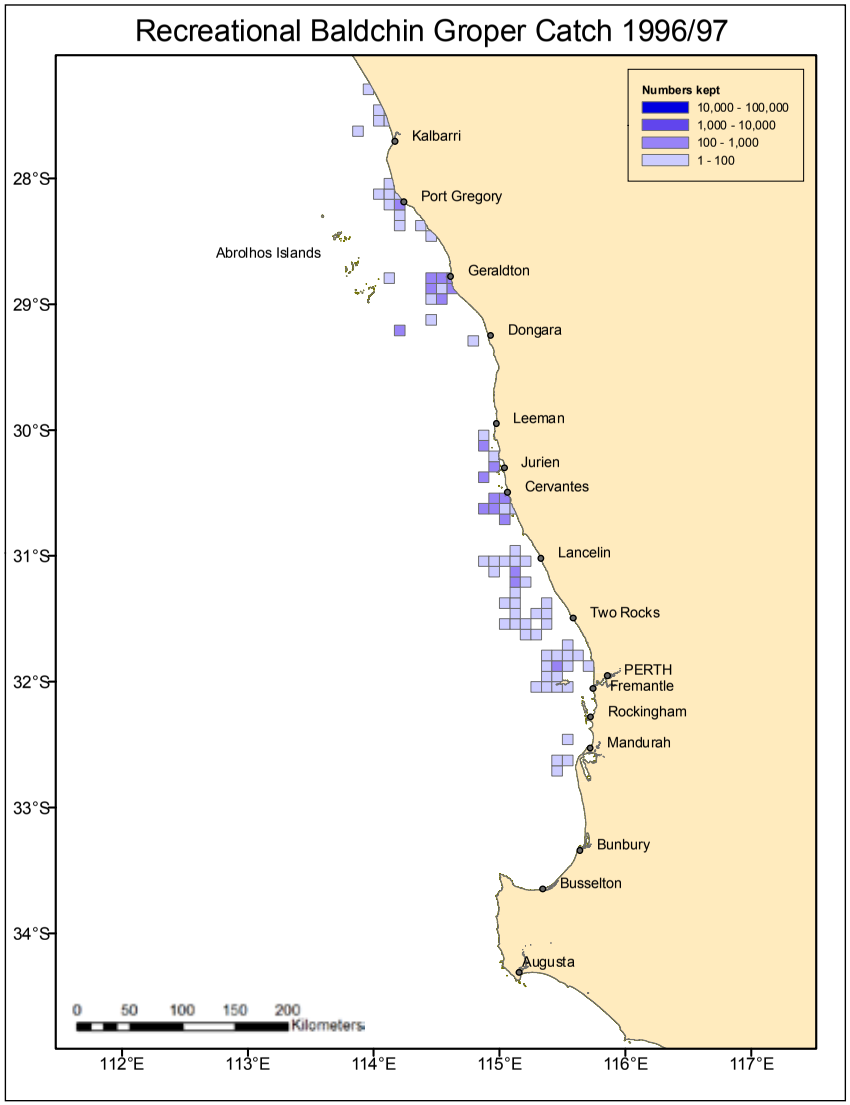


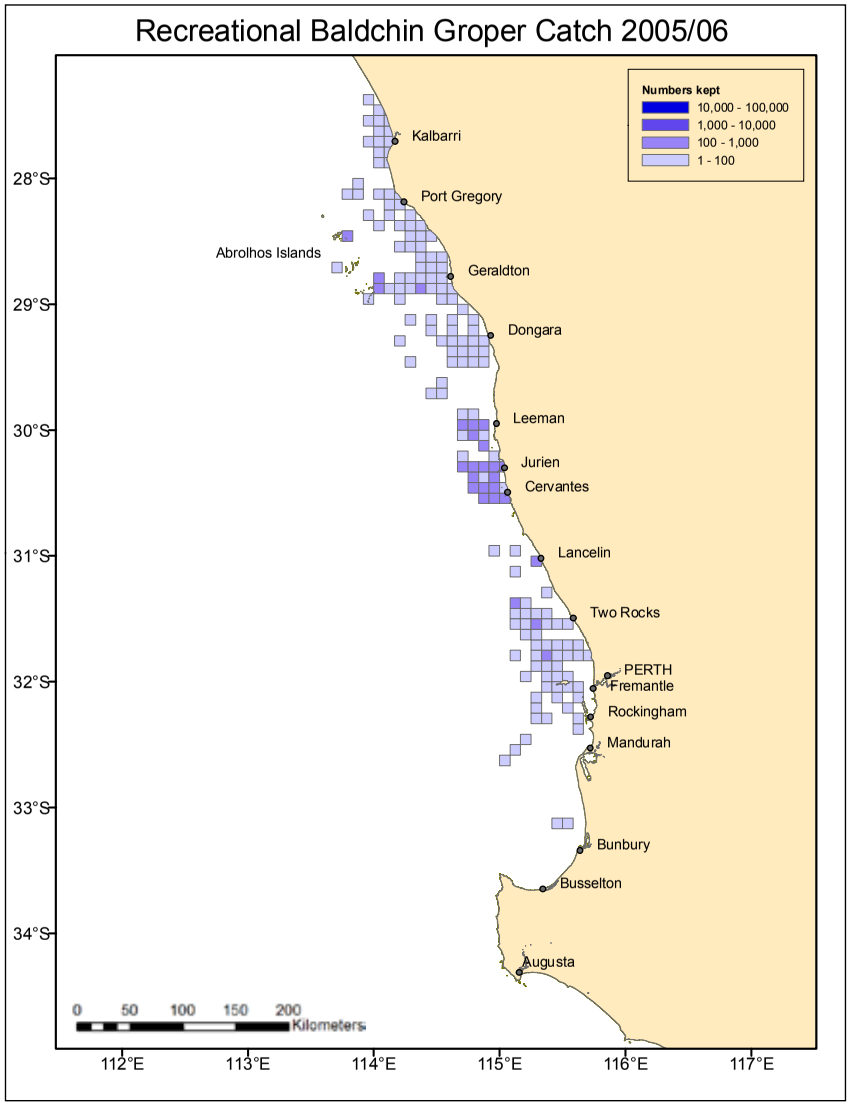
Appendix I Spatial distribution of the estimated recreational ocean line fishing catch of pink snapper in the West Coast Bioregion for boats launched from public ramps



