

SOUTHERN INLAND BIOREGION

ABOUT THE BIOREGION

This region contains WA's only natural permanent freshwater rivers, which are fed by rainfall through winter and spring. These permanent rivers are restricted to the high-rainfall south-west corner of the State and flow through the significant native forest areas. Some of the rivers are more saline in their upper reaches owing to the effects of agricultural clearing of native vegetation in more inland areas.

Across the remainder of the Southern Inland Bioregion, rivers flow primarily during the 3 months of winter rainfall, with very occasional summer flows from inland rain-bearing depressions resulting from decaying cyclones. Most large fresh water bodies are man-made irrigation, water supply or stock-feeding dams. There is a diverse variety of natural water bodies in this region ranging from numerous small springs and billabongs, up to Lake Jasper, the largest permanent freshwater Lake in the South West region, with 440 ha of open water up to 10 m deep. In combination these diverse natural and man-made permanent waterbodies provide valuable habitat for fish and freshwater crustaceans during the summer months. Some natural salt lakes also occur but these generally dry out over summer each year.

The few natural freshwater rivers and man-made lakes support a small native fish fauna and create an environment, particularly in forest areas, which is highly valued by the community for a variety of recreational pursuits.

SUMMARY OF FISHING AND AQUACULTURE ACTIVITIES

While there are no commercial fisheries in the Southern Inland Bioregion, this area provides significant recreational fishing opportunities. The major species fished recreationally are native marron, trout (both rainbow and brown trout) stocked by the Department of Fisheries into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating stock. The native freshwater cobbler is also taken in small numbers, as are the estuarine black bream which are artificially stocked into some inland impoundments that have become saline.

Aquaculture development in the Southern Inland Bioregion is dominated by the farm-dam production of yabbies, which can reach about 200 t annually depending on rainfall and market demand. Semi-intensive culture of marron in purpose-built pond systems provides around 60 t per year and has the potential to expand significantly.

Trout have historically been the mainstay of finfish aquaculture production in this region, originating from heat-tolerant stock maintained at the Department's Pemberton Freshwater Research Centre. Silver perch are also grown in purpose-built ponds to supply local markets.

ECOSYSTEM MANAGEMENT

The conservation of the 13 species of freshwater native fish in freshwater ecosystems in the South-West of WA is a growing issue for the Department of Fisheries. Many of these species are endemic to WA, and are under pressure through increasing salinity, feral fish populations, infrastructure (bridges and dams) and adjacent land-use development.

The Department works with representatives from the Department of Water, the Department of Parks and Wildlife and other stakeholders, to facilitate information exchange and identify research projects and associated funding sources to mitigate environmental impacts and so better protect native fish species. This is being facilitated by the recent establishment of the Freshwater Ecosystem Working Group which aims to coordinate a whole-of-Government approach to the management of freshwater ecosystems in the State.

The Department undertakes a risk-based approach to managing the spread of feral fish in the bioregion. To support this, it has developed a community based reporting tool and education program to support its own routine surveillance activity. Information on aquatic pest distribution is used to prioritise management actions aimed at limiting the impact and preventing the spread of high risk pest fish within the State's freshwater ecosystems.

A key element of reducing the risk of feral fish is the approval process that the Department has in place for assessing proposals to translocate live non-endemic fish species into and within Western Australia, so as to minimise the environmental risks to freshwater ecosystems associated with this activity.

ECOSYSTEM BASED FISHERIES MANAGEMENT

Identification of Ecological Assets using the EBFM framework

The Department is now implementing an Ecosystem Based Fisheries Management (EBFM) framework (see How to Use section for more details). In terms of ecological assets, the Department has recognised the following ecological values for the Southern Inland Bioregion:

Ecosystem structure and biodiversity;

Captured fish species

Listed species (direct impact – capture or interaction);

External Drivers

The full set of ecological assets identified for ongoing monitoring are presented in Southern Inland Ecosystem Management Figure 1.

Risk Assessment of Ecological Assets

The EBFM process identifies the ecological assets in a hierarchical manner such that the assets outlined Figure 1 are often made up of individual components at species or stock level. The risks to each of the individual stock or lower level components are mostly detailed in the individual fishery reports presented in this document. The following table (Southern Inland Ecosystem Management Table 1) provides an overview and cumulative assessment of the current risks to the ecological assets of the Southern Inland Bioregion, at a bioregional level and provides a mechanism for reporting on their status and the fisheries management arrangements that are being applied. These bioregional level risks are now used by the Department as a key input into the Department’s Risk Register which, combined with an assessment of the economic and social values and risks associated with these assets, is integral for use in the annual planning cycle for assigning priorities for activities across all Divisions in this Bioregion.

Summary of Monitoring and Assessment of Ecosystem Assets

Researchers from the Biodiversity and Biosecurity Branch are involved in several research projects related to freshwater biodiversity and conservation. One of these projects has been monitoring and assisting the restoration of hairy marron (freshwater crayfish) populations in the Margaret River. The critically endangered hairy marron (freshwater crayfish) is endemic to the Margaret River. However, the common, widespread smooth marron was accidentally introduced to the lower reaches of the river in the early 1980s. Over time, smooth marron have replaced hairy marron, first from the lower reaches (in the 1980s), then the middle reaches (in the 1990s) and at present hairy marron are only found in the upper reaches, but together with smooth marron.

Hairy crossed with smooth marron hybrids are common in the upper reaches of the Margaret River and the hybrids are fertile and appear to have similar ecological fitness. The displacement of hairy marron by smooth marron is most likely driven by hybridization of what appear to have been two geographically distinct species. Maintaining populations of hairy marron in the upper reaches of the Margaret River is

vital for the conservation of this species and will require ongoing removal of smooth marron and hybrids in combination with re-stocking pure hairy marron from the captive breeding program.

In 2005 The Department of Fisheries was successful in obtaining a grant from the SWCC (South West Catchments Council) to collect “hairy” marron from the wild and establish a breeding program to save this rare species from extinction. The Department has recently collaborated with the University of Western Australia to develop improved genetic tools to identify and characterise hairy marron to support further development of a controlled breeding program. This has resulted in production of genetically pure hairy marron and efforts are now underway to scale up production. Numbers of hairy marron in the Margaret River have declined significantly in recent years due to them being outcompeted by smooth marron and hybrids. As such the priority to ensure that this species does not become extinct is to establish a self-sustaining repository population that can be used to support any future Margaret River restocking program.

Most freshwater fish species are no longer present in large areas of their original range and some have been listed as critically endangered (e.g. Western trout minnow *Galaxias truttaceus hesperius*, and Margaret River marron *Cherax tenuimanus*). While others have been listed as vulnerable to extinction (e.g. Balston’s pygmy perch *Nannatherina balstoni*). This has resulted in a reduced abundance and distribution of many species in lakes, rivers and streams in the southwest bioregion. Research is ongoing into establishing production of threatened native fish species to facilitate stock enhancement in priority waterbodies in the region.

Research and monitoring is also underway to support feral fish surveillance and management. The Department adopts a risk-based approach to managing the threats posed by non-native fish which are widespread in metropolitan waterbodies. Such research includes the evaluation and implementation of control mechanisms (e.g. trapping methods, barrier controls, poisoning) as well as developing methods to identify the diversity of fish species present in water bodies based on the DNA that they shed into their environment.

**SOUTHERN INLAND ECOSYSTEM MANAGEMENT TABLE 1
RISK LEVELS FOR EACH ASSET.**

Risk levels in this table are developed by combining the individual (lower level) elements that make up each of the higher level components. Low and Medium values are both considered to be acceptable levels of risk. High and Significant risks indicate that the asset is no longer in a condition that is considered appropriate and additional management actions are required. Where the value is followed by (non-fishing) this indicates that all, or the majority of the risk value, was not generated by fishing activities.

