

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.

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 dams 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 native fish and crustaceans 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 11 species of obligate 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 climate change, 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
Freshwater 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

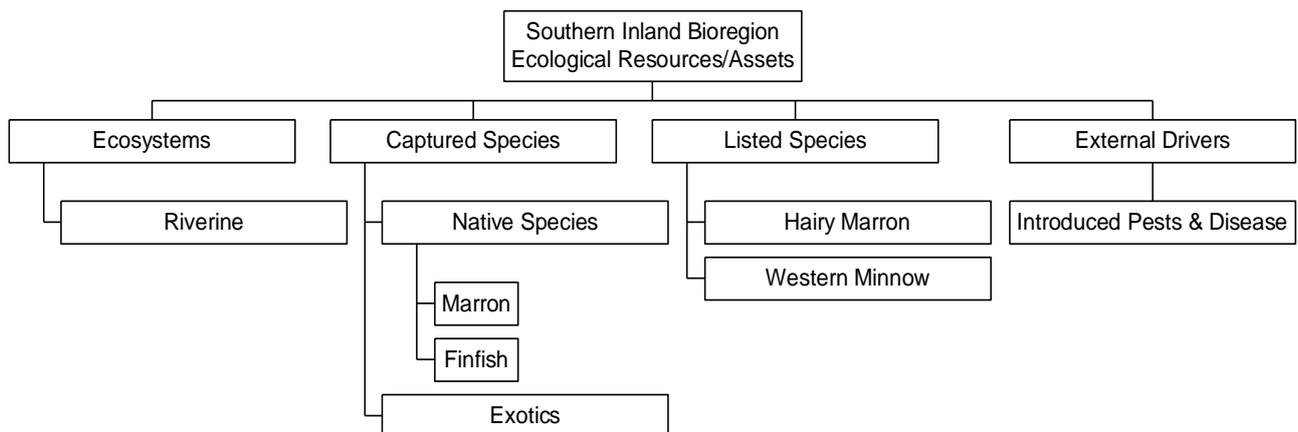
Fish species	Risk	Status and Current Activities
Finfish Native (not listed)	HIGH (non-fishing)	The abundance and distribution of most native fish have been severely impacted due to reduced rainfall and land management practices. This has led to widespread fragmentation of native fish populations (i.e. regional extinctions, which without restocking will be permanent as there is no migration between lakes or catchments).
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. Research activities are aimed at Improving growth rate by increasing the volume of spawnless fish produced at the hatchery.

Listed species

Species	Risk	Status and Current Activities
Hairy Marron	SIGNIFICANT (fishing)	Poaching of hairy marron from the upper reaches of Margaret River has been observed despite a ban on all marron fishing.
	SIGNIFICANT (non-fishing)	A new recovery plan has been developed to guide hairy marron recovery activities. This includes population monitoring, control of threatening processes, a captive breeding program, and Increased community awareness through a zoo display and collaborating with regional NRM groups.
Western Minnow (non fishing)	SIGNIFICANT (non-fishing)	Western minnow were successfully bred in captivity by the department.

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, E. Smith

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*). Native freshwater cobbler (*Tandanus bostocki*) are also taken by anglers in smaller numbers. 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-sustaining 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, Department of Water, Water Corporation, 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 freshwater fish species.

To protect newly released trout from over exploitation, 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, which are open to angling all year.

A combined daily bag limit of 4 applies to rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and 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 actively predated 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 are 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 (FMP250)*. 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 changes to the management arrangements between 2013 and 2014, however the five year management term of FMP 250 expires in September 2016 and as such, a review of the document and stocking strategy will be undertaken in 2015/16.

Landings and Effort

Commercial catch estimate (season 2015)

Not applicable

Recreational catch estimate (season 2015)

53,160 retained fish

At the end of the 2015 season, a phone recall survey was undertaken of 371 metro and 400 country respondents (7.2% of licence holders in that season).

The estimated total effort for 2015 was 34,196 days (standard error $\pm 1,631$), which was the same as the previous year (Freshwater Angling Table 1, Freshwater Angling Figure 1a). The estimated total number of licensed fishers was 10,759 in 2015, which was a very slight increase on the previous year. Overall purchase of licences has been increasing, with 2015 year having the highest number of licences purchased since changes to licensing in 2012 (Freshwater Angling Table 1). The estimated total number of licensed fishers that participated in freshwater angling was 5,638 in 2015; a slight increase from 5,357 in 2014. The average number of days fished per fisher was stable at 6.05 days in 2015 (Freshwater Angling Table 1).

