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Annual report on the monitoring of the recreational marron fishery in 2000, with an analysis of long-term data and changes within this fishery

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Abstract

This report presents the data from the 2000 season and compares the results with previous records. Although the 2000 marron season was relatively successful compared to the 1999 season it was still modest in terms of the historical records. Further, the recreational marron fishery continues to be declining in terms of catch rate, CPUE and other indicators derived from four data sources. The discussion highlights the variable nature of marron populations and the possible causes of the very different population structures of marron within the fishery. Further, possible reasons for the long-term decline of the marron fishery are discussed. It is unlikely that the recreational marron fishery will recover to historical levels of catch and CPUE and the quality of the fishery is likely to decline further without management intervention. Options for maintaining and/or enhancing the marron fishery, and future management options are discussed along with possible outcomes. Regardless, it is imperative that the Department of Fisheries responds rapidly to address the declining quality of this socially and economically important recreational marron fishery.

1.0 Introduction

The recreational marron fishery of the south-west of Western Australia is a unique fishery. The target species, *Cherax tenuimanus* (name currently under review by Dr C Austin, pers. comm.), known as marron, is a large freshwater crayfish species, endemic only to the south-west of Western Australia, although the translocation of marron has resulted in the distribution currently between Hutt River and Esperance (Morrissy 1978a). Marron is the third largest species of freshwater crayfish in the world (Morrissy 1978b), only smaller than the giant Tasmanian crayfish and the Murray crayfish.

Marroning has a long history in Western Australia and indigenous West Australians are likely to have captured marron for hundreds or thousands of years. The recreational marron fishery (RMF) is unusual as regulations and management have been evolving since the early 1950's, an indication of the vulnerability and popularity of the species. Currently, the RMF is one of only five licensed recreational fisheries in Western Australia and is managed by seasonal closures, size and bag limits, the protection of breeding females and gear restrictions. The fishery was first licensed in 1963 (under the Amateur Fisherman's Licence) and later by the Inland Fisherman's Licence (1970) and finally the Recreational Fishing Licence endorsed for marron (1986) (Morrissy 1978b, Anonymous 1988, Morrissy et al. 1990).

The fishery itself is very complex due to the behaviour of marron. As marron release juveniles of a large stage, the distribution of young is relatively limited (c.f. *Panulirus* lobsters which have a long, independent larval phase). Further, the movement of the adults is generally restricted to several hundred metres (Morrissy 1970). These two biological characteristics mean that the fishery is composed of a potentially large number of stocks. This is further enhanced by the presence of large populations in public access dams (e.g. Waroona Dam) which are prevented form moving due to the dam wall. At present, the Research Division has reports from 96 sites across 13 catchments that may reflect 96 different stocks. This does not include marron populations in the closed drinking water dams (e.g. Canning Dam and others (G. Whisson pers. comm.)). However, the major contrast in the fishery is between riverine and dam populations (Shipway 1951, Morrissy 1978b). Further, marron are a crepuscular or nocturnal species, being most active for a few hours after sunset, especially around a new moon and when water temperatures are above 18 °C (Morrissy and Caputi 1981). This makes monitoring and enforcement expensive as marroners are also active after sunset.

Due to the importance of the fishery and the large number of active licences, the fishery is reported on annually in the State of the Fisheries. The information in the State of the Fisheries is derived from a range of survey information collected annually. Currently, detailed information collected on an annual basis is available from the 1970/71 season until the present season (2000), making the dataset relatively long-term for a recreational fishery and very valuable for stock assessment required for management.

The present document summarises the data collected for the 2000 marron season and compares it to previously collected data (e.g. Morrissy 1978b, Morrissy et al 1984, Morrissy and Fellows 1990, Morrissy et al. 1995). Further, the data is discussed in relation to current pressures on the marron fishery and future challenges. It is hoped that this document will encourage feedback and interaction to better manage and maintain the marron fishery, and possibly enhance the fishery in the future.

2.0 Methods

Data for the compilation of the annual report comes from five sources;

a). Pre- and post season surveys by the Research Division, FWA;

b). Volunteer logbook holders;

c). A telephone survey of licence holders;

d). Interaction with a community group, (The Blackwood Basin Group); and,

e). Rainfall data from the Bureau of Meteorology.

2.1 Pre- and post-season research surveys

Pre-and Post season surveys are required to provide estimates of changes in the marron size distribution and abundance caused by marroning activities. These surveys are organised and

executed by research staff at WAMRL. The timing of surveys is based on the moon-phase as marron are most active and vulnerable to sampling around a new moon. For the pre-season survey, sampling occurred between November 1 – 12, 1999. Post season sampling occurred between 28 February to 10 March, 2000.

2.1.1 Site selection

Site selection is based on the distribution of fishing effort from the previous season, sites identified as vulnerable due to changes in the conditions of certain waterbodies (e.g. Water Corporation dam construction) and the rotation of riverine sites to obtain data on new sites. For the 2000 season, three dams sites were chosen; Waroona Dam, Harvey Weir and Wellington Dam. Waroona and Wellington Dams traditionally receive a high degree of effort and a long-time series of information on the marron fishery exists for these two sites. Wellington Dam is the largest dam in the south-west and has been declared snare-only. Waroona Dam is the first major dam south of the Perth Metropolitan region and scoop-netting is permitted. Further, Waroona Dam is in need of repair and is scheduled for draining immediately after the marron season of 2002. Harvey Weir is in the process of being extended and is a prize snare-only fishery. Monitoring changes to the population structure within Harvey Weir for the next few marron seasons will provide information on the impact of dam modification on the resident marron population. Two nights of sampling by the Research Division (FWA) were applied to Harvey Weir, both pre- and post-season, to provide population estimates through mark-release–recapture (MRR) techniques. Within each dam, areas historically sampled by the Research Division are chosen to provide comparative information through time.

