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Fisheries and Marine Officers recreational fishing survey: 1998/99 – 2009/10

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1.0 Executive summary

Throughout Western Australia Fisheries and Marine Officers (FMOs) play a vital role in ensuring the sustainability of fish resources. Since July 1998, in the course of their other compliance activities, FMOs have collected information from recreational fishers on their catch and fishing trip. The primary objective of this report was to summarise the data collected by FMOs and ascertain the effectiveness of the convenience (i.e. unstructured) sampling technique for determining trends in recreational fishing patterns throughout Western Australia. Recreational fishing data was collected by FMOs during 6 629 land-based and boat-based patrols completed between 1998/99 – 2009/10, mostly within the West Coast bioregion. Within these patrols, 47 529 interviews were completed with boat-based groups. Catch rates were calculated for each indicator species within every bioregion, highlighting some trends across the survey period. However, for many species, especially those outside the West Coast bioregion, information on catch was not available for every financial year. This analysis found that some elements of data collection could be modified which would increase the usefulness and robustness of this data for examining the trends in recreational fishing activity across time. Utilising FMOs over trained survey staff in structured sampling designs is advantageous in that they are able to obtain information on illegal catch while their deployment for this work is also likely to be cost-effective, as it can be incorporated into their existing fieldwork components. However, the main challenge for implementing such a sampling design, whether ongoing or for meeting a specific data need, is ensuring that it will provide representative samples from anglers into a system that is structured primarily to execute compliance and education.

2.0 Introduction

Fisheries enforcement arises out of a need to ensure members of the fishing community comply with management measures. Catch and effort data for commercial fisheries are typically monitored through logbook programs and controlled by management plans regulated through legislation. Recreational fishers must adhere to a set of regulations (i.e. species specific bag and size limits) and, due to the largely open access nature of the fishery, the ongoing monitoring of the sector and its associated impacts on fish stocks is a greater challenge for fisheries managers and researchers. Fisheries and Marine Officers (FMOs) are an essential link between policy and the fisher and, in conjunction with their compliance work, they can obtain fisheries data that can be utilised by managers to assess the impacts of fishing. FMOs also have the authority to inspect all catch in the possession of recreational fishers, which can provide information on legal and illegal catch as well as on aspects of catches that may be of use for assessing the status of fish stocks.

Throughout Western Australia FMOs play a vital role in ensuring fish resources are sustainable by undertaking compliance activities such as surveillance, inspections and prosecution of offences as well as liaising with, and educating, recreational and commercial fishers on policy and management arrangements. To facilitate coverage of fishing occurring not only near large population centres, but also along remote parts of the coastline and in offshore waters, these activities are undertaken from vehicles, boats and the air. In 2009/10, approximately 105 FMOs were based around the state in 5 regional and 12 district offices (Figure 1). During this time period, FMOs contacted approximately 70 000 recreational fishers statewide (Fletcher and Santoro, 2011). In October 2010, the Department of Fisheries added an additional 13 FMOs specifically to conduct mobile patrols in an initiative to reduce pressure on fish stocks by improving public awareness of sustainability issues (DoF, 2010).

FMOs use a Daily Patrol Contacts (DPC) system to record and report on their activities during routine compliance patrols (Green and Griffiths, 2005). Benefits of this system are that field staff may undertake reviews of their activities while, at a managerial level, analysis can be undertaken to assess compliance delivery, evaluate its effectiveness and optimise allocation of enforcement effort where required (Green and McKinlay, 2009).

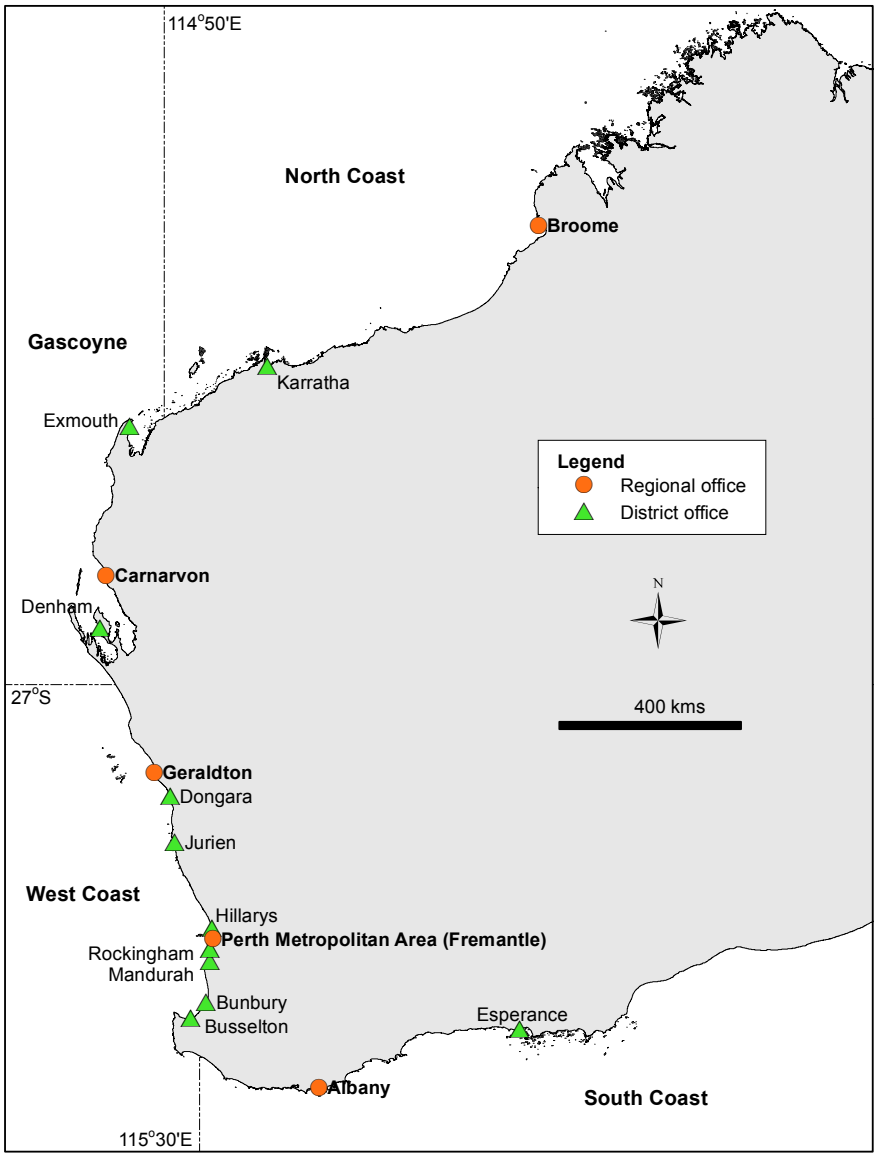

Figure 1 FMOs locations in regional and district offices.

Since July 1998, a recreational fishing contacts survey form has allowed FMOs to record information from shore or boat-based recreational fishers encountered in the course of some of their other compliance activities. Collection of such additional information during routine compliance patrols was instigated as a cost-effective method that could compliment other sources of information on recreational fishing. In 2005/06 financial year, the recreational fishing contacts form was modified and integrated with the marine safety inspection form, which was introduced to fulfil obligations with the Department of Planning and Infrastructure (DPI). These modified marine safety inspection forms were for boat-based fishers only, and therefore the collection of data on recreational fishing was also restricted to this platform. The forms were developed in consultation with the FMOs and intended to capture essential information on recreational fishing during marine safety inspections, while remaining of sufficient simplicity that they could be readily completed in the field, with minimal impact to compliance activities. Full details of the marine safety inspection forms and instructions to FMOs on the information to be collected during inspections are described in Green and Griffiths (2005).

The primary objective of this report was to summarise the data collected on boat-based recreational fishing by FMOs from 1998/99 – 2009/10. Accordingly, these data have been analysed by bioregion and financial year to include information on;

- the number of patrols and interviews completed,
- the number of interviews in which people were involved in recreational fishing,
- group size and number of fishers in each interviewed party,
- the total retained catch of each indicator species and,
- catch rates of each indicator species.

It should be noted that due to the convenience (i.e. unstructured) sampling employed by FMOs during data collection, this data could not be used to calculate weighted estimates of recreational catch and effort, such as in creel or phone surveys. The catch rates presented in this report should also be viewed with caution as rigorous validation was not an ongoing process in the earlier years and, although care was taken to remove errors and outliers, there may still be some residual inaccuracies contained within the dataset. Nonetheless, examination of the results of this cost-effective method of data collection can reveal the effectiveness of the boat-based recreational fishing data collected by FMOs for determining trends in recreational fishing patterns throughout Western Australia, which may be helpful to management.

3.0 Methods

3.1 Data collection

FMOs make contact with people on board recreational boats at various locations during the course of their normal compliance activities. Contact can occur during land-based patrols, when FMOs may be stationed at boat ramps where boats are launching and retrieving. FMOs on boat-based patrols can also approach recreational boats whilst at sea or anchored in protected waters. Due to this diversity of situations, when a recreational boat is approached by an FMO, the people on board may;

- have already completed a recreational fishing episode,
- currently be engaged in recreational fishing,
- be intending to engage in recreational fishing or,
- are not intending to engage in recreational fishing (i.e. participate in other types of recreational activities).

An FMO can choose whether or not to conduct a recreational fishing survey with any boat encountered during a land or boat-based patrol depending on the presence of any operational constraints at a given time. The completion of the recreational fishing survey form and the marine safety inspection form is only a subset of normal, higher priority FMO duties, and was not completed for every contact with a recreational fisher.

