

**The Volunteer Fisheries  
Liaison Officer (VFLO) program:  
an analysis of recreational  
fishing data from 1995 - 2007**

C. B. Smallwood, A. Thomson, D. Harris and D. Johnston



Government of Western Australia  
Department of Fisheries

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**Enquiries:**

WA Fisheries and Marine Research Laboratories, PO Box 20, North Beach, WA 6920

Tel: +61 8 9203 0111

Email: [library@fish.wa.gov.au](mailto:library@fish.wa.gov.au)

Website: [www.fish.wa.gov.au](http://www.fish.wa.gov.au)

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# **The Volunteer Fisheries Liaison Officer (VFLO) program: an analysis of recreational fishing data from 1995 - 2007**

C. B. Smallwood, A. Thomson, D. Harris and D. Johnston

Western Australian Fisheries and Marine Research Laboratories  
P O Box 20, North Beach WA 6920

## **Abstract**

Volunteer Fisheries Liaison Officers (VFLOs) are a group of individuals who participate in volunteer activities promoting sustainable fishing amongst recreational anglers. The program is a Department of Fisheries initiative that has been running since 1993 and, during this time, >600 volunteers have participated in a variety of activities. The aim of this report was to explore the data collected by VFLOs from 1995 - 2007 in each of the state's four marine bioregions. During this period, volunteers undertook >2,000 days of activities, the majority of which were educational displays at events such as boat shows and patrols in coastal, marine and estuarine environs. Patrols focused on interviews with recreational anglers to provide information about sustainable fishing and collect data on catch and effort. These activities were concentrated within the West Coast bioregion, particularly the Perth metropolitan area and Mandurah along with regional centres such as Carnarvon and Albany. The peak period for volunteer activities corresponded to the 'high' or tourist season in each bioregion. A re-branding of the VFLO program in 2008 facilitated a shift towards educational activities and away from patrols and their associated interviews with groups participating in recreational fishing from boats and the shore. However, the efforts of these volunteers produced a longitudinal dataset of recreational fishing activity throughout Western Australia, with 226 species and categories of aquatic organisms retained or released by recreational fishers. The most frequently retained species were blue swimmer crabs, Australian herring, general/sand whiting and tailor. Although there were data limitations due to unstructured sampling strategies, catch rates were calculated for the main species retained by recreational fishers in each bioregion. Furthermore, VFLOs in the Mandurah region were tasked with focusing their patrols during early 2007 to investigate blue swimmer crabs within the Peel/Harvey Estuary, highlighting the potential for these data to be used as an indicator of catch rate trends and recreational fishing activity.



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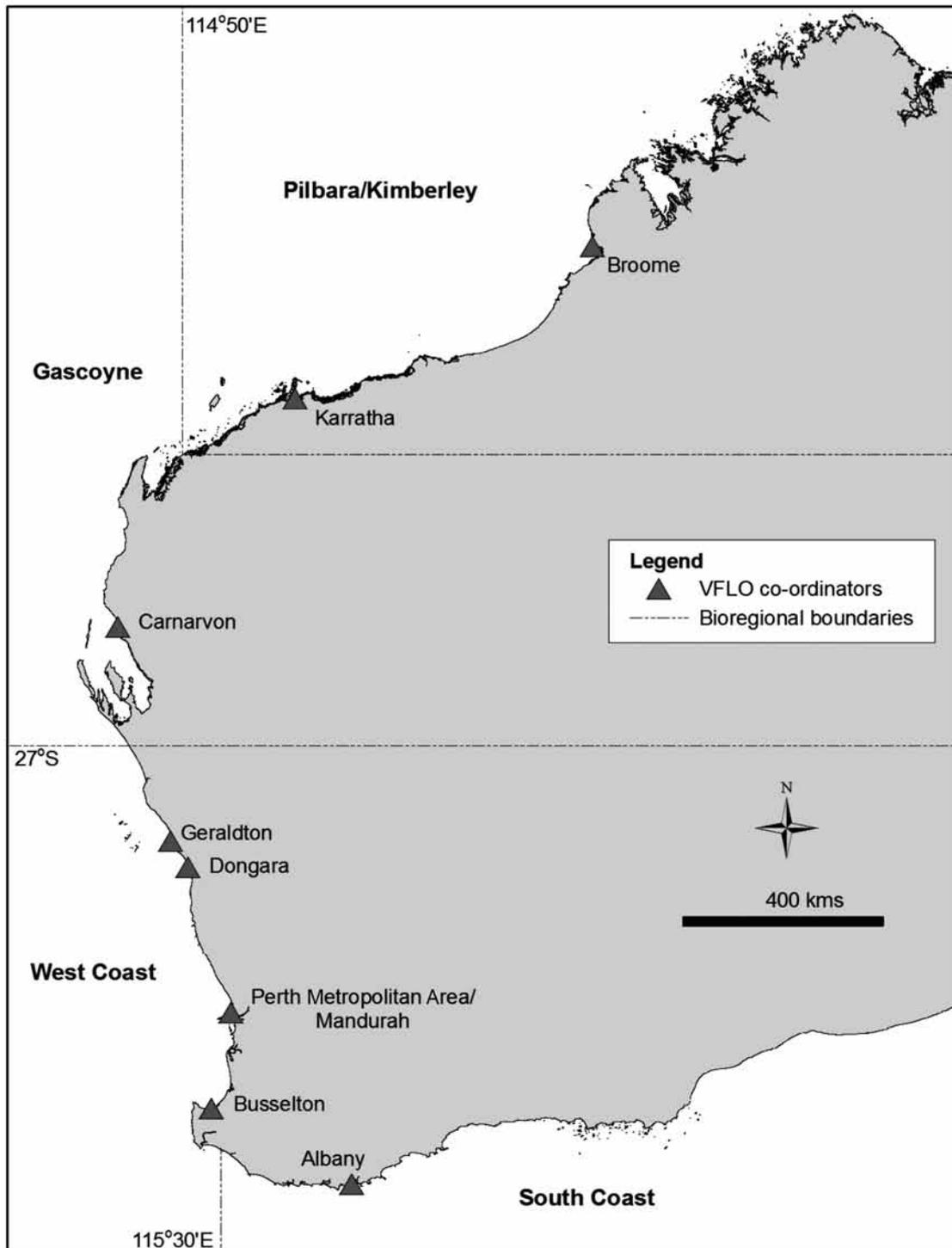
## **1.0 Introduction**

### **1.1 The VFLO program**

Volunteer Fisheries Liaison Officers (VFLOs) are a group of individuals who participate in volunteer activities that promote sustainable fishing amongst recreational anglers. The program was initiated in 1993, and activities undertaken during this time included shore and boat-based patrols, training, education programs (i.e. fishing clinics/workshops, learning with disabilities program), educational displays at events (i.e. boat shows, festivals), participation in fisheries research programs and, presentations to schools and community groups. Re-branding of the VFLO program in 2008 shifted the focus of these activities towards education, rather than data collection involving beach patrols and interviews with people recreationally fishing. Although the newly named Fisheries Volunteers provide ongoing assistance to the Western Australian Department of Fisheries via educational activities and specific research projects across the state, for the purposes of this report, they will be referred to as VFLOs.

The VFLO program was the first of its kind implemented in Australia and is well known in the Western Australian community for its initiatives amongst recreational fishers and the general public. Co-ordinators are situated in eight metropolitan and regional locations for support, and organisational activities, while overall management is centralised within the Community and Education Branch at the Department of Fisheries (Figure 1). Data sheets on which VFLO activities have recorded activities are submitted to the Research Division by these co-ordinators and entered into a database.

As well as a range of educational activities, volunteers conducted patrols throughout the coastal, marine and estuarine environs of Western Australia. The information collected from interviews with shore and boat-based recreational fishers during these patrols has created a dataset of these activities from 1995 - 2007. Hitherto, reports have been produced for volunteers summarising their activities and information collected on patrols conducted during the previous year. This information has generally been distributed via the volunteer co-ordinator or research staff during annual general meetings and bioregional data summaries of activities have also been provided for State of the Fisheries reports (Penn *et al.*, 2005). It was identified at the commencement of the VFLO program that these data may provide useful anecdotal information between the implementation of statistically robust recreational creel or phone/diary surveys.



**Figure 1.** The boundaries of the state's four marine bioregions and location of VFLO co-ordinators throughout Western Australia.

The primary objective of this report was to provide an overall summary of VFLO activities (i.e. total participation and number of people contacted) from 1995 – 2007. Specific focus was also placed on the analysis of data collected during patrols and associated interviews with recreational fishers, which has now been discontinued from the VFLO program. Such analyses included the spatial and temporal distribution of patrols and the calculation of catch rates for taxa caught by recreational fishers within each bioregion, where sufficient samples sizes

were available. The secondary objective was to determine what data could be extracted from the dataset, and its level of usefulness, in determining trends in recreational fishing patterns throughout Western Australia that may be helpful to management.

It should be noted that due to the unstructured data collection methods (i.e. surveying at random times and days), VFLO data could not be used to calculate estimates of recreational catch and effort, such as in creel or phone surveys. The catch rates presented in this report should be viewed with caution, as rigorous validation was not an ongoing process and, although care was taken to remove any errors and outliers, the different methods used by the large number of interviewers may have resulted in some residual inaccuracies.

## **1.2 Blue swimmer crab fishery: a targeted survey**

Data collected by the Department of Fisheries during a creel survey conducted in the Peel/Harvey Estuary during 1998/99 indicated the recreational catch of blue swimmer crabs was significantly higher than for commercial fishers (Malseed and Sumner, 2001). In recent years, the commercial catch in the Peel/Harvey Estuary has dropped to 90 tonnes (from a high of 95 tonnes in 2006/07) (Johnston and Harris, 2009) and anecdotal evidence from community members highlighted concerns over the status of the blue swimmer crab stocks. VFLOs completed a targeted survey of crab catches by recreational fishers in early 2007 to investigate the perceived decline in recreational catch rates of blue swimmer crabs. This targeted survey by the VFLOs aimed to provide catch-rate data, along with spatial information on catch and effort of fishers targeting blue swimmer crabs in the estuary. These data were used as a case study of data collected by VFLOs to investigate the potential contribution of this information to fisheries research and research.

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## **2.0 Methods**

### **2.1 Data collection**

VFLOs generally conduct activities in the area surrounding their place of residence although some may travel further afield. Volunteers work either independently or as part of a team and are supported by co-ordinators in eight metropolitan and regional locations (Figure 1). The activity (contact) and log (interview) sheets used by volunteers to record information on their activities and interactions with recreational fishers are shown in Appendices 1 and 2, respectively, and are explained in detail below.

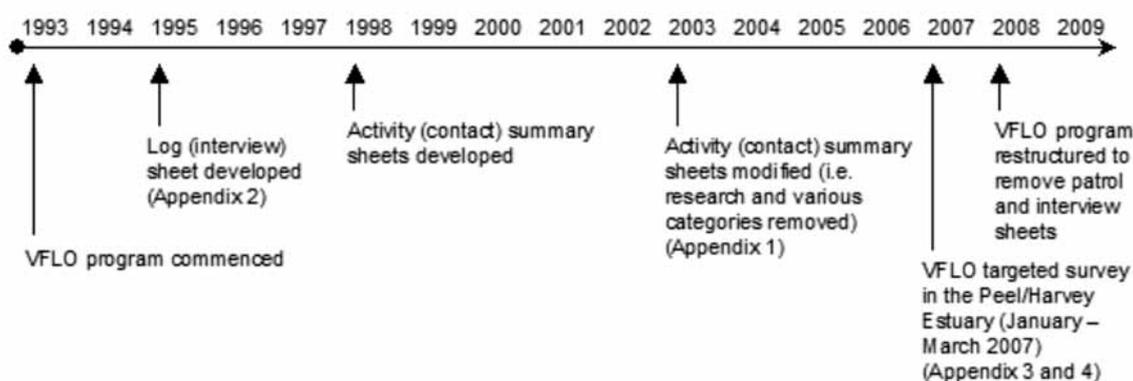
#### **2.1.1 Activity (contact) summary sheets**

Information on activities conducted by volunteers is listed on a contact sheet (Appendix 1). This was developed in 1998 to summarise who, and how many, volunteers were involved in activities, the activity type, hours spent and number of contacts made with recreational fishers or the general public (Figure 2). There are seven categories in which volunteer activities can be classified, which are:

- Patrol – shore and boat patrols where recreational fishers are counted, spoken to or interviewed.

- Program – fishing workshops, learning circles program, fishers with disabilities program.
- Presentation – school and community group presentations.
- Event – displays/shows/festivals/expos, holiday interpretive activities, launches.
- Meeting – team leader/activity co-ordinator meetings, steering committees, AGMs.
- Training – VFLO training and information sessions/briefings/workshops/courses and conferences.
- Other – administration (phone calls, funding applications), local activities (equipment maintenance, brochure distribution).

In addition, there were two categories (research and various), included in the VFLO contact sheets from 1995 - 2003. In 2003, the contact sheets were modified with these activities made redundant and absorbed into the ‘other’ category (Figure 2). However, volunteers still wishing to participate in research activities are able to achieve this through the Research Angler Program (RAP), also run by the Western Australian Department of Fisheries.



**Figure 2.** Timeline of VFLO data collection activities since the inception of the program in 1993.

When an activity was listed as a patrol on a contact sheet, the number of contacts recorded does not always correlate to the number of interviews recorded on the log sheet. This is because the number of contacts represents the total number of fishers or perspective fishers approached (including those interviewed in detail). This differs with log (interview) sheets that record only the number of fishers interviewed by the VFLO on patrol.

On the contact sheet, the total hours spent on each activity type were recorded. During analysis these data were calculated as the number of days for each activity, where one day equals 24-hours, for summary purposes.

### 2.1.2 Log (interview) sheet

The information collected during patrols and interviews with recreational fishers from 1995 - 2007 has been used as a basis for catch-rate analysis. Patrols were predominately conducted from the shore at locations where any type of recreational fishing (i.e. using line, scoop nets, pots) may have been occurring (i.e. beaches, estuaries or rivers). The scheduling of patrols was unstructured, with the volunteers determining where and how long to patrol a particular location (i.e. no defined schedule). The numbers of recreational fishers at a particular location were counted, and a random sample interviewed by volunteers on the patrol.

Summary details of a patrol were listed on the contact sheets while specific location and

interview information were recorded on the log sheet (Appendix 2). The log sheet comprised several discrete sections, which collected information on location, environmental conditions, counts of shore and/or boat fishers and interviews. The interview section was completed with a representative of each fishing group encountered, and was used to record information on the number of people fishing, time spent fishing, fishing platform (shore/boat), number of species retained and/or released.

The log sheets were modified for a targeted survey by VFLOs in the Peel/Harvey Estuary to collect data on the recreational blue swimmer crab fishery from January – April 2007 (Appendix 3). Modifications related to the inclusion of specific questions on knowledge of crabbing rules, number of crabs retained by sex and number of berried females. Fishing location, based on 1.6 x 1.6 nautical mile blocks within the estuary (Appendix 4), was also obtained. These groups were either intercepted while scooping or drop netting near the shore, or at a boat ramp at the end of their boat-based fishing trip. At the request of researchers, four x 3-hour patrols were conducted each week, alternating between mornings and afternoons, weekdays and weekends.

## **2.2 Data analysis**

Data collected by VFLOs was entered into a database at the Research Division at the Western Australian Department of Fisheries. Limited validation occurred during data entry to remove errors and also standardise data fields such as beach and volunteer names. To ensure there was adequate data for longitudinal analysis of data from 1995 - 2007, year was selected as the temporal scale at which information on VFLO patrols and other activities was summarized. Spatial summaries of patrol data were also created using ArcGIS 9.3 to display the densities of patrols undertaken in different regions, thereby providing an overview of these activities throughout Western Australia.

Catch rate was calculated separately for groups interviewed by VFLOs during patrols while fishing from the shore or returning from a boat-based fishing trip. A group was defined as a distinguishable unit of people from which an individual was selected to answer questions regarding their recreational fishing activity. Essential to this calculation was information on the species targeted by each interviewee, which was used to improve the accuracy of catch rates by calculating them separately for groups participating in these different types of fishing. However, this was not directly recorded by VFLOs and was calculated during analysis based on gear type, number of lines (rod or handline) and species caught. Each group, for which this information was available, could be assigned to (a) crabbing (for blue swimmer crabs or other general crab species), (b) fishing for western rock lobster or (c) line fishing for finfish. Although this technique worked efficiently for groups targeting a single species, such as blue swimmer crabs, it was not possible to determine what specific finfish species were targeted by line fishers based on gear type or catch. Therefore, the catch rates for these species were calculated using effort from all line fishing groups for each year from 1995 – 2007. Groups for which targeting information was not recorded during the interview, or who had participated in more than one activity (e.g. line fishing and crabbing with pots), were excluded from calculations as it was not possible to assign effort to a single type of fishing activity to these interviews. This criterion resulted in <10% of groups being excluded from analysis.

Catch rates can be calculated using a number of methods, dependent upon the type of gear and the application of the data. In this report, catch rates have been calculated using different techniques for line fishing and crabbing, and are described in the following sections.