Sampling for the 2000 season incorporated a major effort on river sampling. In 2000, the Murray River was targeted as it is the first major river south of the Perth Metropolitan region and is likely to receive a high level of marroning effort. Three sites along the Murray River were sampled for the 2000 season. These were Yarragil (the most upstream part of Lane-Poole Reserve), Baden Powell Pool, (at the downstream end of Lane-Poole Reserve) and Stawell Road, a site approximately 5 km downstream of Lane-Poole Reserve.

2.1.2 Sampling techniques

In all dams, scoop-netting was used to sample marron. The scoop net used is of smaller mesh (25 x 30 mm) than a legal marroning scoop-net (28 x 130 mm) to allow sampling of just-undersized marron. Further, scoop-netting is the most efficient method of sampling marron (Morrissy 1978b). One kilometre of bank is baited up with a mixture of layer-pellets laced with blood and bone fertiliser. A hand-full of bait is placed every 10 m along the bank at sunset. Three passes are made along the bank at hourly intervals and all marron captured are retained. Any yabbies sighted are also captured. This technique mimics the techniques employed by marroners, with the exception to the distance baited (recreational marroners usually bait less than 500 m of bank). The long distance of bank baited by research staff compensates for “good” and “poor” areas of bank and the vagaries of the prevailing wind.

For rivers, 15 drop nets are set in an overlapping pattern. The drop nets used have a smaller mesh size than legal drop nets (12 x 12 mm compared to 80 x 32 mm) (Morrissy 1989) to retain undersized marron. A similar bait mixture as used in dams is placed into a bait-basket and the nets set just prior to sunset. Again, three passes of the nets are made at hourly intervals, similar to recreational marroning techniques, and all marron captured are retained for in-field processing.

On completion of a nights sampling, all marron within each pass are measured (orbital-carapace length (OCL) ± 0.1 mm) and sexed. Females are classified as berried or non-berried and an estimate of the number of eggs made. At the end of processing, all marron are released.

2.1.3 Estimation of population size

The sampling protocol allows an estimation of the population size of marron in the sampled areas. A basic technique, the Leslie Method (LM), estimates population size by regressing the catch per unit effort (CPUE, number of marron captured per pass or haul) against the cumulative catch over the three passes. The major assumption of the Leslie Method is that the population being sampled is being significantly depleted by the sampling effort (Pauly 1984).

A more robust estimate can be obtained by using a MRR technique, also known as the Peterson Method (PM). Briefly, MRR involves the tagging and release of animals, a time period in which the tagged animals can freely disperse among unmarked individuals, and then a follow-up sampling (Pauly 1984). For the 2000 marron sampling, a MRR exercise occurred in Harvey Weir to provide population estimates both pre and post season. At the end of the first night's sampling at Harvey Weir (for both pre and post season), all marron were marked. Tail-punching was used to mark marron as it is a very cost-effective method of tagging marron and the punch-marks cannot be lost or confused. During the pre-season, the left uropod (tail fan) was punched, while the right uropod was punched for post-season sampling. After tagging, all marron were released evenly over the entire sampling area (approximately 1 km). A second period of sampling occurred two-nights later with the same data collected as described in section 3.1.2, plus information on whether each marron had been tagged.

An estimate of population size can be obtained by ;

$$N = T \cdot n/m,$$

where N = the estimate of the population size, T is the number of marron originally marked and released on the first night, n is the number of marron captured on the second night and m is the number of marron captured on the second night that had been tagged. An estimate of the standard error (s.e.) of the population size can also be calculated via;

$$s.e. = (T^2 \cdot n \cdot (n-m)/ m^3)^{0.5}$$

(Pauly 1984). For the 2000 season, a comparison of the LM and PM population estimates of the size of the marron population in Harvey Weir was performed to compare the two estimates.

2.2 Logbook holders

Logbooks are maintained and distributed by Mr Chris Bird, Technical Officer, WAMRL. Briefly, marroners interested in holding a research logbook contact WAMRL. Logbooks are supplied and explained personally by Mr Bird and contact pre-and post season is maintained. Logbook holders are asked to compete details of each trip, including location, effort and catch data. In 2000, size information was also recorded (see appendix A) as was the presence of yabbies captured while marroning. Logbooks are returned to WAMRL and data entered into an Access database. Distribution of effort, catch and size data is compiled. The

distribution of size is used to estimate the total weight of marron captured during the season. All individual logbook information is confidential.

2.3 Telephone survey

A post-season survey of approximately 800 random licence holders was performed through the Recreational Statistics Section of WAMRL commencing May 2000, approximately 3 months after the end of the 2000 season. Information on licence type, effort and catch is collected using a standard format supplied by the Recreational Statistics Section (WAMRL). It should be noted that 2000 was the first year that the telephone survey was centralised and a comparison of previous data must be made with caution. A total of 806 licence contacts were made, with approximately half the contacts being holders of a marron licence and half being holders of an Umbrella licence. Further, 50% of licence holders surveyed had a metropolitan postal address and 50% had a country address. In this way the survey was as unbiased as possible.

The data collected is used to provide estimates of the number of active licences, the number of trips per licence holder, the distribution of effort and the total catch. These are used as the main data source to detect and monitor overall trends in the RMF. Further, respondents are asked if they captured any yabbies during the 2000 season.

2.4 Interaction with the Blackwood Basin Group (BBG).

Additional river sampling was performed in conjunction with the BBG and volunteers from the Blackwood River catchment. Pre-and post-season sampling occurs with the BBG in areas along the Blackwood River from east of Boyup Brook, to west of Nannup. A total of nine sites were sampled over three nights, with FWA supplying a vehicle, two boats, 60 drops nets and other gear. A similar sampling protocol to that described for river sampling (see section 3.1.2) has used and similar data collected. However, marron were pooled into 10 mm OCL size classes (as compared to the 5 mm classes used by research) and the data does not have the same resolution as the research data. Nonetheless, the data is still useful and important to marron recreational fishing research.