Fishing effort amongst dams was stable, and Harvey Dam continued to receive the highest fishing effort (43% of all effort) (Freshwater Angling Table 2). Fishing effort in rivers is evenly distributed amongst three main rivers; the Blackwood, Collie and Warren Rivers (13%, 16% and 17%

respectively). Total fishing effort across “other” rivers has increased to 37%, a substantial proportion of all effort. The cause of the increase in 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 2015 was 106,611 (by number) (Freshwater Angling Table 3 and Freshwater Angling Figure 2b) of which 53,160 were kept and 53,451, were released, similar to the previous season but substantially higher than 2012 and 2013 (Freshwater Angling Table 3).

The estimated catch per unit effort (CPUE) for all species combined in 2015 (3.12 fish per fisher day) was similar, but slightly higher than that estimated for 2014 (3.03) (Freshwater Angling Figure 1a). Overall, catches of each species were similar to previous years. A large proportion of trout (rainbow and brown) are released by fishers (approximately 70%). From the available data, it is not possible to accurately determine if the fish are released because they are undersize, or if catch and release forms a large social component of the fishery. Most captured redfin perch are retained by fishers (97%), as encouraged by the Department.

FRESHWATER ANGLING TABLE 1

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

Season	Licences	Total fishers	Mean days	Total effort	
				Total effort days	Std error (Total effort)
2012	8541	4167	4.94	20594	1979
2013	9718	4787	4.94	23646	2302
2014	10370	5357	6.35	34021	2368
2015	10759	5638	6.07	34196	1631

FRESHWATER ANGLING TABLE 2

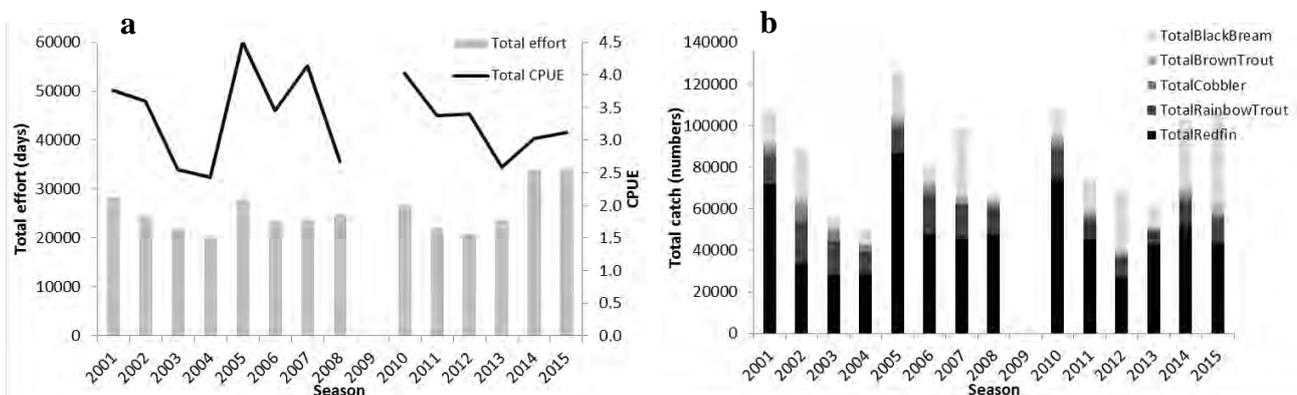
Summary of proportion of effort (days) for individual dams and rivers for seasons (2012 to 2014).

Waterbody	Watercourse	Proportion of effort %			
		Season			
		2012	2013	2014	2015
Dams	Big Brook	6	4	4	9
	Drakes Brook	2	4	4	6
	Harvey	50	49	45	43
	Logue Brook	12	17	15	10
	Waroona	14	13	14	13
	Wellington	9	6	16	16
	Other	7	6	3	4
	Total	100	100	100	100
Rivers	Blackwood	19	18	14	13
	Collie	12	19	14	16
	Donnelly	6	10	8	5
	Hutt	0.4	0	0	0.5
	Margaret	0.1	1	2	1
	Murray	15	11	11	9
	Preston	3	1	4	2
	Warren	24	19	17	17
	Other	20	21	30	37
	Total	100	100	100	100