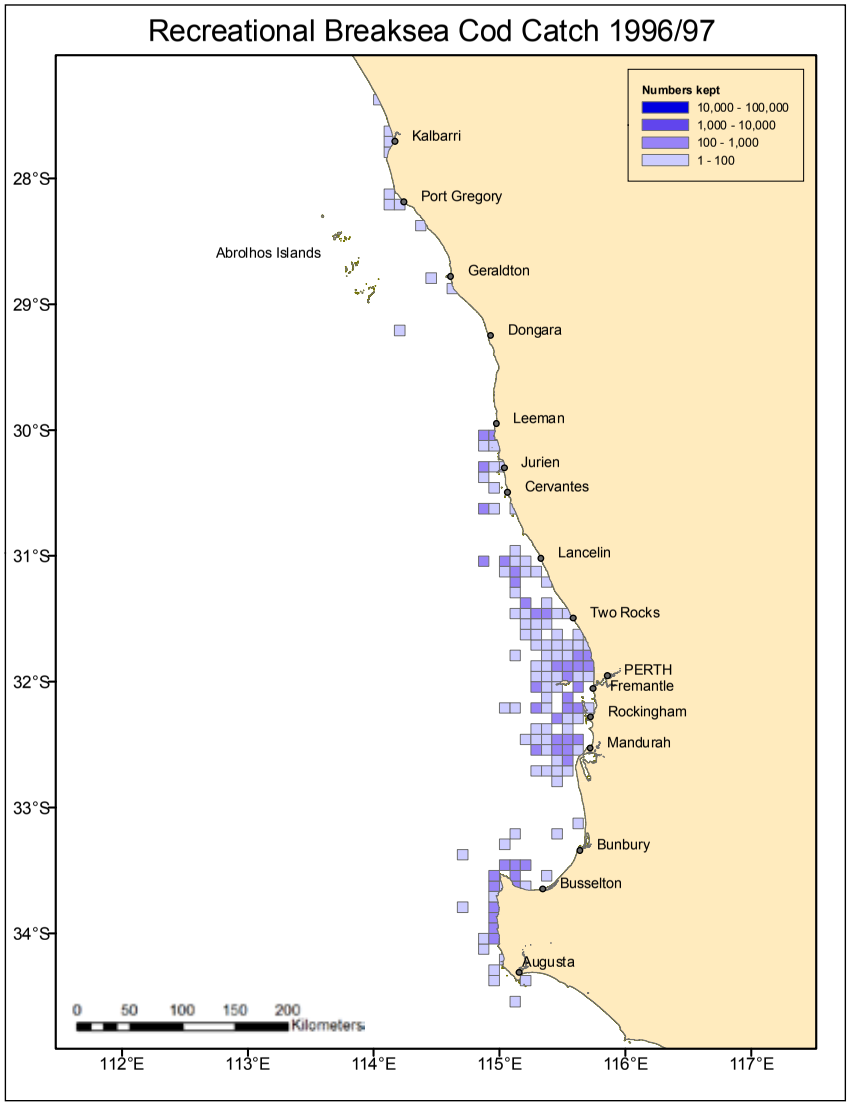


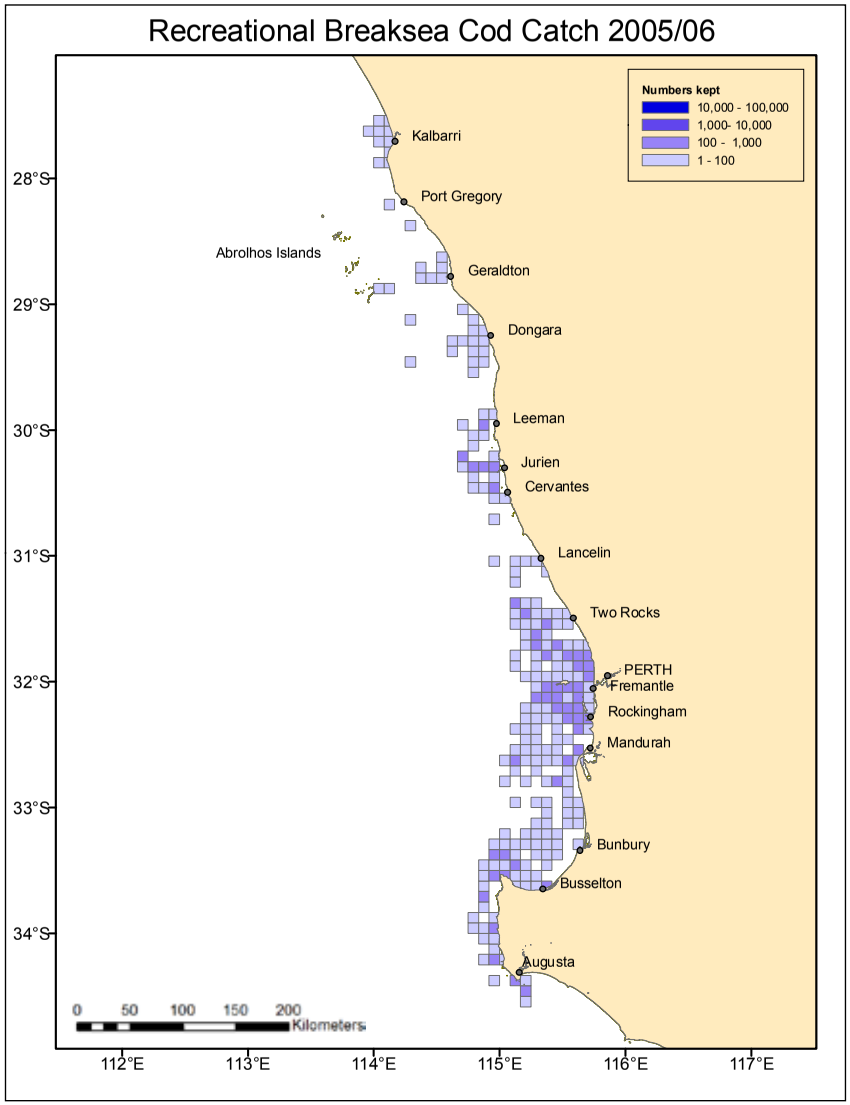
Appendix J Spatial distribution of the estimated recreational ocean line fishing catch of baldchin groper in the West Coast Bioregion for boats launched from public ramps