3.0 Results

3.1 Research surveys

The OCL distribution of marron from all sites along the Murray River was similar with most marron being well-below legal size, even before the 2000 season commenced (Figure 1). Although the size distribution of marron sampled post-season had shifted towards the left (i.e. smaller marron), as expected after the fishing season, there was also evidence of a decline in just-undersized marron after the season (Table 1), a possible indication of illegal fishing.

In contrast, the size distribution of marron from all three dam sites surveyed in for the 2000 marron season (Figure 2) showed a good abundance of legal-sized marron relative to

undersized marron (Table 1). Further, the relative abundance of just-undersized marron increased in all sites post-season, providing evidence of relatively good compliance.

Although the size distributions of marron in both Waroona and Wellington Dams were similar and showed a relatively normal size distribution curve with very few very large marron, the size distribution from Harvey Weir was very different (Figure 2). The largest marron recorded by the research surveys were again from the Harvey Weir site, with animals exceeding 100 mm OCL, well above legal size. Even post-season, extremely large marron were recorded from Harvey Weir. However, the relative number of marron was much lower in Harvey Weir compared to the other dam sites (Table 1).

The abundance of berried females, an indication of breeding success of the population, also varied among research sites (Table 1). At all sites, almost 50% of all females sampled were "berried", indicating that a large proportion of females are contributing to the reproduction of the population. The exception to this was Harvey Weir, in which less than 20% of females were contributing to the reproductive effort. Further, Harvey Weir was also different in terms of the minimum size of females that were berried, with a minimum OCL of 56.0 mm recorded. This size is just above legal size indicating that few reproductive females in Harvey Weir are being protected by the size restriction (OCL 55.5 mm = RCL of 76 mm). In contrast, the minimum size of a berried female from all other sites was between 30.5 – 42.3 mm OCL, well under the legal size limit.

The ratio of males to females varied among sites both pre-and post-season. However, the abundance of males generally declined in post-season surveys (Table 1). The data indicates that the males are more vulnerable to recreational fishing effort than females at most sites. However, the population at Harvey Weir again showed a different pattern to most other populations.

3.1.1 Estimations of population size at Harvey Weir

Estimates of the total marron population in Harvey Weir can be generated by estimating the population size from one kilometre of bank and multiplying the estimates by the total perimeter of the Harvey Weir (approximately 7 km). However, as research sampling does not target small animals, (less than approximately 45 mm OCL), an assumption that there are approximately the same number of small marron un-sampled is made. Hence the calculation of population estimate of marron in Harvey Weir is;

Total N (pre-season) = (Estimate for 1 km x 2) x Total perimeter

= (925.36 x 2) x 7

= 12 955.04 marron

s.e. = (Estimate for 1 km x 2) x Total perimeter

= (184.39 x 2) x 7

= 2 581.46

Similar calculations can be made for the post-season surveys (Table 2). A total weight of marron pre and post season can be estimated from the length-frequency distribution for Harvey Weir (Figure 2), using the average weight of a marron for a given size class

(Table 3). As the weight of marron increases exponentially with OCL, small marron will not contribute significantly to the overall biomass of marron in Harvey Weir, thus the biomass estimates are based on large (>45 mm OCL) marron only. From the PM techniques, an estimate of 0.61 tonnes of marron were removed from Harvey Weir during the 2000 marron season. This represents approximately 26.4% of the total biomass of marron above 45 mm OCL (Table 3).

The LM and PM estimates of population size for the same section of bank at Harvey Weir were vastly different (Table 2). The PM technique, a more robust technique, consistently gave much higher population estimates for the number of marron per km of bank, with the PM estimates being 4.44 to 7.40 times larger than the LM estimates. Due to the large differences in the estimates, no estimates were made for other water bodies using the LM. Although the estimates of population size are vastly different, both techniques revealed a large reduction in numbers (55.89% and 26.52%) immediately after the season when pre and post season population estimates are compared.

Yabbies were again captured at Harvey Weir by the Research Division both pre- and post-season. From the two pre-season surveys, a total of 4 yabbies were recorded contributing 0.6% and 2.6% of the total catch. From the post-season surveys, 10 yabbies were recorded from Harvey Weir contributing between 2.5% and 10.6% of the total catch. Yabbies of both sexes and above reproductive size were recorded.

3.2 Logbook data

A total of 110 completed logbooks were returned after the 2000 season from a total of 130 issued. The logbook information is very detailed and covers a range of waters and catchments. Further, there is almost 30 years of logbook data available so that long term trends can be identified. The information from logbook holders for the 2000 marron season and a comparison of the 1999 information are provided in table 4.

Overall, catch rates were slightly lower in the 2000 season as compared to the 1999 season (Table 4). Of interest is the reduction in the activity by logbook holders and the reduction in the percent of trips that failed to return the bag limit of 10 legal sized marron. There were also fewer marron overall recorded for each logbook holder in the 2000 season (54.1) compared with an average of 69.4 for the 1999 season. Similar trends were observed overall in river and dam statistics. The CPUE of undersized marron was also lower in the 2000 season overall and in rivers.

Drop nets were the major gear type used in rivers although over 25% of marroning effort was performed with snares, slightly up from 1999. Although scoop nets are still the most popular gear type used in dams, a much lower usage rate was recorded for the 2000 season. Conversely, other gear types showed an increase in usage.

Individual river and dam sites displayed a large variation in CPUE of marron. The Warren River displayed higher CPUE rates than average, with Murray River showing much lower CPUE. Wellington, Waroona and Stirling Dams showed similar CPUE, with the Harvey Weir displaying a much lower CPUE relative to the average for dams and the overall average for the entire fishery.

