

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 winter, 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 ACTIVITIES POTENTIALLY IMPACTING THE BIOREGION

Climate Change

The Southern Inland Bioregion is expected to be affected similarly to the West and South Coast Bioregions.

Commercial Fishing

There are currently no commercial fisheries in the Southern Inland Bioregion.

Recreational Fishing

The Southern Inland Bioregion provides significant recreational fishing opportunities. The major species fished recreationally are native marron, trout (both rainbow and brown trout) stocked by the Department into public dams and rivers, and feral redfin perch, an introduced, self-perpetuating stock. The native freshwater cobbler is also taken in small numbers.

Aquaculture

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 some potential to expand.

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.

Tourism

The bioregion is a popular tourist destination with known for its national parks and wineries. Recreational fishing in the region's lakes and rivers is also important for both residents and tourists.

BIOREGIONAL SPECIFIC ECOSYSTEM MANAGEMENT

Within each Bioregion there are a range of management measures that have been implemented to manage the potential impact of activities (See the Ecosystem Management Section for an overview). Management measures specific to the South Inland Bioregion are detailed below.

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. Most of these species are only found in WA, all have had major contractions in their distribution, many species now only consist of small vulnerable fragmented populations, and half are now listed as threatened. They are under pressure from feral fish populations, migration barriers (bridges and dams) and urban land-use development, particularly in the form of unfiltered storm water discharge from roads into natural waterbodies.

The Department works with representatives from the Department of Water and Environmental Regulation, the Department of Biodiversity, Conservation and Attraction, and other stakeholders, to facilitate information exchange, identify research projects and apply for funding to manage freshwater native fish

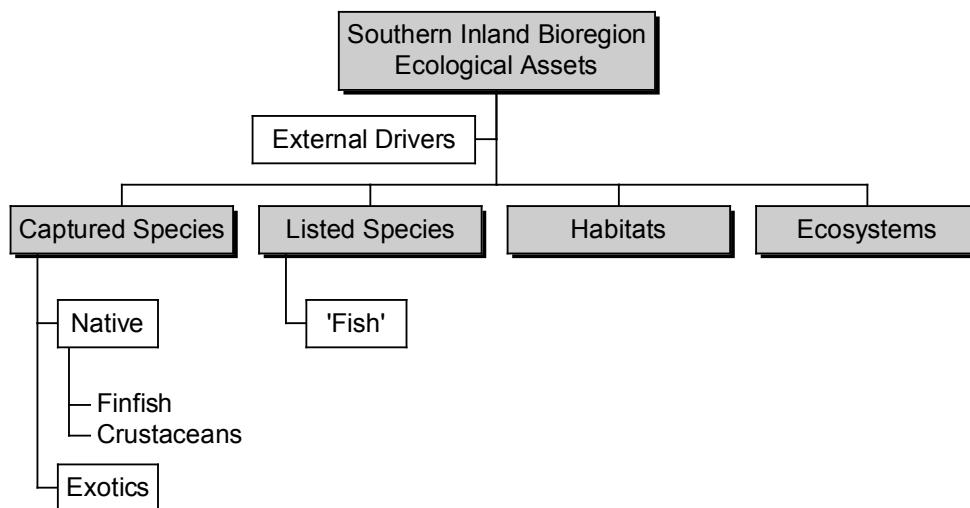
species. This is being facilitated by the Freshwater Ecosystem Working Group which aims to coordinate a whole-of-Government approach to the management of freshwater ecosystems in the State.

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 MONITORING AND STATUS

In order to assess the adequacy of management arrangements aimed at ensuring sustainability of the ecological assets within the Southern Inland Bioregion, the Department must identify and monitor trends in the condition of these resources. This is achieved through application of an Ecosystem Based Fisheries Management (EBFM) framework (Fletcher, *et al.*, 2010) to identify, in a hierarchical manner, the key ecological resources that require ongoing monitoring and assessment. (See How to Use section for more details). These key ecological assets identified for the Southern Inland Bioregion are identified in Southern Inland Overview Figure 1 and their current risk status reported on in the following sections.