The location and time of day at which these marine safety inspections, and associated recreational fishing surveys, are conducted by FMOs is not based on a pre-defined sampling frame and, as such, it is referred to as convenience sampling. This unstructured sampling frame is due to the nature of compliance activities conducted by FMOs which may be either 'random' or 'targeted'. While no prior information influences a decision to approach a random contact, the opposite occurs for targeted contacts, which are selected if information indicates that an offence may have been committed (Green and McKinlay, 2009). Furthermore, specific locations or fisheries may also be targeted by FMOs, especially during times of peak fishing activity to undertake education and compliance activities.

Collection of recreational fishing data by FMOs began in July 1998, using a recreational fishing contacts form similar to those used in creel or bus route surveys (Table 1). Since 2005/06, information on recreational fishing has been integrated into the marine safety inspection form [see Green and McKinley (2009)]. On this form, generic fields relate to any contact with a recreational boat include date, time, location, purpose of the contact (i.e. marine safety inspection or recreational fishing survey) and number of people per boat. Specific fields which relate to the recreational fishing survey included recording the fishing activity of the people on the boat (i.e. had been fishing, will be fishing, not fishing) as well as the retained catch of indicator species (Table 2).

Table 1 Comparison of information collected on each version of the data collection sheets. Note: number of people per boat collected but not entered into database while CR indicates the data field was used in catch rate analysis.

Data fields	1998/99 – 2004/05	2005/06 – 2009/10
Bioregion	✓	✓
Platform – Boat	✓CR	✓CR
Platform – Shore/Dive/Snorkel	✓	x
Trip information (i.e. currently fishing, not fishing, will fish later)	✓CR	✓CR
Number of people per boat	✓	✓
Number of people fishing	✓	x
Gear type	✓	x
Time spent fishing	✓	x
Indicator species	✓CR	✓CR
Non-indicator species	✓	x
Number of fish retained	✓CR	✓CR
Number of fish released	✓	x

This marine safety inspection form was again modified in 2009/10 to improve future analysis and remove some of the inherent biases which occurred in the analysis of the 2005/06 data presented in the FRDC report (Wise and Fletcher, in review). Data from this most recent version of the form is not incorporated into the current analysis.

One of the biggest differences between the two forms used by FMOs to conduct recreational fishing surveys was the introduction of indicator species in 2005/06 as part of the move towards managing suites of species as a collective resource rather than focussing on a large number of individual species (DoF, 2011). Indicator species were selected in each bioregion to represent each of five suites (estuarine, nearshore, inshore demersal, offshore demersal and pelagic) based on their vulnerability to fishing and other considerations (i.e. their economic, community, recreational and cultural value) (Lenanton et al., 2006). The indicator species differed among bioregions, and four bioregion-specific versions of the marine safety inspection form were developed which listed each species (Table 2). Prior to this, data was collected by FMOs on all species retained or released by recreational fishers. Since the first introduction of indicator species on the marine safety inspection form in 2005/06, there have been some changes to the nominated species within each bioregion, and these are noted in Table 2.

The catch recorded for an indicator species is an exact count of the number retained except for whiting, blue swimmer crabs and Australian herring where the number may be estimated if a recreational boat has a large number of individuals on board. Additionally, if the number of fish caught by a recreational fisher appears to be close to the bag limit, the FMO will determine an exact count of the number of individuals of each species within the catch.

Table 2 Common and species names of indicator species within each bioregion for which catch information was collected by FMOs from 2005/2006. Note: ^ indicates species corresponds to current indicator species (DoF, 2011).

South Coast	West Coast	Gascoyne	North Coast
Bight redfish^	Western Australian Dhufish^	Spangled emperor^	Spangled emperor
Centroberyx spp.	*Glaucosoma hebraicum*	*Lethrinus nebulosus*	*Lethrinus nebulosus*
Pink snapper^	Pink snapper^	Pink snapper^	Goldband snapper^
Pagrus auratus	*Pagrus auratus*	*Pagrus auratus*	*Pristipomoides multidens*
Hapuku^	Breaksea cod	Grass emperor	Grass emperor
Polyprion oxygeneios	*Ephinephelides armatus*	*Lethrinus laticaudis*	*Lethrinus laticaudis*
Samson fish^	Baldchin groper^	Baldchin groper	Red emperor^
Seriola hippos	*Choerodon rubescens*	*Choerodon rubescens*	*Lutjanus sebae*
Australian herring^	Australian herring^	Spanish mackerel^	Spanish mackerel^
Arripis georgianus	*Arripis georgianus*	*Scomberomorus* spp.	*Scomberomorus* spp.
Queen snapper^	Tailor^	Tailor^	Threadfin (all species)^
Nemadactylus valenciennesi	*Pomatomus saltatrix*	*Pomatomus saltatrix*	Fam. Polynemidae
Western blue groper^	Blue swimmer crabs	Western yellowfin bream	Coral Trout
Achoeerodus gouldii	*Portunus pelagicus*	*Acanthopagrus latus*	*Plectropomus leopardus*
King George Whiting^	Western rock lobster	Red-throat emperor	Barramundi^
Sillaginodes punctata	*Panulirus cygnus*	*Lethrinus miniatus*	*Lates calcarifer*

3.2 Data analysis

Completed forms were sent to the Regional Services Division at the Western Australian Department of Fisheries where they were entered into a database. Incomplete or incorrect forms (i.e. a marine safety inspection form was used in the wrong bioregion, leading to incorrect indicator species being recorded) were excluded from the analysis (n = 68, <1%). Additionally, the differing versions of the datasheets necessitated the use of several decision rules during the analysis process. The aim of these rules were to standardise data across the two forms so they could provide a continuous record of FMO activities (i.e. number of patrols and interviews) and catch rate for indicator species for the entire sampling period from 1998/99 – 2009/10.

In the context of this analysis, FMO patrols are defined as any land or boat-based trip in which any version of the recreational fishing survey form or marine safety form was completed. As collection of this information forms only a subset of FMO duties, the number of patrols is not reflective of the overall activity patterns of FMOs. As only small numbers of interviews were conducted in some locations, analysis was only undertaken to the level of bioregion and financial year. A patrol may have visited multiple locations/areas within the same district on the same day.

From 1998/99 – 2004/05 information was collected from several different platforms that supported recreational fishing activity (i.e. shore, boat, snorkelling, diving) while from 2005/06 – 2009/10 information was only obtained for recreational boats (Table 1). Data on recreational boat-based fishing could therefore be standardised across the entire sampling period while information collected during the 2 379 interviews where fishing was conducted from other platforms (i.e. shore, diving, snorkelling) is only presented where available. It should be noted that it is not possible to ascertain whether diving or snorkelling is occurring from the shore or a boat.

3.2.1 Calculation of catch rates

For the state's four marine bioregion, catch rates were calculated for indicator species caught during recreational boat-based fishing trips conducted in each financial year from 1998/99 – 2009/10. The sampling unit of an FMO interview is a "trip" or "proposed trip" by a recreational boat during which either fishing activity has, is, or will be occurring, or during which no fishing activity is planned. Only those interviews in which people were still fishing (an incomplete trip), or had completed fishing, were used for catch rate analysis.

As the duration of fishing time was not consistently collected across different versions of the datasheet it was not possible to calculate catch rates per hour over the entire period (Table 1). Similarly, the number of fishers could not be used to calculate catch per person. It should also be highlighted that, as no consistent information was available on gear type (i.e. lines, pots, nets), data from all interviews occurring within a specific bioregion and financial year were used to calculate catch rate for a species, even if no catch for that species was recorded by the fishing party.

From 2005/06 the collection of species information was streamlined to only include catch data for eight indicator species in each bioregion (Table 1; Table 2). To standardise catch rate analysis across the sampling period, only information on these indicator species was extracted from the original form, with the remainder excluded from the analysis. Indicator species such as whiting in the South Coast bioregion and threadfin salmon in the North Coast bioregion actually comprise a general description for several distinct species and required further manipulation to be standardised across the two datasheets. In this situation, data collected on any of these separate species from 1998/99 – 2004/05 were recoded to match the general indicator species categories on the bioregion specific forms. Additionally, only information on retained catch was used to provide information on total catch and to calculate catch rates.

Catch rates were therefore calculated as the number of fish per trip, using both complete and incomplete fishing trips (Pollock et al., 1994) where c_i is the total number of individuals caught for each species and T_i is the number of fishing trips as follows;

$$\hat{R} = \frac{\sum_{i=1}^{n} c_i}{\sum_{i=1}^{n} T_i}.$$

Variance was calculated by

$$Var(\hat{R}) = \frac{\sum_{i=1}^{n} (c_i - \bar{c})^2}{n-1},$$

while standard error was calculated by the usual method

$$SE(\hat{R}) = \sqrt{Var(\hat{R})}.$$

4.0 Results

4.1 Western Australian overview

From July 1998 – June 2010, FMOs conducted 6 629 land-based and boat-based patrols in which recreational fishing survey information were collected. Within these patrols, 47 529 interviews were completed with boat-based groups, 2 237 with shore-based groups and the remainder with groups of individuals who had been diving or snorkelling (Table 3). Of the interviews conducted between 1998/99 – 2004/05, 3.3% (n = 241) contained no information on fishing platform (i.e. shore or boat-based) and were excluded from analysis. In addition, 84% of patrols contained interviews with groups from only one platform while the remaining 16% had interviews with groups on multiple platforms.

The majority of patrols and interviews were completed in the West Coast bioregion. Participation in the survey was 100%, as parties cannot refuse a marine safety inspection by an FMO. Although high response rates can be achieved by on-site creel or access point surveys (>90%) (Smallwood et al., 2006), and also by phone/logbook surveys (>70%) (Hartill et al., 2012), it is rare to achieve 100% participation.

Table 3 Total number of FMO patrols where survey data was recorded on a marine safety inspection form, and associated interviews recorded statewide from 1998/99 – 2009/10. Note: interviews with shore-based fishers, divers and snorkellers only conducted 1998/99 – 2004/05.