FRESHWATER ANGLING TABLE 3

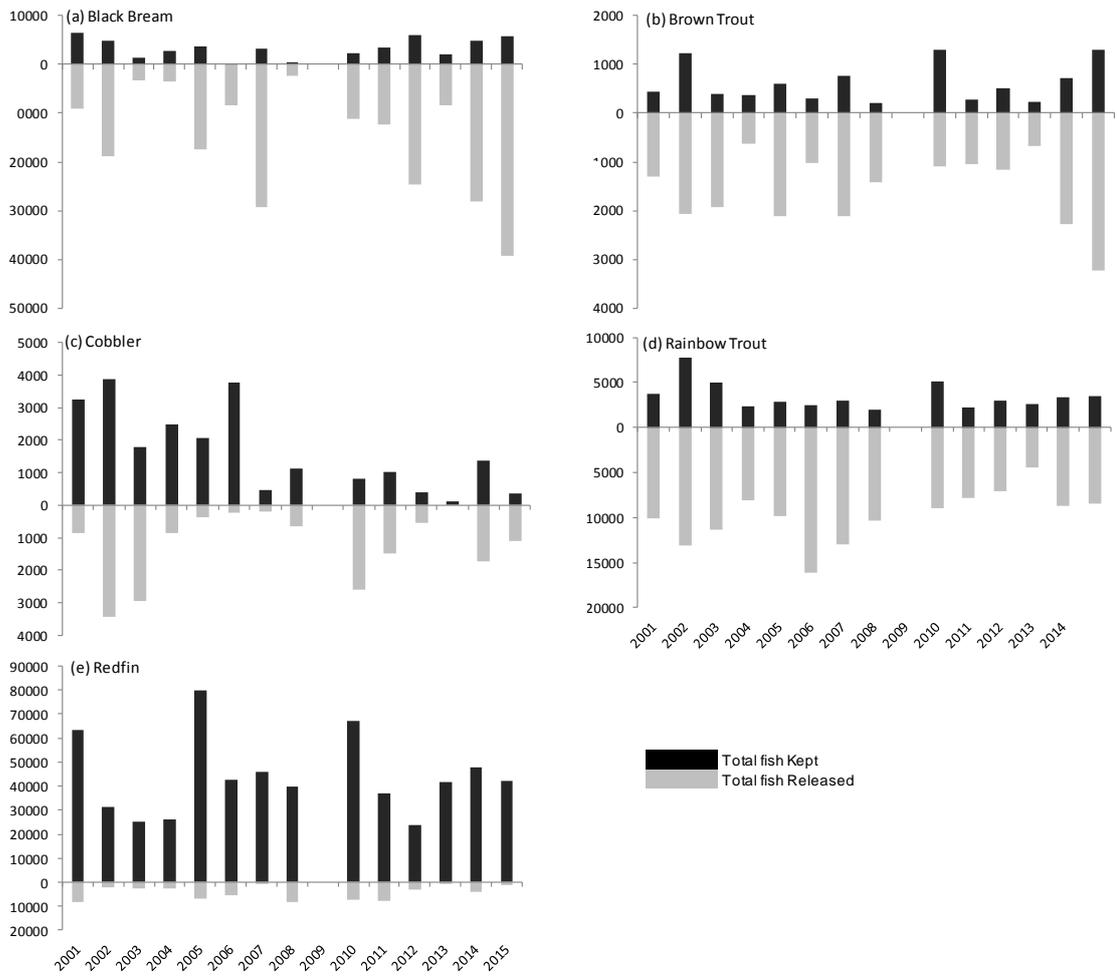
Summary of survey estimates for the main freshwater species targeted for seasons (2012 to 2014). Release rate = (Released /Total)

Season	Species	Total (numbers)			Release rate %
		Kept	Released	Total	
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
2015	Black Bream	5694	39348	45042	87
	Brown Trout	1307	3237	4544	71
	Cobbler	371	1104	1475	75
	Rainbow Trout	3475	8487	11962	71
	Redfin	42313	1275	43588	3
	Total	53160	53451	106611	50



FRESHWATER ANGLING FIGURE 1

Estimated total effort, CPUE (a) and total number of fish caught (b) for 2001 to 2015 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 perch (e) for 2001 to 2015 seasons.

Licensed Recreational Marron Fishery Report

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

Main Features			
Status		Current Landings	
Stock level	Acceptable	Commercial	nil
Fishing level	Acceptable	Recreational catch estimate 2015	70, 807 ± 5650 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, Freshwater Fisheries Reference Group 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 2015 season, licensed fishers were permitted to fish for marron from midday 8th January to midday 5th February 2015. 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 changes to the management arrangements between 2014 and 2015.