SOUTHERN IN LAND ECOSYSTEM MANAGEMENT FIGURE 1

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

External Drivers

External drivers include factors impacting at the bioregional-level that are likely to affect the ecosystem as a whole and may not fall within the direct control of Fishery legislation (e.g. climate change). An understanding of these factors, which are typically environmental (e.g. floods and droughts) is necessary to fully assess the performance of the ecological resource. The main external drivers identified with potential to affect the Southern Inland Bioregion include climate (i.e. a drying climate), habitat loss and introduced pests and diseases.

Climate

External Drivers	Current Risk Status
Climate	MODERATE

Climate effects are likely to be generated with reduced rainfall expected for this region.

Introduced Pests and Diseases

External Drivers	Current Risk Status
Introduced Pests	HIGH
Introduced Diseases	LOW

A high number of other exotic fish species have been released into the South West catchments (e.g. red fin and cichlids). There is an assessment program underway to determine the extent of this and which of these events can be addressed by eradication.

Captured Species

Native Finfish

Captured Species	Aquatic zone	Ecological Risk
Native Finfish	Freshwater	HIGH (non-fishing)

The abundance and distribution of most native fish have been severely impacted due to land and water 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).

Native Crustaceans

Captured Species	Aquatic zone	Ecological Risk
Native Crustaceans	Freshwater	HIGH (non-fishing)

The abundance of smooth marron (*C. cainii*) 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, especially due to reduced rainfall and habitat loss.

Exotics

Captured Species	Aquatic zone	Ecological Risk
Exotics (stocked)	Freshwater	MODERATE (non-fishing)

Trout have been stocked into a limited number of streams in WA for decades. The trout are produced from the Pemberton Freshwater Research Centre and are tolerant of warmer water temperatures. Research activities are aimed at improving growth rate by increasing the number of sterile fish produced at the Centre.

Listed Species

Fish *Crustaceans are classified as fish under the FRMA 1994

Listed species	Ecological Risks
Western trout minnow	SIGNIFICANT (non-fishing)
Hairy marron*	SIGNIFICANT (fishing)
Hairy marron*	SIGNIFICANT (non-fishing)

Listed species	Ecological Risks
Balstons Perch	SIGNIFICANT (non-fishing)
Little Pygmy Perch	SIGNIFICANT (non-fishing)
Black-stripe Minnow	SIGNIFICANT (non-fishing)
Salamanderfish	SIGNIFICANT (non-fishing)

Western trout minnow (*G. truttaceus*) were successfully bred in captivity by the Department.

Poaching of hairy marron (*C. tenuimanus*) from the upper reaches of Margaret River has been observed despite a ban on all marron fishing.

A new recovery plan is being 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 collaboration with regional NRM groups.

Habitats and Ecosystems

Habitat/Ecosystem	Aquatic zone	Current Risk Status
Habitat	Freshwater	HIGH (non-fishing)
Ecosystems	Freshwater	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 that found that 24% no longer have any fish and less than 5% have native fish populations, the rest contain feral species.

In addition there is concern that climate change may lead to a drying climate that could potential alter the habitats and ecosystems in the bioregion. Given that these lakes are predominantly groundwater fed, a significant contributing factor is the over-extraction of water to supply Perth's increasing human population. This is causing the ground water levels to drop and is recognised as being unsustainable for either fish or people.

SOUTH-WEST RECREATIONAL FRESHWATER RESOURCE STATUS REPORT 2017



R. Duffy, F. Trinnie, K. Ryan and M. Yerman

OVERVIEW

The Southern Inland Freshwater Fishery (SIFF) Resource incorporates the Recreational Marron Fishery and the South West Recreational Freshwater Angling (SWRFA) fishery. Both fisheries have separate

recreational licenses and are managed with rules around seasons, gear, bag limits, size limits and area closures.

SUMMARY FEATURES 2017

Fishery Performance		Commercial	Recreational	
Total Catch		NA	Marron: 52,669 ($\pm 4,801$ s.e.) SWRFA: 69,231 ($\pm 9,447$ s.e.) Fish	
Fishing Level		NA	Acceptable	
Stock/Resource Performance		Stock Status	Assessment Indicators	
Marron		Sustainable - Adequate	Annual: Recreational Catch, Effort; Fishery Independent Stock Assessment	
Trout		Sustainable - Adequate	Annual: Number Stocked	
EBFM Performance				
Asset	Level	Asset	Level	
Bycatch	Low Risk	Listed Species	Significant Risk	
Habitat	Moderate Risk	Ecosystem	Low Risk	
Social	High Amenity Moderate Risk	Economic	NA	
Governance	Stable	External Drivers	Significant Risk	