Logbook holders are also asked to record the location of yabbies within the marron fishery if

they captured them. For the 2000 season, there were three locations identified as containing yabbies (Table 5). This brings the total number of sites within the RMF in which yabbies have been identified and confirmed to ten from the logbook records.

3.3 Telephone survey data

A total of 806 valid responses were returned from the telephone survey of licence holders from a total of 21 894 licences valid to participate in the RMF for the 2000 season. The total income to FWA from marron licences was estimated at approximately $ 310 495 (Table 6), similar to the revenue generated from licence sales in 1999 ($ 315 724).

The overall rate of participation was approximately 52.7%, lower than for the 1999 season (Table 7). However, the number of trips per licence holder increased and the total number of trips in the RMF was similar to the 1999 estimate. The CPUE of marron was higher than for 1999 and the number of respondents reaching the bag limit of 10 legal-sized marron was over 25%, much higher than the 1999 estimate. An average of 17.4 marron were recorded per licence holder contacted during the telephone survey, up from the 1999 result (11.36) but much lower than the average reported by logbook holders (54.1). This highlights the amount of data generated by logbook holders and the value of the logbook system.

River sites again received a bulk of the effort with over 28 000 trips reported from river sites (Table 7). The gear used at river sites was similar to that recorded for the 1999 season, with the use of snares being slightly higher. The Blackwood River received a bulk of the river effort with the Warren River receiving much more effort in 2000 than reported for the 1999 season. The Murray River, surveyed by FWA in 2000, received approximately 8% of river effort, or approximately 5.5% of total effort in the marron fishery.

The number of trips to dam sites was similar in 2000 as reported for the 1999 season (Table 7). However, there was a large increase in the number of licence holders using snares. In 2000, over 50% of marroners used snares at dam sites (up from approximately 40% in 1999), with a fall in scoop net use to 22%. Wellington Dam received most of the marron effort to dam sites (35%, or 10.5% of total effort) with Waroona Dam receiving nearly 20% of dam effort (approximately 5.5% of total effort). Stirling Dam and Harvey Weir received lower, yet still significant, levels of marroning effort, despite Stirling Dam being closed to the public. Stirling Dam, Harvey Weir and Waroona Dam received a combined total of 39.75% of marron fishing effort to Dams (11.7% of total marron effort).

Approximately 4% of telephone respondents reported that they had captured yabbies while fishing for marron in the 2000 season. Although few people identified the site of yabby capture, four locations were noted. These were, Hutt River, Bowe River, Stirling Dam and Big Brook Dam.

3.4 Combining data from the telephone survey and logbooks

Logbook holders were asked to return size information from captured marron in 2000. As marron carapace size is related to weight, an estimate of the total tonnage of marron landed in the recreational fishery can be obtained. In years without size information, the total

tonnage is calculated by using the average weight of a just-legal sized marron (125 g) by the estimate of the total number of marron captured. When size information is collected, the estimate of the total number of marron captured can be proportioned into the size distribution recorded by log-book holders and applied to the phone-survey results of the total number of marron captured. This provides a more accurate estimate of the total tonnage of marron captured as different size classes of marron have very different mean weights (Table 8). It should be noted that in the 2000 RMF season, the average weight of each captured and retained marron was approximately 224.3 g calculated from information returned by logbook holders and extrapolated using a "saw-tooth" marron gauge.

In 2000, the total catch of marron was estimated at 44.8 tonnes (Table 9). This is up from the 1999 estimate where fewer marron were captured. In comparison, the marron recreational fishery and the marron aquaculture industry are of a similar size in WA in terms of tonnage produced.

3.5 Blackwood Basin Group data

Data collected in conjunction with volunteers and the BBG was not as robust as the FWA derived data and as such less information is available. However, useful information was still forthcoming from the approximately 200 km of the Blackwood River surveyed.

Overall, five of nine sites sampled produced few or no marron and were of poor quality. Marron were rare or absent in all sites between Boyup Brook and Bridgetown, with relatively few marron captured upstream of Nannup (Figure 3). The two sites surveyed downstream of Nannup (Mellema's Pool and Chris' Folly) returned marron in similar abundances to those recorded in the Murray River by FWA research surveys.

At the Chris' Folly site, approximately 15 km downstream of Nannup, the size-frequency distribution was similar to the distributions recorded from the Murray River (Figures 1 and 3). That is, a large proportion of marron were approximately of legal size or below, with relatively few marron well-above legal size. The pre-and post season distributions at Chris' Folly were similar suggesting a possible moult between pre and post-season surveys, although the abundance of marron was lower post-season.

3.6 Meteorological information

Rainfall for the south-west region of WA was slightly above the long-term mean (Table 10). However, the records for individual catchments ranged between 9.2% below the long term mean, to 4.5% above the long term mean. Dam capacity for public-access irrigation dams was also recorded. The largest public access dam in the south-west, Wellington Dam, was at 83.9% capacity, slightly up on previous years. Overall, 1999 was a relatively wet year.

3.7 Long-term trends

The number of active licence holders in the RMF for 2000 was approximately 11 500 or 52% of the total number of valid licences. This is the second consecutive year of a downturn in participation rates and the 2000 participation rate was the third lowest recorded since 1990 (Figure 4a). Although fewer people participated in the 2000 marron season, the number of

trips was similar (Figure 4b) and the total estimated catch of marron was higher compared to the previous season (Figure 5). This means that although fewer people participated, they captured more marron, producing a higher tonnage. However, in overall terms, the total numbers and estimated tonnage are both relatively low compared to historical levels.

A downward trend in the CPUE data is apparent in the three CPUE estimates (for rivers, dams and from the phone survey), following the downward trend recorded since the marron fishery re-opened in 1990 after a two year closure (Figure 6). It should also be noted that a downward trend is apparent in the entire 30 year data set in all CPUE figures available. When the CPUE data since the fishery reopened (1990) are examined, all CPUE trends indicate that the fishery is steadily declining. This may be due to a relative increase in effort, resulting in a reduced CPUE (Figure 5 b).