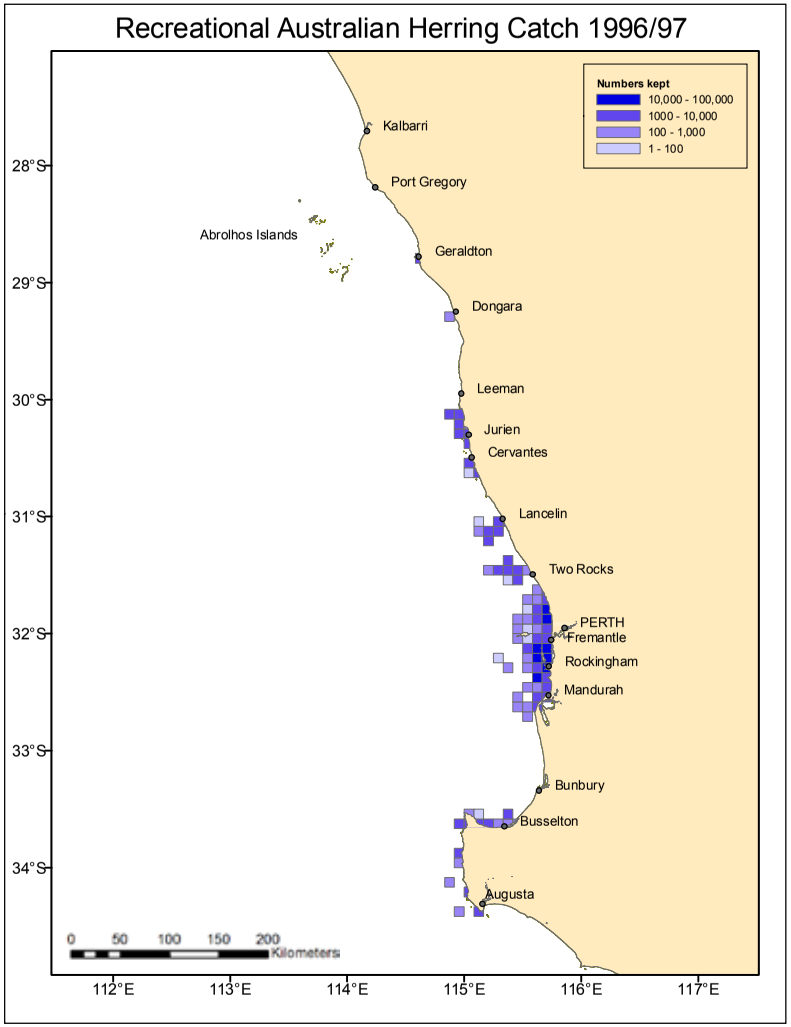
Appendix K Spatial distribution of the estimated recreational ocean line fishing catch of breaksea cod in the West Coast Bioregion for boats launched from public ramps