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.

A modified 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 four dams and eight rivers. This survey was modified slightly in 2014. The survey trialled the inclusion of a drinking water dam where fishing is banned, to act as a control site.

Historical phone surveys revealed that up to 30% of fishing effort in rivers occurs in systems that were not included in the fishery-independent stock assessment. The 2014 fishery-independent stock assessment trialled sampling in three additional river systems, that, along with six other rivers, represent the majority of this effort. These additional rivers will be surveyed on a three year rotation.

Retained Species

Recreational catch estimate (season 2015)

70,807 marron ± 5650 marron

At the end of the 2015 season (8 January 2015 to 5 February 2015), a phone-recall survey was undertaken, sampling 458 metro residents and 376 country residents (5.8% of licence holders for this season). The total number of licensed fishers available to fish at least one day in the 2015 season was 14,357.

The estimated recreational catch for marron was 70,807 (by number, with ±5,650 s.e.) (Recreational Marron Figure 1a) of which 21,480 (±3,581 s.e.) were taken in dams (Figure 2a) and 49,327 (±4,791 s.e.) in rivers (Recreational Marron Figure 2b). This was similar to the estimated catch of marron in 2014 of 71,268.

Total effort was estimated at 20,609 (by days, with ±1,182 s.e.) in 2015 which was higher than the 18,287 days in 2014 (Figure 1). The total number of active fishers was estimated at 7,161 in 2015 which was an increase from 6,232 active fishers in 2014. The average number of fishing days per fisher was 2.88 days (±0.17 s.e.) in 2015.

The catch per unit effort (CPUE) (3.44 marron per fisher day) in 2015 was lower than the CPUE observed (3.90) in 2014 (Recreational Marron Figure 1b) due to the higher amount of effort in 2015. The CPUE observed in dams (3.39 marron per fisher day) was similar to rivers (3.46) in 2015 (Recreational Marron Figure 1b).

The proportion of total effort was 6,340 days (31%) in dams compared to 14,269 days (69%) in rivers in 2015 (Table 1). 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 1).

Wellington Dam and Harvey Dam have always received the highest proportion of fishing effort since surveys began in 2000. From 2000 to 2004, Wellington received the majority fishing effort between the two dams. However, since 2005, with the exception of 2007 and 2015, Harvey Dam has consistently received the most fishing effort (Recreational Marron Figure 2a). The change in effort in 2007 is most likely due to an extremely low minimum water level that year, however this is not the cause for the change in effort in 2015. Therefore, while patterns of fishing remain constant between years, it appears that many fishers actively choose their fishing location.

Effort in rivers is spread over a greater number of sites, with approximately 70% of effort being spread amongst seven systems (Recreational Marron Figure 2b). In 2015, the majority of this effort occurred in the Blackwood River (15%), Collie and Warren Rivers (14%), and the Preston River (11%) (Recreational Marron Figure 2b), this is similar to previous years, although effort in the Blackwood river appears to have decreased by 5 to 10% from historical levels. Effort in other rivers is variable and is only occasionally above 5%. Of note, however, is a consistent decline in effort in the Murray River from around 10% in the early 2000s to less than 6% since 2010.

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 in 2006 (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 marron abundance varies greatly among the surveyed rivers and dams (Recreational Marron Figure 3) and is highly variable between years. Size however, is relatively stable at all sites, although there has been a slight decrease in mean size of marron in Harvey Dam. Harvey Dam, in conjunction with Wellington Dam, are the most heavily fished dams. Therefore, the decrease in mean size in Harvey dam will be monitored carefully in 2015 to determine if the trend continues.

Marron abundance in most dams were similar to previous years (Recreational Marron Figure 3); however, both Wellington Dam and Waroona Dam have shown gradual increases in abundance from lows in 2012 due to favourable rainfall conditions. River CPUE was stable in Preston River, Collie River and Murray River, and increased in Warren River. Analysis of data for the Collie River is annually confounded by tampering and theft of sampling equipment. Stocks in the Blackwood River and Donnelly River, while stable over the last three years are low and will be reassessed based on the results of the 2015 stock assessment.