Ecosystem Structure and Biodiversity

Ecosystem	Risk	Status and Current Activities
Riverine Ecosystems	HIGH (non fishing)	The community structure of most river and lake systems in this bioregion are substantially altered from historical levels. A survey of the main areas has been completed through a state NRM funded project.

Captured fish species

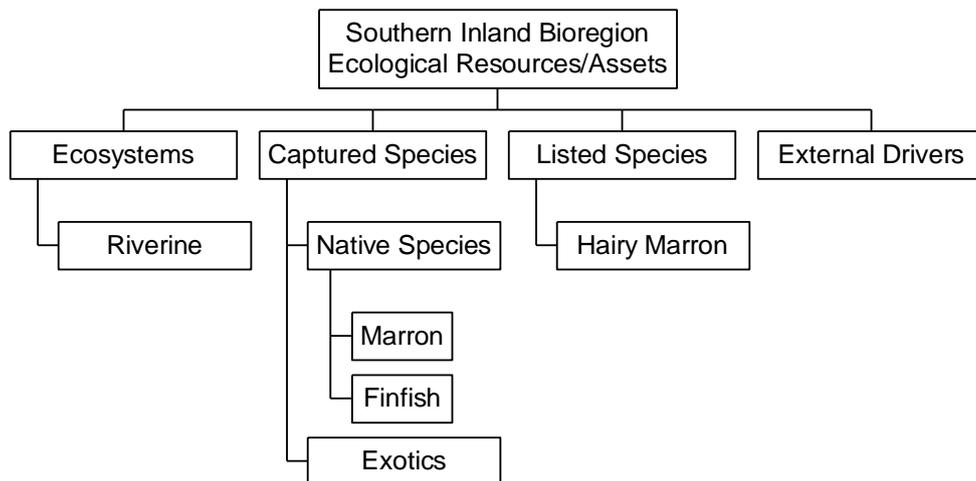
Fish species	Risk	Status and Current Activities
Finfish Native (not listed)	HIGH (non-fishing)	The abundance and distribution of most native fish have been severely impacted due to reduced rainfall and land management practices. This has led to widespread fragmentation of native fish populations (i.e. regional extinctions, which without restocking will be permanent as there is no migration between lakes or catchments) and some species are already listed in danger of extinction
Crustaceans Native	HIGH (non fishing)	The abundance of smooth marron has been monitored at regular intervals for a number of decades. The fishery arrangements have been through a number of significant updates to ensure that the catch is sustainable. The biggest threat to these stocks is from non-fishing causes.
Exotics (Stocked)	MODERATE	Trout have been stocked into a limited number of streams in WA for decades. The trout are produced from the Pemberton Hatchery and are heat tolerant.

Listed species

Listed fish species	Species	Risk	Status and Current Activities
Listed Species	Hairy Marron Western Minnow (non fishing)	SIGNIFICANT	There is a monitoring and restoration program for hairy marron and there is a captive breeding program for endangered finfish (see details above)

External Drivers (non fishing)

External Drivers	Risk	Status and Current Activities
Pests and Diseases	HIGH	A high number of exotic fish species have been released into the South West catchments. There is an assessment program underway to determine the extent of this and which of these events can be addressed by eradication.



SOUTHERN INLAND ECOSYSTEM MANAGEMENT FIGURE 1

Component tree showing the ecological assets identified and separately assessed for the Southern Inland Bioregion.

FISHERIES

Licensed South-West Recreational Freshwater Angling Fishery Report: Statistics only

R. Duffy, F. Trinnie, K. Ryan, B. Rome

Fishery Description

The South-West recreational freshwater fishery is primarily an angling fishery for rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and redfin perch (*Perca fluviatilis*). In addition, anglers take the native freshwater cobbler (*Tandanus bostocki*). Rainbow and brown trout are the subject of an annual controlled stocking program by the Department of Fisheries, while the non-native species redfin perch were previously released in the South-West and now occur as self-breeding populations in most water bodies.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Fish Resources Management Regulations 1995

Freshwater Recreational Fishing Licence

Consultation process

Meetings between the Department of Fisheries, Recfishwest and Freshwater fishers.

Boundaries

The South-West freshwater angling licence authorises anglers to fish for freshwater finfish species in all inland waters of Western Australia south of 29° latitude (Greenough) and above the tidal influence including all lakes, dams, rivers and their tributaries.

Management arrangements

Access to this fishery is controlled by licences, seasonal closures, fishing gear restrictions, minimum sizes, and bag limits. Licensed anglers may only use a single rod, reel and line or single handline when targeting these species.

To protect newly released trout, a closed season applies from 1 July to 31 August in rivers and dams in the south-west of the State, with the exception of the Murray, Blackwood, Donnelly and Warren Rivers and sections of the Serpentine River.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), freshwater cobbler (*Tandanus bostocki*). Rainbow and brown trout have a minimum legal size limit of 300 mm, but no minimum legal size limit applies to freshwater cobbler. No bag limit or size limit applies to redfin perch (*Perca fluviatilis*) and anglers are encouraged not to return any redfin to the water as this feral species negatively affects the marron fishery and predated actively on trout fry.

The trout stocking program administered by the Department of Fisheries in consultation with Recfishwest focuses on public waters where trout have been stocked or been present since the 1930s. The Department's trout stocking processes are conducted in accordance with the Department's Five-Year Management Strategy for the Recreational Trout Fishery- Fisheries Management Paper 250. This strategy, developed by the Department in collaboration with Recfishwest and the Recreational Fisheries Stakeholder Sub-Committee (RFFSS), ensures that an appropriate level of management is provided for the translocation of trout into rivers and dams of the South West of Western Australia. All trout stocked into public waters are produced at the Department of Fisheries, Pemberton Freshwater Research Centre (PFRC).

There were no significant change to the management arrangements between 2013 and 2014.

Landings and Effort

Commercial catch estimate (season 2013/14)

Not applicable

Recreational catch estimate (season 2013/14)

58,203 retained fish

At the end of the 2014 season, a phone recall survey was undertaken of 397 metro and 398 country respondents (7.7% of licence holders in that season). Extrapolation of the survey results estimated that approximately half of all licence holders actively fished (Freshwater Angling Table 1). Therefore, there is a large proportion of people that purchase a license but don't actually use it.

The estimated total effort for 2014 was 34,021 days (with standard error $\pm 2,368$), which was an increase from 23,646 in 2013 (Freshwater Angling Table 1, Freshwater Angling Figure 1a). The estimated total number of licensed fishers was 10,370 in 2014, which was an increase from 9,718 in 2013 (Freshwater Angling Table 1). The estimated total number of licensed fishers that participated in freshwater angling was 5,357 in 2014; an increase from 4,787 in 2013 (Freshwater Angling Table 1). The average number of days fished per fisher was 6.35 days in 2014, which was higher than the 4.94 in 2013. Harvey Dam continued to receive the highest fishing pressure (45% of all effort) (Freshwater Angling Table 2). The highest proportion of fishing in rivers was undertaken in the Warren River (Freshwater Angling Table 2). Fishing effort in the main rivers in Freshwater Angling Table 3 was generally lower than previous years, whilst the effort in "other rivers" has increased. The cause of the increase fishing effort is unknown, but it demonstrates that fishers are prepared to visit new areas in search of fish.

The estimated total recreational catch from south-west freshwater angling across all species for 2014 was 103,017 (by number) (fig 2b) of which 58,203 were kept and 44,814 were released. This was an increase from 2013, where the estimated total recreational catch was 61,075 (by number) (Freshwater Angling Table 3).