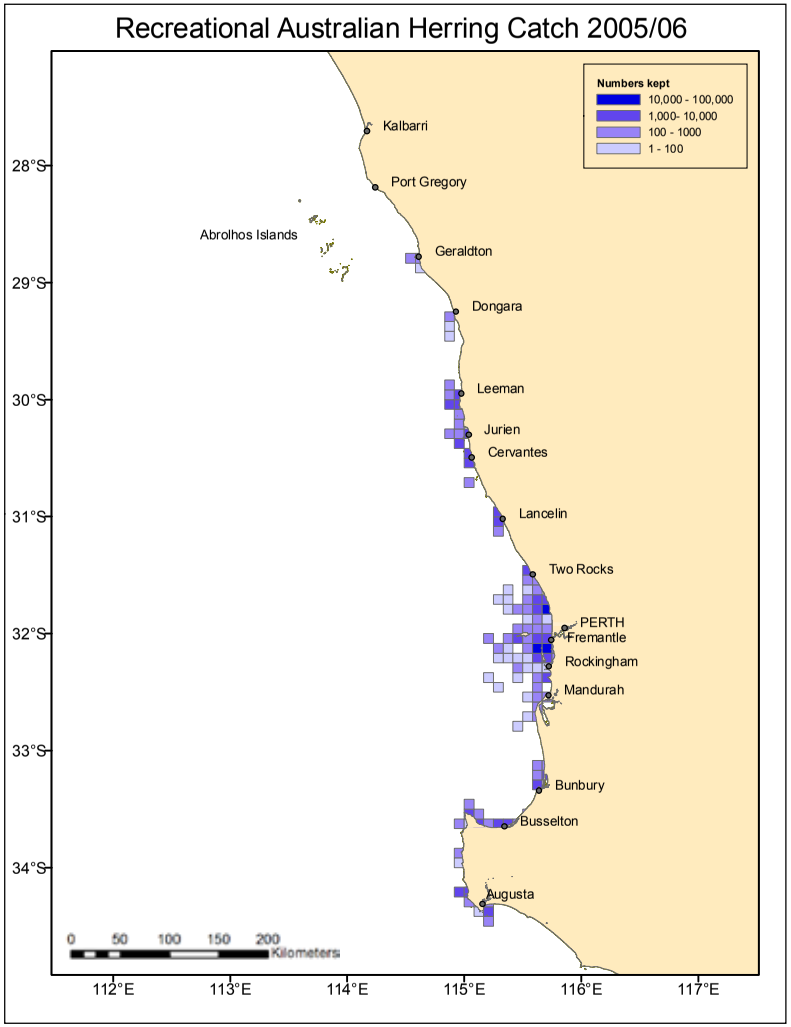




Appendix L Spatial distribution of the estimated recreational ocean line fishing catch of Australian herring for trailer boats in the West Coast Bioregion.

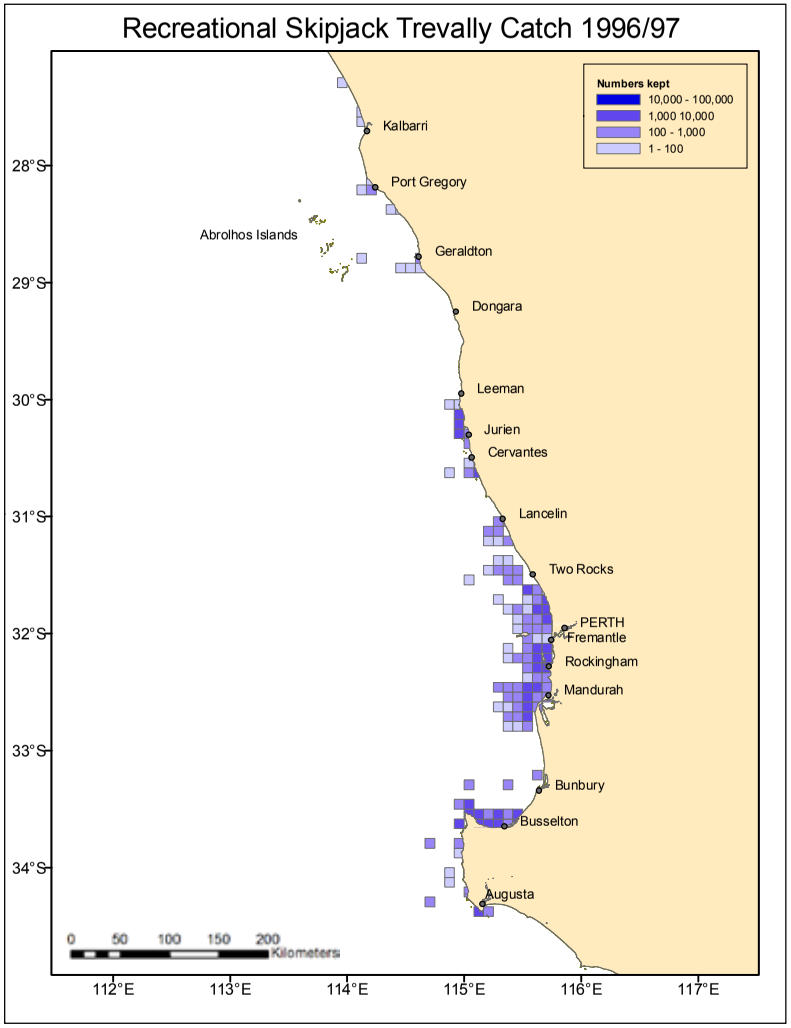
Note that fishing in multiple locations on a single day can confound the estimation of spatial distribution of catches for individual species and that this most likely affects the inshore species – see *Discussion* section *Spatial and temporal variations*).