Bioregion	Number of patrols	Number of interviews by platform			
		Boat	Shore	Diving	Snorkelling
West Coast	4 211	37 181	1 288	95	28
South Coast	341	787	154	7	1
Gascoyne	1 537	5 266	613	4	6
North Coast	540	4 295	182	1	0
Total	**6 629**	**47 529**	**2 237**	**107**	**35**

Prior to the introduction of indicator species in 2005/06, FMOs could record information on any species kept or released by recreational fishers. During this time, a total of 379 species and general categories of aquatic organisms were retained and/or released by recreational fishers across all bioregions (Appendix 1). All of the indicator species listed on the bioregional marine safety inspection forms were recorded in this time period.

4.2 West Coast bioregion

A total of 4 211 land and boat-based patrols were completed at in the West Coast bioregion from 1998/99 – 2009/2010, of which 75% were conducted after the introduction of the marine safety inspection form in 2005/06 (Table 4). The majority (96%) of the 37 181 interviews with boat-based groups were also conducted during this same time period. From 1998/99 – 2004/05 the majority of patrols were completed in the districts of Mandurah and Perth Metropolitan area while from 2005/06 – 2009/10 they were completed predominantly in Mandurah and Hillarys.

Table 4 Total number of FMO patrols where survey data was recorded on a marine safety inspection form, and associated interviews with boat-based groups, recorded for each financial year in the West Coast bioregion.

Financial Year	Number of patrols	Number of interviews
1998/99	341	509
1999/00	17	22
2000/01	100	137
2001/02	210	320
2002/03	270	440
2003/04	84	146
2004/05	37	42
2005/06	782	9 301
2006/07	642	7 433
2007/08	581	6 636
2008/09	519	4 750
2009/10	628	7 445
Total	**4 211**	**37 181**

Interviews with boat-based groups were predominantly incomplete (i.e. fishing currently) or complete (i.e. has been fishing) trips which could be later incorporated into catch rate analysis. Although less than 2% of interviews prior to 2004/05 were excluded from catch rate analysis as respondents stated they were not fishing or would be fishing later, this increased to 14% for interviews undertaken from 2005/06 (Table 5). Such a pattern was to be expected as the DPI-orientated marine safety inspection form focussed on inspections prior to departure while fisheries compliance inspections must take place after returning from a fishing trip.

The mean number of people per boat was calculated for the entire sampling period from 1998/99 – 2009/2010 as 2.4 people (n = 18 131, SE ± 0.01). Between 1998/99 – 2004/05 the mean number of fishers per boat was 2.2 people (SE ± 0.02) and the mean fishing time 2.5 hours (SE ± 0.06). In this same time period, in which information was collected for all species, 72% of all interviews retained one or more indicator species. Due to a large number of interviews having no associated catch information, this percentage of retained indicator species dropped to 25% of all interviews between 2005/06 – 2009/10.

Table 5 Total number of interviews in which people were boat-based fishing in the West Coast bioregion between 1998/99 – 2009/10. Note: * indicates used in catch rate analysis.

	Code	Description	Number of interviews
1998/99 - 2004/05	C*	Completed fishing	1 450
	F*	Fishing currently	117
	N	Not fishing today	27
	L	Will fish later	16
		Unknown	6
2005/06 – 2009/10	Y*	Is/has been fishing	20 554
	N	Will/has not fish(ed)	9 275
	W	Will be fishing	4 708
	X	Invalid survey	1 028

Blue swimmer crabs and western rock lobster were the most frequently retained indicator species recorded by FMOs during boat-based interviews, with 25 105 and 18 733, respectively (Table 6). The most frequently retained finfish species were Australian herring (16 069), followed by Western Australian dhufish (1 845) and pink snapper (1 266).

Table 6 Total catch of indicator species recorded during interviews with recreational fishers in the West Coast bioregion from 1998/99 – 2009/2010. Note: interviews with shore-based fishers only conducted 1998/99 – 2004/05.

Indicator species	Number retained by platform	
	Boat	Shore
Blue swimmer crabs	26 105	3 796
Western rock lobster	18 733	78
Australian herring	16 069	2 081
Western Australian Dhufish	1 845	0
Pink snapper	1 266	4
Breaksea cod	1 232	0
Tailor	932	349
Baldchin groper	902	3

Catch rates were calculated for each indicator species in the West Coast bioregion (Figure 2). It should be noted that due to the variability of catch rates, the scales applied to each graph differ and are therefore not directly comparable between species.

The trend in catch rates for all species remained fairly static, with occasional small peaks such as pink snapper and breaksea cod in 1999/00 or blue swimmer crabs in 1999/00 and 2003/04. Tailor and baldchin groper were the only two species for which data were not available across all financial years. The standard errors were also often two or three times larger than the catch rate, especially for species such as Australian herring, Western Australian dhufish and western rock lobster. Such variability surrounding catch rates is not unexpected with this type of survey and, similar to other convenience sampling surveys (Smallwood et al., 2010), the data may provide useful indication of long-term changes in catch rate despite the large standard errors.

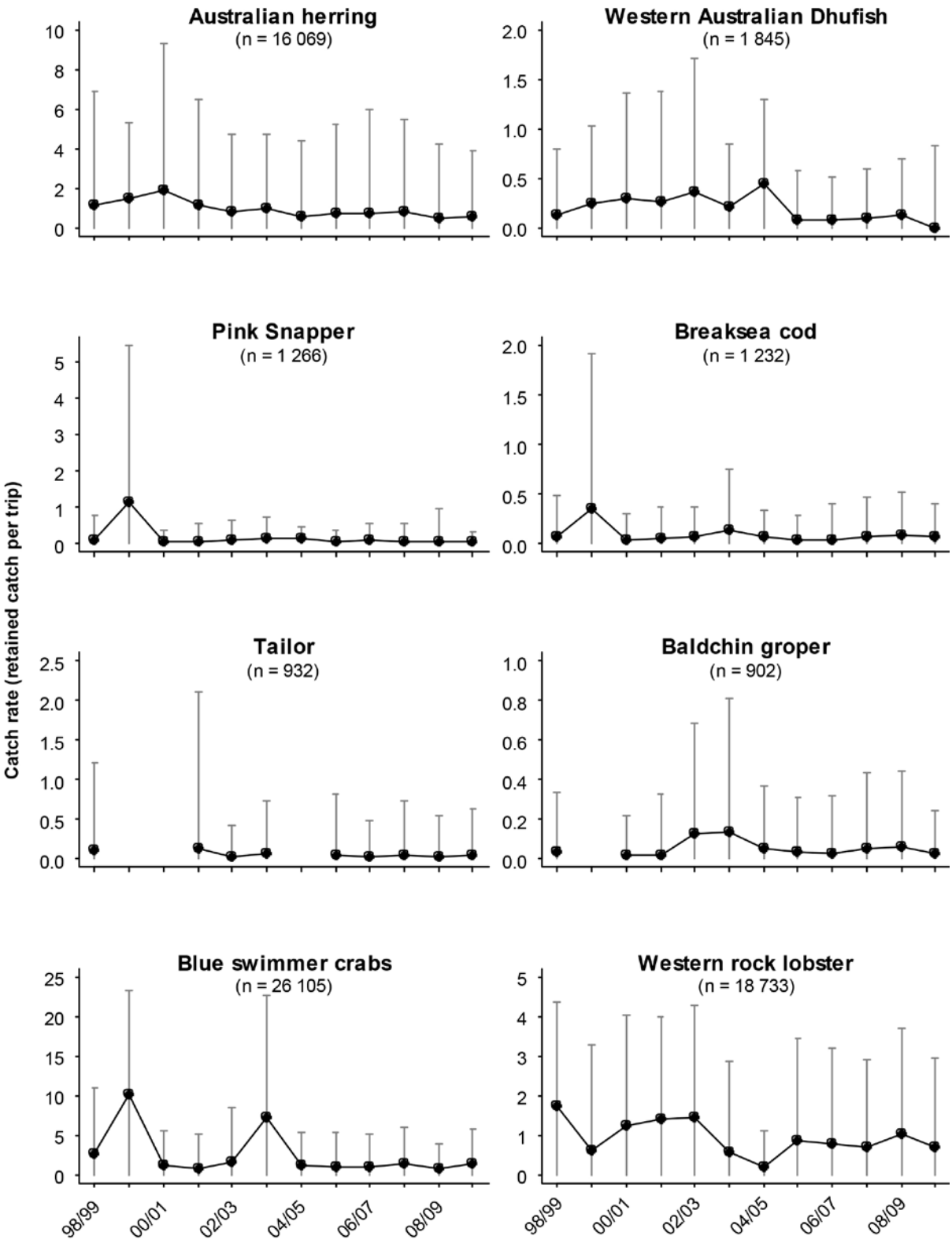

Figure 2 Catch rates (±SE) of indicator species calculated for each financial year from interviews with boat-based recreational fishers in the West Coast bioregion from 1998/99 – 2009/2010 where n = number of retained catch.

4.3 South Coast bioregion

A total of 341 land and boat-based patrols were completed in the South Coast bioregion from 1998/99 – 2009/2010, of which 53% were conducted after the introduction of the marine safety inspection form in 2005/06 (Table 7). The majority (83%) of the 787 interviews with boat-based groups were also conducted during this same timeframe. There were three financial years (1998/99, 1999/00 and 2009/10) for which no recreational fishing surveys were completed. From 1998/99 – 2004/05 similar numbers of patrols were completed in the districts of Esperance and Albany, while from 2005/06 – 2009/10 they were completed predominantly in Albany.

Table 7 Total number of FMO patrols where survey data was recorded on a marine safety inspection form, and associated interviews with boat-based groups, recorded for each financial year in the South Coast bioregion.