The estimated catch per unit effort (CPUE) for all species combined in 2014 (3.03 (number of fish per fisher day)) was higher than the CPUE estimated for 2013 (2.58) (fig 1a). In 2014, the CPUE for fish kept (1.71 fish per fisher day) was

higher than the CPUE for fish released (1.32), which was similar to 2013 where the CPUE for fish kept (1.98) was higher than the CPUE for fish released (0.61). For information on individual species, refer to fig 2). Catches of all species are relatively stable.

Of particular interest is the large number of trout that are released by fishers each year. From the available data, it is not possible to accurately determine if the fish released because they are undersized, or if catch and release forms a large part of the fishery.

FRESHWATER ANGLING TABLE 1

Summary of survey respondent effort and total effort extrapolated to all licence holders for seasons (2012 to 2014).

Season	Stratum	Licences	Total effort			
			Total fishers	Mean days	Total effort days	Std error (Total effort)
2012	Ctry	3591	1742	6.24	10868	
2012	Metro	4950	2426	4.01	9726	
		8541	4167	4.94	20594	1979
2013	Ctry	4004	1902	7.35	13979	
2013	Metro	5714	2886	3.35	9667	
		9718	4787	4.94	23646	2302
2014	Ctry	4631	2350	7.40	17393	
2014	Metro	5739	3007	5.53	16628	
		10370	5357	6.35	34021	2368

FRESHWATER ANGLING TABLE 2

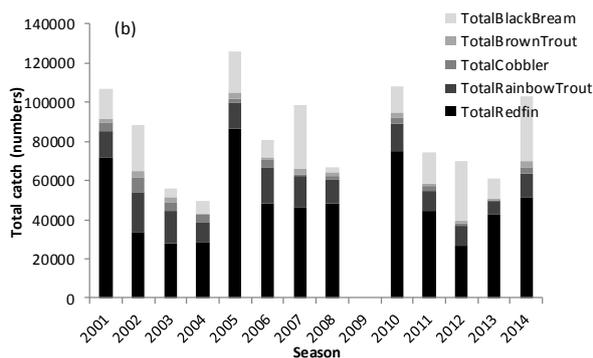
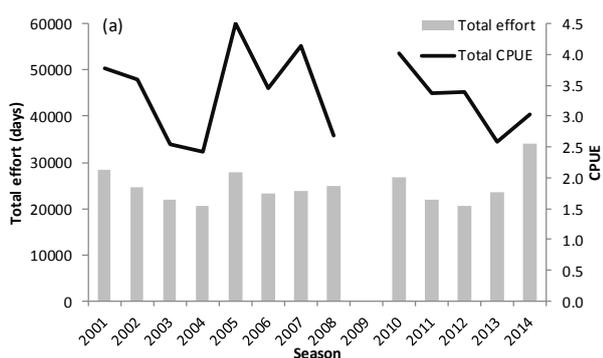
Summary of proportion of effort (days) for individual dams and rivers for seasons (2012 to 2014).

Waterbody	Watercourse	Proportion of effort %		
		2012	2013	2014
Dams	Big Brook	6	4	4
	Drakes Brook	2	4	4
	Harvey	50	49	45
	Logue Brook	12	17	15
	Waroona	14	13	14
	Wellington	9	6	16
	Other	7	6	3
	Total	100	100	100
Rivers	Blackwood	19	18	14
	Collie	12	19	14
	Donnelly	6	10	8
	Hutt	0.4	0	0
	Margaret	0.1	1	2
	Murray	15	11	11
	Preston	3	1	4
	Warren	24	19	17
	Other	20	21	30
	Total	100	100	100

FRESHWATER ANGLING TABLE 3

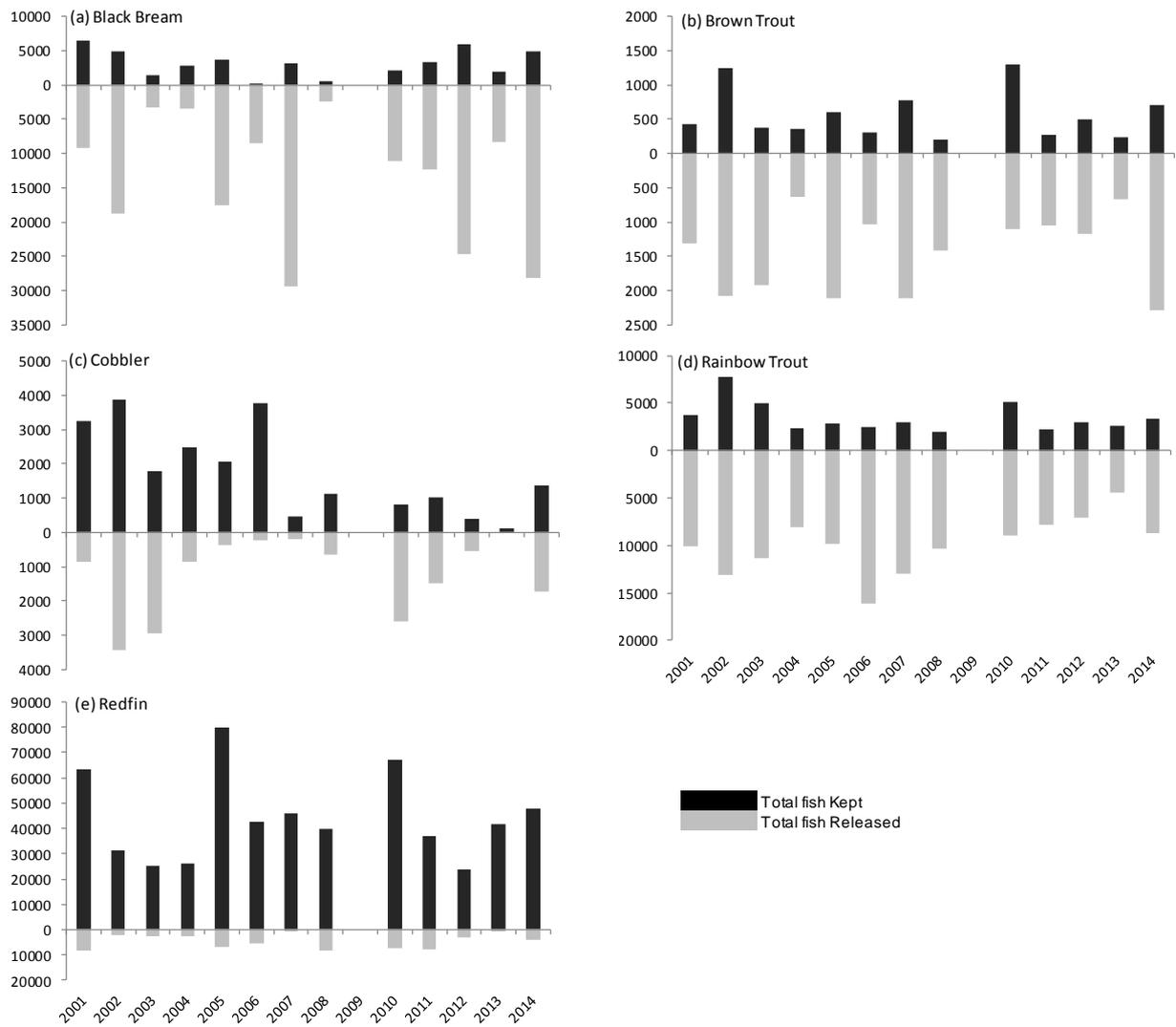
Summary of survey estimates for the main freshwater species targeted for seasons (2012 to 2014). Release rate = (Released /Total)

Season	Species	Total (numbers)		Total	Release rate %
		Kept	Released		
2012	Black Bream	5955	24607	30561	81
	Brown Trout	501	1169	1670	70
	Cobbler	394	556	949	59
	Rainbow Trout	2958	7026	9984	70
	Redfin	23913	3014	26926	11
	Total	33720	36371	70092	52
2013	Black Bream	1987	8338	10325	81
	Brown Trout	237	669	906	74
	Cobbler	114	0	114	0
	Rainbow Trout	2578	4396	6974	63
	Redfin	41841	915	42756	2
	Total	46757	14318	61075	23
2014	Black Bream	4948	28131	33079	85
	Brown Trout	708	2282	2990	76
	Cobbler	1381	1718	3099	55
	Rainbow Trout	3389	8761	12151	72
	Redfin	47776	3922	51698	8
	Total	58203	44814	103017	59



FRESHWATER ANGLING FIGURE 1

Estimated total effort, CPUE (a) and total number of fish caught (b) for 2001 to 2014 seasons.