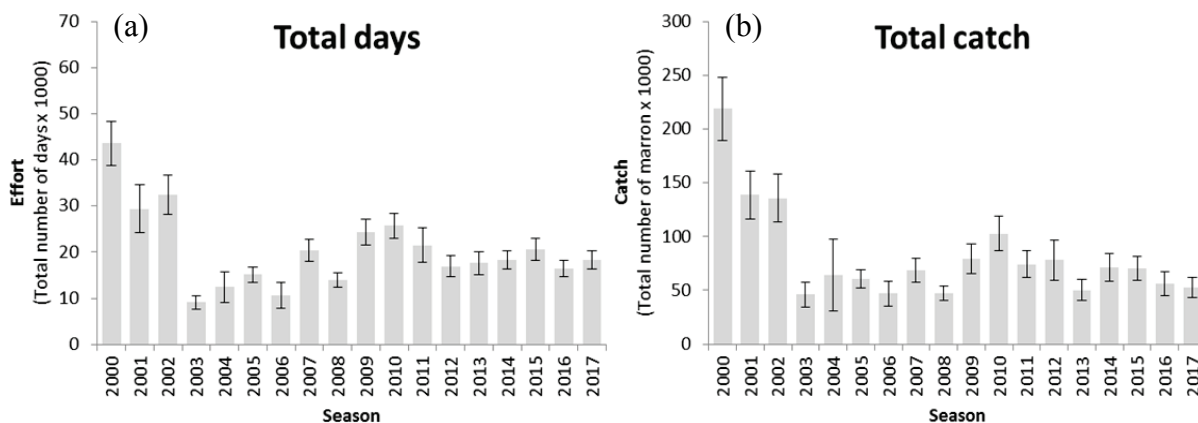
CATCH AND LANDINGS

Marron (*Cherax cainii*): The total estimated fishing effort was higher in 2017 compared to 2016 (18,386 (± 999 s.e.) days vs 16,433 (± 949) days). Total estimated recreational catch for the 2017 season was 52,669 ($\pm 4,801$ s.e.) marron, similar to the 2016 catch of 56,155 ($\pm 5,817$) (Recreational Fishery Figure 1). The number of licensed fishers was down (12,896 in 2017 vs 14,006 in 2016), however the number of active fishers was slightly higher (6,057 in 2017 vs 5,688 in 2016), an increase in participation rate in 2017 compared to 2016 (46% vs 39%). Choices around fishing effort in 2017 were based mainly on social reasons, and less related to access, cost or fishing quality, whereas in 2016, limited access rated highly in the reason for the lower participation.

SWRFA: Children under the age of 16 were no longer required to hold a Freshwater Angling licence after March 2016. Survey design does not permit portioning

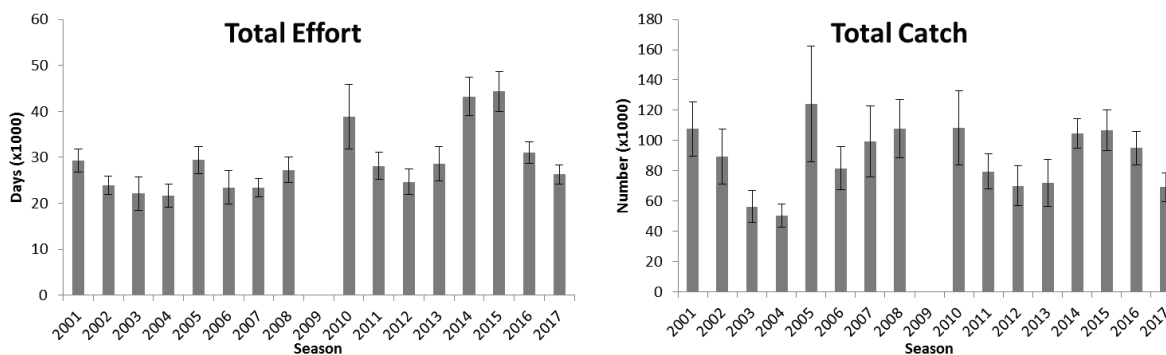
of the contribution of this age group to historical surveys. Therefore, the 2017 survey is not directly comparable to previous surveys.