Financial Year	Number of patrols	Number of interviews
1998/99	-	-
1999/00	-	-
2000/01	67	26
2001/02	6	3
2002/03	43	34
2003/04	14	15
2004/05	30	52
2005/06	76	283
2006/07	82	313
2007/08	14	42
2008/09	9	19
2009/10	-	-
Total	**341**	**787**

Interviews with boat-based groups were predominantly incomplete (i.e. fishing currently) or complete (i.e. has been fishing) trips which could be later incorporated into catch rate analysis. Although 2% of interviews prior to 2004/05 were excluded from catch rate analysis as respondents stated they were not fishing or would be fishing later, this increased to 13% for interviews undertaken from 2005/06 (Table 8). Such a pattern was to be expected as the DPI-oriented marine safety inspection form focussed on inspections prior to departure.

Table 8 Total number of interviews in which people were boat-based fishing in the South Coast bioregion between 1998/99 – 2009/10. Note: * indicates used in catch rate analysis.

	Code	Description	Number of interviews
1998/99 - 2004/05	C*	Completed fishing	106
	F*	Fishing currently	21
	N	Not fishing today	0
	L	Will fish later	3
		Unknown	0
2005/06 – 2009/10	Y*	Is/has been fishing	556
	N	Will/has not fish(ed)	45
	W	Will be fishing	37
	X	Invalid survey	19

The mean number of people per boat was calculated for the entire sampling period from 1998/99 – 2009/2010 as 2.8 people (SE ± 0.09). For the period from 1998/99 – 2004/05 the mean number of fishers per boat was 2.7 people (SE ± 0.1) and the mean fishing time 4.2 hours (SE ± 0.17). In this same time period, in which information was collected for all species, 83% of all interviews retained one or more indicator species. This percentage of retained indicator species dropped to 50% of all interviews between 2005/06 – 2009/10.

Whiting (all species) (1 463) and Australian herring (769) were the most frequently retained indicator species recorded by FMOs, followed by bight redfish (706) and Queen snapper (400) (Table 9). Only 7 hapuku were recorded for the entire survey period from 1998/99 – 2009/10.

Catch rates were calculated for each indicator species in the South Coast bioregion and the low number of interviews has resulted in all species having an incomplete record across financial years (Figure 3). As with the West Coast bioregion, the trend in catch rates for all species remained fairly static for those years although small peaks were evident for whiting (general) from 2002/03 – 2006/07, bight redfish from 2003/03 – 2005/06 and queen snapper from 2000/01 – 2003/04. Standard errors were two or three times larger than the catch rate for all species except for bight redfish and queen snapper.

Table 9 Total catch of indicator species recorded during interviews with recreational fishers in the South Coast bioregion from 1998/99 – 2009/2010. Note: interviews with shore-based fishers only conducted 1998/99 – 2004/05.

Indicator species	Number retained by platform	
	Boat	Shore
Whiting (all species)	1 463	27
Australian herring	769	170
Bight redfish	706	0
Queen snapper	400	0
Pink snapper	245	0
Samson fish	45	0
Blue groper	27	0
Hapuku	7	0

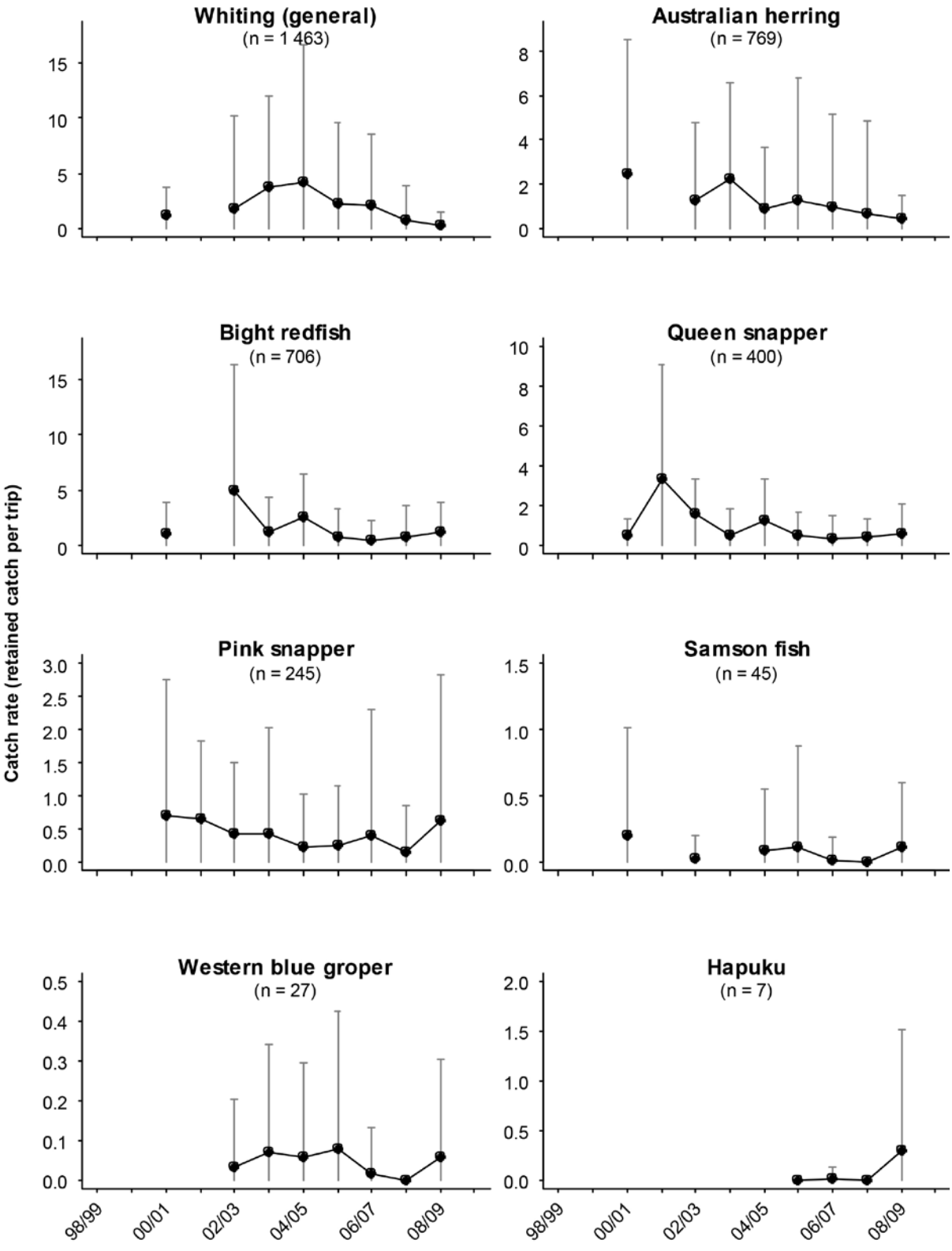

Figure 3 Catch rates (±SE) of indicator species calculated for each financial year from interviews with boat-based recreational fishers in the South Coast bioregion from 1998/99 – 2009/2010 where n = number of retained catch.

4.4 Gascoyne Coast bioregion

A total of 1 537 land and boat-based patrols were completed in the Gascoyne Coast bioregion from 1998/99 – 2009/2010, of which 73% were conducted prior to the introduction of the marine safety inspection form in 2005/06 (Table 10). Around half of the 5 266 interviews with boat-based groups were also conducted during this same timeframe, with a maximum of 1 221 completed in 2005/06. From 1998/99 – 2004/05 the majority of patrols were completed in Denham while from 2005/06 – 2009/10 they were completed predominantly in Exmouth.

Table 10 Total number of FMO patrols where survey data was recorded on a marine safety inspection form, and associated interviews with boat-based groups, recorded for each financial year in the Gascoyne Coast bioregion.

Financial Year	Number of patrols	Number of interviews
1998/99	9	9
1999/00	4	1
2000/01	162	260
2001/02	189	545
2002/03	414	770
2003/04	222	535
2004/05	120	511
2005/06	171	1 221
2006/07	142	935
2007/08	76	324
2008/09	21	120
2009/10	7	35
Total	**1 537**	**5 266**

Interviews with boat-based groups were predominantly incomplete (i.e. fishing currently) or complete (i.e. has been fishing) trips which could be later incorporated into catch rate analysis. Although less than 3% of interviews prior to 2004/05 were excluded from catch rate analysis as respondents stated they were not fishing or would be fishing later, this increased to 22% for interviews undertaken from 2005/06 (Table 11). Such a pattern was to be expected as the DPI-oriented marine safety inspection form focussed on inspections prior to departure.

Table 11 Total number of interviews in which people were boat-based fishing in the Gascoyne Coast bioregion between 1998/99 – 2009/10. Note: * indicates used in catch rate analysis.

	Code	Description	Number of interviews
1998/99 - 2004/05	C*	Completed fishing	2 443
	F*	Fishing currently	129
	N	Not fishing today	4
	L	Will fish later	52
		Unknown	3
2005/06 – 2009/10	Y*	Is/has been fishing	1 832
	N	Will/has not fish(ed)	163
	W	Will be fishing	338
	X	Invalid survey	302

The mean number of people per boat was calculated for the entire sampling period in the Gascoyne Coast bioregion from 1998/99 – 2009/2010 as 3.5 people (SE ± 0.04). For the period

from 1998/99 – 2004/05 the mean number of fishers per boat was 3.2 people (SE ± 0.4) and the mean fishing time 6.2 hours (SE ± 0.37). These mean group sizes and fishing times are larger than recorded in the West Coast and South Coast bioregions. This is likely to be due to people investing more time in their fishing trips in these remote locations, resulting in longer fishing times. Anecdotal evidence supports the latter, since many fishers undertake trips to the Gascoyne Coast bioregion in groups with the sole purpose of going fishing. In this same time period, in which information was collected for all species, 62% of all interviews retained one or more indicator species. This percentage of retained indicator species dropped to 33% of all interviews between 2005/06 – 2009/10.