### 2.2.1 Calculation of catch rates: line fishing

Groups identified as line fishing were those using rods or handlines. They were calculated separately for shore- and boat-based groups within each bioregion for each year (starting in January and finishing in December of the same year). There was insufficient data collected to calculate catch rates at finer temporal scales. Furthermore, there were only sufficient sample sizes to conduct analysis of catch rates for a few key species retained within each bioregion.

Catch rates for shore-based groups were based on incomplete trip information, as interviews occurred while fishing was still underway. The unit of measurement for these catch rates was fish/person/hour and it was assumed to be constant for the entire fishing trip (Pollock *et al.*, 1994). These shore-based catch rates were calculated for each stratum  $k$  by

$$\hat{R}_k = \frac{\sum_{j=1}^{n_k} w_{kj} c_{kj}}{\sum_{j=1}^{n_k} L_{kj}}$$

where  $c_{kj}$  is the total catch and  $L_{kj}$  the total effort, in person hours, for party  $j$  with  $w_{kj}$  fishers,  $n_k$  is the number of shore-based parties where the catch was recorded (Pollock *et al.*, 1994).

Catch rates for boat-based groups (calculated as fish/person/hour) were based on complete trip information, as groups were interviewed at boat ramps or launching facilities at the end of their trip. The catch rate for these boat-based groups was calculated for each stratum  $k$  by

$$\hat{R}_k = \frac{\sum_{j=1}^{n_k} c_{kj} / n_k}{\sum_{j=1}^{n_k} p_{kj} L_{kj} / n_k}$$

where  $n_k$  is the number of boats where the catch was recorded,  $c_{kj}$  the catch for boat  $j$ ,  $L_{kj}$  the effort (in boat hours) for boat  $j$  and  $p_{jk}$  is the number of persons fishing on boat  $j$  (Crone and Malvestuto, 1991).

### 2.2.2 Calculation of catch rates: crabbing

Groups identified as targeting crabs were those using scoop or drop nets. Sufficient data was available to calculate catch rates for groups crabbing in the Peel/Harvey Estuary only. There were differences between this analysis (and that completed for line fishing) to more accurately reflect the catch rates of blue swimmer crabs, which occur predominantly in the summer and autumn months. These data were therefore aggregated to 12-month periods starting in December of one year and finishing in November of the following year (represented as 1996/97).

Catch rates for groups crabbing from boats and the shore were calculated as crabs/person/potting hour using the number of retained crabs / (number of people fishing in group \* hours fished \* number of pots). Analysis was restricted to the predominant gear type for each platform, comprising scoop nets for shore groups and drop nets for boat fishers. A transformation [ $\log(\text{catch rate}+0.1)$ ] was applied to reduce the skewness of the distribution and catch rates were presented for each 12-month period, in the form of least-squared means. Catch rates for boat-based groups were also calculated using crabs/potting hour to investigate

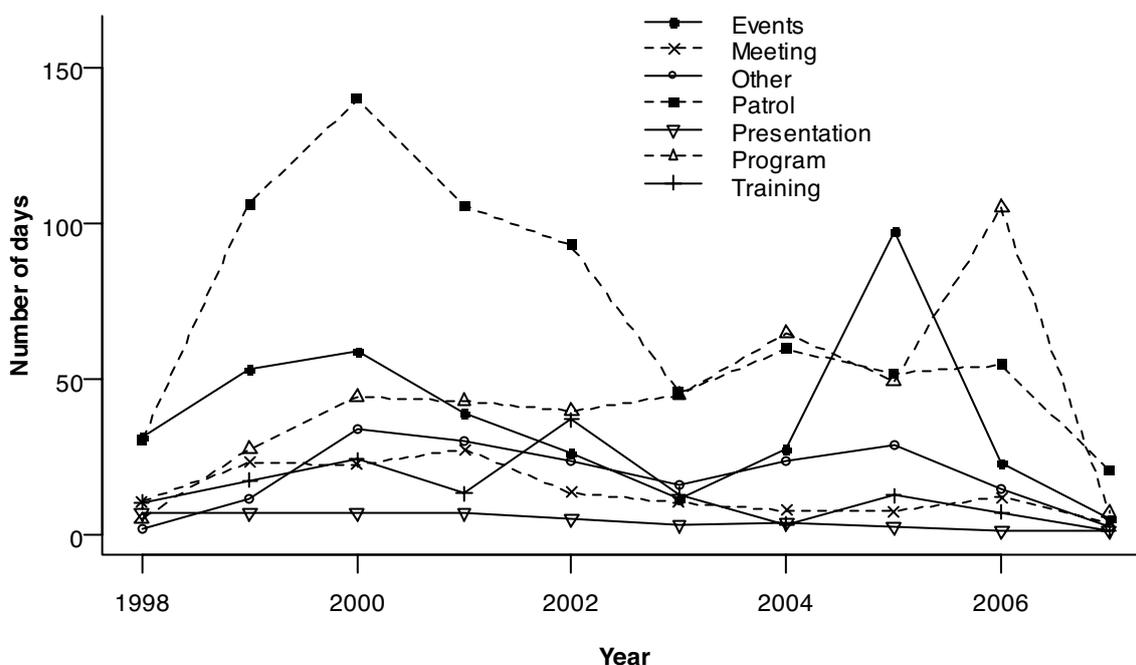
the effect of group size on this estimate and was calculated using the number of retained crabs / (hours fished \* number of pots).

The data available for the Peel/Harvey Estuary also supported investigation of factors such as year, seasonality, time of day and group size using analysis of variance (ANOVA). Seasonality was indicated by the month in which the observation was reported with summer categorised from November – February and autumn categorised from March – May. Time of day was based on whether the fishing group was interviewed in the morning (prior to 12 noon) or in the afternoon (after 12 noon). The effect of group size on efficiency of boat-based crabbing was also tested (i.e. boat limits are enacted when there are more than 2 people on the boat).

### 3.0 Results

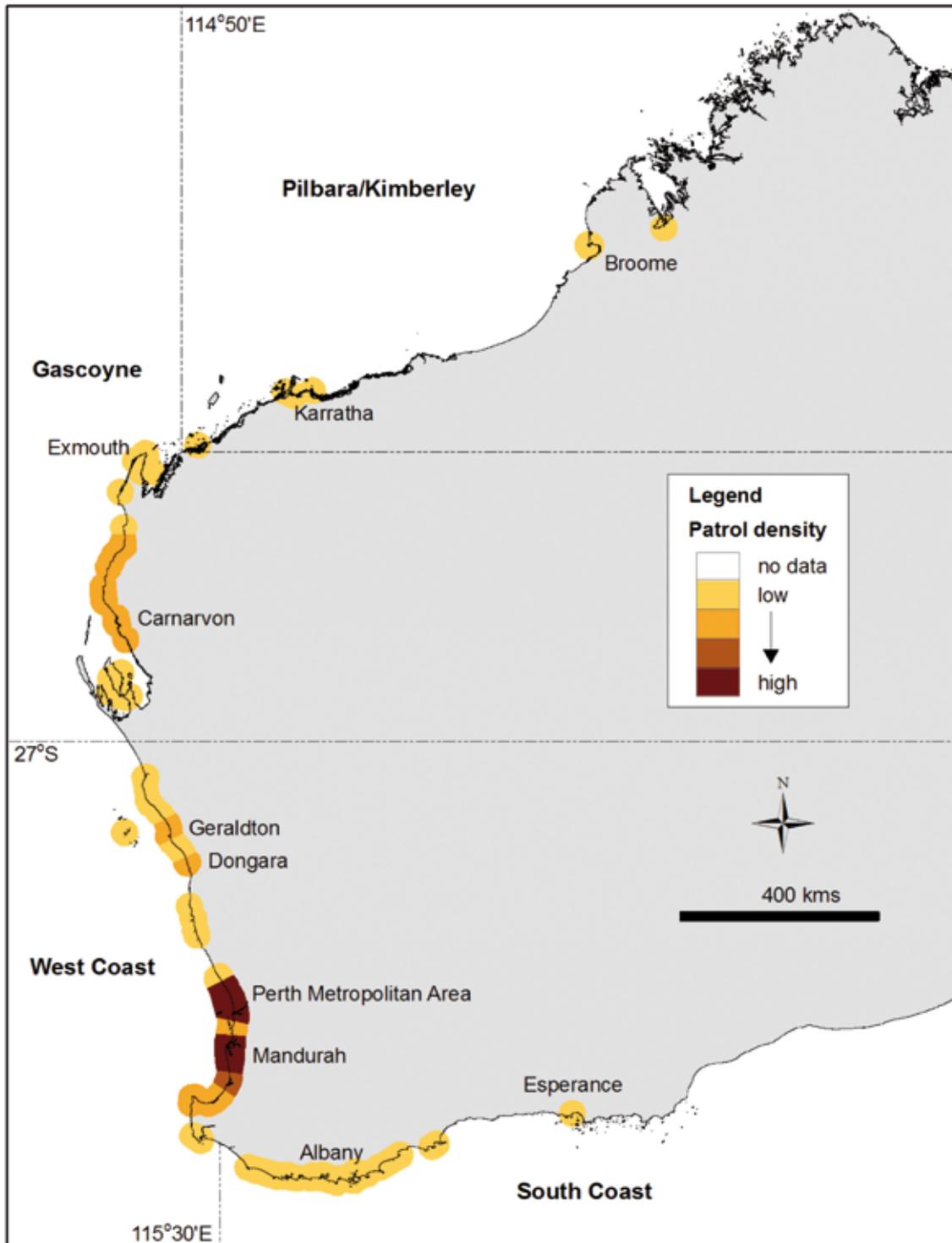
#### 3.1 Western Australia Overview

Information collected on activity (contact) summary sheets completed from 1998 – 2007 revealed >600 volunteers have participated in the VFLO program throughout all four of the state’s marine bioregions. The majority of volunteers conducted patrols and educational activities in the district surrounding their place of residence. Overall, there were 2,389 days of activity with patrols the most frequently conducted (707 days), followed by events (375 days) and program activities (432 days). There were >100 days of activity recorded annually since 1998, with patrols the most popular in the majority of years, along with events and program activities (Figure 3). Prior to this, a sheet for recording the details of volunteer activities had not been developed.



**Figure 3.** Total number of days spent annually on each activity type conducted by volunteers in Western Australia from 1998 – 2007, where 1 day equals 24-hours.

There were 7,060 patrols by VFLOs in 508 different locations throughout Western Australia during the span of the VFLO program. Of all patrols completed in this time period, 35% were undertaken at a location on only one occasion. While, conversely, <5% of patrols were at a location on more than 50 occasions. The majority of patrols were in the West Coast and Gascoyne bioregions with higher densities around major regional and metropolitan centres (Figure 4).



**Figure 4.** Distribution and density of patrols conducted by VFLOs in Western Australia from 1995 – 2007.

There were 23,816 interviews completed with shore and boat-based groups fishing in marine, estuarine and freshwater environments. A total of 226 species and general categories of aquatic organisms were retained and/or released by recreational fishers (Appendix 5). Statewide, the most frequently retained species were blue swimmer crabs (*Portunus pelagicus*), Australian herring (*Arripis georgianus*), general whiting (*Sillago* spp.) and yellow-fin whiting (*Sillago schomburgkii*). Recreational fishers also released large numbers of these aforementioned species as well as other general crab species, skipjack trevally (*Pseudocaranx dentex*) and common blowfish (*Torquigener pleurogramma*).

## 3.2 West Coast bioregion

### 3.2.1 Summary of activities

The majority of VFLOs involved in the program have been located within the West Coast bioregion. A total of 2,260 days (where 1 day equals 24-hours) were spent conducting activities such as patrols (650 days), educational programs (423 days) and events (342 days) such as the Mandurah boat show (Table 1).

**Table 1. Total number of days spent on each activity type, mean activity length and number of contacts conducted by VFLOs in the West Coast bioregion from 1995 – 2007**

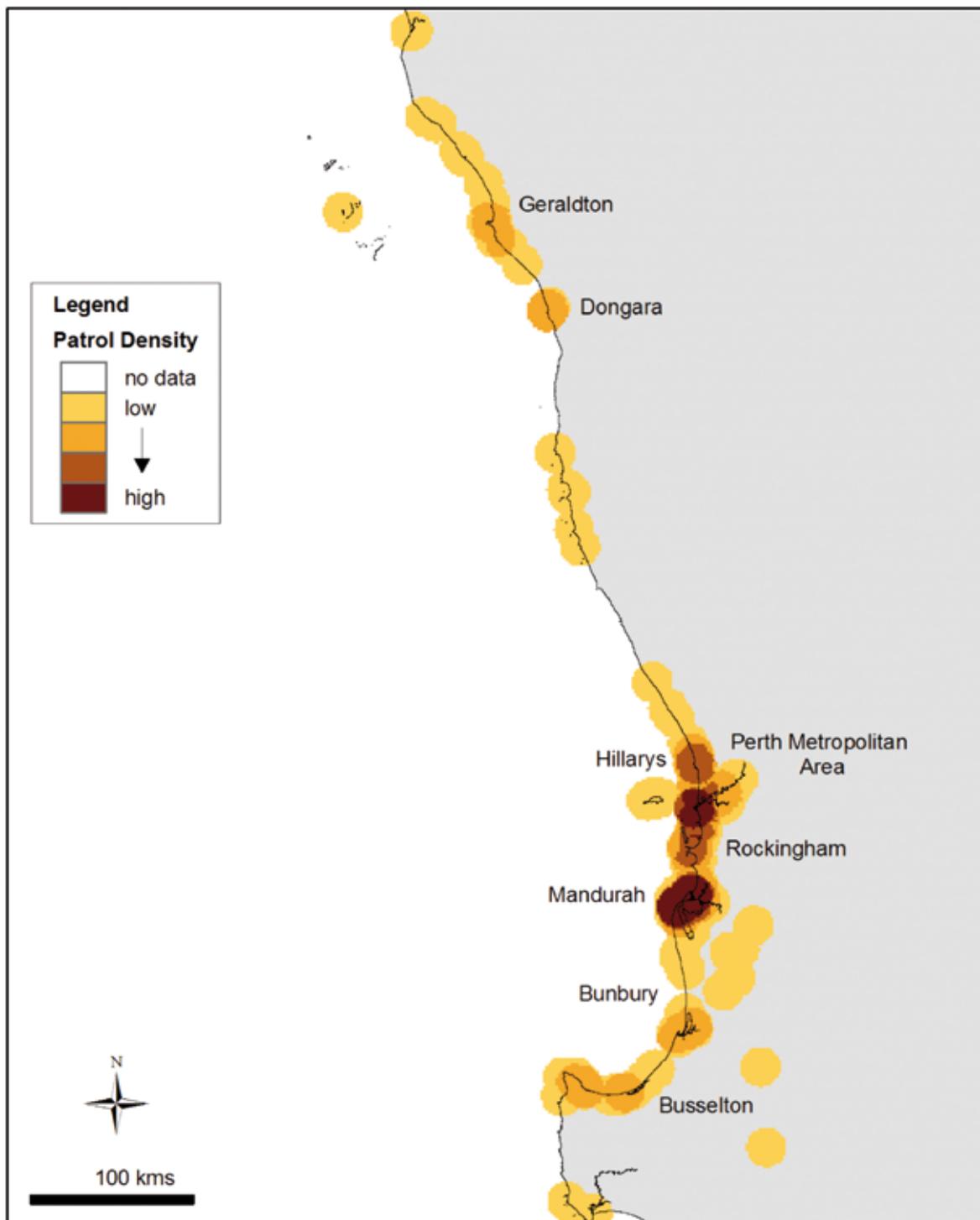
Activities	Total number of days (1 day = 24-hours)	Mean activity length (hours)	Mean number of contacts
Patrol	650	3.6	41
Program	423	5.9	29
Event	342	6.9	217
Various*	279	4.6	79
Other	184	3.9	28
Training	132	5.5	29
Meeting	135	3.4	14
Research*	51	4.0	13
Presentation	43	2.3	30

\* categories incorporated into 'other' after 2003.