The total estimated fishing effort was lower in 2017 compared to 2016 (26,258 days in 2017 vs. 31,106 days in 2016). The estimated total recreational catch from SWRFA across all species for 2017 was 69,231 ($\pm 9,447$ s.e.) fish of which 43,984 ($\pm 8,325$ s.e.) were kept and 25,247 ($\pm 4,441$ s.e.) were released. This was a decrease from 2016, where the estimated total recreational catch was 94,972 fish ($\pm 11,043$ s.e.) (Recreational Fishery Figure 2). The estimated number of licensed fishers in 2017 (9,447) was down slightly on 2016 (9,918), however it remained around the long-term average.



RECREATIONAL FISHERY FIGURE 1.

Estimated (a) total days people went marroning and (b) total number of marron caught, from 2000 to 2017 for marron licence holders in the SIFF marron fishery.



RECREATIONAL FISHERY FIGURE 2.

Estimated (a) total days fished and (b) total number of finfish caught, from 2001 to 2017 for licence holders in the SWRFA fishery.

INDICATOR SPECIES ASSESSMENTS AND STOCK STATUS

Marron (Sustainable-Adequate)

Smooth marron (*Cherax cainii*), are the third largest crayfish in the world and endemic to Western Australia (Beatty *et al.* 2016). The Marron Fishery is composed of many discrete populations (Beatty *et al.* 2016) that exhibit biological and life history traits that differ among systems (Beatty *et al.* 2011), including fecundity (Beatty *et al.* 2016) and growth (Lawrence 2007). Refer to Southern Inland Freshwater Fishery Resource Assessment Report (RAR) (in prep.) for further information.

Total effort was higher in 2017 (18,386 days \pm 999 s.e.) compared to 2016 (16,433 days \pm 949 s.e.) but similar to effort levels since 2011. The number of days fished per fisher was similar between 2017 (3.04 days \pm 0.16 s.e.) and 2016 (2.89 days \pm 0.17 s.e.). The reduced catch of marron, despite a higher number of participants and an increase in the average number of days fished, may indicate marron stocks are under pressure. Marron catch has been correlated with rainfall (de Graaf *et al.*, 2010), rainfall for the last three

years has been similar, but below average, potentially placing ongoing pressure on marron populations and recruitment.