Pink snapper and grass emperor were the most frequently retained indicator species recorded by FMOs, with 5 145 and 3 794 fish retained, respectively (Table 12). Spangled emperor (1 572) and red-throat emperor (1 005) were also frequently retained.

Table 12 Total catch of indicator species recorded during interviews with recreational fishers in the Gascoyne Coast bioregion from 1998/99 – 2009/2010. Note: interviews with shore-based fishers only conducted 1998/99 – 2004/05.

Indicator species	Number retained by platform	
	Boat	Shore
Pink snapper	5 145	51
Grass emperor (Black snapper)	3 794	23
Spangled emperor	1 572	18
Red-throat emperor	1 005	1
Baldchin groper	568	2
Tailor	501	51
Spanish mackerel	384	48
Western yellowfin bream	61	25

Catch rates were calculated for each indicator species in the Gascoyne Coast bioregion and all species had a complete record from 2000/01, although data prior to this financial year was unavailable for all species except spangled emperor (Figure 3). The trend in catch rates for all species remained fairly static for those years where it could be calculated, while the standard errors were large for the majority of species, except for spangled emperor. Increased catch rates were evident for pink snapper from 2000/02 – 2005/06, tailor from 2001/02 – 2005/06 and Spanish mackerel from 2005/06 – 2008/09.

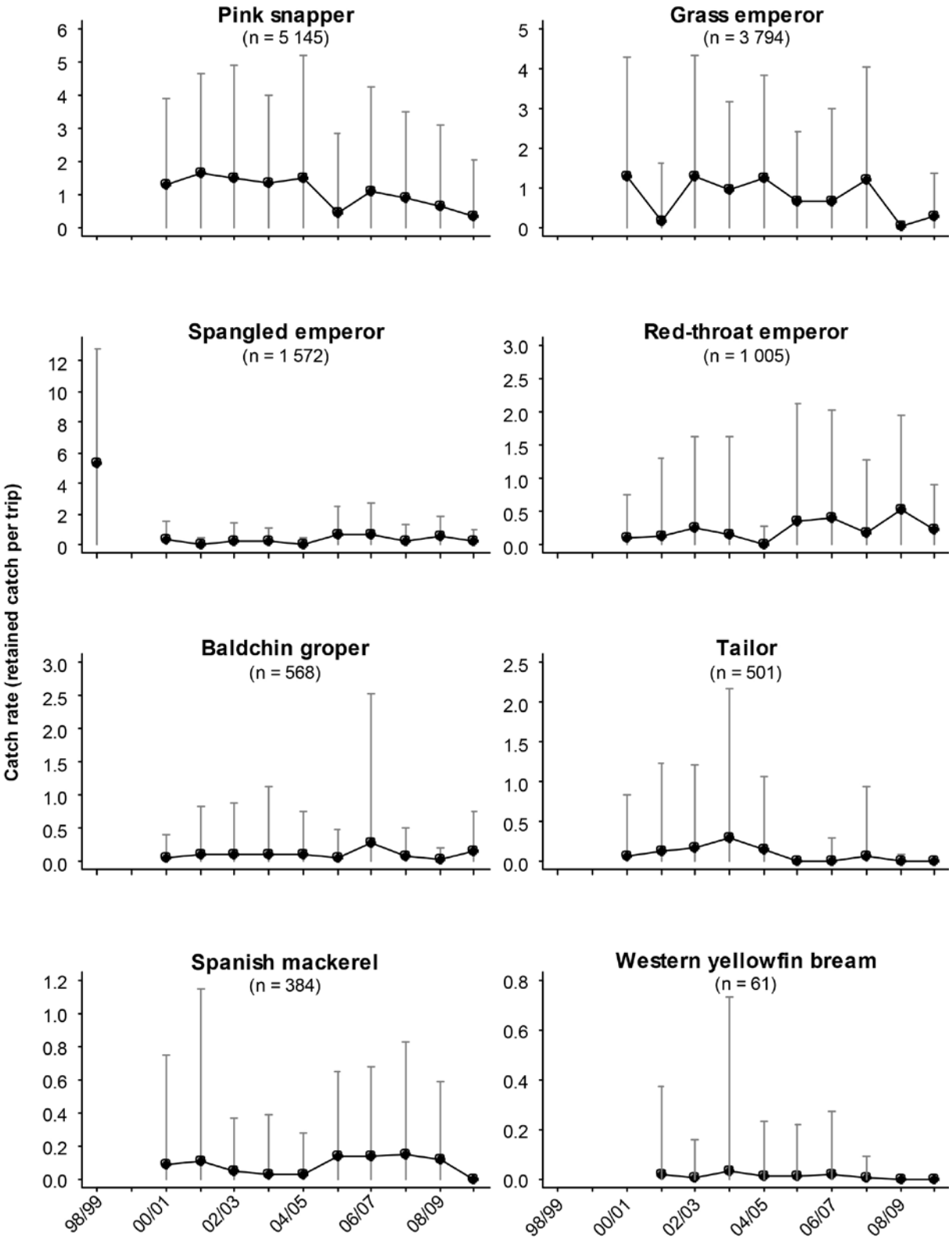

Figure 4 Catch rates (±SE) of indicator species calculated for each financial year from interviews with boat-based recreational fishers in the Gascoyne Coast bioregion from 1998/99 – 2009/2010 where n = number of retained catch.

4.5 North Coast bioregion

A total of 540 land and boat-based patrols were completed in the North Coast bioregion from 1998/99 – 2009/2010, of which 80% were conducted after the introduction of the marine safety inspection form in 2005/06 (Table 13). The majority (94%) of the 4 295 interviews with boat-based groups were also conducted during this same timeframe, with a maximum of 1 088 completed in 2009/10. There were no recreational fishing surveys completed during FMO patrols in 1998/99 – 1999/00. From 1998/99 – 2004/05 the majority of patrols were completed in the district of Broome while from 2005/06 – 2009/10 they were completed predominantly in Karratha.

Table 13 Total number of FMO patrols where survey data was recorded on a marine safety inspection form, and associated interviews with boat-based groups, information recorded for each financial year in the North Coast bioregion.

Financial Year	Number of patrols	Number of interviews
1998/99	-	-
1999/00	-	-
2000/01	18	42
2001/02	11	31
2002/03	46	111
2003/04	31	84
2004/05	4	3
2005/06	98	640
2006/07	108	941
2007/08	96	903
2008/09	42	452
2009/10	86	1 088
Total	**540**	**4 295**

Interviews with boat-based groups were predominantly incomplete or complete trips which could be later incorporated into catch rate analysis. Although 14% of interviews prior to 2004/05 were excluded from catch rate analysis as respondents stated they were not fishing or would be fishing later, this increased to 23% for interviews undertaken from 2005/06 (Table 14). As stated previously, such a pattern was to be expected as the DPI-oriented marine safety inspection form focussed on inspections prior to departure.

The mean number of people per boat was calculated for the entire sampling period in the North Coast bioregion from 1998/99 – 2009/2010 as 2.9 people (SE ± 0.03). For the period from 1998/99 – 2004/05 the mean number of fishers per boat was 2.8 people (SE ± 0.1) and the mean fishing time 4.0 hours (SE ± 0.14). In this same time period, in which information was collected for all species, 34% of all interviews retained one or more indicator species. This percentage of retained indicator species dropped to 19% of all interviews between 2005/06 – 2009/10.

Table 14 Total number of interviews in which people were boat-based fishing in the North Coast bioregion between 1998/99 – 2009/10. Note: * indicates used in catch rate analysis.

	Code	Description	Number of interviews
1998/99 - 2004/05	C*	Completed fishing	154
	F*	Fishing currently	78
	N	Not fishing today	4
	L	Will fish later	33
		Unknown	2
2005/06 – 2009/10	Y*	Is/has been fishing	2 991
	N	Will/has not fish(ed)	288
	W	Will be fishing	633
	X	Invalid survey	112

Grass emperor (610) and coral trout (484) were the most frequently retained indicator species recorded by FMOs (Table 15). Spanish mackerel (281) and spangled emperor (220) were also frequently retained whilst only 4 goldband snapper were recorded over the entire sampling period. The low catch of goldband snapper is likely to be due to this being an offshore demersal species located in depths beyond those routinely fished by recreational anglers.

Table 15 Total catch of indicator species recorded during interviews with recreational fishers in the North Coast bioregion from 1998/99 – 2009/2010. Note: interviews with shore-based fishers only conducted 1998/99 – 2004/05.

Indicator species	Number retained by platform	
	Boat	Shore
Grass emperor (Black snapper)	610	0
Coral trout	484	0
Spanish mackerel	281	0
Spangled emperor	220	0
Red emperor	160	0
Threadfin (all species)	142	10
Barramundi	141	7
Goldband snapper	4	0

Catch rates were calculated for each indicator species in the North Coast bioregion and the small number of interviews resulted in all species having an incomplete record across the sampling period (Figure 5). Due to the variability of catch rates, the scales applied to each graph do differ and are therefore not directly comparable between species. The paucity of data made it difficult to interpret trends in catch rates. However, for most species it appeared to be fairly static. Grass emperor, coral trout and red emperor all displayed a small peak in catch rates occurring from 2003/04 – 2005/06 while barramundi had a peak from 2000/01 – 2002/03. Standard errors were two or three times larger than the catch rate for all species.