Long-term size distribution data of marron captured from the fishery exists for the entire fishery, and can be examined for rivers and dams, the major division in the fishery. For the fishery overall there seems to be a relatively stable population structure (Figure 7), with a slight decline in the abundance of large marron (> 80 mm OCL) in catches through time. However, when examining the distributions of OCL from rivers and dams separately (Figures 8 and 9), it appears that the abundance of large marron has declined in public access dams such that very few marron above 80 mm OCL are captured from dams (Figure 8). In contrast, the OCL distributions for marron captured in rivers still consists of large marron (Figure 9), although a decline in extremely large marron is evident through time. OCL distributions for marron by individual rivers and dams have been included in Appendix B.

4.0 Discussion of results

The recreational marron fishery continues to be a popular and active recreational fishery in WA. For the 2000 season, over 21,000 people purchased a recreational licence allowing them to participate in the RMF, generating income from licence sales in excess of $310,000 (Table 6). However, the participation rate fell to approximately 52% of licence holders (75% of marron licence holders; 25% of umbrella licence holders), reducing the number of active licences operating in the fishery. This is the second successive year of declining participation rates (Figure 4a). The recreational marron fishery returned a similar level of effort (trips) for the 2000 season as recorded for the 1999 season (approximately 41,000 nights) (Figure 4b). The CPUE estimated from the telephone survey data was slightly higher than for 1999, producing a higher number and therefore weight of landed marron (Tables 5 and 6). However, both the estimated number and weight of marron captured are well below historical levels (Figure 5).

On examination of the data sets obtained, several key indices are lower than for the previous seasons. Logbook holders, generally the most experienced recreational marroning group, reported a reduced number of trips, reduced percentage of trips resulting in the bag limit of ten marron, and reductions in CPUE of legal sized marron and total number of marron reported per logbook holder. This is despite a reduction in the number of trips made by logbook holders when no marron were captured (Table 4).

In contrast, results from the telephone survey indicated that effort and CPUE increased compared to 1999 data. This may be a result of the increased success due to a decline in the

number of licence holders operating in the 2000 season. However, a similar total effort (total number of trips) were performed in the 2000 season. It should noted that the 2000 season was the first time the telephone survey had been centralised and there may be some biases in the results. For example, the new survey divides the licences into four groups (metropolitan umbrella and marron, country umbrella and marron) and calculates catch, effort and CPUE for each group before summing the total catch and effort for the entire fishery. For previous years, no distinction between licence groups was made. From initial calculations, the new survey technique results in the estimates of catch and effort being approximately 5% and 10% higher than previous methods, respectively. For future years, the telephone survey will remain centralised.

From data provided by logbooks and the telephone survey, the total tonnage of the fishery can be estimated. For the 2000 season, approximately 44.8 tonnes of marron were taken by recreational fishers. To provide a comparison, the estimated production by the marron aquaculture industry was slightly below this figure. Although the total estimated tonnage was higher in 2000 than for 1999, it is still relatively low when compared to long-term trends. The 2000 season estimates of catch may be due to better than average rainfall for the south-west in 1999. Rainfall has been implicated as a major factor in regulating marron numbers (Anonymous 1988), as rainfall increases the quality of habitats by increasing the amount of nutrients entering lentic and lotic environments and by providing more space for marron due to higher river and dam levels (Morrissy 1978b, Morrissy et al 1984, Morrissy and Fellows 1990, Morrissy et al. 1995).

4.1 Effects of marron biology and ecology on the recreational fishery

The recreational marron fishery is divided in to a large number of sites (approximately 96) across at least 13 catchments between Geraldton and Esperance in both rivers and dams. This large geographical range of the fishery means that individual stocks are exposed to a range of environmental conditions (e.g. catchment characteristics including nutrient inputs) and fishing effort. Further, the biology and ecology of marron (that is, brooders with limited dispersal) (Morrissy 1970) means that populations are locally recruiting. These factors act synergistically to make each marron stock independent and have a different stock structure.

Generally, OCL distributions from dams and rivers are different. For example, many of the dam sites contain relatively large populations that that are centred about the minimum legal size (OCL – 55.5 mm, RCL – 76 mm) (Figure 2). Further, after the season, the abundance of above legal size marron is very low. This indicates that a high level of fishing pressure is exerted during the season, removing most of the larger marron. In contrast, river populations are generally have a higher proportion of smaller marron, with the sites surveyed in 2000 in the Murray River indicating that the mean marron OCL was 35 – 40 mm, very much below-legal size.

However, differences in stock structures are in part a result of different gear selectivities (e.g. scoop netting in dams; drop netting in rivers), the productivity of the individual waterbodies and fishing effort and gears in the waterbodies. Although partitioning of these influences is not possible at the present time, marron populations can be divided into three broad categories;

1. Typical riverine populations

These populations are likely to be mainly a result of low productivity of the systems they inhabit. These are typically of a low relative number of marron of which most marron are well-below legal size, a reflection of a slow growth rate. However, a large proportion of females contribute to the season's breeding and most are below legal size which removes the risk of recruitment overfishing in these populations. Thus riverine populations appear to be of a low but stable size and are generally protected by the size regulations.

2. Typical dam populations

These are relatively large populations of marron of which most marron are centred around legal size. These populations seem to produce good numbers of just-legal sized marron and a large proportion of undersized females contribute to the reproductive effort of the population. Marron, in general, appear to be protected by the size regulations. Like riverine populations, marron in may of the dams reproduce well below legal size and are this are protected from recruitment overfishing. However, the fishing pressure is high and very few marron grow much larger than legal size which may expose these populations to growth overfishing. These populations may be a result of high productivity due to the typically large catchment areas of the dams providing good inputs of nutrients into the system.