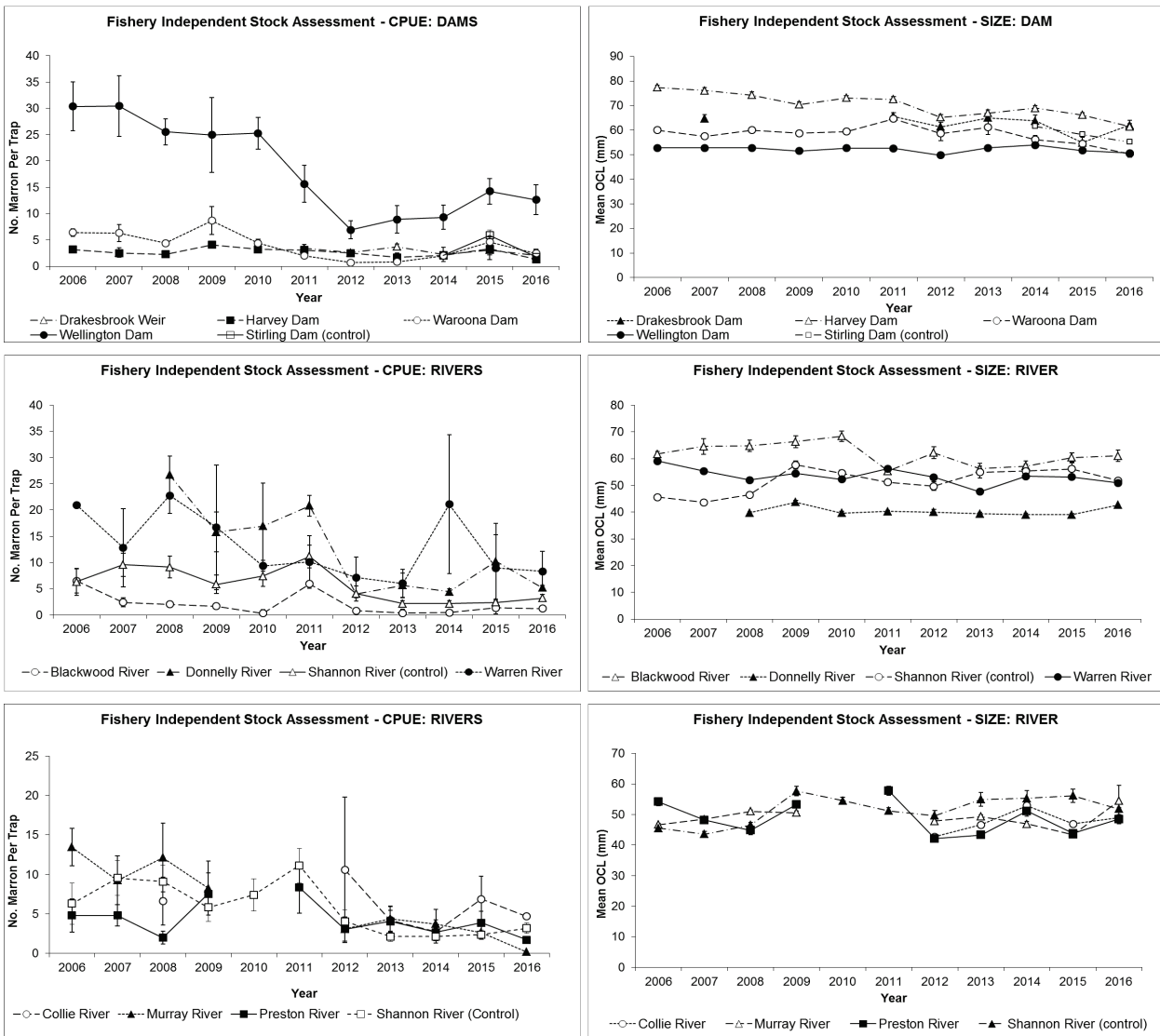
Distribution of fishing effort between dams and rivers has remained consistent with historic patterns (approximately 35% in dams and 65% in rivers). The distribution of fishing effort across particular rivers and dams is largely consistent across years, although some fluctuations occur. (Refer to RAR (in prep) for further information.)

Fishery independent survey data showed relative abundance of marron varied greatly among indicator sites (Recreational Fishery Figure 3). Patterns in size data vary between systems. Of concern is a decline in mean size in a number of systems. Interpretation of this data is confounded by control sites where no fishing is allowed showing conflicting trends; mean size of marron in Shannon River has increased; mean size in Stirling Dam has decreased. Therefore, while fishing may have impacted the mean size of animals, it is also likely be driven by environmental factors.

Overall marron stocks are considered **sustainable-adequate** due to stable recreational catch, although fishery independent survey data suggests they are under pressure from environmental conditions, i.e. CPUE in the Shannon River, a system completely

closed to fishing, shows a similar pattern to rivers where fishing occurs. In addition, there is some evidence of site-specific reductions in abundance from

fishery independent CPUE data. For more information refer to RAR (in prep.).



RECREATIONAL FISHERY FIGURE 3.

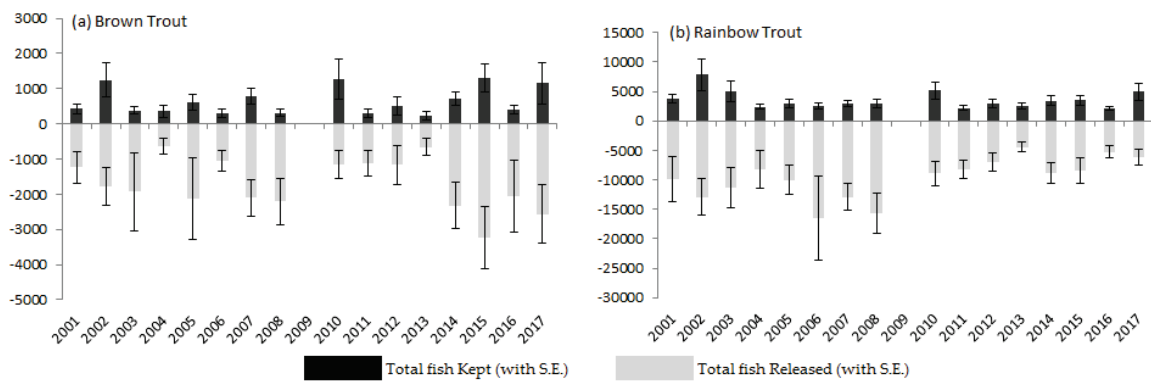
The relative abundance (CPUE) and size (mm OCL) of marron in four dams and eight rivers as determined by the fishery-independent stock assessment. Note: Missing values occur in years a site was not sampled.