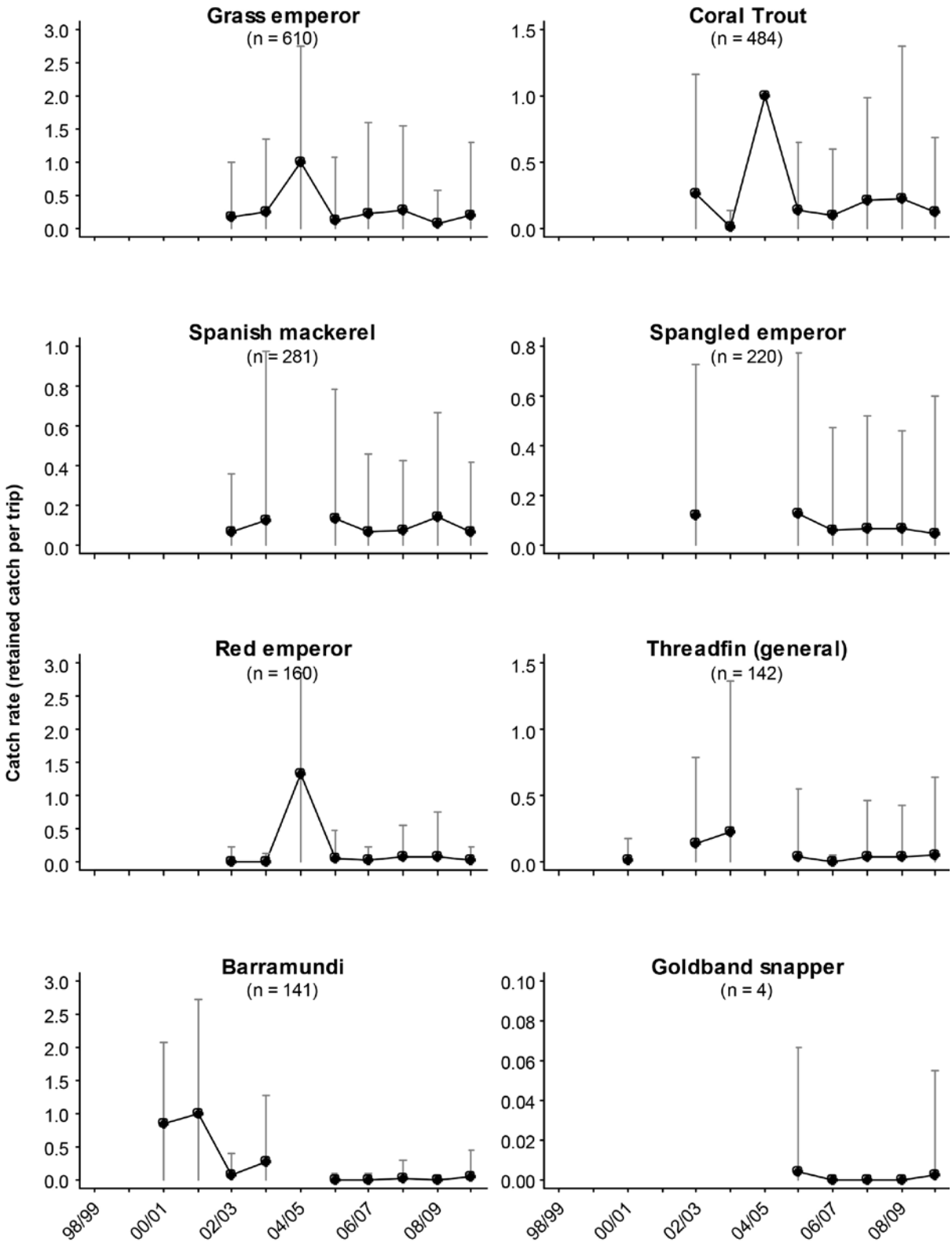

Figure 5 Catch rates (±SE) of indicator species calculated for each financial year from interviews with boat-based recreational fishers in the North Coast bioregion from 1998/99 – 2009/2010 where n = number of retained catch.

5.0 Discussion and conclusion

Analysis of recreational fishing data collected by FMOs from 1998/99 – 2009/10 showed that while patrols and interviews were conducted throughout the state, the majority were conducted in the West Coast bioregion. The temporal distribution of these activities was not consistent across this time period, with no patrols conducted in some financial years, especially prior to 2000/01. Over 75% of groups intercepted by FMOs in each bioregion had either completed their fishing activity, or were currently fishing. The remaining groups, who were either planning to fish later or who were not fishing, were excluded from analysis as no catch rate could be calculated. Interestingly, the number of groups excluded from analysis increased by about 10% within each bioregion after 2005/06, when the datasheet was integrated with the marine safety inspection form. This indicates more interviews were being undertaken when boats were launching (in line with the change to the marine safety inspection form), thereby reducing the opportunity to obtain information on catch.

There were a number of uncertainties associated with the convenience sampling method used by FMOs to collect information from groups involved in boat-based recreational fishing. These stemmed primarily from the lack of spatial and temporal stratification and randomisation in patrols. FMOs generally have good knowledge of popular fishing locations within their region, and are likely to target those at which higher rates of recreational fishing is known to occur and at times when catch rates are good (e.g. intercepting fishers targeting pink snapper in Cockburn Sound during spawning times). This would bias catch rates if locations and times of year for which fishing is known to be more productive are sampled more frequently. It is not possible to assess this bias without comparison to other catch rate data collected from stratified or randomised surveys.

Validation of the data collected by FMOs was undertaken where possible and decision rules were used to standardise information across the different versions of the forms, while also removing any records which were incomplete or incorrect (i.e. a West Coast bioregion form used in the South Coast bioregion, resulting in invalid recording of indicator species). Much of this excluded data was from prior to 2004/05, where there were more fields to complete, leading to an increase in errors or incomplete records. Many of these issues were therefore minimised with the introduction of a reduced number of fields on the marine safety inspection form. However, some of these fields that were removed (i.e. number of fishers, length of fishing time, gear type) could have contributed to more detailed calculations of catch rate.

Retained catch was recorded for each indicator species and along with the number of fishing trips, was used to calculate catch rate for each bioregion and financial year from 1998/99 – 2009/10. This highlighted some trends, with some small peaks and troughs in catch rates evident for some species across the survey period. However, for many species, especially those outside of the West Coast bioregion, information on catch was not available for every financial year. Such small sample sizes, and the convenience of the sampling regime employed by the FMOs, make it difficult to determine whether catch rates were representative of recreational fishing activity. The uncertainty associated with the catch rate for each financial year was also large for the majority of indicator species, as signified by the large standard errors. This was primarily due to the lack of information on gear type beyond 2005/06, which resulted in all the fishing trips for a specific financial year being used to calculate catch rate for a species, even if no catch was recorded. Gear type is often used during catch rate analysis to assist with determining the species being targeted by recreational fishers, thereby providing a more accurate result for estimating catch rate of a particular species. Complete and incomplete fishing trips were treated

in the same manner, even though groups still engaged in fishing activity may have caught more fish after the time of interview. These factors are likely to have the effect of underestimating catch rate. The non-random sampling regime also meant that no weighting data were available to produce unbiased estimates of recreational catch rates.

It was difficult to directly compare the catch rates based upon information collected by FMOs with those calculated in other recreational surveys. Total effort and catch could not be calculated using FMO data due to the convenience sampling regime. Due to a lack of information on fishing time and number of fishers beyond 2005/06, estimates are also represented as another unit of measurement (i.e. catch/trip). The marine safety inspection forms have since been modified to include fishing time and number of fishers, so that any future analysis could be calculated to the 'person' level, similar to other sampling techniques.

The spatio-temporal distribution of fishing trips by recreational boats within each bioregion and specified year is likely to be related to the spatial distribution of boat ramps and/or moorings, the demographic characteristics of groups on recreational boats, and the location of fishing grounds and fish assemblages in different districts and areas within each bioregion. A well-defined sampling frame to collect recreational fishing data would help to provide appropriate spatial coverage of the bioregion and appropriate temporal coverage both within and among days of the year.

If recreational fishing data continue to be collected by FMOs during land or boat-based patrols, then there are some elements which need to be considered that could increase the usefulness and robustness of this data for examining the trends in recreational fishing activity across time. For example, the indicator species currently provided on the marine safety inspection form should be consistent with those used for assessing the status of a broader suite of species (DoF, 2011).

If continued, the greatest benefit to the collection of recreational fishing data by FMOs would be obtained by developing a structured and randomised survey schedule from which unbiased estimates of catch rates could be obtained. These surveys could be of an ongoing nature, or be implemented over specific spatial and temporal timeframes to meet a certain data requirement (i.e. a 3 month study at a small number of boat ramps in the metropolitan area). Such a sampling regime could be used to produce unbiased estimates of non-compliance to complement catch estimates from other surveys, i.e. the statewide recreational boat-fishing survey.

Any structured sampling regime will need to incorporate a number of elements including;

- determination of appropriate sampling frequency,
- selection of specific boat ramps (or shore sites) at which the surveys should be undertaken,
- random allocation of survey days across both weekdays, weekends and public holidays,
- random allocation of shift times across mornings and afternoon periods,
- standard procedures to be followed if weather patterns or sea-conditions are substantially different to what is expected (or the sample size increased) and,
- standard procedures for occasions when FMOs become involved in opportunistic and protracted enforcement activities flowing from encounters with recreational fishers.

The survey form itself would also need to be modified to allow collection of existing additional information such as the number of fishers, fishing duration, start and finish time at the ramp

and total number of retrievals. If sampling is to be interrupted by operational constraints, then a method of accounting for the lost interview time at the ramp would need to be developed. Or, if the number of patrols is sufficiently large, the data used for subsequent analysis could be restricted to the subset of uninterrupted sampling and which meet other sample design requirements.

Utilising FMOs over trained survey staff in structured sampling designs is advantageous in that they are able to obtain information on illegal catch which may not be volunteered by recreational fishers. Their deployment for this work is also likely to be cost-effective, as it can be incorporated into their existing fieldwork components, while their high-profile inspections may also act as a deterrent to non-compliant behaviour. However, the main challenge for implementing such a sampling design, whether ongoing or for meeting a specific data need, is ensuring that it will provide representative samples from anglers into a system that is structured primarily to execute compliance and education.