Further, the fishing pressure removes very large marron which do not have the same growth rate of younger marron. Thus, the fishing effort may be regulating the population size, increasing the carrying capacity of the area resulting in a larger number of smaller (i.e. just-legal sized marron). A similar result has been identified by Momot (1992) for exploited crayfish populations lakes in Ontario, North America.

3. Atypical populations

These populations do not display such a normally-distributed OCL distribution and are typically of a low number or marron. A large proportion of the population is well-above legal size, suggesting that the growth rate is high. However, the relative abundance of marron is low. Further, few females below legal-size contribute to the breeding population and thus these populations appear to be at risk of recruitment overfishing

Again, it should be noted that the sampling gears used in dams (scoop nets) have different biases than the gears used in rivers (drop nets). Thus the distributions reflect, in part, different gear biases. Although the biases associated with drop nets have been quantified (Morrissy 1989), biases associated with scoop nets have not be quantified.

Although these broad populations exist, even within a waterbody there appear to be separate populations. For example, the OCL distribution of marron collected along the Blackwood River displayed a range of distribution patterns (Figure 3). Some of the patterns showed a distribution centred around or just below the legal size (e.g. Maranup Ford, Chris'Folly), similar to the OCL distributions recorded in Waroona and Wellington Dams. Other sites were more like Harvey Weir, for example the Bridgetown Pool. However, it should be noted that the numbers of marron sampled from the Blackwood River were of similar or lower abundances to those collected from the Murray River. In contrast to survey results organised by the BBG, the CPUE estimates produced from the telephone survey indicated that the CPUE of the Murray River was relatively low while the Blackwood River displayed a moderate CPUE. This suggests that other areas of the Blackwood River not sampled with the

BBG may be of a higher "quality" and emphasises the heterogenous nature of the marron populations even along a single river. This is not surprising given the range in river health along most of the river courses of the south-west (degraded to nearly pristine). For example, freshwater soaks enter the Blackwood River at various places upstream, maintaining marron populations consisting of large numbers of individuals (G. Cassells, pers. comm.), even near sites that produced relatively few marron via surveys (Figure 3).

4.2 Historical and overall trends in the recreational fishery

The historical data collected on the recreational marron fishery can be divided in to two major periods either side of the season closures of 1988 and 1989. (i.e. pre-1988 and post 1990). This is, in-part, a reflection of the management of the RMF before and after the season closures of 1988 and 1989 due to declining catches coupled with several years of drought (Anonymous 1988).

Although catches were high in the RMF in the mid 1970's, declines in catches and CPUE were recorded from approximately 1976 up to the closure of the fishery in 1988 (Figure 5). These downward trends are likely to be due to a range of factors, most of which are outside the management of the Department of Fisheries (e.g. land management, water diversions into private and public dams, degrading of riparian vegetation and rivers due to farm management, rainfall and climate variability to name a few). However, some of this decline may be a result of historically high bag limits (up to 30 per night), changes in gear types and related efficiencies and other factors that are within the management realm of the Department of Fisheries (e.g. the extent of illegal fishing practices).

After the season re-opened in 1990, a large catch was recorded for this first season, similar to historically high levels. However, after this initial "bonanza" year, the catches declined to relatively low levels. Although fluctuations have occurred in catches since 1990, the total catch appears to be stabilised, albeit at a much lower level. Again, the lower level is due to a combination of factors, many of which are outside the control of the Department of Fisheries. Further, some of these influences are unlikely to be restored to historical levels (for example, large-scale clearing throughout many of the catchments). Thus, future catches within the RMF are unlikely to be of a similar high level as recorded in the early to mid 1970's and are expected to remain within the range of 100,00 to 300,000 marron per season.

Although the total catches may be considered to be at stable but low levels, the CPUE estimated from three data sources indicate that a decline in CPUE is still occurring (Figure 6). If the current trend continues, the fishery overall will be reduced to an insignificant level within the next decade. However, the fishery as a recreational activity is likely to be affected earlier than this if the CPUE declines below what recreational marroners perceive to be an acceptable level. The decline in the number of trips made by logbook holders, generally the more experienced marroners, suggest that a decline in participation and effort is already occurring. A simple survey would reveal a minimum level of acceptability or quality (e.g. CPUE) of recreational marron fishing and which may be applied as a management goal (that is preservation of marron catch rates above a certain CPUE). However, the CPUE in the 1990's (about 5 marron per marroner per trip) suggests that this CPUE is still sufficient to encourage a significant recreational activity, as long as the CPUE can be maintained at this level in the future.

It has been postulated (e.g. Morrissy 1978b, Morrissy et al. 1984, Anonymous 1988, Morrissy and Fellows 1990, Morrissy et al. 1995, Molony 1999, Molony and Bird 1999,) that marron numbers are influenced by rainfall in previous years. That is, higher rainfall enhances the number of marron. Although the exact mechanism is unknown, increased rainfall increases the nutrient input into rivers and dams, and increases river and dam levels, thereby increasing the amount of usable habitat by marron. Increases in available habitat may enhance the survival of young (0+) marron by reducing intra-specific competition for resources and reducing predation due to a combination of increases in habitat and making conditions difficult for visual predators (e.g. fishes, birds, marroners) due to turbid and fast-flowing water. In the past 10 years since the marron fishery was closed, there has been a range of winter rainfalls between approximately 77 – 110% of the long-term mean of the south-west (Figure 10). Despite this contrasting history of winter rainfalls, the CPUE of marron has continued to decline. Thus, although the strength of winter rainfall may have been important in influencing the abundance and survival of marron in the past, the impact on the contemporary fishery appears to be reduced. This is emphasised by plots of CPUE versus Effort (trips) in rivers and dams, where the last 10 years of the plot are relatively similar in CPUE despite contrasting rainfall (Figure 11).