Overall marron stocks are considered adequate, although under pressure. Recreational CPUE has remained correlated, indicating fishers are not having to work harder for their catch. However, the stock assessment is detecting a decrease in marron stocks. The decrease in stocks is across the entire size range, therefore it is not considered to be a result of fishing effort, in addition marron fishers are considered to generally comply with legal catch and bag limits. The decrease in abundance witnessed in some systems, has also occurred in the Shannon River which has been closed to all marron fishing since 2007. Whist poaching is known to occur in the Shannon River, the effort is not considered to be high enough to cause this decline. Therefore the changes in marron abundance and size appear largely to be a result of environmental variables.

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 recreational marron fishers.

Listed species interaction: Negligible

A second species of marron, the critically endangered hairy marron, *Cherax tenuimanus*, occurs only in Margaret River. It is threatened mainly by smooth marron, *Cherax cainii*, following the introduction of this species into Margaret River in the early 1980's. 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 Parks and Wildlife, and other stakeholders is nearly complete and will guide recovery actions for the next 5 years. These actions include the removal of smooth marron from habitat shared with hairy marron, a captive breeding program to increase the numbers of hairy marron, and the creation of new populations of hairy marron using the captive bred stock.

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 in 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 is collected. In the past, this data was collected as part of a marron logbook program, however, this program ceased operation in 2008. The estimated 20,000 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. This level of catch has rarely been achieved, with the exception of 2010, a year of extremely low rainfall.

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, limited growth in the fishery is permissible 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. However, external factors such as rainfall, dam levels and river flow are likely to be the main factors that drive marron abundance (see External Factors below).

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 2015 was 20,609 ($\pm 5,650$) fishing days with a 28 day season. Catch and effort in 2015 are still strongly correlated and show the same relationship as previous seasons. Should effort change and catch does not change proportionately, management changes may be required to reduce the impact of fishing on marron stocks.

New management initiatives (2014/15)

For 2015 the marron season started at midday on 8th January and ran for a 28 day period until midday 5th February. Fisheries managers and scientists continue to monitor the impact of changing rainfall patterns in the South-West on marron populations.

External Factors

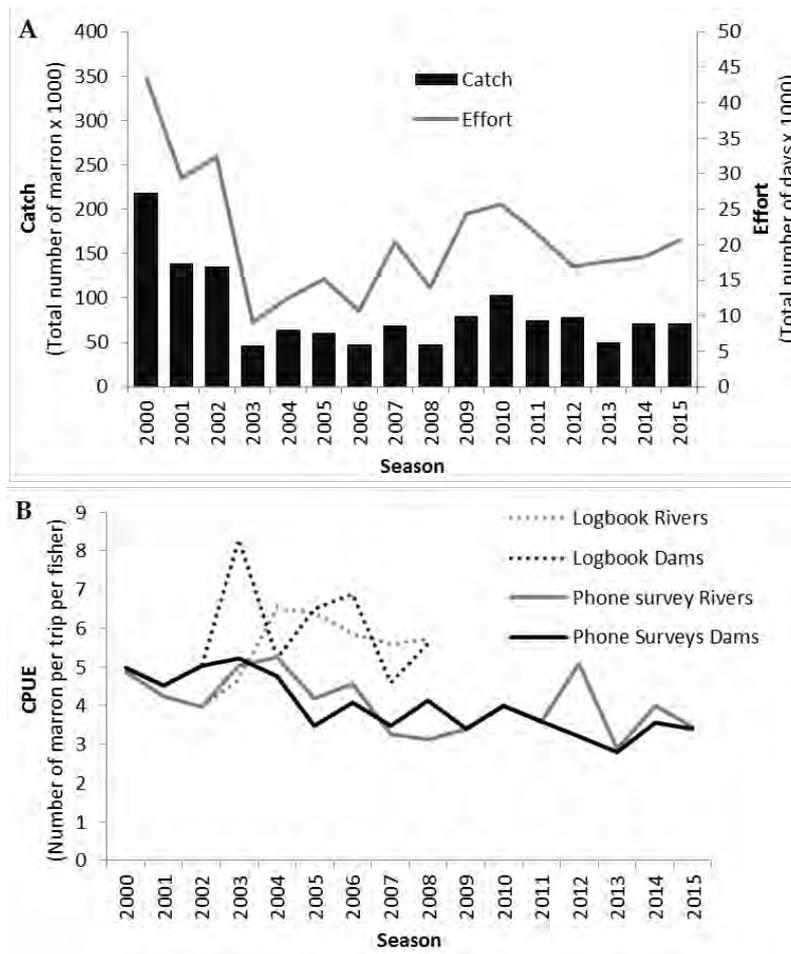
In 2014, the Department of Fisheries received a report of marron from Grimwade Dam containing an infection of numerous white cysts. A sample of marron was collected and analysed. The cysts were determined to contain the second life stage of a previously undescribed species of trematode, belonging to the genus *Choanocotyle*. The final host for the trematode is a turtle, so there was no risk to humans consuming the infected marron. A similar species has previously been described in turtles in WA and this new species of trematode is believed to be a native species. To investigate this further, the Department of Fisheries, in conjunction with the Department of Parks and Wildlife will complete a joint investigation into the life cycle of the trematode. In addition, the 2015 stock assessment will collect samples of marron from river systems throughout the south-west, to confirm the distribution of the trematode.