FRESHWATER ANGLING FIGURE 2

Total kept and released numbers by species Black Bream (a) Brown trout (b) Cobbler (c) Rainbow trout (d) and redfin (e) for 2001 to 2014 seasons.

Licensed Recreational Marron Fishery Report

R. Duffy, F. Trinnie, K. Ryan.

Main Features			
Status	Current Landings		
Stock level	Acceptable	Commercial	nil
Fishing level	Acceptable	Recreational catch estimate	
		2013	50, 330 marron
		2014	71,268 marron

Fishery Description

Marron are endemic to Western Australia and are the third largest freshwater crayfish in the world. Recreational fishing occurs in freshwater dams and rivers throughout the southern part of the State extending from as far north as Geraldton, to Esperance in the east. Fishers may only use legal scoop nets, drop nets or snares to take marron.

Governing legislation/fishing authority

Fish Resources Management Act 1994 and subsidiary legislation

Fish Resources Management Regulations 1995

Marron Recreational Fishing Licence

Consultation process

Meetings between the Department of Fisheries, Recfishwest and freshwater fishers.

Boundaries

The recreational marron fishery extends from the Hutt River north of Geraldton to waters near Esperance. The fishery operates in freshwater dams and rivers, although drinking water supply dams servicing the Perth metropolitan area and south-west regional centres are closed to the public by the Water Corporation.

Management arrangements

This fishery is managed through input controls of licences, closed seasons and gear restrictions, and the output controls of size and bag limits (see <http://www.fish.wa.gov.au/>).

All marron fishers require a Marron Recreational Fishing Licence. For the 2013 season, licensed fishers were permitted to fish for marron from midday 8th January to midday 5th February 2013. Three types of legal gear exist; scoop nets, drop nets and snares. In most waters there is a minimum size of 80 mm carapace length and a daily bag limit of 8 marron per day. The possession limit was decreased from 20 marron to 16 marron in 2012. The exception to these reductions were Harvey Dam, Waroona Dam and Hutt River which are managed as snare only 'Trophy Waters' with a minimum legal size of 90 mm carapace length and a daily bag and possession limit of 5 marron.

There were no significant change to the management arrangements between 2013 and 2014.

Research summary

Detailed research on the marron stocks in south-west rivers and dams has been undertaken since the 1970s, including Logbook Surveys from 1971 to 2008 and an annual phone recall survey from 1990 to 1999. These surveys have been documented elsewhere.

An annual phone recall survey has been undertaken to quantify the marron recreational catch and effort in public waterways (dams and rivers) since 2000. This survey utilises the Marron Recreational Fishing Licence (and the Umbrella

Fishing Licence from 2000 to 2011) as a sampling frame to contact fishers.

In conjunction with the annual phone survey, annual monitoring through fishery-independent surveys provides data on relative abundance and average size of marron in three dams and eight rivers.

Retained Species

Recreational catch estimate (season 2013)

50,330 marron

Recreational catch estimate (season 2014)

71,268 marron

At the end of the 2013 season (8 January 2013 to 5 February 2013), a phone survey was undertaken to sample 200 metro and 200 country respondents (3.7% of licence holders in that season). At the end of the 2014 season (8 January 2014 to 5 February 2014) a total of 414 licence holders from metro and 344 from country areas were included in the survey (6.7% of licence holders in that season).

The estimated recreational marron catch for 2013 was 50,330 (by number, with standard error $\pm 5,376$) (Recreational Marron Table 1, Recreational Marron Figure 1) with an estimated 35,982 taken in rivers and 14,350 in dams (Recreational Marron Table 2). The estimated marron catch for 2014 was 71,268 (by number, $\pm 7,234$) (Recreational Marron Table 1, Recreational Marron Figure 1) with an estimated 49,653 taken in rivers and 19,638 in dams (Recreational Marron Table 2).

The catch per unit effort (CPUE) in 2013 (2.85 (number per fisher day) was lower than the CPUE observed in 2014 (3.90) (Recreational Marron Figure 1). In 2013, the CPUE observed in rivers (2.87 number per fisher day) was almost the same in dams (2.80). Similarly, in 2014 the CPUE in rivers (3.99) was higher than in dams (3.57) (fig 1).

Total effort was estimated at 17,641 days in 2013 and 18,267 in 2014 (Recreational Marron Table 1). Total number of licensed fishers was 10,728 in 2013 and 11,392 in 2014 (Recreational Marron Table 1). The total number of active fishers was estimated at 6,060 in 2013 and 6,232 in 2014. The average number of fishing days per fisher was 2.91 days in 2013 and 2.93 in 2014 (Recreational Marron Table 1).

The proportion of total effort in 2013 was 12,544 days (71%) in rivers compared to 5,134 days (29%) in dams (Recreational Marron Table 3). Similarly, the proportion of total effort in 2014 was 12,438 days (69%) in rivers compared to 5,504 days (31%) in dams (Recreational Marron Table 3). This division of effort between dams and rivers is consistent over time and demonstrates the importance of rivers to the marron fishing experience (Recreational Marron Table 6). The proportion of effort in Wellington Dam and Harvey Dam has increased from 58% in 2012 to 88% in 2014 (Recreational Marron Table 4). Although these levels are within the historical range future research should attempt to identify the cause of this pattern (Recreational Marron Figure 2a). Effort in rivers is spread over a greater number of sites with the Warren, Blackwood and Collie Rivers accounting for 40 to 50% of the effort rivers receive (Recreational

Marron Table 5). However, unspecified systems still account for a substantial portion of all river fishing effort (approximately 30%) (Recreational Marron Figure 2b, Recreational Marron Table 4).

Stock Assessment

Assessment complete: Yes

Assessment Method and level:

Level 4 - Fishery Independent Direct Survey

Breeding stock levels: Acceptable

Fishery-dependent catch and effort data (e.g. CPUE as determined by logbook or phone survey) can be poor indicators of true stock abundance especially in heavily managed fisheries (i.e. those with seasons, bag limits, size limits and gear restrictions) like the Recreational Marron Fishery. In 2006 a new stock assessment program using traps was initiated that provided fishery-independent data on relative abundance and average size (mm Orbital Carapace Length [OCL]) of marron in three dams (Waroona Dam, Wellington Dam, Harvey Dam) and eight rivers (Shannon, Warren, Donnelly, Blackwood, Preston, Collie, Murray and Moore River). These three dams and eight rivers account for more than 75% of the total fishing effort of the Recreational Marron Fishery (see Recreational Marron Figure 2).

The annual fishery-independent survey provides vital data for monitoring trends in stocks, evaluating the performance of changes in management on stocks and will allow for recommendations to be made for adjustments to the management of the fishery when necessary.

Relative abundance and size of marron varies greatly among the surveyed rivers and dams (Recreational Marron Figure 3). Size of animals in most locations has stayed relatively stable. However, the mean size in Moore River has shown a steady decrease since a peak in 2009 and recorded the lowest mean size since initiation of the stock assessment survey in 2006 (Recreational Marron Figure 3). The mean size of animals in Drakesbrook Weir was the largest recorded for any dam or river since the initiation of this survey.