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7.0 References

DoF, 2010. New mobile patrols are frontline in Fisheries Department war on illegal fishing. www.fish.wa.gov.au/docs/media Date accessed: 23 February 2012

DoF, 2011. Resource assessment framework (RAF) for finfish resources in Western Australia. Western Australian Department of Fisheries, Perth, Western Australia, p. 24.

Fletcher, W. J. and Santoro, K. (Eds.), 2011. State of the fisheries and aquatic resources report 2010/2011, Perth, Western Australia.

Green, T. J. and Griffiths, D., 2005. DeePCee Manual v2.4. Western Australian Department of Fisheries, Perth, Western Australia, p. 41.

Green, T. J. and McKinlay, J. P., 2009. Compliance program evaluation and optimisation in commercial and recreational Western Australian fisheries. Western Australian Department of Fisheries, Perth, Western Australia, p. 77.

Hartill, B. W., Cryer, M., Lyle, J. M., Rees, E. B., Ryan, K. L., Steffe, A. S., Taylor, M. D., West, L. and Wise, B. S., 2012. Scale-and context-dependent selection of recreational ahrvest estimation methods: the australasian experience. North Americal Journal of Fisheries Management 32, 109 – 123.

Lenanton, R., Fletcher, W. J. and Gaughan, D. J., 2006. Integrated fisheries management in Western Australia – a significant challenge for fisheries scientists. In: Phelan, M. J. and Bajhau, H. S.s (Eds.), Australian Society for Fish Biology, Darwin, Northern Territory, pp. 37 – 43.

Pollock, K. H., Jones, C. M. and Brown, T. L., 1994. Angler survey methods and their applications in fisheries management. American Fisheries Society, Bethesda, Maryland.

Smallwood, C. B., Beckley, L. E. and Sumner, N. R., 2006. Shore-based recreational angling in the Rottnest Island Reserve, Western Australia: spatial and temporal distribution of catch and fishing effort. Pacific Conservation Biology 12, 238-51.

Smallwood, C. B., Thomson, A., Harris, D. and Johnston, D., 2010. The Volunteer Fisheries Liaison Officer (VFLO) program: an analysis of recreational fishing data from 1995 – 2007. Western Australian Department of Fisheries, Perth, Western Australia, p. 52.

Wise, B. S. and Fletcher, W. J., in review. Determination and development of cost effective techniques to monitor catch and effort in Western Australian demersal finfish fisheries. Final Report for FRDC Project 2005/034 and WAMSI Subproject 4.4.3. Western Australian Department of Fisheries, Perth, Western Australia.

8.0 Appendices

Appendix 1 Complete list of species retained and/or released in each bioregion by recreational fishers (using any platform) interviewed by FMOs from 1998/99 – 2004/05. Note: ❄ indicates an indicator species in recreational surveys from 2004/05 – 2009/10

Common Name	Scientific Name	North Coast	Gascoyne	West Coast	South Coast
Abalone, Brown-Lipped	*Haliotis conicopora*			✓	
Abalone, Green Lip	*Haliotis laevigata*		✓	✓	✓
Abalone, Roe's – General	*Haliotis roei*			✓	✓
Albacore	*Thunnus alalunga*			✓	
Archerfishes, General	Family Toxotidae	✓			
Barracouta	*Thyrsites atun*				✓
Barracuda	*Sphyraena barracuda*		✓		
Barramundi	*Lates calcarifer*	✓❄			
Bass, Red	*Lutjanus bohar*		✓		
Bass, Sand	*Psammoperca waigiensis*		✓	✓	
Blackfish, Western Rock (Chad)	*Girella tephraeops*				✓
Blowfish, Common	*Torquigener pleurogramma*			✓	
Blowfish, Northwest (Silver Toadfish)	*Lagocephalus sceleratus*		✓	✓	
Blue Devil, Western	*Paraplesiops meleagris*				✓
Boarfishes, general				✓	
Bonitos, general	*Scombridae* spp.		✓	✓	✓
Boxfish/Cowfish	Family Ostraciidae			✓	
Bream, Black	*Acanthopagrus butcheri*	✓		✓	✓
Bream, Fingermark	*Lutjanus johnii*	✓	✓		
Bream, Northwest Black / Piindicator Bream	*Acanthopagrus palmaris*	✓			
Bream, Silver (Tarwhine)	*Rhabdosargus sarba*	✓	✓	✓	✓
Bream, Western Yellowfin	*Acanthopagrus latus*	✓	✓❄		
Buffalo Bream, Common	*Kyphosus sydneyanus*		✓	✓	✓
Buffalo Bream, Western	*Kyphosus cornelii*		✓	✓	✓
Butterfish, Western	*Pentapodus vitta*		✓	✓	
Catfish, Fork-Tailed	*Arius* spp.	✓			
Catfish, general		✓	✓		
Catfish, Giant Salmon	*Arius thalassinus*		✓		
Chinaman Fish	*Symphorus nematophorus*	✓	✓		
Cobbler	*Cnidoglanis macrocephalus*			✓	
Cobia	*Rachycentron canadus*	✓	✓	✓	
Cod, Barramundi	*Cromileptes altivelis*		✓		
Cod, Black-Tipped	*Epinephelus fasciatus*		✓		
Cod, Breaksea (Black-arse Cod)	*Epinephelides armatus*		✓	✓❄	✓
Cod, Chinaman	*Epinephelus rivulatus*	✓	✓	✓	
Cod, Coral	*Cephalopholis miniata*		✓		
Cod, Estuary/Slimy Cod	*Epinephelus coioides*		✓	✓	

Common Name	Scientific Name	North Coast	Gascoyne	West Coast	South Coast
Cod, Honeycomb	*Epinephelus merra*		✓		
Cod, Potato	*Epinephelus tukula*				
Cods – General		✓	✓	✓	
Crab, Blue manna	*Portunus pelagicus*	✓	✓	✓❄	
Crab, Mud Brown	*Seylla olivacea*	✓			
Crab, Mud Green	*Scylla serrata*	✓	✓		
Crabs, General		✓	✓	✓	
Croaker, Green-Backed	*Johnius amblycephalus*	✓			
Cuttlefish			✓	✓	
Dart, Common	*Trachinotus botla*		✓		
Dart, general	*Trachinotus* spp.		✓	✓	
Dhufish, Western Australian	*Glaucosoma hebraicum*		✓	✓❄	✓
Dolphinfish, Common / Mahi Mahi	*Coryphaena hippurus*		✓		
Eel Moray, Green (Brown Reef Eel)	*Gymnothorax prasinus*		✓	✓	
Eels, General	*Gymnothorax* spp.	✓			
Emperor, Blue-spotted	*Lethrinus punctulatus*		✓		
Emperor, Grass (Emperor, Blue-Lined, Black Snapper)	*Lethrinus laticaudis*	✓❄	✓❄		
Emperor, Pink-Eared (Purple-Headed)	*Lethrinus lentjan*		✓		
Emperor, Red	*Lutjanus sebae*	✓❄	✓		
Emperor, Spangled	*Lethrinus nebulosus*	✓❄	✓❄	✓	
Emperor, Spotcheek	*Lethrinus rubrioperculatus*		✓		
Emperor, Sweetlip (Red Throat)	*Lethrinus miniatus*	✓	✓❄	✓	
Emperor, Threadfin	*Lethrinus genivittatus*	✓			
Emperor, Variegated	*Lethrinus variegatus*		✓		
Emperor, Yellow-Tailed	*Lethrinus atkinsoni*		✓		
Emperors, General	Family Lethrinidae	✓	✓	✓	
Firefish, Red	*Pterois volitans*			✓	
Flathead, Bar-tailed	*Platycephalus endrachtensis*		✓		
Flathead, Southern Blue-Spotted	*Platycephalus speculator*			✓	
Flatheads, General	Family Platycephalidae	✓	✓	✓	✓
Flounders, General			✓	✓	✓
Foxfish, Western	*Bodianus frenchii*			✓	✓
Fusiliers, Jobfishes	Family Caesionidae	✓	✓		
Garfishes	Family Hemiramphidae	✓	✓	✓	✓
General Fish				✓	
Goatfish, general			✓	✓	✓
Groper, Baldchin	*Choerodon rubescens*		✓❄	✓❄	
Groper, Malabar	*Epinephelus malabaricus*		✓		
Groper, Western Blue	*Achoerodus gouldii*			✓	✓❄
Grunter, Sooty	*Hephaestus fuliginosus*	✓			

Common Name	Scientific Name	North Coast	Gascoyne	West Coast	South Coast
Gurnards, General				✓	
Hardyheads/Silversides, general			✓	✓	
Harlequin Fish	*Othos dentex*			✓	✓
Herring – Bony (Not Perth)	Family Clupeidae	✓	✓		
Herring, Australian	*Arripis georgianus*		✓	✓❄	✓❄
Herring, Giant	*Elops hawaiensis*		✓	✓	
Herring, Perth	*Nematalosa vlaminghi*			✓	
Javelinfishes, general	*Pomadasys* spp	✓			
Jawfish	Family Opistognathidae	✓			
Jew, Black (Northern Mulloway)	*Protonibea diacanthus*	✓			
Jobfish, Rosy (Rosy Snapper)	*Pristipomoides filamentosus*		✓		
John Dory	*Zeus faber*		✓		
Kingfish, Yellowtail	*Seriola lalandi*		✓	✓	✓
Leatherjackets, General			✓	✓	✓
Lizardfishes/Grinners, General			✓		
Longtoms, General	Family Belonidae		✓		
Mackerel, Australian Spotted	*Scomberomorus munroi*	✓	✓		
Mackerel, Blue	*Scomber australasicus*			✓	✓
Mackerel, Narrow-Barred Spanish	*Scomberomorus commerson*	✓❄	✓❄	✓	
Mackerel, Queensland School (Dog Mackerel)	*Scomberomorus queenslandicus*		✓		
Mackerel, Scaly	*Sardinella lemuru*			✓	
Mackerel, Shark	*Grammatorcynus bicarinatus*	✓	✓		
Mackerels, General	Family Scombridae	✓	✓	✓	✓
Mackerels/Tunas, General	Family Scombridae		✓		
Mangrove Jack	*Lutjanus argentimaculatus*	✓	✓	✓	
Marron	*Cherax tenuimanus*			✓	
Monindicatorfish	*Erosa erosa*	✓			
Morwong, Dusky	*Dactylophora nigricans*			✓	
Morwong, Red-lipped (Red-band)	*Cheilodactylus rubrolabiatus*			✓	
Morwongs, General			✓	✓	
Mullet, Diamond-Scale	*Liza vaigiensis*	✓			
Mullet, Sea	*Mugil cephalus*	✓	✓	✓	✓
Mullet, Yellow Eye (Pilch)	*Aldrichetta forsteri*			✓	✓
Mullets, General		✓	✓	✓	
Mulloway	*Argyrosomus hololepidotus*	✓	✓	✓	✓
Mussels	*Mytilus* spp.		✓	✓	
Octopus, General			✓	✓	
Parrotfish, General			✓	✓	
Perch, Magpie	*Cheilodactylus nigripes*				✓
Perch, Moses	*Lutjanus russelli*		✓		