Rainfall in the south-west of Western Australia has declined by 10-15% since 1975 according to CSIRO models. The decline has been most noticeable in autumn and early winter rains. 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. CSIRO models predict an additional 7% decrease in rainfall by 2030. Managing the marron fishery in the face of these external changes will be a major challenge.

RECREATIONAL MARRON TABLE 1

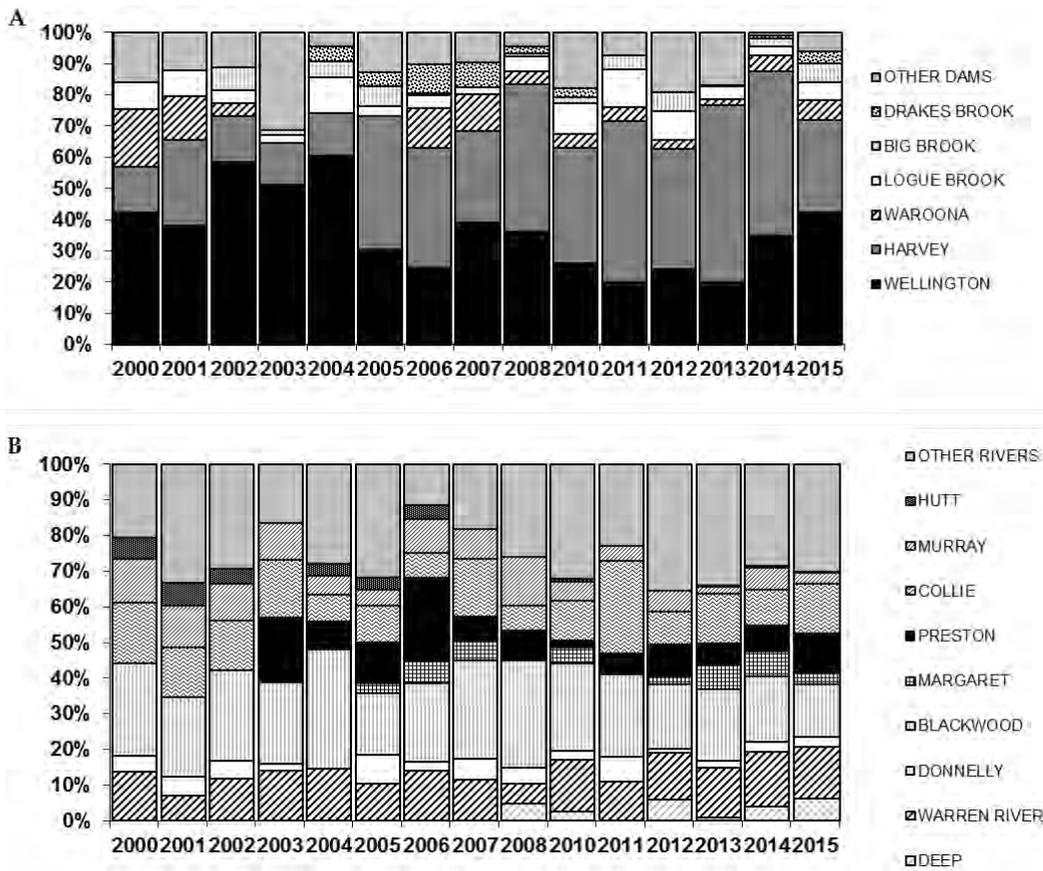
Proportion of total effort between river and dams from 2000 to 2015.