Marron abundances in Waroona Dam were lower than previous years, however, Wellington Dam showed an increase, as too did Drakesbrook Weir. River CPUE was stable, with some rivers showing an increase in CPUE. Donnelly River is the only river to show a substantial decline. CPUE in this river has always been highly variable, therefore this year's low catch is not alarming, but will continue to be monitored closely.

In addition to data on abundance and size, the annual fishery independent survey also provides information on size-at-maturity and fecundity for each of the rivers and dams. From the locations surveyed, the current breeding stock levels appear adequate (based on typical size-at-maturity). Size-at-maturity, i.e. size at which 50% of the females are mature, seems to be below the minimum legal size of 80 mm Rostrum Carapace Length (RCL) for the majority of marron stocks in the South-West. Present size restrictions seem to adequately protect the majority of the female breeding stocks. A larger minimum legal size of 90 mm RCL has been introduced to protect the breeding stocks and these water bodies are managed as 'Trophy' waters.

Investigations into enhancing stock estimation methods are currently being undertaken. The work consists of a comparison of population estimation methods (tagging vs capture data). At the conclusion of this research, the results will be used to enhance estimates obtained from the annual fishery independent stock assessment.

Non-Retained Species

Bycatch species impact: Negligible

The marron fishery does capture small quantities of non-target species, principally gilgies (*Cherax quinquecarinatus*, *C. crassimanus*) and koonacs (*C. plebejus*, *C. glaber*). Although little is known about their biology, the impact of the marron fishery on these species is thought to be low as gilgies and koonacs are smaller than marron and are not targeted by marroners.

Listed species interaction: Negligible

A second type of marron has been identified ('Hairy' marron) which is threatened mainly by the extension in range of the more common 'Smooth' marron, which is the basis of the recreational marron fishery. In late 2002, recreational marron fishing upstream of Ten Mile Brook Junction (including all its tributaries) on the Margaret River was prohibited to remove the impacts of fishing on the remaining 'Hairy' marron stocks. However, illegal fishing is still reported in this reach of the Margaret River. A recovery plan, developed jointly between the Department of Fisheries, the Department of Environment and Conservation, and other stakeholders on the recovery team is underway for the 'Hairy' marron.

Ecosystem Effects

Food chain effects: Low

The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect, noting that the bulk of the marron biomass is below legal size and that marron of all sizes have similar food and habitat requirements. Marron taken from man-made dams are already living in highly modified habitats, as such their removal does not significantly impact on natural freshwater ecosystem function.

Habitat effects: Negligible

The impact of this fishery on the aquatic habitat is negligible. The major effects are litter in surrounding areas and the trampling of areas of riparian vegetation by marroners and subsequent bank erosion.

Social Effects

The marron fishery is an iconic fishery and a major recreational activity in regional areas of the south-west of the State. The effect of rainfall on the availability of marron habitat is expected to increase awareness of changes in climate patterns in the South-West.

Economic Effects

The value of the recreational marron catch cannot be calculated as no data on the size of marron captured by recreational fishers was collected. In the past, this data was collected as part of the Marron logbook program, however, this program ceased operation in 2008. The estimated 25,700 days of marroning in regional locations is likely to have provided a significant economic boost to regional towns in the South-West.

Fishery Governance

Target catch (or effort) range

96,000-136,000 marron

In 2006, the Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) proposed that, based on the available research data and the knowledge of the marron fishery, the fishery be managed to a maximum target catch of between 96,000-136,000 marron. Effort has steadily increased since 2003 with a proportionate increase in catch. In 2007 the marron season was increased from 16 to 23 days. The season was increased to 28 days in 2009 with fixed dates whereas previously seasons varied each year to match with lunar cycles. Assuming relatively stable marron abundance, a limited growth in the fishery is allowed while maintaining catches at a sustainable level. Variations in marron abundance (fishery independent surveys) and marron catches (phone survey) will be monitored to determine the impact of the changes in season length and increase in legal minimum size.

Current fishing (or effort) level **Acceptable**

Fishing effort has been low under current management arrangements. Since 2003 when the reduced 16 day season was introduced effort (fishing days) dropped considerably

from ~40,000 fishing days (2000-2002) to ~11,000 fishing days (2003-2006). The season length was extended from 16 to 23 days in 2007 and a significant increase in effort from ~11,000 (2003-2006) to ~17,000 fishing days (2007-2008) was observed. The effort for 2014 was 18,267 fishing days with a 28 day season.

New management initiatives (2014/15)

For 2014 the marron season started at midday on 08 January and ran for a 28 day period until midday 05 February. Fisheries managers and scientists continue to monitor the impact of changing rainfall patterns in the South-West on marron populations. As a result of this monitoring and discussions with stakeholder groups, it was decided a precautionary approach would be taken and the 2012 daily bag limit would be reduced from 10 to 8 animals per licensed fisherman.

External Factors

Winter rainfall plays a major role in marron reproduction, growth and survival. Rainfall increases the quality of areas for marron by transporting leaf-litter into streams (providing food sources for marron growth and reproduction) and by maintaining water volume and quality. A second major issue in this fishery is access to irrigation dams. The Water Corporation closed access to Stirling Dam in 2001 and Logue Brook Dam in 2008 to divert water to the metropolitan water supply.

RECREATIONAL MARRON TABLE 1

Summary of survey estimates for each regional stratum from previous (2012) and current seasons (2013 and 2014). Participants, number of fishers actively using licence; Partrate, participation rate (participants/sample); Totalfishers (licences x partrate); Total effort (totalfishers x daysmean); Catchrate (totmarron/dayssum); Totalcatch (catchrate x totaleffort).

Season	Stratum	totalfishers	daysmean	catchrate	totaleffort	stderr	totalcatch	stderr
2012	Ctry	3964	3.11	4.87	12329		60042	
2012	Metro	1698	2.71	3.93	4603		18088	
	Total	5663	2.99	4.61	16931	1371	78130	10014
2013	Ctry	4285	3.16	2.86	13542		38730	
2013	Metro	1774	2.31	2.83	4099		11600	
	Total	6060	2.91	2.85	17641	1487	50330	5376
2014	Ctry	4249	3.24	4.17	13766		57405	
2014	Metro	1983	2.27	3.08	4501		13863	
	Total	6232	2.93	3.90	18267	1254	71268	7234

RECREATIONAL MARRON TABLE 2

Summary of survey estimates by stratum and waterbody type for the previous season (2012) and current seasons (2013 and 2014). Participants, number of fishers actively using licence; Participation rate, participation rate (participants/sample); Totalfishers (licences x participation rate); Total effort (total fishers x days mean); Catchrate (total marron/days sum); Totalcatch (catch rate x total effort).

Season	Stratum	Waterbody	Licences	Total population				
				totalfishers	daysmean	catchrate	totaleffort	totalcatch
2012	Ctry	Dam	6446	999	3.19	3.89	3187	12398
2012	Metro	Dam	3466	433	2.44	1.18	1057	1247
	Total		9912	1432	2.96	3.22	4244	13646
2012	Ctry	River	6446	3320	2.74	5.23	9096	47572
2012	Metro	River	3466	1421	2.50	4.75	3553	16875
	Total		9912	4741	2.67	5.10	12649	64447
2013	Ctry	Dam	6912	1486	2.66	2.97	3953	11740
2013	Metro	Dam	3816	649	1.82	2.21	1181	2609
	Total		10728	2135	2.40	2.80	5134	14350
2013	Ctry	River	6912	3214	2.99	2.81	9610	27004
2013	Metro	River	3816	1183	2.48	3.06	2934	8977
	Total		10728	4397	2.85	2.87	12544	35982
2014	Ctry	Dam	7308	1296	2.93	4.03	3797	15302
2014	Metro	Dam	4084	829	2.06	2.54	1707	4336
	Total		11392	2125	2.59	3.57	5504	19638
2014	Ctry	River	7308	3335	2.9	4.19	9672	40528
2014	Metro	River	4084	1263	2.19	3.3	2765	9125
	Total		11392	4598	2.71	3.99	12438	49653

RECREATIONAL MARRON TABLE 3

Proportion of total effort between river and dams from 2000 to 2014.