There are several possible reason to explain the current weaker relationship between rainfall and marron catches. Firstly, as the south-west develops, more and more surface water is being dammed thus restricting the amount of run-off and therefore nutrient input into rivers and dams within the fishery. Secondly, development has also resulted in modifications to the river banks and riparian vegetation, which may reduce the amount of appropriate marron habitats. Thirdly, in the upper reaches of many of the south-west rivers, land practices have led to increased salinisation of the ground water which may make the water quality unsuitable for marron. This is exemplified by the low abundances of marron in the upper reaches of the Blackwood River (Figure 3). Fourthly, the distribution of other predatory species, including red-fin perch and cormorants, has increased and extra predatory pressures may be exerted on marron populations. Finally, the high fishing pressure and vulnerability of marron to recreational fishing, in conjunction with any or all of the above reasons, may reduce the positive effects of rainfall in future years as many populations may be exposed to recruitment overfishing. Despite the reason(s), it seems unlikely that the CPUE in the recreational marron fishery will increase without management intervention.

There are a number of possible options to address the declining CPUE, which may result in CPUE being maintained or enhanced, at least in certain waterbodies. These options include;

1. Closure of fishery to accumulate stocks – A relatively cheap management option but unpopular and difficult to enforce. Further, this would result in another “gold-rush” (Anonymous 1988) when the season re-opens and is unlikely to have long-term benefits, noting that there is little evidence to indicate that spawning stocks are limiting recruitment;

2. Rotational closures of selected water bodies – It is suggested by Morrissy et al. (1984) and others (Anonymous 1988) that dam populations of marron take approximately 3 years to recruit into the fishery (76 mm CL) while river populations take approximately 5 years. Using this information as a basis, rotational closures of waterbodies on a three to five year cycle may be implemented, allowing some locations to be exploited while others are allowed to rebuild. However, this would assist the recreational marron fishery if stocks were at risk from growth overfishing, which there is currently no evidence. Further, a

rotational closure would cause confusion to licence holders and the closure of selected waterbodies is likely to be difficult to enforce. Further, it is likely that marroning effort would be focussed on fewer locations, increasing the impact on 'open' populations;

3. Changes in management controls – Marron numbers may be maintained by altering the regulations. Presently, the minimum legal size of marron (76 mm RCL) is based on a size of marron that allows most individuals in most populations to reproduce at least once, protecting most stocks from recruitment overfishing (noting the likely exception in Harvey Weir). Increasing the minimum legal size would protect more of the population but would reduce CPUE and total catch further, possible below what is acceptable to encourage recreational marroners to buy a licence. Reducing the bag limit (from 10) may not have much impact on the fishery as the average CPUE is currently about 5 marron per marroner per night. The only other options available are further gear restrictions (of which snaring is likely to be phased in to be the only gear-type allowable in dams), or a reduced season. However, it is unclear if any changes would protect stocks from recruitment overfishing.

4. Overall reduction in effort – The number of recreational licences issued for marroning is not currently limited. That is, any person applying is likely to be issued a licence for marroning. This means that the overall effort and catch is not limited (c.f. TAC (Total Allowable Catch) in commercial fisheries (Hilborn and Walters 1992)). A cap on the total effort, by issuing a maximum number of licences, could limit the effort in the fishery and increase catch rates or fishing success but is unlikely to significantly reduce total catch. This would require the forming of a policy for the issuing of licences (e.g. random allocation). A reduction in the length of the season is unlikely to reduce effort unless a substantial reduction in effort occurs. However, in the 2000 season, the number of trips per active licence was approximately 3.6 during the season and marroners may simply perform a similar number of trips during a shorter season.

5. Improving marron survival – Installing artificial habitats may be a viable option especially in impoundments (public access dams) that have a large resident red-fin population. However, this will need the consent of Water Corporation and will require an investment into research to evaluate the impact and effectiveness of artificial habitats. A current NHT project will examine the effectiveness of artificial marron refugia.

6. Enhancement by the stocking of 0+ juveniles may be effective in areas where breeding stocks are limiting recruitment (due to recruitment overfishing), or newly refurbished dams (e.g. Harvey Weir). However, this will require an evaluation of the effectiveness and cost-benefit analysis before commencing.

Of the above, the supply of artificial habitats (5) is likely to be a long-term, low-cost solution, especially in public-access dams where the management Agency (Water Corporation) has had a policy of clearing the bottom of dams (removing all tree-stumps etc from a dam to minimise the risk of blockages to outlets). This policy has in effect removed any habitat and shelter for marron, an important consideration due to marron being a nocturnal species which shows a preference to using shelter as opposed to constructing burrows (Maguire et al. 1999).

Secondly, the removal of structure may impact further on marron populations by not providing adequate protection for small (0+) marron from adult marron or introduced

predators such as red-fin perch. For example, Beattie (2000) could not locate newly released and small marron (OCL < 20 mm) in samples from Waroona Dam (Lake Navarino) despite collecting large numbers from isolated ponds at the same times of year in a similar location. However, small marron (<20 mm OCL) were regularly found in the stomach contents of exotic red-fin perch captured from Waroona Dam between January and March, the time that small marron were collected from ponds. Research performed by Curtin University indicated that trout also consume crayfish, but have a much broader diet that includes insects (G. Whisson, pers. comm.). By providing a habitat that could protect small marron (up to 20 or 30 mm OCL) from predation (e.g. red-fin) could increase the survival of marron in Waroona Dam up to the limit of its productivity (i.e. carrying capacity).

This may also be the reason that the Harvey Weir population of marron is so unusual. Harvey Weir also has much of the structure removed and has a large resident population of redfin (pers. obs.). Thus, the survival of small (0+) marron would be reduced due to predation. This may be allowing the growth rates of marron in the Weir to be much higher than for other places due to low intra-specific competition and relatively high food availability. If this is the case then the marron of Harvey Weir should have a similar age distribution to marron from other dams. Presently there is no ageing tool available for marron and age information is not available. Accurate ageing information for marron would provide another level of resolution to better understand and manage this unique stock, especially in regards to the estimation of fishing and natural mortality rates.