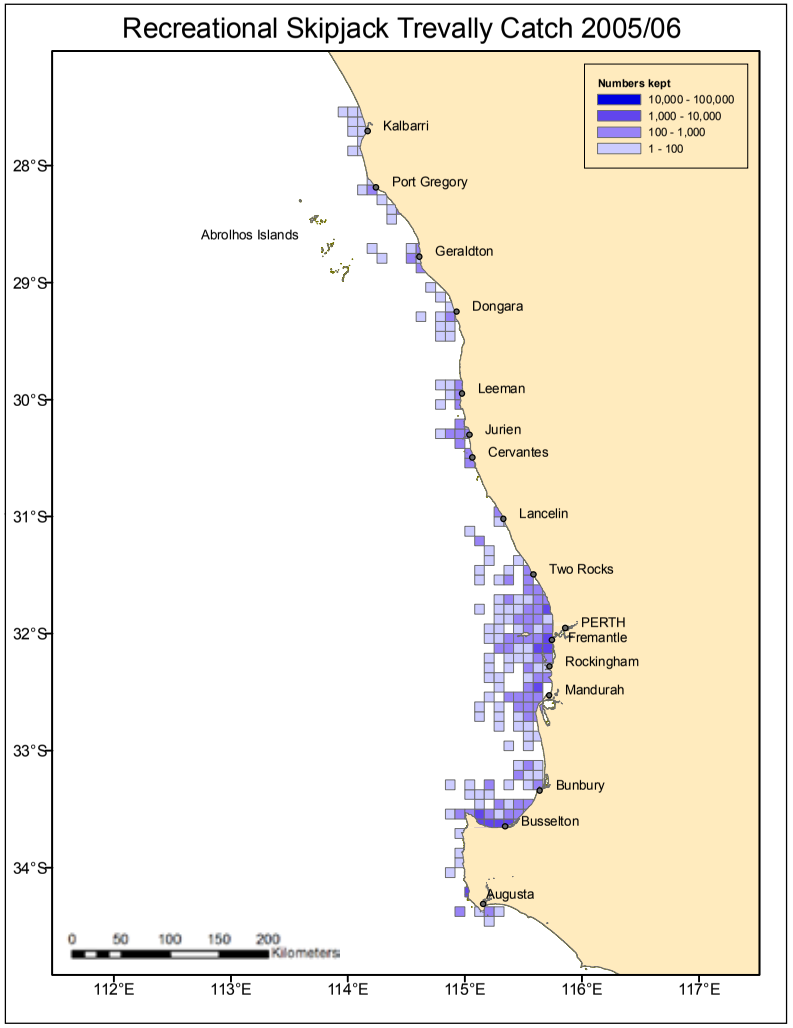




Appendix M Spatial distribution of the estimated recreational ocean line fishing catch of skipjack trevally in the West Coast Bioregion for boats launched from public ramps.

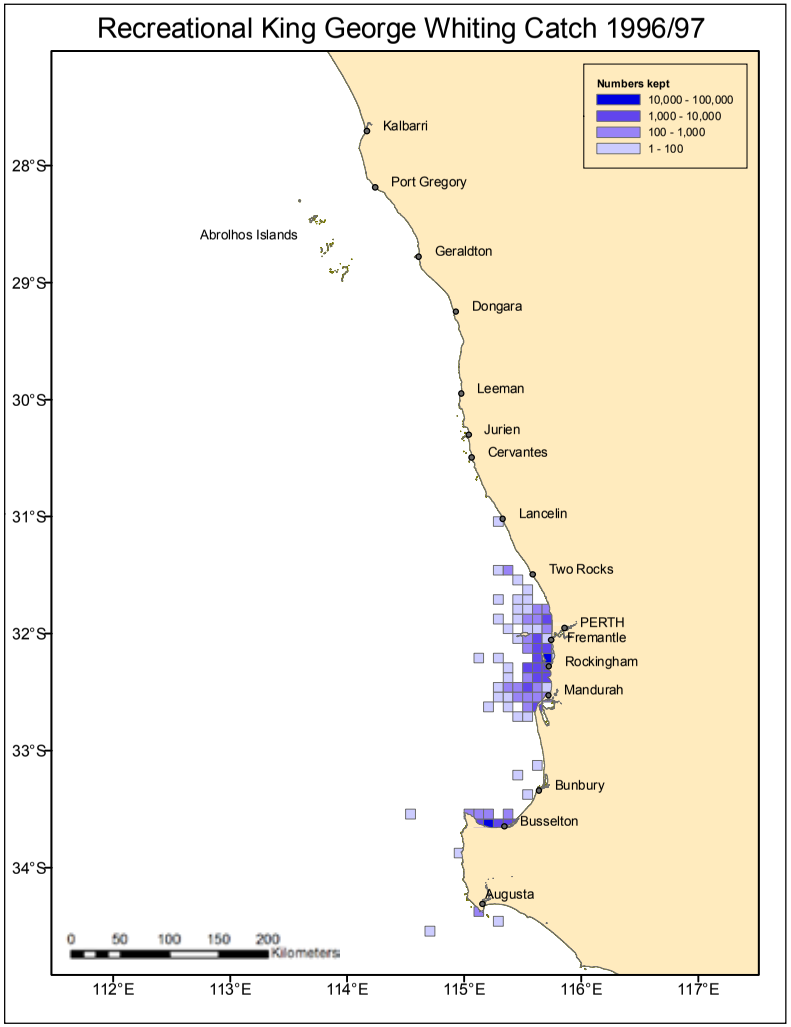
Note that fishing in multiple locations on a single day can confound the estimation of spatial distribution of catches for individual species and that this most likely affects the inshore species – see *Discussion* section *Spatial and temporal variations*).