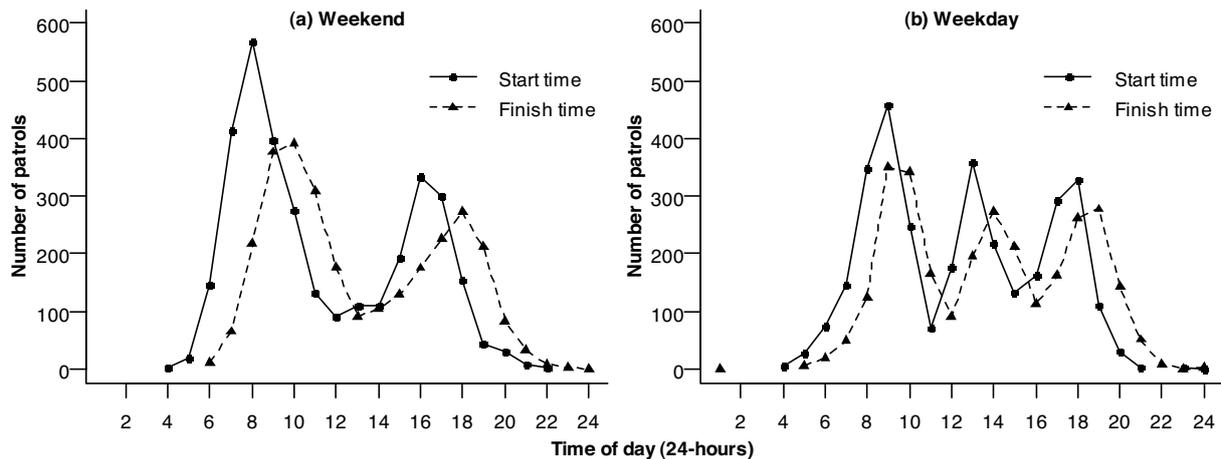
### 3.2.2 Temporal and spatial distribution of patrols

There were 6,432 patrols conducted in the West Coast bioregion from 1995 – 2007 (comprising 91.1% of those conducted statewide during the same time period). The majority of these were conducted in Mandurah and the Perth Metropolitan Area (Figure 5), with the most popular sites the Old Traffic Bridge, Dawesville Cut, Mary Street Lagoon/Boat Ramp, Port Bouvard Boat Ramp, North Mole, Peel Estuary Inlet, Hillarys Marina, Busselton Jetty and Olive Road Beach/Boat Ramp.

There were similar numbers of patrols on weekends and weekdays, with peaks occurring at the same times of the day, around 7 am - 9 am and 5 pm - 7 pm (Figure 6). However, weekdays had an additional peak in the number of patrols around 12 noon – 2 pm. There were a mean of 3.4 interviews/patrol ( $SD = 4.1$ ) and December - April were the peak months for patrols in the West Coast bioregion, with 60% completed during this period.



**Figure 5.** Distribution of patrols conducted by VFLOs within the West Coast bioregion from 1995 – 2007.



**Figure 6.** The start and finish time of patrols conducted by VFLOs in the West Coast bioregion on (a) weekdays and (b) weekends from 1995 - 2007.

### 3.2.3 Characteristics of fishing groups

Recreational fishers interviewed by VFLOs during patrols in the West Coast bioregion were predominantly shore (70%) and boat-based (24%), which encompasses all groups targeting finfish, crabs or western rock lobster. Diving as method of fishing was undertaken by 1% of groups while the remaining 6% of respondents had no information recorded on their type of fishing platform.

There was a mean of 2.4 people/group ( $SD = 1.5$ ) interviewed by VFLOs during patrols. The majority of interviewees were between 20 - 39 years (35%) and 40 - 59 years (36%) of age (Table 2). The average time spent fishing was 2.9 hours ( $SD = 1.8$ ) for boat-based groups and 1.6 hours ( $SD = 1.4$ ) for shore-based groups at the time of interview.

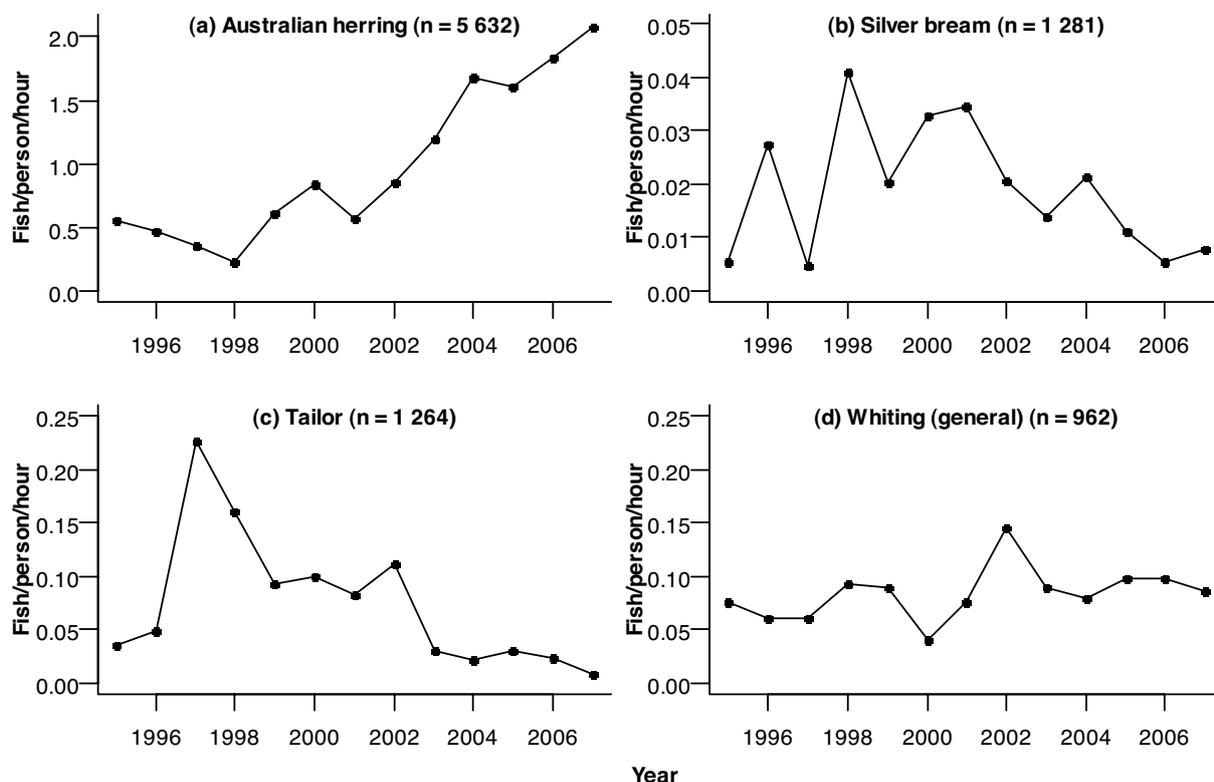
**Table 2.** Age of fishers interviewed on VFLO patrols from 1995 – 2007 in the West Coast bioregion (number of interviews = 20 384).

Age (years)	Number of interviewees
0 – 19	1 218 (6%)
20 – 39	7 153 (35%)
40 – 59	7 297 (36%)
60 +	4 716 (23%)

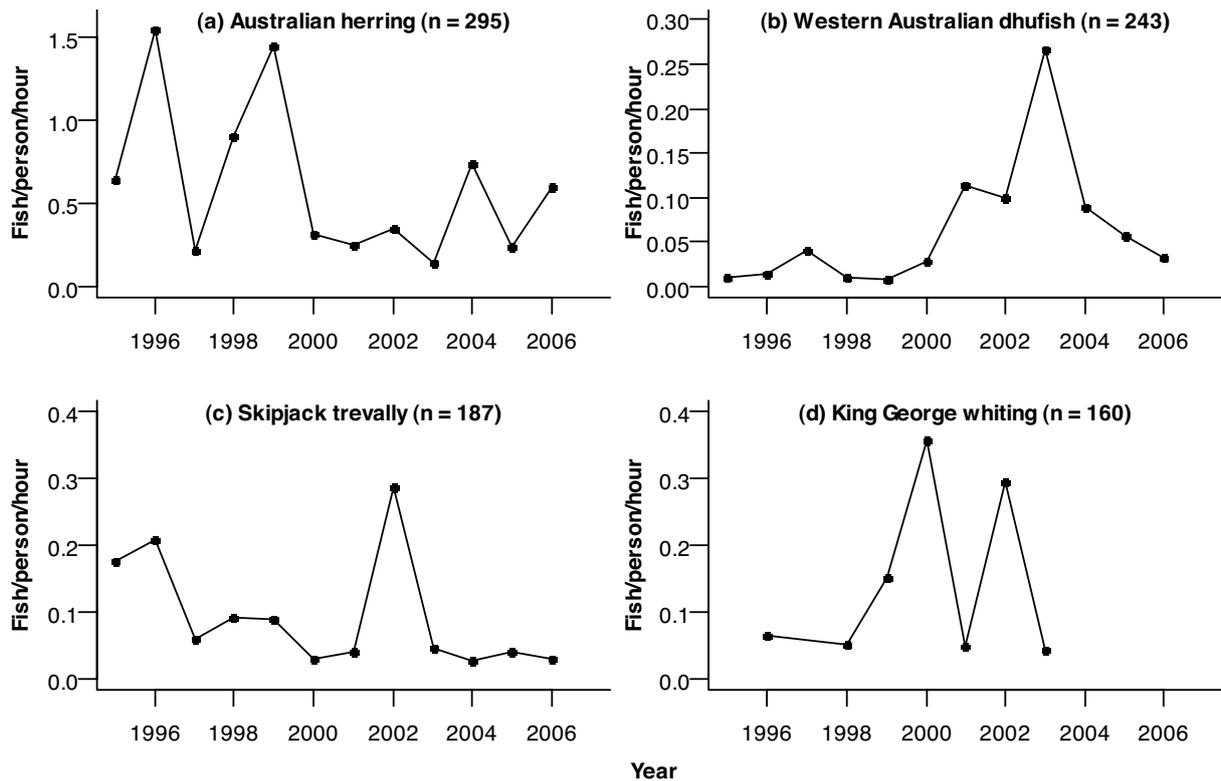
### 3.2.4 Species composition, catch and catch rates

There were 162 species and general categories of aquatic organisms retained or released by recreational fishers in the West Coast bioregion (Appendix 5). The most frequently recorded by shore fishers were Australian herring, blue swimmer crabs, tailor (*Pomatomus saltatrix*), general/sand whiting, silver bream (*Rhabdosargus sarba*) and yellow-fin whiting. For boat-based fishers, the most frequently caught were blue swimmer crabs, Australian herring, general crabs, general/sand whiting, western rock lobster (*Panulirus cygnus*), yellow-fin whiting, unknown species, skipjack trevally and King George whiting (*Sillaginodes punctata*). A creel survey of boat anglers by Sumner and Williamson (1999) also reflected this species composition, with whiting, Australian herring and skipjack trevally the most frequently retained.

The catch rates for the main fish species retained and released by shore- and boat-based groups using rods or handlines were calculated annually from 1995 – 2007 (Figure 7; Figure 8). The sample sizes for each species were >160 and showed increasing trends for Australian herring caught from the shore (Figure 7a) and a decreasing trend for silver bream and tailor (Figure 7b, c). The trends for all other main species remained fairly static, or with dramatic short-term changes, such as for Australian herring caught from boats (Figure 8a).



**Figure 7.** Shore-based catch rates (fish/person/hour) for (a) Australian herring, (b) silver bream, (c) tailor and (d) general whiting species, retained by shore-based groups interviewed while fishing using rods or handlines in the West Coast bioregion from 1995 – 2007.

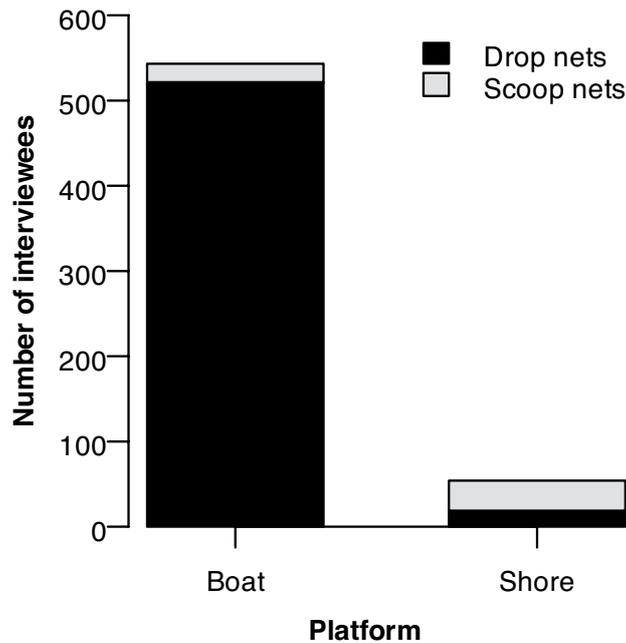


**Figure 8.** Boat-based catch rates (fish/person/hour) for (a) Australian herring, (b) Western Australian dhufish, (c) skipjack trevally and (d) King George whiting retained by boat-based groups using rods or handlines and interviewed at the completion of their fishing trip in the West Coast bioregion from 1995 – 2007.

### 3.3 Blue swimmer crab fishery (Peel/Harvey Estuary)

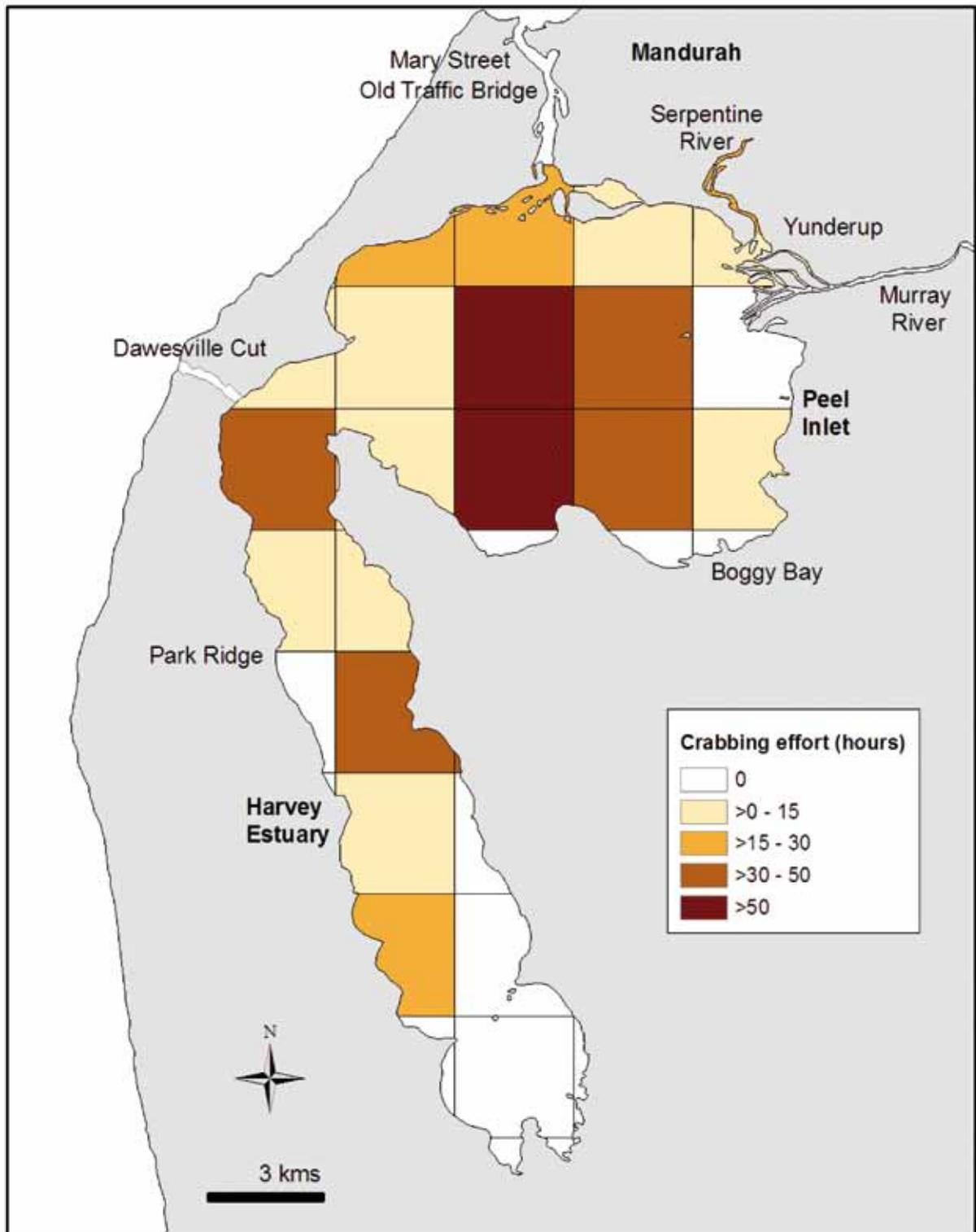
A small number of VFLOs were specifically requested to obtain data from recreational fishers in the Peel/Harvey Estuary from January – April 2007. These data were collected to address concerns over the status of blue swimmer crab stocks in this area and resulted in shore-based patrols on 56 days (comprising ~113 hours) between the hours of 7 am and 6.30 pm. These patrols were distributed around the estuary at a number of locations (Appendix 4) and resulted in 258 interviews with groups fishing recreationally, of which the majority were targeting blue swimmer crabs.

Recreational fishers that targeted blue swimmer crabs predominantly resided in Mandurah and suburbs surrounding the Peel/Harvey Estuary (62.3%). The remaining groups were from the greater Perth metropolitan area (32.9%), regional Western Australia (0.8%) and interstate (0.8%). Most were targeting crabs from boats (91.4%), while the remainder were shore-based (8.6%). These boat-based groups predominantly fished using drop nets (96.3%), while most shore fishers used scoop nets (63.0%) and the remainder used drop nets (37.0%) (Figure 9).