Season	Effort (proportion)	
	Rivers	Dams
2000	0.70	0.30
2001	0.74	0.26
2002	0.69	0.31
2003	0.78	0.22
2004	0.86	0.14
2005	0.75	0.25
2006	0.72	0.27
2007	0.65	0.38
2008	0.69	0.31
2010	0.58	0.43
2011	0.75	0.25
2012	0.75	0.25
2013	0.71	0.29
2014	0.69	0.31

RECREATIONAL MARRON TABLE 4

Total fishers and total effort for each individual dam for previous (2012) and current seasons (2013 and 2014).

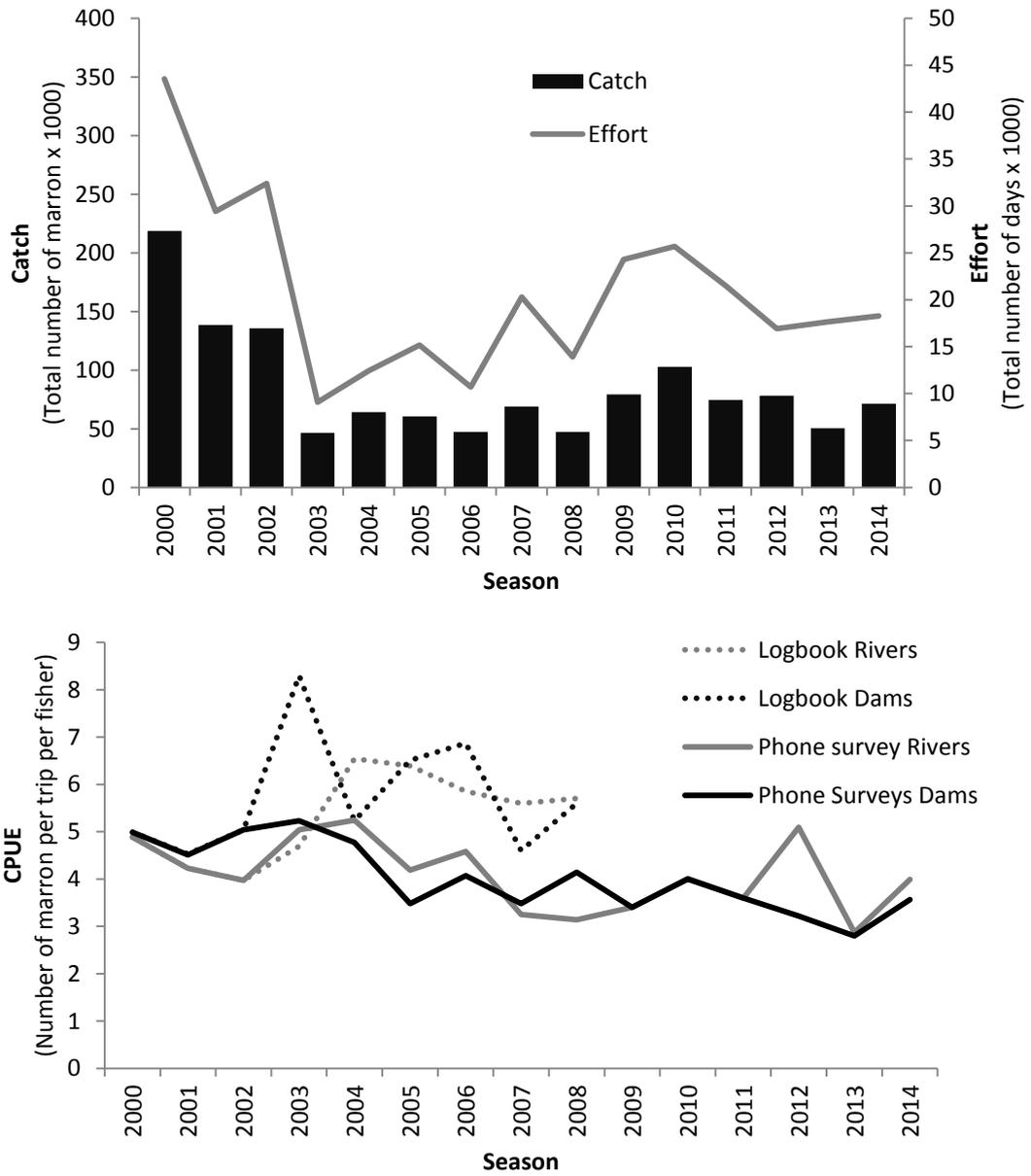
Season	Watercourse	Total population		% effort
		totalfishers	totaleffort	
2012	BigBrook	99	233	5
	DrakesBrook	64	322	8
	Harvey	610	1587	37
	LogueBrook	151	389	9
	Waroona	99	116	3
	Wellington	347	888	21
	Other	325	713	17
	Total		4248	100
2013	BigBrook	19	19	0.4
	DrakesBrook	0	0	0
	Harvey	1108	2944	57
	LogueBrook	107	230	4
	Waroona	92	92	2
	Wellington	529	1006	20
	Other	417	853	17
	Total		5144	100
2014	BigBrook	72	133	2.4
	DrakesBrook	30	39	1
	Harvey	1089	2920	53
	LogueBrook	151	171	3
	Waroona	149	250	5
	Wellington	673	1914	35
	Other	82	82	1
	Total		5508	100

RECREATIONAL MARRON TABLE 5

Total fishers and total effort for each individual river for previous (2012) and current seasons (2013 and 2014).