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
2015	0.69	0.31



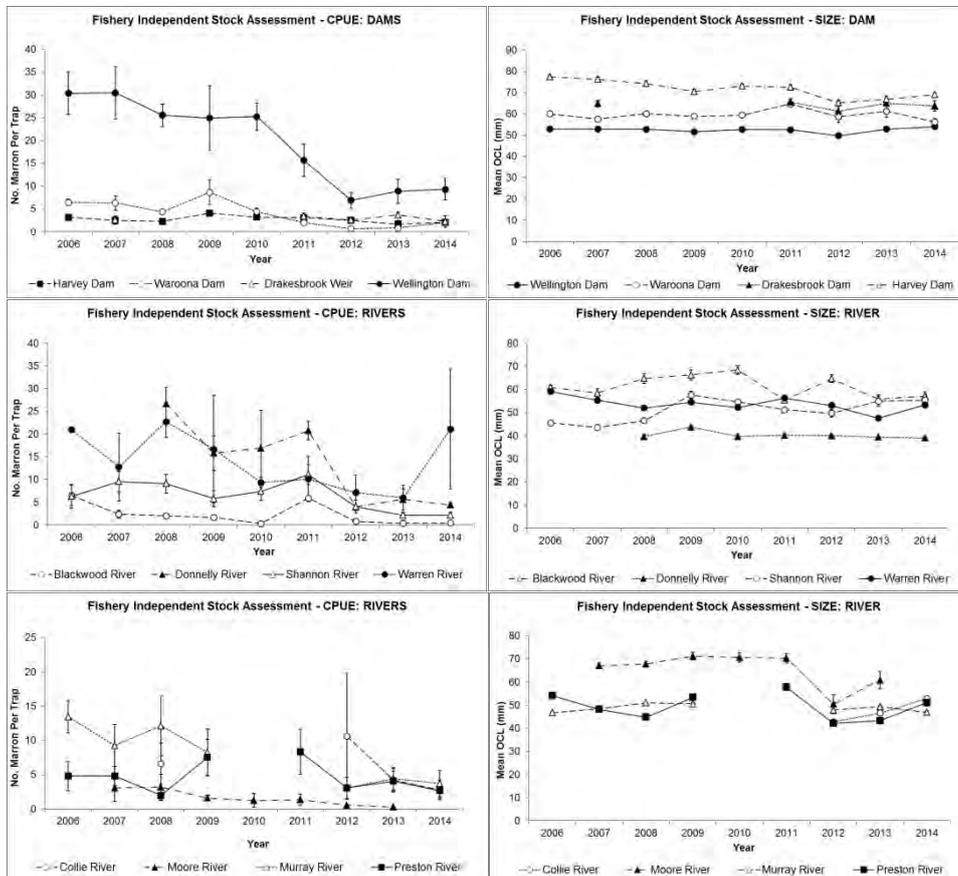
RECREATIONAL MARRON FIGURE 1

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 2015.



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 2015.



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 collaborative

project with the University of British Columbia was recently completed which sought 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.

Marron aquaculture in the south west of the State continues to perform well and annual production remains relatively stable. There is some interest among the marron growers in increasing production by undertaking research on marron nutrition and diets.

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 effective compliance program. Activities undertaken by FMOs include educating the public, inspecting licences, size and bag limits and patrolling waterways to ensure no illegal gear is being used to take marron.

FMOs engage in joint patrol/operation initiatives with police to investigate the theft of marron from private properties and licensed aquaculture sites as well as with Water Corporation Rangers to target State waters in and around catchment areas.

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 authorised as honorary FMOs to assist with the compliance of illegal fishing in Water Corporation dams. Some Department of Parks and Wildlife officers have also been authorised as honorary FMOs and play an important role in marron compliance throughout the South West.

The other main recreational fishing activities for the Southern Inland bioregion is freshwater angling and netting. Compliance effort in these fisheries primarily focuses on fish

size and bag limits, licences, gear specifications, closed area and seasonal restrictions. Inspections of fish wholesale and retail premises form part of the compliance activities conducted by FMOs in the Southern Inland bioregion.

Commercial fishing activity occurs in some rivers in the Southern Inland Bioregion and 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, licensing and inspecting consignments of fish for minimum legal sizes.

Activities during 2013/14

During 2013/14 FMOs delivered 2,809 'on-patrol' officer hours to the Southern Inland bioregion, an increase of 323 hours on the previous year (Southern Inland Compliance Figure 1).

Officers conduct patrols throughout the bioregion in vehicles, motorbikes, vessels and canoes. There were 5,266 field contacts with recreational fishers, an increase of 1190 from the previous year, and 32 contacts with commercial operators a decrease of 26 from the previous year (Southern Inland Compliance Table 1)

There were 69 infringement warnings and 86 infringement notices issued with a further 61 prosecutions for recreational offences.