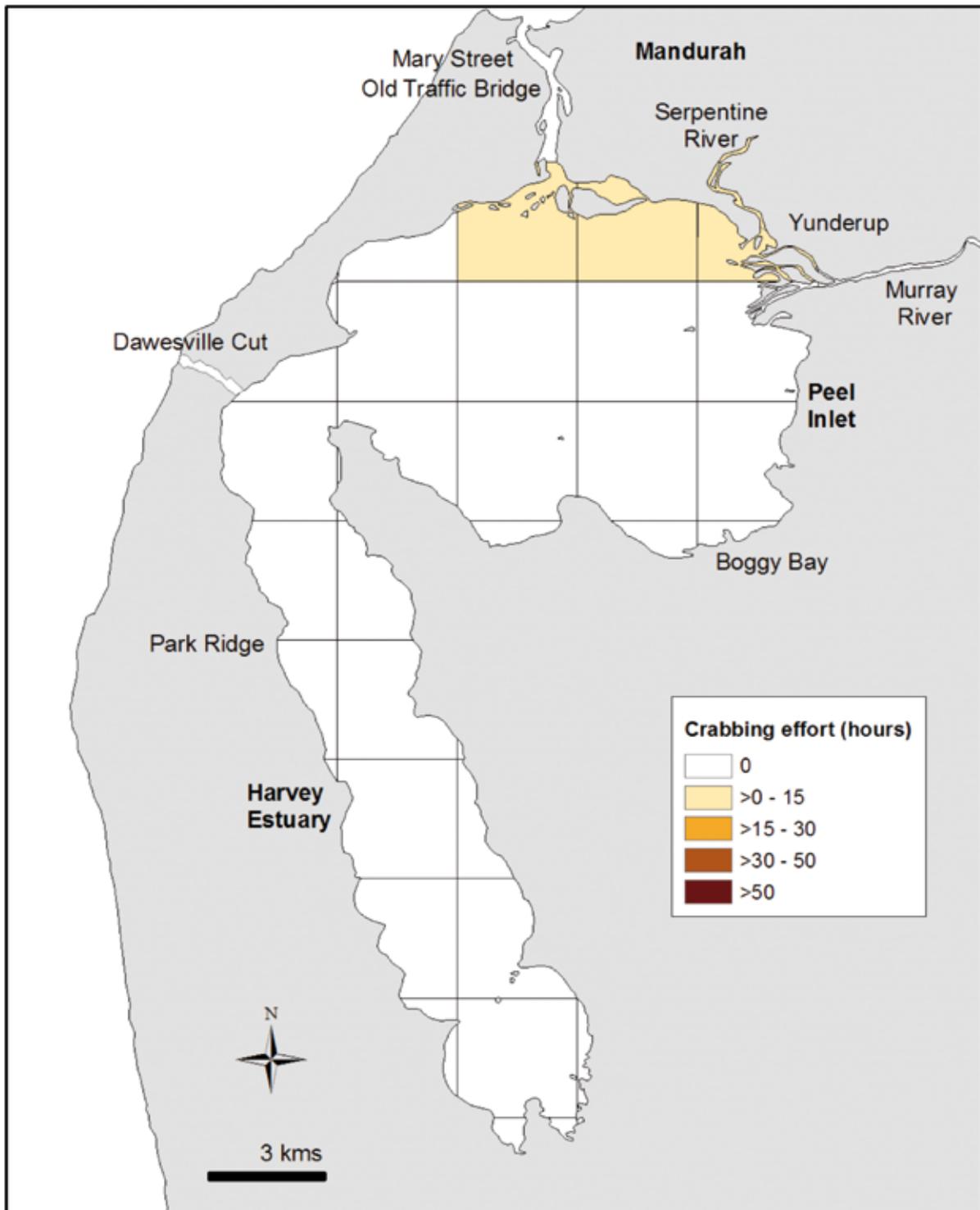


**Figure 9.** Number of people interviewed while targeting blue swimmer crabs in the Peel Harvey Estuary from boats and the shore, and their selected type of fishing gear, from January – April 2007.

Crabbing effort (in hours fished) for boat-based groups occurred mostly in the deeper waters through the middle of the Peel Inlet and also in the Serpentine River (Figure 10). Crabbing was also reported throughout the Harvey Estuary, although this was concentrated in the northern reaches. This spatial distribution differed for people targeting blue swimmer crabs from the shore, with effort concentrated solely within the Peel Inlet, particularly along the northern side around Yunderup (Figure 11). No people were interviewed targeting blue swimmer crabs from the shore in the Harvey Estuary, but limited accesses restrict crabbing (and patrol) activity in this area.



**Figure 10.** Spatial distribution of boat-based crabbing effort (in hours fished) by people interviewed while targeting blue swimmer crabs between January – April 2007.



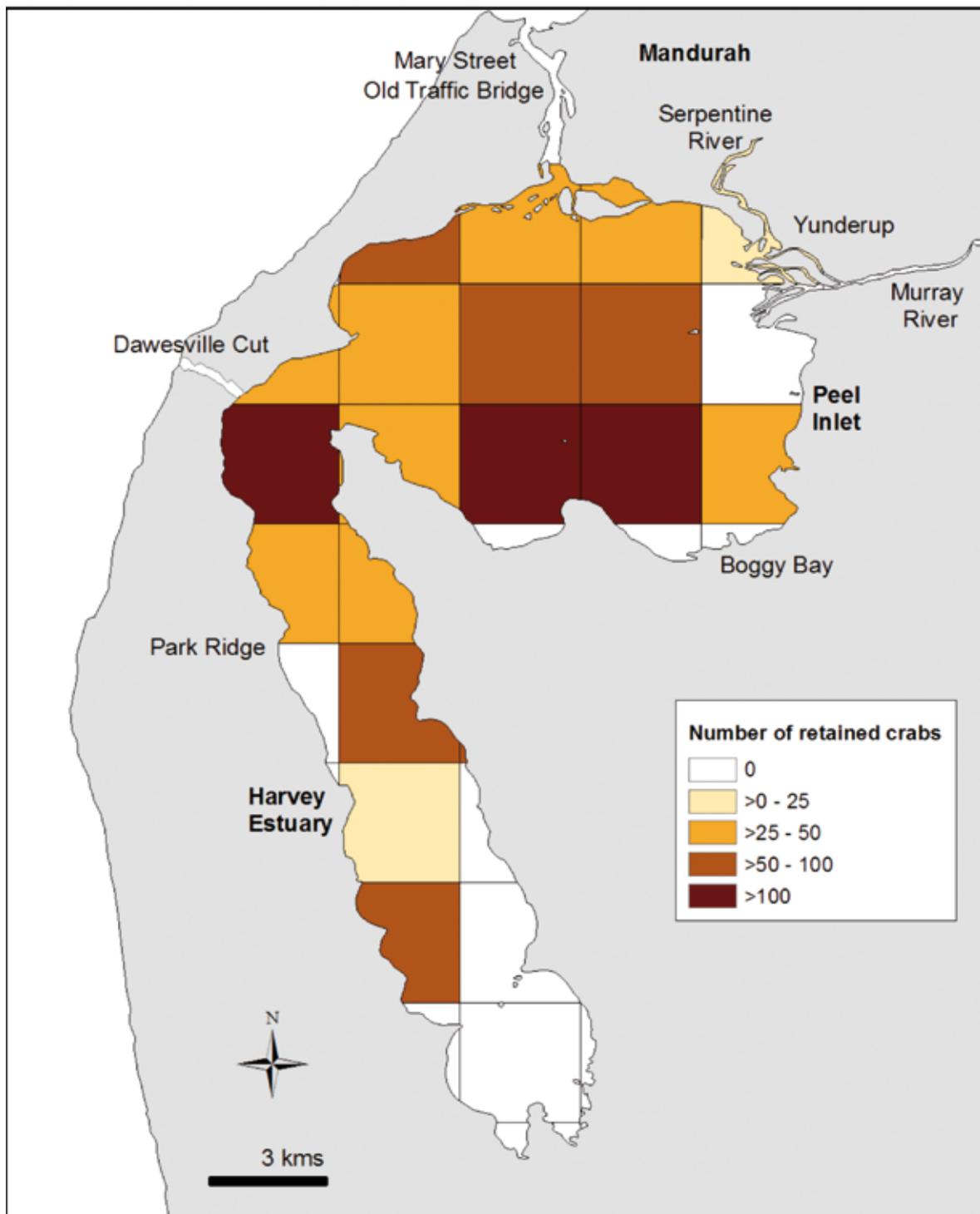
**Figure 11.** Spatial distribution of shore-based crabbing effort (in hours fished) by people interviewed while targeting blue swimmer crabs between January – April 2007.

The retained catch of blue swimmer crabs during this period was predominantly male crabs caught from boats (1,254) (Table 3). Undersized crabs and berried females were also released from boats and the shore, along with some sized individuals that were returned to the water (92).

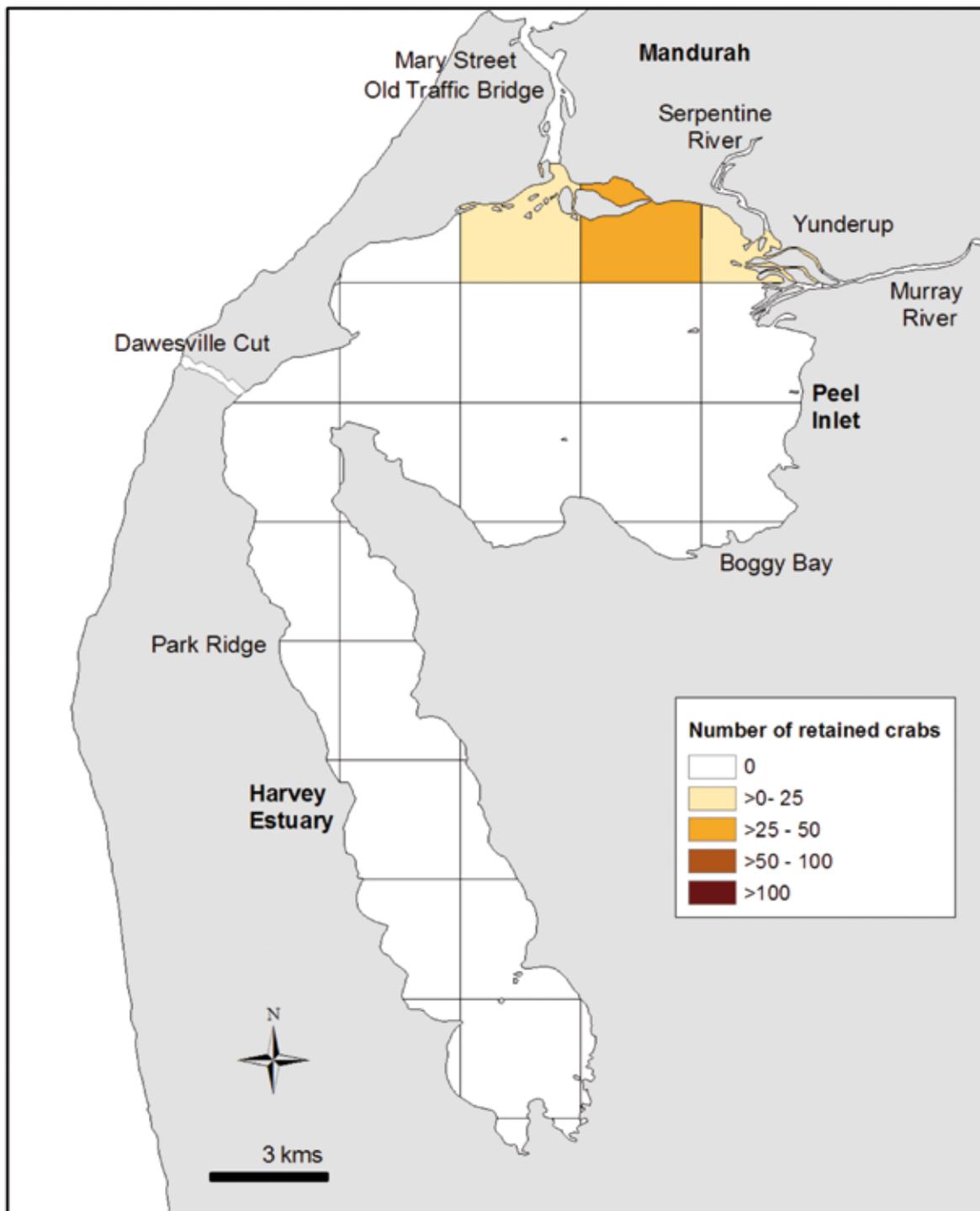
**Table 3.** Composition of the recreational blue swimmer crab catch for people interviewed by VFLOs while targeting blue swimmer crabs from boats and the shore from January – April 2007 in the Peel/Harvey Estuary.

	Boat		Shore	
	Male	Female	Male	Female
<b>Retained crabs</b>				
<i>Total</i>	1,254	58	43	1
<b>Released crabs</b>				
Undersize	417	59	74	1
Sized	50	31	0	11
Berried	n/a	15	n/a	0
<i>Total</i>	467	105	74	12

The spatial distribution of the catch of blue swimmer crabs retained by respondents interviewed by VFLOs during this period also varied throughout the Peel/Harvey Estuary. The spatial distribution catch of retained crabs by boat-based groups reflected the spatial distribution of crabbing effort. The largest quantities of crabs were caught in the middle of the Peel Inlet and near to the Dawesville Cut, with smaller numbers caught in the shallower banks around the edges of this northern region and also to the south, in the Harvey Estuary (Figure 12). The catches of blue swimmer crabs by shore-based groups also mirrored the effort that occurred in each area of the Peel/Harvey Estuary (Figure 13). Most blue swimmer crabs were caught in the Yunderup region along the northern edge of the Peel Inlet. There was no shore-based fishing effort, and therefore no retained catch, in the Harvey Estuary, which is likely to be due to the limited number of access points along this shoreline which restricts both crabbing and patrols by VFLOs.



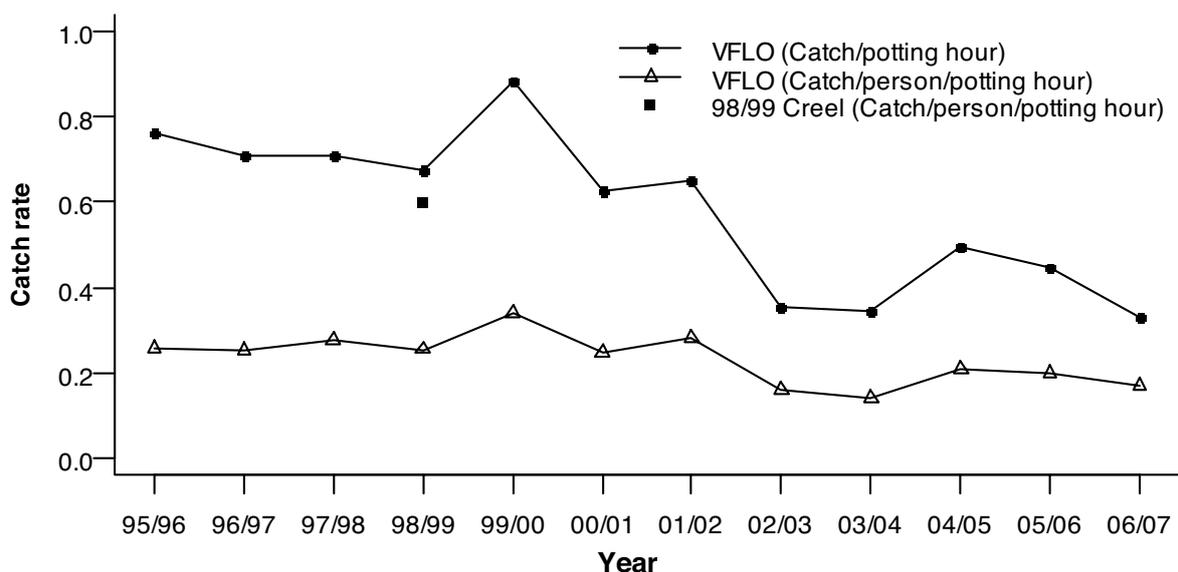
**Figure 12.** Retained boat catch of blue swimmer crabs by people interviewed by VFLOs while crabbing in the Peel/Harvey Estuary between January – April 2007.



**Figure 13.** Retained shore catch of blue swimmer crabs by people interviewed by VFLOs while crabbing in the Peel/Harvey Estuary between January – April 2007.

The catch rates of blue swimmer crabs in the Peel/Harvey Estuary were calculated for the period from 1995 - 2007 for all shore and boat-based groups interviewed by VFLOs who were targeting this species. This analysis was undertaken on an annual basis, with each year starting in December and finishing in November of the following year, to better reflect the catches of blue swimmer crabs, which predominately occur in the summer months from December and into autumn.