Trout (Annually Stocked)

Rainbow trout (*Oncorhynchus mykiss*) and Brown trout (*Salmo trutta*) are produced at the Pemberton Freshwater Research Centre Facility and released into rivers and dams of south-west WA. Wild self-sustaining populations are thought to be limited; therefore stock levels are dependent on release rates and are supplemented annually. Numbers stocked in 2016 were similar to 2015. Stocking numbers for rainbow trout were: 570,000 fry, 35,000 yearlings and 2,500 ex-broodstock. Stocking numbers for brown

trout were 20,000 fry and 300 brown trout ex-brood stock.

The total estimated recreational catch of each species in 2017, was slightly lower than 2016, due in part to reduced effort, however it could also be a result of the absence of fishers under 16 years old that cannot be included in the phone surveys as they no longer require a licence. Overall, catches were within historical levels (Recreational Fishery Figure 4). For information on other freshwater fish species, refer to RAR (in prep.).



RECREATIONAL FISHERY FIGURE 4.

Total kept and released by species (a) Brown trout (b) Rainbow trout for 2001 to 2017 seasons.

BYCATCH AND PROTECTED SPECIES INTERACTIONS

Bycatch: The Marron Fishery also reports captures of 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. The introduced yabby also composes a small part of the fishery and carry some disease risks. There is little to no bycatch in the SWRFA due to the small size of non-target native species. Therefore the impact of the fishery on bycatch is a **low** risk.

Protected Species: Trout stocking occurs only in waterways where protected species are absent, therefore the fishery has no impact on protected species. Anecdotal evidence suggests that Redfin Perch, despite being feral, are still stocked and spread by fishers. Therefore, they have the potential to negatively impact protected species through direct predation.

A second species of marron, the critically endangered hairy marron, *Cherax tenuimanus*, occurs only in Margaret River. In late 2002, recreational marron fishing within Margaret River, upstream of Ten Mile Brook Junction was prohibited to remove the impacts of fishing on the remaining hairy marron stocks. Illegal fishing is still recorded in this reach of the Margaret River by the Department of Primary Industries and Regional Development, Fisheries Division (Fisheries), and combined with the small population size is considered a **significant risk**.

HABITAT AND ECOSYSTEM INTERACTIONS

Habitat: The major habitat impacts of the Marron Fishery and the SWRFA are litter in surrounding areas, and fishers trampling riparian vegetation and subsequent bank erosion. However, they can also provide an environmental benefit through the removal of large numbers of feral redfin perch (*Perca*

fluviatilis). Therefore, impact on habitat is considered a **moderate risk**.

Ecosystem: The removal of legal-sized marron from freshwater rivers is unlikely to have a significant effect on ecosystem function, as the bulk of the marron biomass is below legal size and 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 ecosystem function.

Stocking of trout has occurred in WA waters for over 100 years. To minimise adverse impacts of trout on native species, they are stocked only in rivers where non-native fish species are also present, and protected species are absent. SWRFA is largely a lure and fly fishery, however there is a small risk to the ecosystem through bait collection, its use, the release of unwanted live bait (mainly for redfin perch), and potential to spread disease and parasites, e.g. *Thelohania*. Therefore the resource is considered to have a **low risk** to the ecosystem.

SOCIAL AND ECONOMIC OUTCOMES

Social

The Marron Fishery in particular is iconic, whilst the SWRFA has an enthusiastic base of fishers and a dedicated angling group (Western Australian Trout and Freshwater Angling Association (WATFAA)), therefore the resource has high social amenity. Both fisheries attract tourists to regional areas and a FRDC project is underway examining the social drivers of the Marron Fishery.