The marron fishery was a major focus for the compliance and education program in this bioregion especially in the South West corner. 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.

SOUTHERN INLAND BIOREGION

Aquaculture compliance activities (classified as 'commercial' in Southern Inland Compliance Table 1) were also a focus in the Southern Inland Bioregion. Activities mainly involved targeted inspections of aquaculture facilities, to ensure that licences were held and there was compliance with the conditions of those licences. FMOs continue to work closely with police and industry to investigate any reports of illegal interference with lawful aquaculture establishments.

Community education staff addressed three key issues in the education strategy for the 2013/14 marron season. These included a lack of awareness of legal versus illegal gear for marron fishing, lack of awareness of the noon to noon daily bag limits, and lack of education material being accessed by the community when purchasing marron licences, particularly when paid online.

A mail-out to target peak tourist locations was distributed to 25 stakeholders including campgrounds and visitor centres within key marron fishing areas, and caravan parks from Albany through to Dwellingup. The aim of the mail out was to circulate the 'Don't get caught in a trap' poster and the Recreational marron fishing guide. Additionally, several articles on the issues associated with using traps, and advertisements to promote the 'Don't get caught in a trap' campaign were run prior to and during marron season in Albany, Walpole, Busselton and Margaret River.

Initiatives for 2014/15

Compliance operations will continue to cover all fisheries within the Bioregion with each District setting their own

priorities for their particular fisheries. There however will be particular compliance effort concentrated towards targeting 'out of season' marron fishing with both covert and overt patrols. A high-profile compliance presence is again planned for the marron season focussing on key areas known for high activity as well as areas identified as experiencing pressure through the use of illegal methods.

FMOs are committed to maintaining joint patrols and partnerships with external stakeholders. The unlawful removal of marron from dams on private property and aquaculture facilities remains an important focus for joint agency collaboration in the sharing of intelligence and resource sharing.

FMO's will remain an integral part of the Departments ability to liaise with and educate stakeholders from all sectors.

Community education activities will again include a mail out to stakeholders in key marron fishing areas, with the aim to increase our stakeholder list. Other strategies will include articles and advertisements in newspapers, and displays at relevant community events to target recreational fishers prior to, and during the marron fishing season. 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.

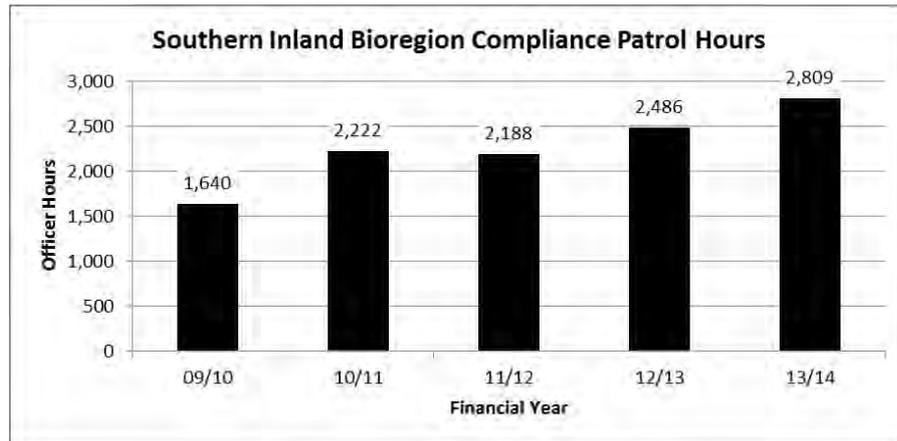
SOUTHERN INLAND COMPLIANCE TABLE 1

This table gives a summary of compliance and educative contacts and detected offences within the Southern Inland bioregion during the 2013/14 financial year.

PATROL HOURS DELIVERED TO THE BIOREGION	2,809 Officer Hours
CONTACT WITH THE COMMERCIAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	32
Infringement warnings	3
Infringement notices	5
Prosecutions	6
CONTACT WITH THE RECREATIONAL FISHING COMMUNITY	
Field contacts by Fisheries & Marine Officers	5,266
Infringement warnings	69
Infringement notices	86
Prosecutions	61
OTHER FISHING-RELATED CONTACTS WITH THE COMMUNITY*	
Field contacts by Fisheries & Marine Officers	617
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

“On Patrol” Officer Hours showing the level of compliance patrol activity delivered to the Southern Inland Bioregion over the previous five years. The 2013/14 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 etc.).