Boat-based catch rates were calculated using two methods, crabs/potting hour and crabs/person/potting hour. Crabs/person/potting hour produced a lower catch rate, as would be expected with the incorporation of group size as an additional denominator value (Figure 14). However, even though different catch rates were obtained by the two methods, similar percentage drops (~40%) were obtained when comparing between years with maximum (99/00) and minimum (02/03 and 03/04) catch rates, indicating that both units of measurement identify similar patterns over time. Group size was consistent across years and was non-significant when tested against catch/person/potting hour. The validity of either method for calculating catch rates for crabbing is therefore supported by these analyses. Year and time of day (i.e. whether the survey was completed before or after 12 noon) had significant effects on catch rate (Table 4).

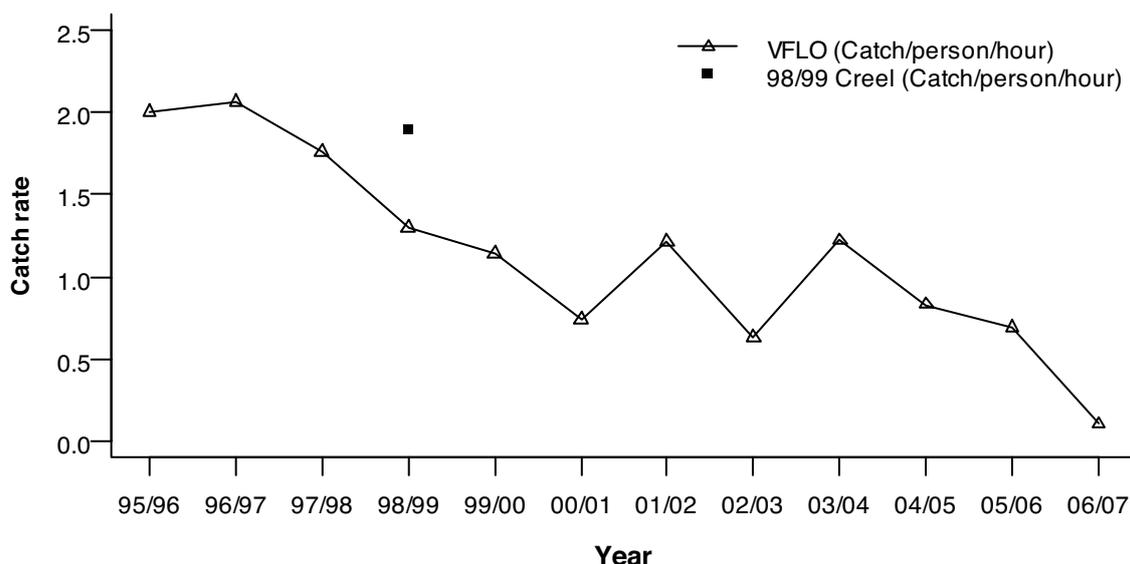


**Figure 14.** Least squared means of boat-based catch rates (as both crabs/person/potting hour and crabs/potting hour) of retained blue swimmer crabs within the Peel/Harvey Estuary for each year from 1994/95 – 2006/07 (number of interviews = 1,681).

**Table 4.** ANOVA for  $\log(\text{catch rate}+0.1)$  where catch rate is defined as crabs/person/potting hour for groups who fished on boats. Note: #summer (November – February) and autumn (March – May).

Factor	DF	SS	MS	F	$\rho$
Year	11	26.7	2.4	6.85	<0.001
Seasonality <sup>#</sup>	1	0.1	0.1	0.27	0.6044
Time of day	1	17.1	17.1	48.4	<0.001
Year*Seasonality	11	8.9	0.8	2.29	0.008
Error	1,632	577.8	0.35		

Shore-based catch rates, calculated as crabs/person/hour, identified a declining trend from 1995/96 to 2000/01 which then stabilised, with variability, until 2005/06 before the decline continued until the end of data collection in 2006/07 (Figure 15). Catch rates calculated during the 1998/99 creel survey were slightly higher than catch rates calculated from VFLO data collected in the same year. Time of day was excluded from statistical analysis of shore-based crabbing, as all interviews were undertaken in the morning prior to 12 noon. Based on catch rates calculated as crabs/person/ hour, year was identified as a significant factor (Table 5).



**Figure 15.** Least squared means of shore-based catch rates (crabs/person/hour) of retained blue swimmer crabs within the Mandurah region for each year from 1994/95 – 2006/07 (number of interviews = 1,010).

**Table 5.** ANOVA for  $\log(\text{catch rate}+0.1)$  where catch rate is defined as crabs/person/ hour for groups who fished from the shore. Note: #summer (November – February) and autumn (March – May).

Factor	DF	SS	MS	F	$\rho$
Year	11	114.9	10.4	5.2	<0.001
Seasonality#	1	2.5	2.5	1.3	0.2614
Year*Seasonality	10	35.5	3.5	1.8	0.0624
Error	987	1,981.6	2.0		

### 3.4 South Coast bioregion

#### 3.4.1 Summary of activities

Between 1995 and 2007 there were 38 VFLOs involved in volunteer activities throughout the South Coast bioregion. The total time spent conducting activities was 91 days. This comprised patrols (35 days), events (21 days) and various activities (14 days) (Table 6).

**Table 6.** Total number of days spent on each activity type, mean activity length and number of contacts conducted by VFLOs in the South Coast bioregion from 1995 – 2007.

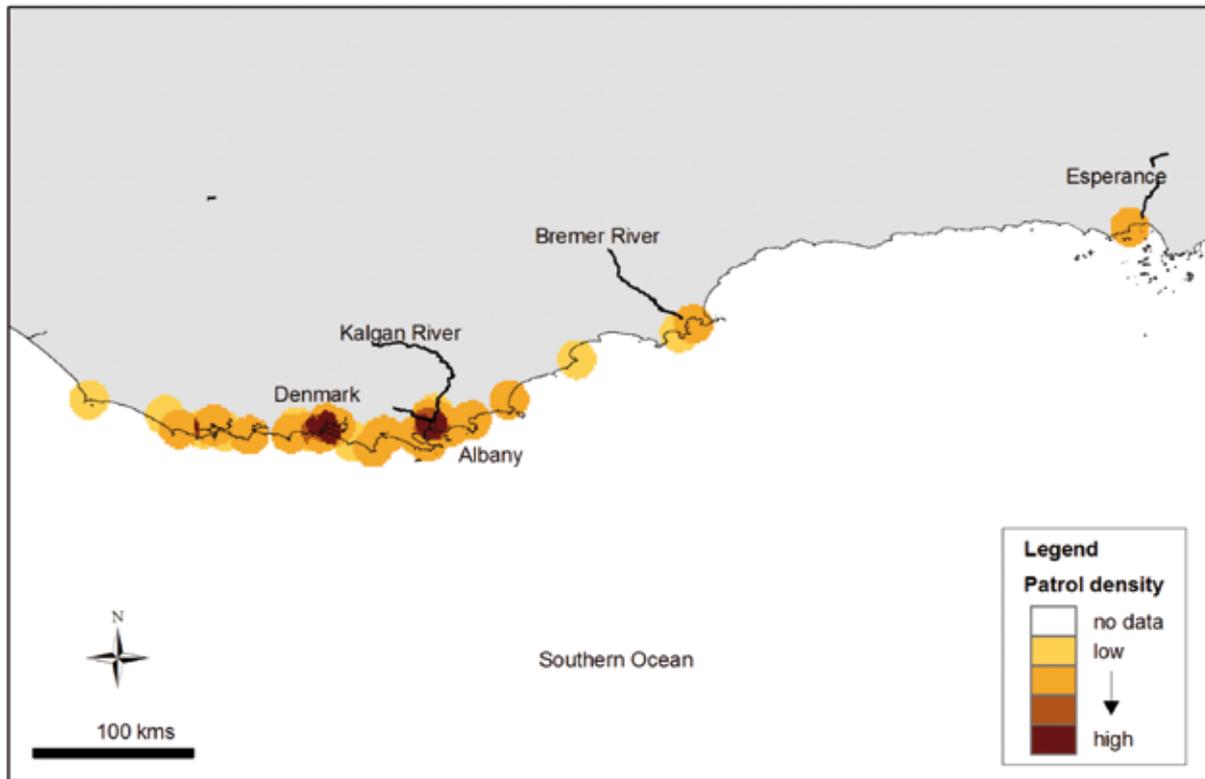
Activities	Total number of days (1 day = 24-hours)	Mean activity length (hours)	Mean number of contacts
Patrol	35	4.7	17
Event	21	5.2	116
Various*	14	3.6	38
Program	6	3.6	30
Training	5	6.1	10
Meeting	4	3.1	5
Other	4	2.4	9
Presentation	2	3.6	35
Research*	0	0	0

\* categories incorporated into 'other' after 2003.

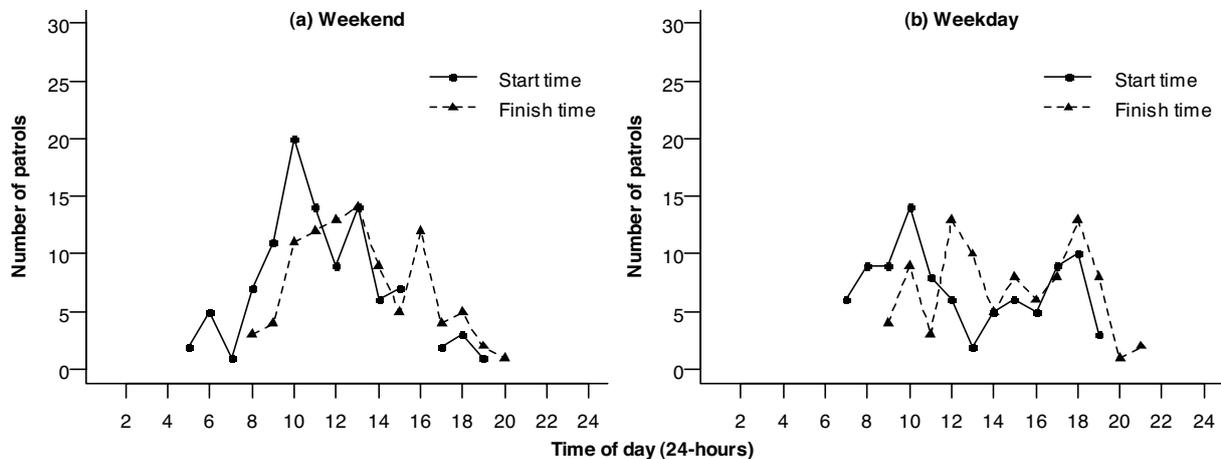
### 3.4.2 Temporal and spatial distribution of patrols

There were a total of 196 patrols conducted by VFLOs within the South Coast bioregion between 1995 – 2007. The majority of these were near the regional centres of Albany and Denmark, with lower densities at Bremer Bay and Esperance (Figure 16).

All patrols undertaken within the South Coast bioregion were between the hours of 5 am – 9 pm (Figure 17). The majority of patrols were conducted on weekends, with the highest number of patrols starting at 10 am and 1 pm. The peak in start times for weekday patrols was at 10am and between 5 pm – 6 pm, which had corresponding peaks in patrol finishing times at 12 noon and 6 pm – 7 pm. On both weekday and weekends there were a number of points where the number of patrols with a finish time exceeds start time which is due to incomplete information on log (interview) forms. As with the West Coast bioregion, December to April are the peak months for patrols by VFLOs in the South Coast bioregion, with 69% of patrols conducted during this time. There was an average 1.8 interviews/patrol ( $SD = 2.6$ ) in the South Coast bioregion and there was no specific time of day in which there were substantially more interviews/patrol.



**Figure 16.** Distribution of patrols conducted by VFLOs within the South Coast bioregion from 1995 – 2007.



**Figure 17.** The start and finish time of patrols conducted by VFLOs in the South Coast bioregion on (a) weekdays and (b) weekends between 1995 - 2007.

### 3.4.3 Characteristics of fishing groups

Groups interviewed by VFLOs in the South Coast bioregion were predominately fishing, crabbing or targeting rock lobster from the shore (61%) and boats (36%). There were <1% of groups who used diving as a method of fishing while the remaining 2% of groups interviewed had no information recorded on their fishing platform.

There was a mean of 2.8 fishers/group ( $SD = 1.5$ ) and the majority of interviewees were aged between 20 - 39 (40%) and 40 - 59 (35%) of age (Table 7). The mean fishing time was 3.3 hours ( $SD = 2.0$ ) for boat-based groups and 1.9 hours ( $SD = 1.9$ ) for shore-based groups at time of interview.

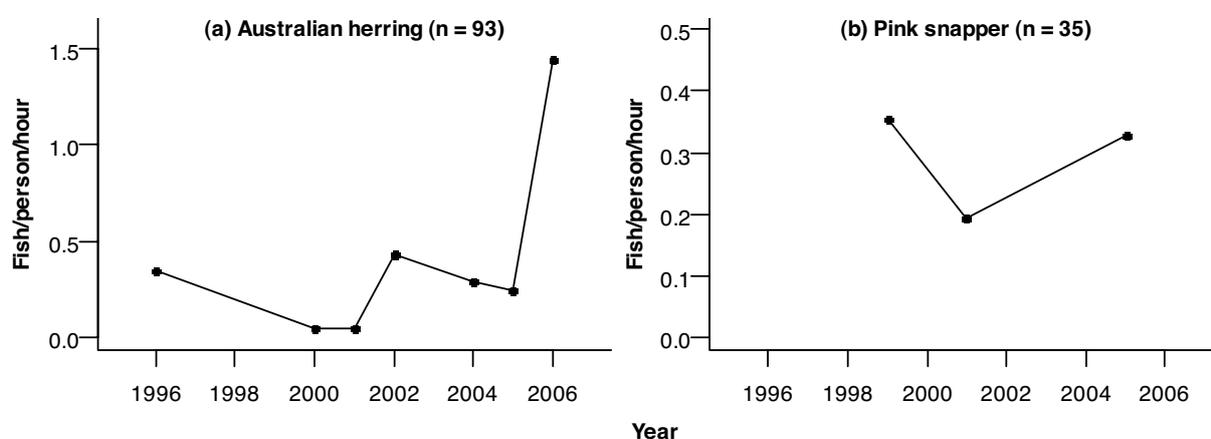
**Table 7.** Age of fishers interviewed on VFLO patrols between 1995 and 2007 in the South Coast bioregion (number of interviews = 515).

Age (years)	Number of interviewees
0 – 19	35 (7%)
20 – 39	204 (40%)
40 – 59	183 (35%)
60 +	93 (18%)

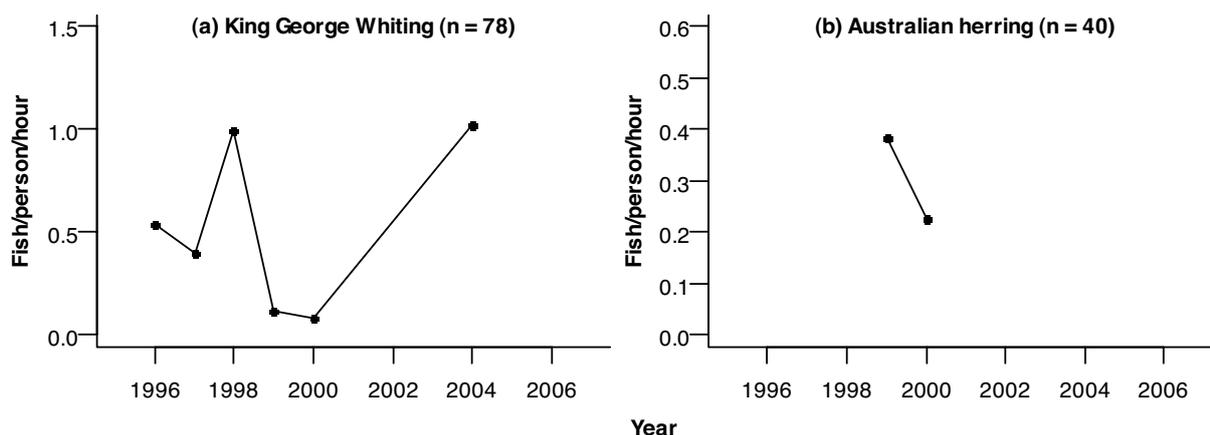
### 3.4.4 Species composition, catch and catch rates

There was a total of 66 species and general categories of aquatic organisms retained or released by recreational fishers in the South Coast bioregion (Appendix 5). The most frequently retained species by boat-based recreational groups were King George whiting, Australian herring, general/sand whiting, black bream (*Acanthopagrus butcheri*) and pink snapper. This was similar to shore-based groups for which the most frequently retained species were Australian herring, pink snapper, unknown species, skipjack trevally and silver bream. Previous creel surveys of estuarine and/or coastal recreational fishing in this bioregion (Ayvazian *et al.*, 1997; Smallwood and Sumner, 2007) have both shown these identified species to be frequently caught by recreational anglers.

The sample size used to determine catch rates in the South Coast bioregion were considerably lower than for the West Coast bioregion and there were no patrols conducted in 1995 and 2007. The highest sample sizes for groups involved in fishing only (using a rod or handline) were Australian herring for shore-based groups (Figure 18a) and King George whiting for boat-based groups (Figure 19a). For shore-based catch rates, there were many years where data was not recorded for the majority of species, making it difficult, if not impossible, to interpret trends in catch rates. Australian herring had the most data points and for this species catch rate information was available for all years. The same problem of isolated data points also existed for boat-based groups, especially Australian herring (Figure 19b).