Common Name	Scientific Name	North Coast	Gascoyne	West Coast	South Coast
Perch, Pearl (Deepsea Jewfish)	*Glaucosoma buergeri*		✓		
Perch, Redfin (European)	*Perca fluviatilis*			✓	✓
Pigfishes, General	*Bodianus* spp.		✓		
Pike, Long-finned	*Dinolestes lewini*			✓	✓
Prawn, Cherabin (Freshwater Prawn)	*Macrobrachium rosenbergii*	✓			
Prawn, River	*Metapenaeus dalli*			✓	
Prawn, Western King	*Penaeus latisulcatus*	✓			
Queenfish, Talang	*Scomberoides commersonnianus*		✓		
Queenfishes, General	*Scomberoides spp*	✓	✓		✓
Ray, Eagle	*Myliobatis australis*			✓	
Ray, Southern Fiddler	*Trygonorhina fasciata*			✓	
Ray, White-Spotted Shovelnose	*Rhynchobatus djiddensis*		✓		
Rays, Shovelnose, General	Family Rhinobatidae		✓		✓
Redfish, Bight (Red snapper, Nannygai)	*Centroberyx gerrardi*			✓	✓❄
Remora	*Remora remora*		✓		
Rock Lobster, Southern	*Jasus edwardsii*			✓	
Rock Lobster, Western	*Panulirus cygnus*		✓	✓❄	
Rock Lobsters, Tropical		✓			
Rockcod, Rankin's (White-Blotched)	*Epinephelus multinotatus*	✓	✓		
Rockcod, Tomato	*Cephalopholis sonnerati*		✓		
Runner, Rainbow	*Elegatis bipinnulata*		✓		
Sailfish, Indo-Pacific	*Istiophorus platypterus*	✓			
Salmon, Australian	*Arripis truttaceus*	✓		✓	✓
Samson Fish/Sea Kingfish	*Seriola hippos*		✓	✓	✓❄
Sawfish, Green	*Pristis zijsron*				
Scad, Yellowtail	*Trachurus novaezelandiae*	✓	✓	✓	✓
Scorpioncod, Western Red	*Scorpaena sumptuosa*			✓	
Scorpionfishes, General	Family Scorpaenidae	✓			
Seabream, Robinson's	*Gymnocranius grandoculis*		✓		
Seaperch, Crimson	*Lutjanus erythropterus*	✓			
Seaperch, Maori	*Lutjanus rivulatus*	✓			
Seaperch, Saddle-tailed (Scarlet)	*Lutjanus malabaricus*	✓	✓		
Seaperch, Stripey (Spanish Flag)	*Lutjanus carponotatus*	✓	✓		
Seaperches, General			✓	✓	
Seapikes/Barracuda/Snook, general			✓	✓	✓
Sergeant Baker	*Aulopus purpurissatus*			✓	✓
Shark, Black-tip Reef	*Carcharhinus melanopterus*		✓		
Shark, Bronze Whaler	*Carcharhinus brachyurus*		✓	✓	✓

Common Name	Scientific Name	North Coast	Gascoyne	West Coast	South Coast
Shark, General		✓	✓	✓	✓
Shark, Gummy	*Mustelus antarcticus*			✓	✓
Shark, Leopard	*Stegostoma fasciatum*		✓		
Shark, Long-Nosed Grey (Spinner)	*Charcharhinus brevipinna*	✓			
Shark, Port Jackson	*Heterodontus portusjacksoni*			✓	
Shark, School	*Galeorhinus galeus*		✓		
Shark, Spurdogs and Dogfishes	Family Squalidae			✓	
Shark, Tiger	*Galeocerdo cuvieri*		✓		
Shark, Whiskery	*Furgaleus macki*			✓	✓
Shark, Whitetip	*Carcharhinus longimanus*		✓		
Sharks, Hammerhead	*Sphyrna* spp.		✓	✓	
Snake, Sea		✓	✓		
Snapper, Goldband	*Pristipomoides multidens*		✓❄		
Snapper, Long-Spined	*Argyrops spinifer*		✓		
Snapper, Pink	*Pagrus auratus*		✓❄	✓❄	✓❄
Snapper, Queen (Blue Morwong)	*Nemadactylus valenciennesi*			✓	✓❄
Snappers/Bream, General	Family Sparidae	✓	✓	✓	✓
Snook	*Sphyraena novaehollandiae*		✓	✓	✓
Squids, General			✓	✓	✓
Stingrays, General		✓	✓	✓	
Swallowtail	*Centroberyx lineatus*				✓
Sweep, Banded	*Scorpis georgianus*				✓
Sweep, Sea	*Scorpis aequipinnis*			✓	✓
Sweetlips, General		✓	✓		
Sweetlips, Gold-Spotted	*Plectorhinchus flavomaculatus*			✓	
Sweetlips, Minstrel	*Plectorhinchus chaetodontoides*			✓	
Sweetlips, Painted	*Diagramma labiosum*		✓	✓	
Swordfish, Broadbill - General	*Xiphias gladius*	✓			
Tailor	*Pomatomus saltatrix*		✓❄	✓❄	
Threadfin Salmon - General	Family Polynemidae	✓			
Threadfin Salmon, Bluenose	*Eleuthronema tetradactylum*	✓❄			
Threadfin Salmon, Giant	*Polydactylus macrochir*	✓❄			
Threadfin Salmon, Northern	*Polydactylus plebius*	❄	✓		
Threadfin-Bream, Purple	*Pentapodus emeryii*	❄	✓		
Threadfin-Breams/ Butterfishes /Monocle Breams	Family Nemipteridae		✓	✓	
Trevallies, General		✓	✓	✓	✓
Trevally, Black	*Caranx lugubris*		✓		
Trevally, Bludger	*Carangoides gymnostethus*	✓	✓		
Trevally, Giant	*Caranx ignobilis*	✓	✓		

Common Name	Scientific Name	North Coast	Gascoyne	West Coast	South Coast
Trevally, Golden	*Gnathanodon speciosus*	✓	✓		
Trevally, Gold-Spotted/Turrum	*Carangoides fulvoguttatus*		✓		
Trevally, Skipjack/Silver	*Pseudocaranx dentex*	✓	✓	✓	✓
Triggerfishes, general	Family Balistidae		✓		
Trout, Brown	*Salmo trutta*				✓
Trout, Coral	*Plectropomus leopardus*	✓❄	✓	✓	
Trout, Coronation	*Variola louti*		✓		
Trout, Rainbow	*Oncorhynchus mykiss*			✓	✓
Trumpeter, Yellowtail	*Amniataba caudavittatus*		✓		
Trumpeters/Grunters, General	Family Teraponidae	✓	✓	✓	
Tuna, Bigeye	*Thunnus obesus*		✓		
Tuna, Mackerel	*Euthynnus affinis*	✓	✓		
Tuna, Northern Bluefin (Long-Tailed)	*Thunnus tonggol*	✓	✓	✓	
Tuna, Skipjack	*Katsuwonis pelamis*		✓		
Tuna, Southern Bluefin	*Thunnus maccoyii*		✓		
Tuna, Yellowfin	*Thunnus albacares*		✓		
Tunas, General	Family Scombridae	✓	✓	✓	
Tuskfish, Blackspot (Blue Bone)	*Choerodon schoenleinii*	✓	✓		
Tuskfish, Blue	*Choerodon cyanodus*		✓		
Tuskfish, Bluespotted	*Choerodon cauteroma*		✓		
Tuskfish, general		✓	✓		
Unknown Species		✓	✓	✓	✓
Wahoo	*Acanthocybium solandri*		✓		
Whiptail, False	*Pentapodus porosus*	✓			
Whiting, General / Sand		✓	✓	✓	✓
Whiting, King George	*Sillaginodes punctata*			✓	✓
Whiting, Northern	*Sillago sihama*	✓			
Whiting, School Southern / Silver	*Sillago bassensis*			✓	✓❄
Whiting, Trumpeter	*Sillago maculata*			✓	❄
Whiting, Western School	*Sillago vittata*			✓	❄
Whiting, Yellow-Finned	*Sillago schomburgkii*		✓	✓	✓❄
Wirrah, Western	*Acanthistius serratus*			✓	
Wobbegongs/Catsharks, General	*Orectolobus* spp.			✓	
Wrasse, Brown-Spotted	*Pseudolabrus parilus*			✓	✓
Wrasse, Tripletail Maori	*Cheilinus trilobatus*		✓		
Wrasse, Western King	*Coris auricularis*			✓	
Wrasse/Gropers, General		✓	✓	✓	✓
Yabby	*Cherax* spp.			✓	
Zebra Fish					✓
	Total	**74**	**148**	**105**	**52**