The effect of reduced rainfall in the future on the availability of marron habitat is expected to increase awareness of changes in climate patterns in the South-West. In 2015, the drying of Cardiff Town Pool, on the south branch of the Collie River, resulted in the death of a number of large marron and gained significant media attention. Fisheries is investigating how these situations can be managed in the future. Social aspects are identified as having **high amenity** and a **moderate risk**.

Economic

The SIFF is likely to support tourism to regional towns in the South-West. As this resource does not generate income, a risk score is not applicable.

GOVERNANCE SYSTEM

Allowable Catch Tolerance Levels (Acceptable)

Marron: In 2006, the Recreational Freshwater Fisheries Stakeholder Subcommittee (RFFSS) proposed that, based on the available science the fishery be managed to a catch range of 96,000-136,000 marron. This level of catch has rarely been achieved with the exception of 2010, a year of extremely low rainfall. Recreational catch has largely fluctuated between 50,000 and 100,000 animals since 2001. Fishery independent surveys indicate negative impacts of fishing on stocks, therefore, although catch is considered **acceptable** it should be reviewed.

SWRFA: There are no allowable catch and tolerance levels specified as trout are stocked annually.

Harvest Strategy

The marron fishery is managed under a constant catch harvest strategy, although the Harvest strategy has not been formalised. The SWRFA fishery is based on stocking (inputs). While a stocking committee determines numbers and locations to be stocked, there is currently no formal harvest strategy for this fishery.

Compliance

Southern Region Fisheries and Marine Officers apply compliance through the delivery of an Operational Plan. Areas of high interest have been identified and patrols are designed to frequent those, and other areas. Patrol and compliance planning focuses on out-of-season illegal fishing, illegal use of fishing gear, and a

high profile presence through the marron season. Compliance activities are supported by educational activities.

Consultation

Meetings between the Department, Recfishwest, Freshwater Fisheries Reference Group and freshwater fishers are held regularly.

Consultation with non-fisher stakeholders is undertaken in accordance with the Department's Stakeholder Engagement Guidelines.

Management Initiatives (Stable)

Children under the age of 16 are no longer required to hold a licence after March 2016.

EXTERNAL DRIVERS

Rainfall in the south-west of Western Australia has declined by 10-15% since 1975 according to CSIRO models and it predicts an additional 7% decrease in rainfall by 2030 (CSIRO 2009). The decline has been most noticeable in autumn and early winter rains. The impact of reduced rainfall has included a greater than 80% reduction of runoff into dams. This has negative implications for rivers and lakes in the south-west and the associated fish and crustacean assemblages. The major impact of these changes will be through a reduction in habitat availability, with negative implications for fish and crustacean abundance. Reduced river flows inhibit movement, and combined with increasing salinity, could negatively impact populations of all freshwater species. In addition, the drying climate may lead to more frequent and higher intensity bushfires that can impact the fisheries through restricting fisher access, and associated impacts of fire and fire management methods on stream fauna.

Significant risk.

REFERENCES

- Beatty S, de Graaf M, Molony B, Nguyen V, and Pollock K. 2011. Plasticity in population biology of *Cherax cainii* (Decapoda: Parastacidae) inhabiting lentic and lotic environments in south-western Australia: Implications for the sustainable management of the recreational fishery. *Fisheries Research* 110(2011), 312-324pp.
- Beatty S, de Graaf M, Duffy R, Nguyen V, Molony B. 2016. Plasticity in the reproductive biology of the smooth marron *Cherax cainii* (Decapoda: Parastacidae): A large freshwater crayfish of south-western Australia. *Fisheries Research* 177, 128-136pp.
- CSIRO. 2009. Surface water yields in south-west Western Australia. A report to the Australian Government from the CSIRO south-west Western Australia Sustainable Yields Project. CSIRO Water for a Healthy Country Flagship, Australia.
- de Graaf, M., Beatty, S.J., Molony, B.M., 2010. Evaluation of the recreational marron fishery against environmental change and human interaction. Final report to Fisheries Research and Development Corporation on Project No. 2003/027. Fisheries Research Report No. 211. Department of Fisheries, Western Australia.
- Lawrence C. 2007. Improved performance of marron using genetic and pond management strategies. Final FRDC Report – Project No. 2000/215.