**Figure 18.** Catch rate (fish/person/hour) for (a) Australian herring and (b) pink snapper retained by shore-based groups interviewed while fishing using rods or handlines in the South Coast bioregion from 1995 – 2007.



**Figure 19.** Catch rate (fish/person/hour) for (a) King George whiting and (b) Australian herring retained by boat-based groups using rods or handlines and interviewed at the completion of their fishing trip in the South Coast bioregion from 1995 – 2007.

### 3.5 Gascoyne bioregion

#### 3.5.1 Summary of activities

There have been 36 VFLOs involved in conducting activities throughout the Gascoyne bioregion between 1995 – 2007. The total time spent undertaking these activities was 18 days and comprised of mostly patrols (14 days) and events (2 days) (Table 8).

**Table 8.** Total number of days spent on each activity type, mean activity length and number of contacts conducted by VFLOs in the Gascoyne bioregion from 1995 – 2007.

Activities	Total number of days (1 day = 24-hours)	Mean activity length (hours)	Mean number of contacts
Patrol	14	3.8	22
Event	2	4.1	128
Various*	1	5.7	62
Training	1	7.5	n/a
Program	0	0	0
Meeting	0	0	0
Other	0	0	0
Presentation	0	0	0
Research*	0	0	0

\* categories incorporated into 'other' after 2003.

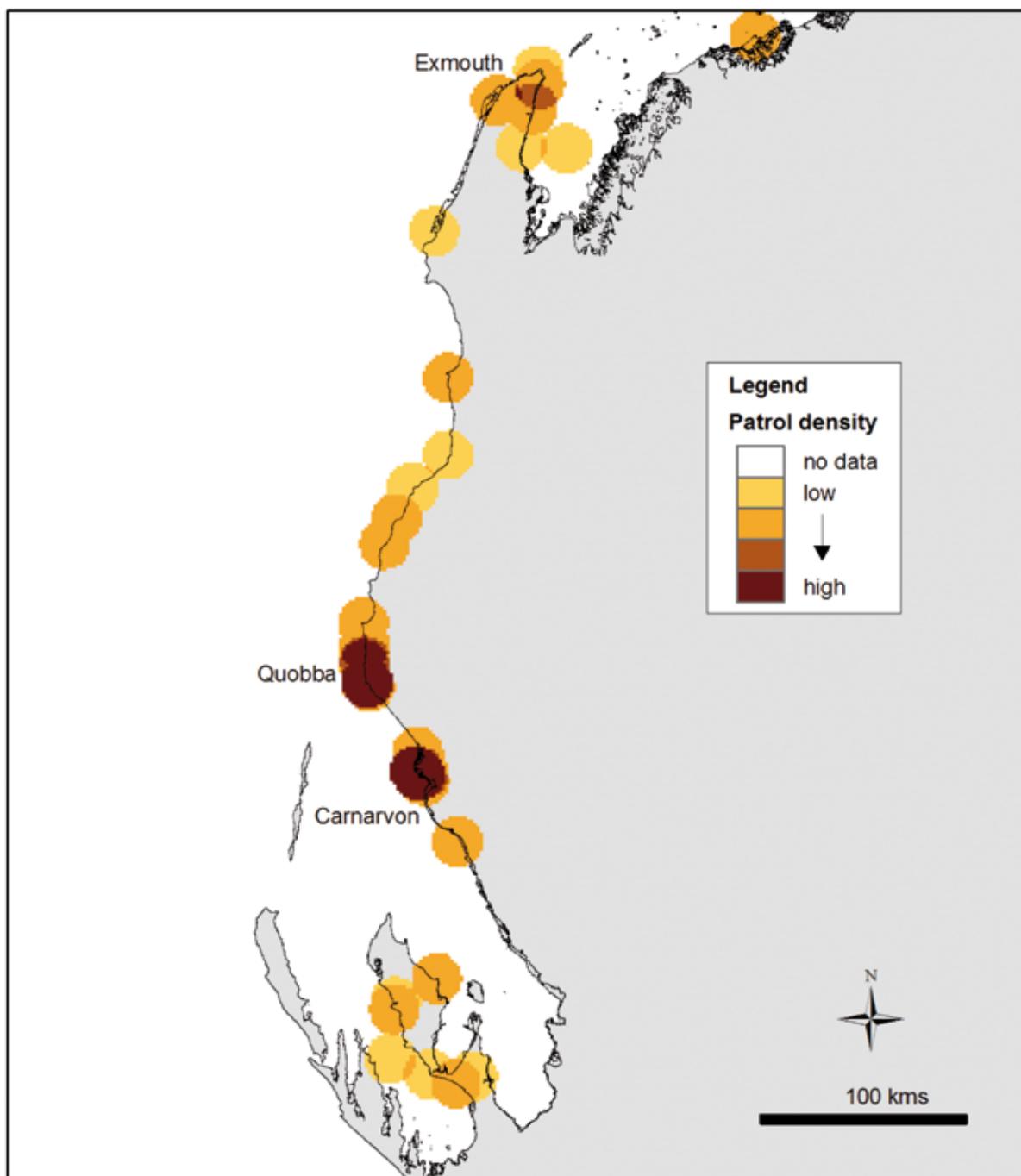
#### 3.5.2 Temporal and spatial distribution of patrols

There were a total of 401 patrols conducted in the Gascoyne bioregion from 1995 – 2007. These were mostly undertaken in and around the town of Carnarvon where the most popular locations were the 1 Mile and Prawn Jetties (Figure 20). The Quobba boat ramp, beaches and blowholes as well as Exmouth were also frequently visited during patrols.

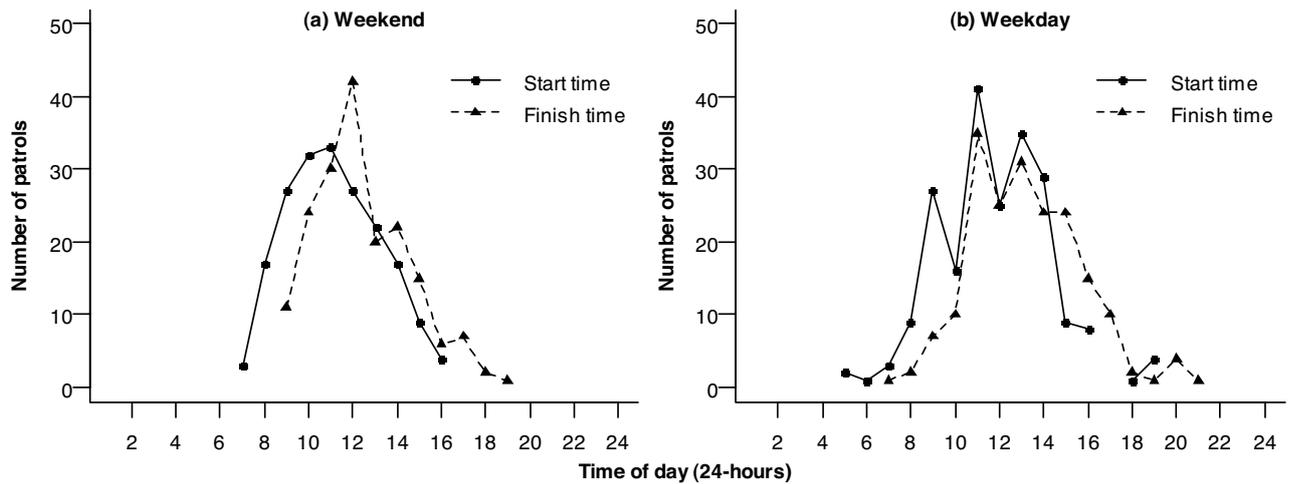
In the Gascoyne bioregion the VFLOs conducted a similar number of patrols on both weekends and weekdays (Figure 21). The most popular times for commencing patrols on weekdays

were between 9 am and 1 pm. Although most patrols commenced between 9 am and 11 am on weekends, the higher peak for patrol finishing times at noon suggests there were patrols for which this information was not recorded. The peak time for patrols within the Gascoyne bioregion was April to August, with 73% of patrols conducted within these months.

There was an average of 2 interviews/patrol ( $SD = 2.5$ ) in the Gascoyne bioregion. The highest average number of interviews/patrol occurred between 1 pm and 4 pm on both weekdays and weekends.



**Figure 20.** Distribution of patrols conducted by VFLOs within the Gascoyne bioregion from 1995 – 2007.



**Figure 21.** The start and finish time of patrols conducted by VFLOs in the Gascoyne bioregion on (a) weekdays and (b) weekends from 1995 - 2007.

### 3.5.3 Characteristics of fishing groups

In the Gascoyne bioregion, 75% of groups interviewed during patrols were fishing from the shore, 19% from boats and 4% were diving. For the remaining 11% of groups, no information was recorded on whether fishing from the boat or shore. The average time spent fishing for boat-based groups was 2.8 hours ( $SD = 1.6$ ) and, for shore-based groups, 1.9 hours ( $SD = 1.3$ ) (at time of interview). The average group size was 2.4 people ( $SD = 1.3$ ), with the majority of these in the 60+ (36%) and 40 - 59 (34%) age categories (Table 9).

**Table 9.** Age of fishers interviewed on VFLO patrols from 1995 - 2007 in the Gascoyne Coast bioregion (number of interviews = 1,050).

Age (years)	Number of interviewees
0 - 19	24 (2%)
20 - 39	299 (28%)
40 - 59	353 (34%)
60 +	374 (36%)

### 3.5.4 Species composition, catch and catch rates

There were 89 species and general categories of aquatic organisms retained or released by recreational fishers in the Gascoyne bioregion (Appendix 5). The most frequently caught species by shore-based fishing groups were blue swimmer crabs, garfishes, general/sand whiting, silver bream and mulloway (*Argyrosomus hololepidotus*). For boat-based fishing groups the main species were western rock lobster, pink snapper, spangled emperor (*Lethrinus nebulosus*), blue swimmer crabs and stripey seaperch (*Lutjanus carponotatus*). The species composition in the creel survey conducted by Sumner *et al.* (2002) differ somewhat from that found by the VFLOs, with blue-line emperor most frequently caught by boat-based anglers and whiting (general species) by shore-based anglers. The small number of patrols in the Gascoyne bioregion resulted in insufficient data being available to generate a time series for the catch rates of these main species.

## 3.6 Pilbara/Kimberley bioregion

### 3.6.1 Summary of activities

There were 22 VFLOs who participated in volunteer activities throughout the Pilbara/Kimberley bioregion from 1995 - 2007. They spent 20 days conducting activities, the majority of which were events (8 days) and patrols (7 days) (Table 10). There were no program, research or other activities recorded as being completed by VFLOs in this bioregion during the life of the program.

**Table 10.** Total number of days spent on each activity type, mean activity length and number of contacts conducted by VFLOs in the Pilbara/Kimberley bioregion from 1995 – 2007.

Activities	Total number of days (1 day = 24-hours)	Mean activity length (hours)	Mean number of contacts
Event	8	6.3	747
Patrol	7	5.5	20
Various*	3	5.1	34
Training	1	5.2	n/a
Meeting	<1	2	n/a
Presentation	<1	2	n/a
Program	0	0	0
Other	0	0	0
Research*	0	0	0

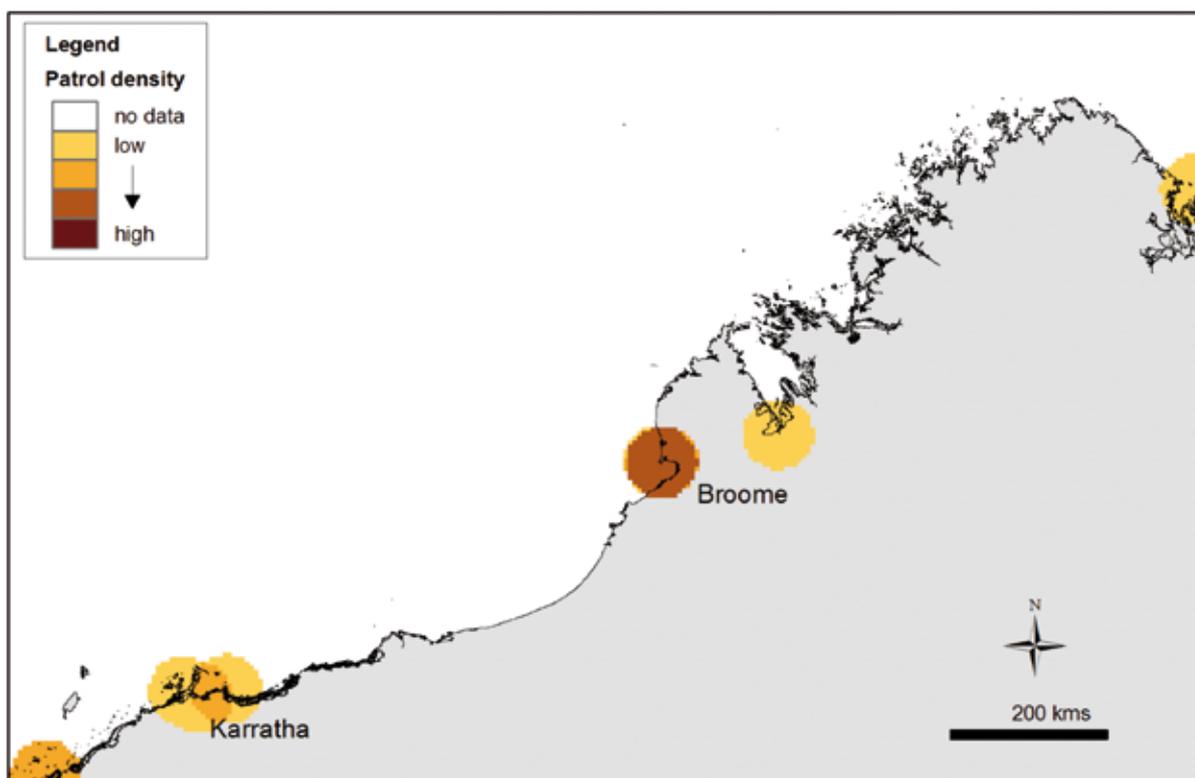
\* categories incorporated into 'other' after 2003

### 3.6.2 Temporal and spatial distribution of patrols

There were 31 patrols conducted in the Pilbara/Kimberley bioregion. These were undertaken predominantly in Broome, Dampier and Karratha, with negligible activity in all other locations. The most popular locations for patrols were the Broome Jetty and Entrance Point (Figure 22).

The paucity of data from the Pilbara/Kimberley bioregion made it difficult to interpret patrol data. Weekday patrols all commenced between noon and 4 pm, however, there were no finish times recorded. Weekend patrols all occurred between 6 am and 6 pm. The peak time for patrols by VFLOs in this bioregion was between July and September, with 64% of patrols conducted in this period.

There was an average of 2.8 interviews/patrol ( $SD = 2.4$ ) in the Pilbara/Kimberley bioregion. The highest number of interviews/patrol occurred in the late afternoon and early evening.



**Figure 22.** Distribution of patrols conducted by VFLOs within the Pilbara/Kimberley bioregion from 1995 – 2007.

### 3.6.3 Characteristics of fishing groups

Interviews by VLFOs in the Pilbara/Kimberley bioregion showed groups were divided almost evenly between boat-based (49%) and shore-based (43%) fishing. The remaining 8% of interviews had no information recorded on their fishing platform. The mean group size was 2.9 people ( $SD = 1.4$ ) and mean fishing time 3.7 hours ( $SD = 1.9$ ) for boat-based groups at the completion of fishing trips, while for shore-based groups mean group size was 1.8 people ( $SD = 0.9$ ) with a mean fishing time of 1.5 hours ( $SD = 1.0$ ) at time of interview. Most of the interviewees were in the 20 - 39 age category (Table 11).

**Table 11.** Age of fishers interviewed on VFLO patrols from 1995 - 2007 in the Pilbara/ Kimberley bioregion (number of interviews = 76).

Age (years)	Number of interviewees
0 – 19	3 (4%)
20 – 39	40 (53%)
40 – 59	23 (30%)
60 +	10 (13%)

### 3.6.4 Species composition, catch and catch rates

There were 36 species and general categories of aquatic organisms recorded as retained or released by recreational fishers in the Pilbara/Kimberley bioregion (Appendix 5). The main species caught by shore-based respondents were unknown species and garfishes. For boat-based anglers, the main species were stripey seaperch, blue-lined emperor (black snapper)

(*Lethrinus laticaudis*), blue-spotted emperor (*Lethrinus punctulatus*), bluenose threadfin salmon (*Eleutheronema tetradactylum*) and fingermark bream (*Lutjanus johnii*). Due to the small number of patrols in this bioregion, there was insufficient data to generate a time series for the catch rates of these species. The main species recorded by VFLOs differs from that in the creel survey by Williamson *et al.* (2006), where mullet (general) and blue swimmer crabs were the most frequently caught species by shore and boat-based recreational fishers, respectively.