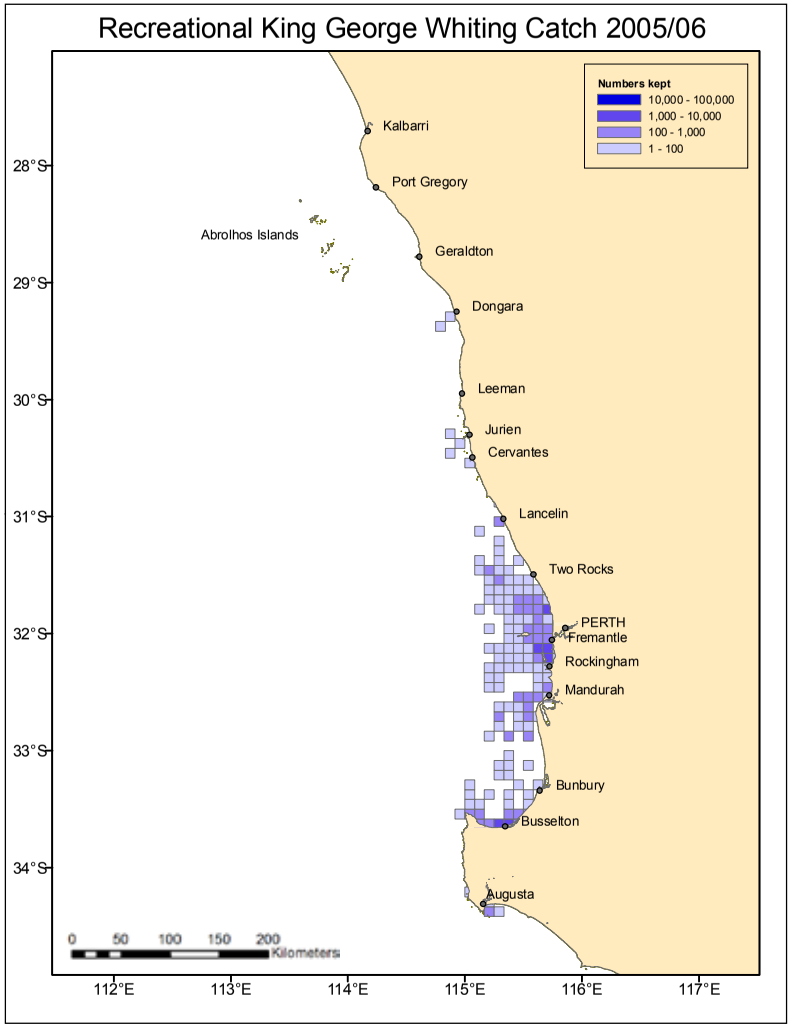




Appendix N Spatial distribution of the estimated recreational ocean line fishing catch of King George whiting in the West Coast Bioregion for boats launched from public ramps.

Note that fishing in multiple locations on a single day can confound the estimation of spatial distribution of catches for individual species and that this most likely affects the inshore species – see *Discussion* section *Spatial and temporal variations*).





Appendix O Spatial distribution of the estimated recreational ocean line fishing catch of combined whiting species in the West Coast Bioregion for boats launched from public ramps.

Note that fishing in multiple locations on a single day can confound the estimation of spatial distribution of catches for individual species and that this most likely affects the inshore species – see *Discussion* section *Spatial and temporal variations*)