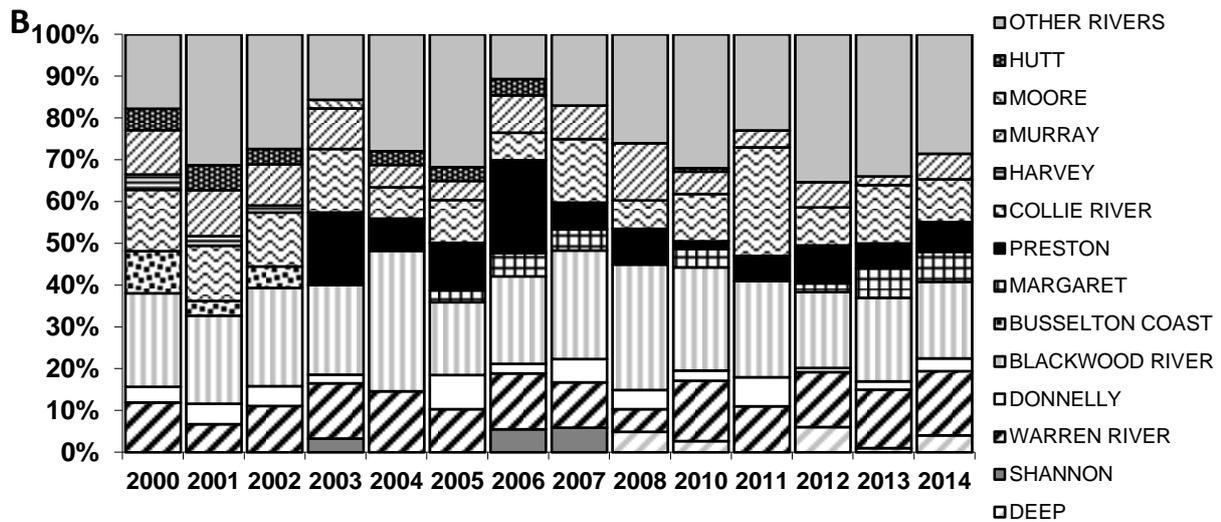
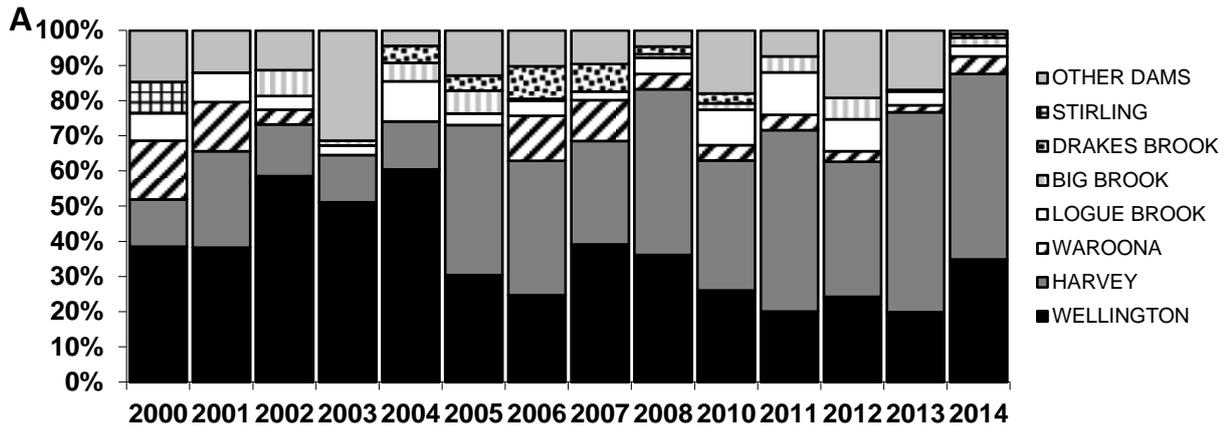
Season	Watercourse	Total population		% effort
		totalfishers	totaleffort	
2012	Blackwood	944	2455	19
	Collie	525	1228	10
	Deep	307	844	7
	Donnelly	114	163	1
	Hutt	32	64	1
	Margaret	146	293	2
	Murray	265	826	7
	Preston	340	1242	10
	Warren	637	1718	14
	Other	1787	3806	30
	Total		12638	100

Season	Watercourse	Total population		
		totalfishers	totaleffort	% effort
2013	Blackwood	1036	2544	20
	Collie	751	1695	14
	Deep	54	73	1
	Donnelly	104	207	2
	Hutt	35	35	0.3
	Margaret	246	928	7
	Murray	161	288	2
	Preston	246	764	6
	Warren	609	1709	14
	Other	1418	4309	34
	Total			12550
2014	Blackwood	962	2289	18
	Collie	568	1260	10
	Deep	222	508	4
	Donnelly	208	392	3
	Hutt	82	82	0.7
	Margaret	283	923	7
	Murray	344	777	6
	Preston	435	881	7
	Warren	753	1849	15
	Other	1404	3492	28
	Total			12454



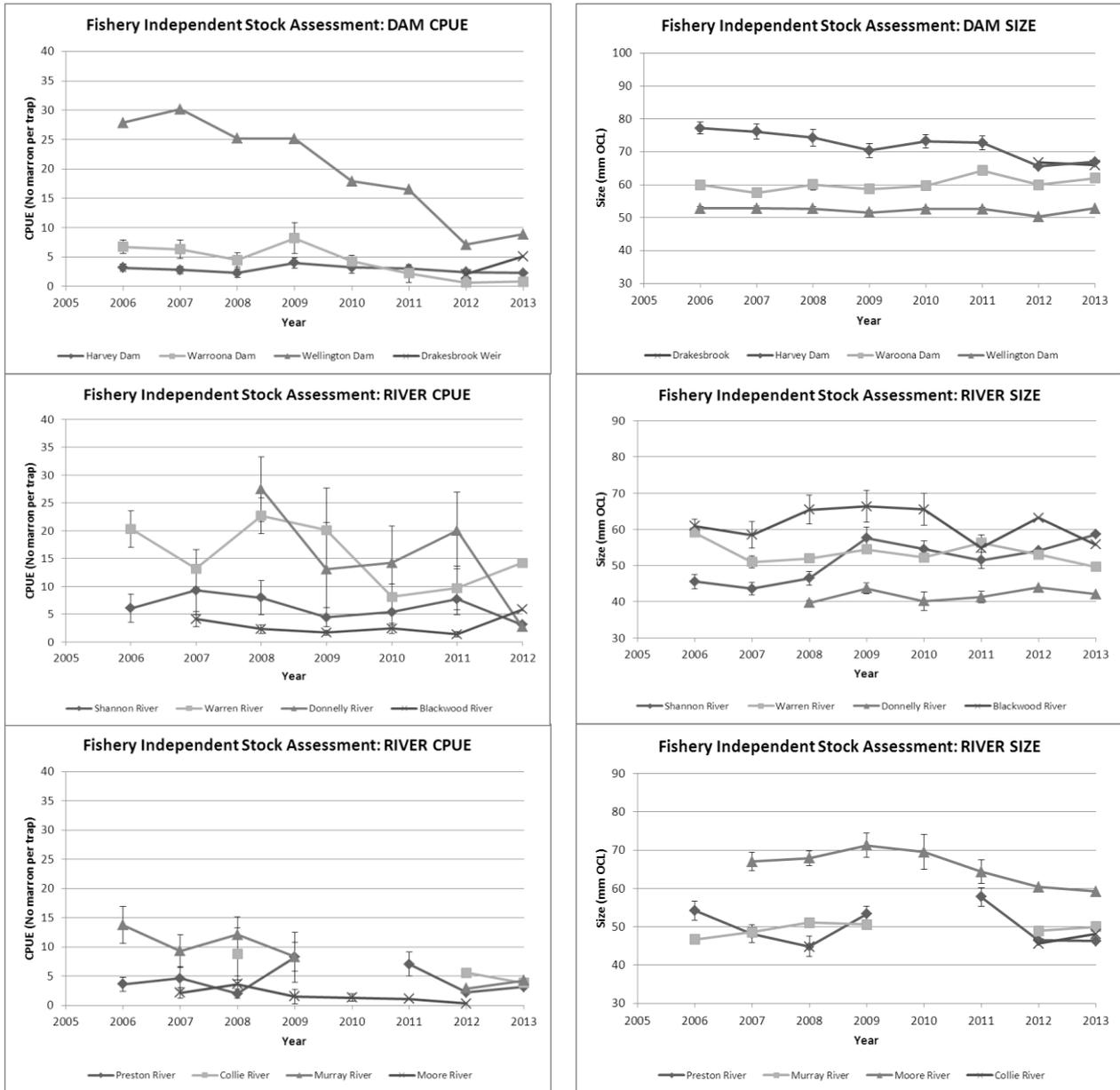
RECREATIONAL MARRON FIGURE 1

The estimates of total marron catch in numbers and effort in days from phone surveys (a) and the catch per unit effort by logbook surveys and phone surveys (b) from 2000 to 2014.



RECREATIONAL MARRON FIGURE 2

The distribution of marron effort among individual dams (a) and individual rivers (b) of the recreational marron fishery from 2000 to 2014.



RECREATIONAL MARRON FIGURE 3

The relative abundance (CPUE) and size (mm OCL) of marron in four dams and eight rivers as determined by the fishery-independent stock assessment. Note: Values may be missing for a year if the site was not able to be sampled.