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## 4.0 Discussion

The majority of VFLOs were based in the West Coast bioregion and, as a result, the information collected during patrols was predominantly obtained from interviewees recreationally fishing from boats and the shore in this area (>500 days, compared to <100 days of patrols in all other bioregions). As VFLOs are generally keen recreational fishers, their past experiences may influence or determine the location of these patrols, noting that there were some localities which were re-visited on >50 occasions. Maps of patrol densities shown throughout the report indicate most patrols were undertaken within, or adjacent to large population centres, such as Perth Metropolitan Area, Mandurah, Carnarvon and Albany.

There were a number of uncertainties associated with the sampling method used by VFLOs to collect information from groups involved in recreational fishing. These stemmed primarily from the lack of stratification in patrol times, as they were not undertaken randomly across a day or on different day types. As a consequence, all interviewees who were shore-based crabbing in the Peel/Harvey Estuary during the targeted survey (January – April 2007) were interviewed prior to 12 noon. VFLOs generally have good knowledge of popular fishing locations in their local area and may target these areas where (and when) they know recreational fishing occurs. This may bias catch rates as some fishing areas and times of year for which fishing is known to be more productive and may have been sampled more frequently.

Catch rates were summarised annually for the main species caught in each bioregion from 1995 - 2007. This highlighted some trends, however, for many species it was difficult to determine whether this was representative of actual catch rates, or simply due to the low sample sizes and non-standardised (unstratified) sampling schedules. The species composition obtained by the VFLOs in each bioregion generally reflected that recorded in previous surveys of recreational fishers using creel and bus route methods (Ayvazian *et al.*, 1997; Sumner and Williamson, 1999; Sumner *et al.*, 2002; Williamson *et al.*, 2006; Smallwood and Sumner, 2007), particularly in the West and South Coast bioregions. However, the Gascoyne and Pilbara/Kimberley bioregions, with less volunteers and smaller sample sizes, obtained different species composition when compared to data collected using creel surveys.

The flexible nature of the VFLO program may be responsible for the large variation in number of patrols across years and this, in turn, results in substantial variation in sample sizes during this same time scale. These variations in activity were clearly identified when comparing the number of days of activities completed in each year. Conversely, it may be possible to make inter-annual comparisons in catch rates between locations with larger sampling effort (i.e. the Perth metropolitan area or Mandurah), as although there are biases in data collection techniques, this method was consistent across all years.

For regions such as Mandurah, with larger sample sizes, it was possible to dissect the data on a finer spatial scale by utilizing data collected in a targeted survey of fishers by VFLOs from January – April 2007. Recreational crabbing in the Peel/Harvey Estuary was used as a case study for this analysis. There were more people recorded crabbing from boats than from the shore, and these groups were using predominantly drop nets and scoop nets, respectively. The catch rates of blue swimmer crabs from both these platforms had been exhibiting a declining trend since 1995, supporting anecdotal evidence from the community. Additional spatial data on the location of crabbing in the estuary, collected by VFLOs during early 2007, found that most activity was concentrated in the Peel Inlet.

It was difficult to directly compare the catch rates based upon information collected by VFLOs with those calculated in other recreational surveys. Total effort and catch could not be calculated using VFLO data due to the non-standardised sampling regime. Estimates such as catch rate are also represented as another unit of measurement (e.g. kg/pot lift). However, for recreational crabbing in the Peel/Harvey Estuary catch rates from creel survey estimates were re-calculated in a comparable unit of measurement. This demonstrated the potential for comparing between single creel survey data points and the longitudinal VLFO dataset. Boat-based crabbing catch rate in the Peel/Harvey Estuary was also calculated using two units of measurement (crabs/potting hour and crabs/person/potting hour). The parallel trends were shown across years by these methods although patterns are less marked using crabs/person/potting hour due to the inclusion of number of fisher in each group into the calculation.

It was difficult to determine the species being targeted by recreational fishers interviewed by VLFOs as this was not directly recorded on log sheets. This was determined using information such as gear or pot type to determine whether a group was fishing or crabbing. If this could not be assigned, due to incomplete data, that interview was excluded from analysis, resulting in the exclusion of 1.6% of interviews with shore groups and 6.2% of interviews with boat groups. This increased the precision of catch rates and reduced the likelihood of underestimating these values as, when using this method, only fishers targeting a particular species were incorporated.

The validation of data collected by VFLOs was undertaken as thoroughly as possible. If there was doubt about details recorded on the log sheets during patrols and interviews, it was excluded from the analysis. Some interviews were excluded from the calculations as they were not completed correctly or were incomplete and this resulted in 12% of interviews being excluded from analysis. This issue highlights the need for ongoing training and improving knowledge in the importance of completing all data fields on each form. Essential fields on the log sheets required for calculating catch rates were; species targeted, time spent fishing, number of people fishing, location, date and catch (number of retained and released fish) information.

The focus of the VLFO program has now shifted away from patrols and interviews to focus on educational activities. However, if patrol activities were re-established within the program there is additional information that could be collected, with little effort, to increase the robustness of patrol data for fisheries research. This includes;

- collecting random samples of fish/invertebrate lengths which could be used to determine the weight of recreational catches and the number of undersize fish retained,
- identifying what species groups are targeting to allow a more accurate calculation of catch rate (as applied in the modified log sheets for the Peel/Harvey Estuary),
- encouraging the collection of more species specific information, rather than applying general groupings to family level; and

- collecting information on the type of environment or location in which groups were fishing, especially for boat-based groups, as it is difficult to determine this (especially if interviewed at a boat ramp where there is nearby access to both an oceanic and estuarine environment).

The contact sheet still being used by VFLOs to record hours spent on each activity is well structured and there are few problems entering and extracting data from the database. The log (interview) sheet could be simplified, with some fields being removed as they are infrequently completed by the VFLOs or there is some confusion as to what data is actually being recorded. Training, or a structured system for passing on information (such as the current VFLO newsletter), may be useful to distribute information to VFLOs and a structured sampling system could be implemented for popular patrol locations which would help minimise some of the biases inherent with the current method and provide a more accurate indication of catch rate trends in Western Australia.

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## **5.0 Conclusions**

This analysis of VFLO data has provided a summary of activities completed by volunteers from 1995 – 2007. In this time, VFLOs undertook >2,000 days of activities throughout Western Australia, which were focused in the Perth metropolitan area, Mandurah and coastal centres in regional locations, such as Carnarvon or Albany. In all bioregions, patrols (which were the focus of this report) and events were the most frequently conducted activity. Although patrols and their associated interviews with recreational fishers have been discontinued in the VFLO program, they produced a longitudinal dataset from which information, such as the main species caught and some catch rates, could be extracted. Although the sample sizes were very small in some areas, and the unstructured nature of data collection resulted in inherent biases, the case study of recreational crabbing in the Peel/Harvey Estuary demonstrated that these data are able to provide catch rate trends over time if specific objectives are addressed through some level of scheduling (i.e. stratification of time of day and selection of predetermined locations). This information was able to provide data for areas and periods of time where other data were not available and identify a need for additional research in the estuary.

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## Appendix 2 Log (interview) sheet used by VFLOs during interviews with recreational fishers throughout Western Australia.

Sheet ..... of .....



**FISHERIES**  
WESTERN AUSTRALIA

### VFLO Interview Log Sheet

	Fisher Number	1	2	3	4																										
VFLOs: _____	Time of interview																														
Date: ____/____/____	Time spent fishing (decimal hours)																														
Location: _____	Age group																														
Start time: _____	Sex																														
End time: _____	Postcode																														
VFLO Boat: <input type="checkbox"/>	Member angling club (Y/N)																														
No. of Shore fishers: _____	Boat/Shore/Dive/sNorkel																														
	Number in group																														
No. of Boat Trailers: _____	Number of persons fishing																														
	Number of lines used																														
	Gear (Number and Type)																														
	Species 1																														
	Total number kept																														
	Number released																														
	Number undersize kept																														
	Species 2																														
	Total number kept																														
	Number released																														
	Number undersize kept																														
	Species 3																														
	Total number kept																														
	Number released																														
	Number undersize kept																														
	Species 4																														
	Total number kept																														
	Number released																														
	Number undersize kept																														
	Species 5																														
	Total number kept																														
	Number released																														
	Number undersize kept																														
	Boat Registration Number																														
<p><b>WIND</b></p> <table border="1" style="width: 100%; text-align: center; font-size: small;"> <tr> <th>Calm</th> <th>Light</th> <th>Mod</th> <th>Strong</th> <th>Gale</th> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </table> <p>Direction: _____</p> <p><b>WATER</b></p> <table border="1" style="width: 100%; text-align: center; font-size: small;"> <tr> <th>Calm</th> <th>Slight</th> <th>Mod</th> <th>Rough</th> <th>V. Rough</th> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </table> <p><b>CLOUD COVER &amp; RAINFALL</b></p> <table border="1" style="width: 100%; text-align: center; font-size: small;"> <tr> <th>Cloud %</th> <th>Nil</th> <th>Light</th> <th>Moderate</th> <th>Heavy</th> </tr> <tr> <td></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> </tr> </table> <p>Shore-based contacts (TALLY): _____</p> <p>Boat contacts (TALLY): _____</p> <p><b>LENGTHS OF RANDOM SAMPLE (mm)</b></p> <p>Species: _____</p> <p>Lengths: _____</p>	Calm	Light	Mod	Strong	Gale	1	2	3	4	5	Calm	Slight	Mod	Rough	V. Rough	1	2	3	4	5	Cloud %	Nil	Light	Moderate	Heavy		1	2	3	4	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center; margin: 0;"><b>Gear Types</b></p> <p style="margin: 0;">DR: Drop net (crab or marron)</p> <p style="margin: 0;">SE: Set (or gill) net</p> <p style="margin: 0;">HA: Haul (or drag) net</p> <p style="margin: 0;">CA: Cast (or throw) net</p> <p style="margin: 0;">PO: Pot (rock lobster)</p> <p style="margin: 0;">SC: Scoop (crab, prawn or marron)</p> <p style="margin: 0;">SN: Snare (rock lobster or marron)</p> <p style="margin: 0;">HO: Hook (rock lobster or crab)</p> <p style="margin: 0;">SP: Spear</p> </div> <p><b>Issues/Comments:</b></p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>
Calm	Light	Mod	Strong	Gale																											
1	2	3	4	5																											
Calm	Slight	Mod	Rough	V. Rough																											
1	2	3	4	5																											
Cloud %	Nil	Light	Moderate	Heavy																											
	1	2	3	4																											
	NB: Contacts - fishers or prospective fishers spoken to but not interviewed in detail																														

**Appendix 3 Log (interview) sheet used by VFLOs during interviews with recreational fishers in the Peel/Harvey Estuary during the VFLO Blue Swimmer Crab survey from January – April 2007.**

Sheet ..... of .....



**2006/07 VFLO BLUE SWIMMER CRAB SURVEY**

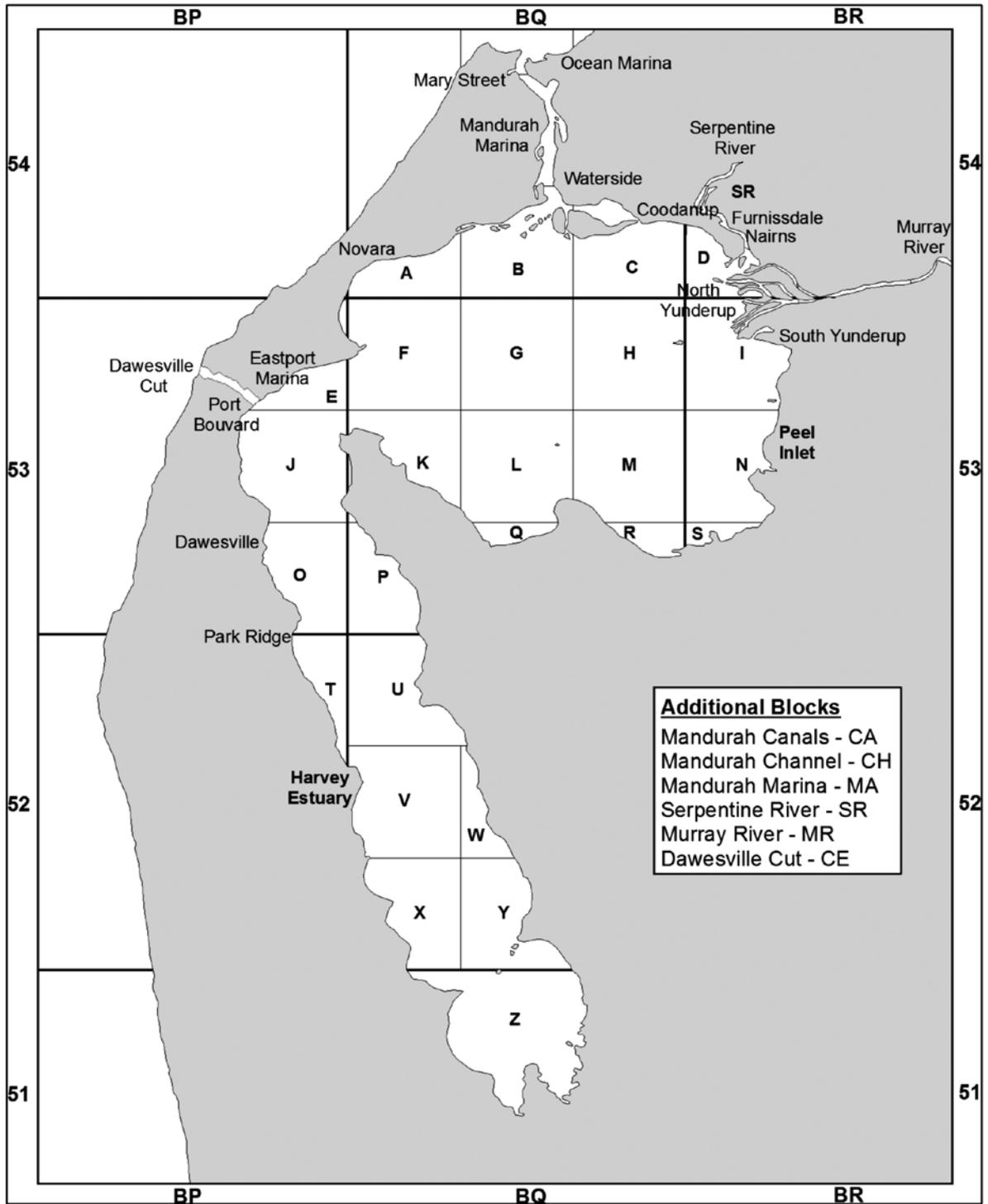
**Interview Log Sheet**



VFLOs:	Fisher Number	1	2	3	4
DATE: ____ / ____ / ____	Time of interview				
BOAT RAMP / SHORE ZONE / PUNT ZONE: _____	Boat/Shore/Dive/Snorkel				
START TIME: ____ : ____	Number in group				
END TIME: ____ : ____	Number in group fishing				
VFLO BOAT USED (Y/N): _____	Age of interviewee				
	Time started fishing				
	Total time spent fishing (dec hours)				
	Time spent crabbing (dec hours)				
	Location of fishing (transect letter)				
	Gear (Number & Type)				
NUMBER OF BOAT TRAILERS:	Number of fishing lines used				
ON ARRIVAL: _____	Boat registration number				
ON DEPARTURE: _____	Home Postcode of interviewee				
	Knowledge - Bag limit				
	of crabbing - Boat limit				
	rules (Y/N): - Minimum size limit				
NUMBER OF SHORE FISHERS:	<b>Male crabs</b>				
	Total number kept				
	Number size released				
SHORE BASED CONTACTS (TALLY):	Number undersize released				
	<b>Female crabs</b>				
	Total number kept				
	Number berried released				
	Number size released				
	Number undersize released				
BOAT BASED CONTACTS (TALLY):	<b>Species 2</b>				
	Total number kept				
	Number released				
<b>WIND CONDITIONS</b>	<b>Species 3</b>				
DIRECTION: _____	Total number kept				
CALM   LIGHT   MOD.   STRONG   GALE	Number released				
<b>WATER CONDITIONS</b>	<b>Species 4</b>				
CALM   SLIGHT   MOD.   ROUGH   V. ROUGH	Total number kept				
	Number released				
CLOUD COVER (%): _____	<b>Species 5</b>				
<b>RAINFALL</b>	Total number kept				
NIL   LIGHT   MODERATE   HEAVY	Number released				
<b>Gear Types</b>		Issues / Comments :			
DR : Drop Net (crab or marron)	SE : Set (or gill) net				
HA : Haul (or drag) net	SC : Scoop (crab, prawn or marron)				
CA : Cast (or throw) net	SN : Snare (rock lobster or marron)				
PO : Pot (rock lobster)	HO : Hook (rock lobster or crab)				

NB: Contacts – fishers or prospective fishers spoken to but not interviewed in detail

**Appendix 4 Location of standard 1.6 x 1.6 nautical mile blocks throughout the Peel/Harvey Estuary from which recreational fishers identified their fishing location during the VFLO Blue Swimmer Crab survey from January – April 2007.**