AQUACULTURE

Regional Research and Development Overview

Previous research undertaken at the Pemberton Freshwater Research Centre focused on marron husbandry and selective breeding research. Current research is focusing on captive breeding programs for conserving endangered marron and native fish.

The Pemberton Freshwater Research Centre continues to be the only major supplier of trout fingerlings to the aquaculture industry and for recreational fisheries stocking. Future research in this area will focus on improving the efficacy of triploidy induction in the Pemberton trout line. The production of infertile triploid trout is considered an

important mechanism to prevent establishment and spread of stocked trout which also has potential benefits for aquaculture (eg increased growth rates). A new collaborative project with the University of British Columbia is underway which aims to understand the genetic basis for the high thermal tolerance of the selectively bred Pemberton trout line. This line is considered internationally significant and is potentially important in understanding thermal tolerance in trout. This has potential implications for future aquaculture and restocking programs worldwide, especially in areas affected by climate change.

COMPLIANCE AND COMMUNITY EDUCATION

Fisheries and Marine Officers (FMOs) based in Geraldton, Dongara, Jurien, Lancelin, Hillarys, Fremantle, Rockingham, Mandurah, Bunbury, Busselton, Albany and Esperance conduct recreational fishing compliance and education activities in the Southern Inland bioregion.

The highest risk of non-compliance in the Southern Inland bioregion is within the recreational marron fishery. The marron season lasts for just 28 days annually (8 January to 5 February). Intelligence information shows there is a risk of illegal fishing during the closed season. This illegal fishing is usually higher during the period from September to December, after the winter rains and prior to the season opening.

During the marron season additional resources are provided to ensure compliance. Strategic rostering practices ensure that available staff from neighbouring districts contribute to operational needs in providing a high profile and professional presence. This presence provides education, licence inspections, size and bag limit inspections and patrols of waterways to ensure no illegal gear is being used to take marron.

FMOs frequently engage in joint patrol/operation initiatives with police to investigate the theft of marron from private properties and licensed aquaculture sites.

Dams and catchment areas once open to marroning are being closed by the Water Corporation, which presents further challenges to ensure compliance in these areas. A number of Water Corporation Rangers have been authorized as honorary FMOs to assist with the compliance of illegal fishing on Water Corporation dams. Some Department of Parks and Wildlife officers have also been authorized as honorary FMOs and play an important role in marron compliance throughout the South West.

The other main education focus for this fishery is checking bag limits, that fishers hold a current freshwater recreational fishing licence and line fishing does not occur during the closed season (1 July – 31 August).

Compliance patrols for the other recreational fisheries in these inland areas, as well as inspections of fish wholesale and retail premises form part of the compliance activities conducted by FMOs in the Southern Inland bioregion.

Commercial fishing activity in rivers is included in the Southern Inland bioregion and some compliance patrols target fishing activity in the West Coast and South Coast estuarine fisheries. The compliance effort in these fisheries focuses mainly on closed waters, setting times, net lengths and licensing.

Activities during 2012/13

During 2012/13 FMOs delivered 2,486 'on-patrol' officer hours during to the Southern Inland bioregion, an increase of

about 300 hours on the previous year (Southern Inland Compliance Figure 1).

Officers conducted patrols throughout the bioregion in vehicles, dinghies and canoes, making 4,076 field contacts with recreational fishers and 58 contacts with commercial operators (Southern Inland Compliance Table 1).

There were four infringement warnings and four infringement notices issued with a further 39 prosecutions for recreational offences.

The marron fishery continues to be the major focus for the compliance and education program in this bioregion. The compliance activities for the 2013 season included a pre-season operation which specifically targeted 'Out of Season' fishing activities. A number of people were found to be illegally fishing out of season and faced prosecution. The second phase of the operation included a high-profile presence during the marron season which targeted both highly frequented and less frequented marron fishing locations.

Aquaculture compliance activities (classified as 'commercial' in Southern Inland Compliance Table 1) are also a focus in the Southern Inland bioregion for FMOs. Activities mainly involve inspection of aquaculture facilities, oversight of broodstock collection to ensure compliance with exemption conditions, and inspection of proposed aquaculture sites to ensure that the harvesting does not affect the wild stocks in WA waters. FMOs continue to work closely with police to investigate theft from farm dams.

Initiatives for 2013/14

Compliance operations will again target 'out of season' marron fishing with both covert and overt patrols. A high-profile professional presence is again planned for the marron season.

FMOs are committed to maintaining joint patrols and partnerships with external stakeholders. The joint patrols have been included in the operational plans for the coming peak marron fishing times.

Theft of marron from dams on private property and aquaculture facilities remains a focus of joint agency collaboration in the sharing of intelligence information and resource sharing.

Community education activities will target recreational fishers prior to the start of the marron fishery and the delivery of fisheries programs to school children and the public. The awareness of freshwater biodiversity and the threat posed by introduced species will also be promoted. The community education team will maintain partnerships with natural resource management groups and the community to enable a holistic approach to catchment management and issues facing the sustainability of freshwater species.

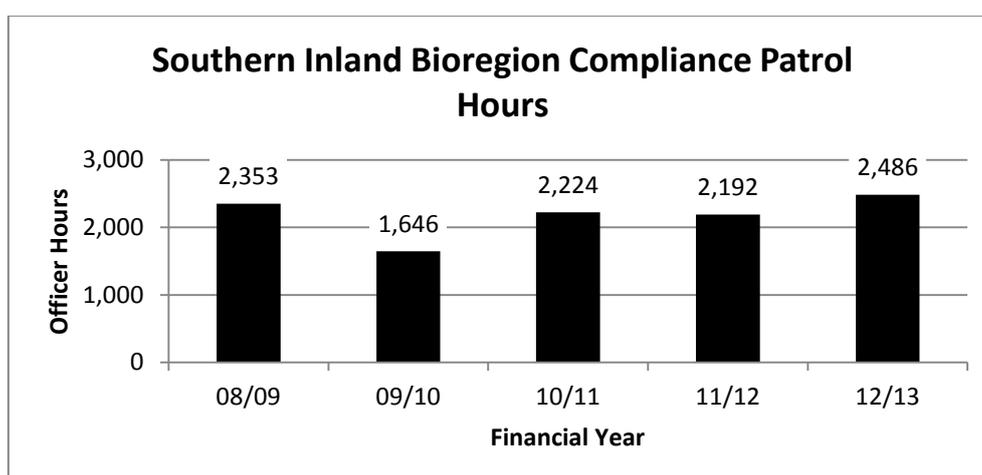
SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2012/13 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,486 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	58
Infringement warnings	2
Infringement notices	0
Prosecutions	2
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	4,076
Infringement warnings	4
Infringement notices	4
Prosecutions	39
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	1,082
Fishwatch Reports**	Not recorded

* Contacts are classified according to the specific fishery, which is usually clearly delineated as being either commercial or recreational. The “other fishing-related contacts with the community” category is used where multiple fisheries are contacted and it is not possible to accurately classify the contacts into one specific fishery – typically, the majority of contacts are these contacts are recreational in nature (e.g. personal contacts in marine protected areas), but contacts made in relation to fish kills, shark patrols and inspections of commercial fish wholesale and retail premises, etc, are also included in this category.

**Fishwatch calls relating to the Southern Inland bioregion are not recorded as the service provider reporting mechanism only details calls referred to district offices. Calls relating to the Southern Inland bioregion will be included in both the South Coast and West Coast Bioregion totals.



SOUTHERN INLAND COMPLIANCE FIGURE 1

In this figure, “On Patrol” Officer Hours shows the level of compliance patrol activity delivered to the Southern Inland Bioregion over the previous five years. The 2012/13 total gives the patrol hours in the bioregion that resulted in the contacts detailed in Table 1. The totals exclude time spent on other compliance related tasks, e.g. travel time between patrol areas, preparation and planning time.