**Appendix 5 List of species retained and/or released in each bioregion by shore and boat-based recreational fishers interviewed by VFLOs from 1995 to 2007.**

Common Name	Scientific Name	Pilbara/ Kimberley	Gascoyne	West Coast	South Coast
Abalone, Brown-Lipped	<i>Haliotis conicopora</i>			✓	✓
Abalone, Roe's - General	<i>Haliotis roei</i>			✓	
Amberjack	<i>Seriola dumerili</i>			✓	
Anchovy, Australian	<i>Engraulis australis</i>			✓	
Barracuda	<i>Sphyraena barracuda</i>		✓		
Barramundi	<i>Lates calcarifer</i>	✓			
Batfishes, general	Family Ephippidae			✓	
Blackfish, Western Rock (Chad)	<i>Girella tephraeops</i>			✓	
Blowfish, Common	<i>Torquigener pleurogramma</i>			✓	
Blowfish, Northwest (Silver Toadfish)	<i>Lagocephalus sceleratus</i>			✓	
Blue Devil, Western	<i>Paraplesiops meleagris</i>			✓	
Bonito, Leaping	<i>Cybiosarda elegans</i>			✓	
Bonito, Oriental	<i>Sarda orientalis</i>			✓	
Bonitos, general	<i>Scombridae</i> spp.			✓	✓
Bottom fish				✓	
Boxfish/Cowfish	Family Ostraciidae			✓	✓
Bream, Black	<i>Acanthopagrus butcheri</i>			✓	✓
Bream, Fingermark	<i>Lutjanus johnii</i>	✓			
Bream, Monocle	<i>Scolopsis monogramma</i>		✓		
Bream, Silver (Tarwhine)	<i>Rhabdosargus sarba</i>	✓	✓	✓	✓
Bream, Western Yellowfin	<i>Acanthopagrus latus</i>		✓	✓	
Buffalo Bream, Common	<i>Kyphosus sydneyanus</i>			✓	✓
Buffalo Bream, Western	<i>Kyphosus cornelii</i>			✓	
Butterfish, Western	<i>Pentapodus vitta</i>		✓	✓	
Cale, Herring	<i>Odax cyanomelas</i>			✓	
Cardinalfish, Red-Striped	<i>Apogon victoriae</i>			✓	
Catfish, general	Family Ariidae	✓	✓		
Cobbler	<i>Cnidoglanis macrocephalus</i>			✓	✓
Cobia	<i>Rachycentron canadus</i>		✓	✓	
Cockle	<i>Anadara and katelysia</i> spp.				✓
Cod, Breaksea (Black-arse Cod)	<i>Epinephelides armatus</i>			✓	✓

Common Name	Scientific Name	Pilbara/ Kimberley	Gascoyne	West Coast	South Coast
Cod, Chinaman	<i>Epinephelus rivulatus</i>	✓	✓	✓	
Cod, Estuary/Slimy Cod	<i>Epinephelus coioides</i>		✓		
Cod, Flowery	<i>Epinephelus fuscoguttatus</i>		✓		
Cods, general	Family Serranidae	✓	✓	✓	✓
Crab, Blue manna	<i>Portunus pelagicus</i>		✓	✓	✓
Crab, Mud Green	<i>Scylla serrata</i>	✓	✓		
Crab, Sand	Family Portunidae		✓		
Crabs, general				✓	
Cuttlefish	Family Sepiidae			✓	
Dart, Black-Spotted	<i>Trachinotus bailloni</i>		✓		
Dart, Common	<i>Trachinotus botla</i>		✓	✓	
Dart, general	<i>Trachinotus</i> spp.		✓	✓	
Dhufish, Western Australian	<i>Glaucosoma hebraicum</i>			✓	✓
Drummers/Buffalo Breams, general	Family Kyphosidae			✓	
Eel, Serpent	<i>Ophisurus serpens</i>			✓	
Eels, general	<i>Gymnothorax</i> spp.		✓	✓	
Emperor, Blue-Lined (Black Snapper)	<i>Lethrinus laticaudis</i>	✓	✓		
Emperor, Blue-spotted	<i>Lethrinus punctulatus</i>	✓	✓		
Emperor, Red	<i>Lutjanus sebae</i>	✓	✓	✓	
Emperor, Spangled	<i>Lethrinus nebulosus</i>		✓		
Emperor, Sweetlip (Red Throat)	<i>Lethrinus miniatus</i>	✓	✓	✓	
Emperors, general	Family Lethrinidae		✓	✓	
Flathead, Bar-tailed	<i>Platycephalus endrachtensis</i>		✓	✓	
Flatheads, general	Family Platycephalidae		✓	✓	✓
Flounder, Large-Toothed	<i>Pseudorhombus arsius</i>			✓	
Flounders, general	Family Bothidae		✓	✓	✓
Foxfish, Western	<i>Bodianus frenchii</i>			✓	✓
Frogfishes	<i>Batrachoididae</i>			✓	
Fusiliers, Jobfishes	Family Caesionidae	✓			
Garfish, Robust	<i>Hemiramphus robustus</i>		✓	✓	
Garfish, Southern Sea	<i>Hyporhamphus melanochir</i>			✓	✓
Garfishes	Family Hemiramphidae	✓	✓	✓	✓
Goatfish, general	Family Mullidae			✓	✓
Gobbleguts	<i>Apogon rueppellii</i>			✓	

Common Name	Scientific Name	Pilbara/ Kimberley	Gascoyne	West Coast	South Coast
Grinner, Painted	<i>Trachinocephalus myops</i>			✓	
Groper, Baldchin	<i>Choerodon rubescens</i>		✓	✓	✓
Groper, Western Blue	<i>Achoerodus gouldii</i>			✓	
Gurnards, general	Family Triglidae			✓	
Hardyheads/Silversides, general	Family Atherinidae		✓		
Harlequin Fish	<i>Othos dentex</i>			✓	✓
Herring, Australian	<i>Arripis georgianus</i>			✓	✓
Herring, Perth	<i>Nematalosa vlaminghi</i>			✓	
Javelinfishes, general	<i>Pomadasys</i> spp.	✓			
John Dory	<i>Zeus faber</i>			✓	
Kingfish, Black-Banded	<i>Seriolina nigrofasciata</i>			✓	
Kingfish, Yellowtail	<i>Seriola lalandi</i>			✓	✓
Leatherjacket, Chinaman	<i>Nelusetta ayraudi</i>			✓	
Leatherjackets, general	Family Monacanthidae		✓	✓	✓
Lizardfishes/Grinners, general			✓	✓	
Longtoms, general	Family Belonidae		✓	✓	
Mackerel, Australian Spotted	<i>Scomberomorus munroi</i>	✓	✓		
Mackerel, Blue	<i>Scomber australasicus</i>			✓	
Mackerel, Broad-Barred Spanish	<i>Scomberomorus semifasciatus</i>		✓		
Mackerel, Narrow-Barred Spanish	<i>Scomberomorus commerson</i>	✓	✓	✓	
Mackerel, Queensland School	<i>Scomberomorus queenslandicus</i>				✓
Mackerel, Scaly	<i>Sardinella lemuru</i>			✓	
Mackerels, general	Family Scombridae			✓	✓
Mackerels/Tunas, general	Family Scombridae		✓	✓	
Mangrove Jack	<i>Lutjanus argentimaculatus</i>	✓	✓		
Marron	<i>Cherax tenuimanus</i>			✓	
Milkfish	<i>Chanos chanos</i>		✓		
Monkeyfish	<i>Erosa erosa</i>	✓			
Moonfish	<i>Mene maculate</i>			✓	
Morwong, Dusky	<i>Dactylophora nigricans</i>			✓	
Morwongs, general	Family Cheilodactylidae			✓	
Mullet, Sea	<i>Mugil cephalus</i>		✓	✓	✓
Mullet, Yellow Eye (Pilch)	<i>Aldrichetta forsteri</i>			✓	✓

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Mulletts, general	Family Mugilidae		✓	✓	✓
Mulloway	<i>Argyrosomus hololepidotus</i>	✓	✓	✓	✓
Mussels	<i>Mytilus</i> , spp.			✓	
Octopus, general				✓	✓
Parrotfish, Dusky	<i>Scarus prasiognathus</i>		✓		
Parrotfish, Ember	<i>Scarus rubroviolaceus</i>		✓		
Parrotfish, General	Family Scaridae			✓	
Perch, Redfin (European)	<i>Perca fluviatilis</i>			✓	
Pike, Long-finned	<i>Dinolestes lewini</i>			✓	
Pilchard (Mullie)	<i>Sardinops neopilchardus</i>			✓	✓
Pomfret, Woodward's	<i>Schuetta woodwardi</i>			✓	
Prawn, River	<i>Metapenaeus dalli</i>			✓	
Prawn, Western King	<i>Penaeus latisulcatus</i>			✓	
Pufferfishes, Toadfishes And Tobies	Family Tetraodontidae			✓	
Queenfish, Needleskin	<i>Scomberoides tol</i>				✓
Queenfishes, general	<i>Scomberoides</i> spp.		✓	✓	✓
Ray, Eagle	<i>Myliobatis australis</i>			✓	✓
Ray, Southern Fiddler	<i>Trygonorhina fasciata</i>			✓	
Ray, Southern Shovelnose	<i>Aptychotrema vincentiana</i>			✓	
Rays, general	Order rajiformes			✓	
Rays, Shovelnose, general	Family Rhinobatidae			✓	
Rock Lobster, Southern	<i>Jasus edwardsii</i>			✓	
Rock Lobster, Western	<i>Panulirus cygnus</i>		✓	✓	
Rockcod, Rankin's (White- Blotched)	<i>Epinephelus multinotatus</i>		✓		
Salmon, Australian	<i>Arripis truttaceus</i>			✓	✓
Samson Fish/Sea Kingfish	<i>Seriola hippos</i>			✓	✓
Sawshark, Common	<i>Pristiophorus cirratus</i>			✓	
Scad	<i>Decapterus</i> spp.			✓	✓
Scad, Yellowtail	<i>Trachurus novaezelandiae</i>		✓	✓	✓
Scorpioncod, Western Red	<i>Scorpaena sumptuosa</i>			✓	
Sea Carp, Western	<i>Aplodactylus westralis</i>		✓		
Seaperch, Dark-Tailed (Maroon Perch)	<i>Lutjanus lemniscatus</i>		✓		
Seaperch, Saddle-tailed (Scarlet)	<i>Lutjanus malabaricus</i>	✓			

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Seaperch, Striped	<i>Lutjanus vitta</i>		✓		
Seaperch, Stripey (Spanish Flag)	<i>Lutjanus carponotatus</i>	✓	✓	✓	
Seaperches, General	Family Serranidae	✓	✓	✓	✓
Seapikes/Barracuda/Snook, general	Family Sphyrnidae			✓	
Sergeant Baker	<i>Aulopus purpurissatus</i>			✓	✓
Shark, Black-tip Reef	<i>Carcharhinus melanopterus</i>		✓		
Shark, Bronze Whaler	<i>Carcharhinus brachyurus</i>		✓	✓	✓
Shark, general		✓	✓	✓	✓
Shark, Gummy	<i>Mustelus antarcticus</i>		✓	✓	
Shark, Gummy/School/Pencil, general	Family Triakidae			✓	
Shark, Port Jackson	<i>Heterodontus portusjacksoni</i>		✓	✓	✓
Shark, School	<i>Galeorhinus galeus</i>			✓	
Shark, Smooth Hammerhead	<i>Sphyrna zygaena</i>			✓	
Shark, Tiger	<i>Galeocerdo cuvieri</i>		✓		
Shark, Whalers, general	Family Carcharhinidae			✓	
Shark, Whiskery	<i>Furgaleus macki</i>			✓	
Sharks, Hammerhead	<i>Sphyrna</i> spp.		✓	✓	
Sharks, Horn	Family Heterodontidae			✓	
Snapper, Pale	<i>Etelis radiosus</i>			✓	
Snapper, Pink	<i>Pagrus auratus</i>		✓	✓	✓
Snapper, Queen (Blue Morwong)	<i>Nemadactylus valenciennesi</i>			✓	✓
Snapper, Red (Nannygai)	<i>Centroberyx gerrardi</i>			✓	✓
Snappers/Bream, general	Family Sparidae		✓	✓	✓
Snook	<i>Sphyrna novaehollandiae</i>			✓	✓
Spinefoot, Black	<i>Siganus fuscescens</i>		✓		
Squids, general	Family Cephalopodidae		✓	✓	✓
Stingrays, general	Family Dasyatidae			✓	
Stonefish, Estuarine	<i>Synanceia horrida</i>			✓	
Sunfish, Oblong	<i>Ranzania laevis</i>			✓	
Swallowtail	<i>Centroberyx lineatus</i>		✓	✓	✓
Sweep, Banded	<i>Scorpius georgianus</i>			✓	✓
Sweep, Footballer	<i>Neatypus obliquus</i>			✓	

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Sweep, Sea	<i>Scorpius aequipinnis</i>			✓	✓
Sweetlips, general	Family Haemulidae			✓	
Sweetlips, Painted	<i>Diagramma labiosum</i>	✓			
Tailor	<i>Pomatomus saltatrix</i>		✓	✓	✓
Threadfin Salmon - General	Family Polynemidae	✓	✓	✓	
Threadfin Salmon, Bluenose	<i>Eleuthronema tetradactylum</i>	✓			
Threadfin-Breams/ Butterfishes/Monocle Breams	Family Nemipteridae		✓	✓	
Trevallies, general	Family Carangidae	✓		✓	✓
Trevally, Black Crested	<i>Ulua aurochs</i>		✓		
Trevally, Bludger	<i>Carangoides gymnostethus</i>	✓			
Trevally, Giant	<i>Caranx ignobilis</i>		✓		
Trevally, Golden	<i>Gnathanodon speciosus</i>	✓	✓	✓	
Trevally, Gold-Spotted/ Turrum	<i>Carangoides fulvoguttatus</i>	✓	✓		
Trevally, Sand	<i>Pseudocaranx wrighti</i>			✓	
Trevally, Skipjack/Silver	<i>Pseudocaranx dentex</i>		✓	✓	✓
Trevally, White-tongued	<i>Carangoides talamparoides</i>	✓			
Trout (Freshwater)	<i>Oncorhynchus mykiss</i> & <i>Salmo trutta</i>			✓	
Trout, Bar-cheeked Coral	<i>Plectropomus maculatus</i>	✓			
Trout, Brown	<i>Salmo trutta</i>			✓	
Trout, Coral	<i>Plectropomus leopardus</i>	✓	✓	✓	
Trout, Coronation	<i>Variola louti</i>		✓		
Trout, Rainbow	<i>Oncorhynchus mykiss</i>			✓	
Trumpeter (4 Lined)	<i>Pelates quadrilineatus</i>			✓	
Trumpeter, Sea (Stormy Perch)	<i>Pelsartia humeralis</i>			✓	
Trumpeter, Yellowtail	<i>Amniataba caudavittatus</i>			✓	
Trumpeters/Grunters, general	Family Teraponidae	✓	✓	✓	✓
Tuna, Mackerel	<i>Euthynnus affinis</i>		✓		
Tuna, Skipjack	<i>Katsuwonis pelamis</i>			✓	
Tuna, Southern Bluefin	<i>Thunnus maccoyii</i>			✓	
Tuna, Yellowfin	<i>Thunnus albacares</i>		✓		

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Tunas, General	Family Scombridae		✓	✓	
Tuskfish, Blackspot (Blue Bone)	<i>Choerodon schoenleinii</i>	✓	✓		
Tuskfish, general	Family Labridae			✓	
Unknown species		✓	✓	✓	✓
Whiting, Blue Weed	<i>Haletta semifasciata</i>			✓	
Whiting, general/Sand	Family Sillaginidae		✓	✓	✓
Whiting, King George	<i>Sillaginodes punctata</i>			✓	✓
Whiting, School Southern/ Silver	<i>Sillago bassensis</i>			✓	
Whiting, Trumpeter	<i>Sillago maculate</i>			✓	
Whiting, Western School	<i>Sillago vittata</i>			✓	✓
Whiting, Yellow-Finned (Western Sand)	<i>Sillago schomburgkii</i>		✓	✓	✓
Wirrah, Western	<i>Acanthistius serratus</i>			✓	
Wirrahs, general	<i>Acanthistius sp.</i>			✓	
Wobbegongs/Catsharks, general	<i>Orectolobus sp.</i>		✓	✓	✓
Wrasse, Brown-Spotted	<i>Pseudolabrus parilus</i>		✓	✓	✓
Wrasse, Maori	<i>Ophthalmolepis lineolatus</i>		✓	✓	
Wrasse, Red Banded	<i>Pseudolabris biserialis</i>			✓	
Wrasse, Senator	<i>Pictilabrus laticlavus</i>			✓	
Wrasse, Western King	<i>Coris auricularis</i>			✓	
Wrasse/Gropers, general	Family Labridae		✓	✓	✓
Zebra Fish	<i>Girella zebra</i>			✓	
<b>Number of Species</b>		<b>36</b>	<b>89</b>	<b>162</b>	<b>66</b>