Over the next 3 – 5 years, major changes to the marron fishery are expected to further reduce catches. These changes include the permanent closure of Stirling Dam (with 2.52% of total marroning effort), the modifications and expansion of Harvey Weir (3.72% of effort) and the draining and disruption to Waroona Dam (5.47% of effort). These three sites combined represent approximately 39.75% of total dam effort (11.71% of total effort), and a significant proportion of the total effort in the Harvey River Catchment. Strategically, these dams are important as Waroona Dam is the closest major dam to the Perth Metropolitan region (approximately 1.5 hours by road) and Harvey Weir is renowned as a snare-only marron fishery, due to the number of large marron captured. Although, in the immediate short to medium term these modifications will have a major negative impact on the recreational marron fishery, it may be an opportunity for the Department of Fisheries to enhance the marron fisheries in Waroona Dam and Harvey Weir by actively reducing red-fin populations and providing additional marron habitat while water levels are at their lowest, thereby increasing the productivity of these dams and providing a long-term benefit to the recreational marron fishery.

What is required is a re-evaluation of the entire recreational marron fishery using a holistic approach, that includes recreational effort, productivity and carrying capacity of different water bodies (e.g. dams and rivers) and the biological and ecological requirements and pressures placed on marron. Now is an ideal stage to implement such a review due to relatively small catches and declining CPUE, reduction in the number of active licences and the major changes to public access dams in the south-west which will reduce the total marron catches for at least 3 – 5 years after the 2001 season. An FRDC proposal encompassing these and other factors that influence the recreational marron fishery is being prepared to submit in the December 2001 funding round.

5.0 Acknowledgements

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7.0 Tables

Table 1. Summary data from marron collected during research surveys pre and post 2000 season.

a). Pre-season 2000

Site	Gear	Number Captured	♂:♀	Total :legal sized marron	Total ♀: Berried ♀	Minimum size of berried ♀ (OCL mm)
Yarragil	Drop nets	135	1.81 : 1	1 : 0.06	1 : 0.58	42.3
Baden Powell	Drop nets	137	1.21 : 1	1 : 0.13	1 : 0.74	30.5
Stawell Road	Drop nets	94	1.61 : 1	1 : 0.09	1 : 0.41	32.7
Wellington Dam	Scoop	630	1.54 : 1	1 : 0.23	1 : 0.88	40.2
Waroona Dam	Scoop	344	1.02 : 1	1 : 0.37	1 : 0.80	40.6
Harvey Weir 1	Scoop	117	0.81 : 1	1 : 0.61	1 : 0.17	58.2
Harvey Weir 2	Scoop	174	1.07 : 1	1: 0.66	1 : 0.09	56.0

b). Post-season 2000

Site	Gear	Number Captured	♂:♀	Total :legal sized marron
Yarragil	Drop nets	157	0.91 : 1	1 : 0.006
Baden Powell	Drop nets	186	1.00 : 1	1 : 0.03
Stawell Road	Drop nets	158	1.20 : 1	1 : 0.03
Wellington Dam	Scoop	518	0.98 : 1	1 : 0.06
Waroona Dam	Scoop	160	0.80 : 1	1 : 0.125
Harvey Weir 1	Scoop	40	1.67 : 1	1 : 0.23
Harvey Weir 2	Scoop	85	1.24 : 1	1 : 0.27

Table 2. Comparison of marron population estimation techniques using the Leslie (LM) and Peterson (PM) methods at Harvey Weir, pre- and post- 2000 marron season. (The total population estimate uses the research survey data on 1 km of bank, and multiplied this up by the approximate perimeter of Harvey Weir, in this case approximately 7 km).

Time	Estimation Technique	Population Estimate of Marron per km of bank (standard error)	Total Population Estimate (standard error)
Pre-Season	LM	208.37	2 921.80
	PM	925.36 (± 184.39)	12 955.04
			(± 2 581.46)
Post-Season	LM	91.92	1 286.88
	PM	680.00 (± 295.03)	9 520.0
			(± 4 130.42)
Reduction in Numbers	LM	55.96%	
During the 2000 Season	PM	26.52%	

Table 3. Estimates of the total biomass of marron and removal in tonnes in Harvey Weir, pre and post season 2000.

	Estimate (± standard error)
Pre Season 2000 (tonnes)	1.47 (± 0.29)
Post Season 2000 (tonnes)	1.08 (± 0.47)
Tonnage Removed	0.39
% Removed	26.5

Table 4. Summary of logbook information from the 1999 and 2000 season. [CPUE = Catch per unit effort. A unit of effort is one trip by one fisher, with a trip being a single night of marroning.]

Data Set	Parameter	1999 Season	2000 Season
Logbooks	# Logbooks returned	119	110
	# Logbook holders >1 trip	102	81
All Waters	Mean trips/ Logbook	5.75	5.27
Combined	% of trips with no legal marron ("zero-trips")	11.49	7.98
	% of trips resulting in filling bag limit (10 marron)	24.23	21.43
	Catch rate of legal-sized marron (no. per trip)	5.56	5.34
	Catch rate of under-sized marron (no. per trip)	4.19	3.04
	Mean marron reported per logbook	69.4	54.1
All Rivers	Catch rate of legal-sized marron (no. per trip)	5.83	5.18
	Catch rate of under-sized marron (no. per trip)	4.32	2.77
	% of trips using Drop nets	72.93	71.17
	% of trips using Scoop nets	1.50	2.49
	% of trips using snares	25.56	26.33
Warren River	Mean CPUE (legal sized)	N/A	6.19
Murray River	Mean CPUE (legal sized)	N/A	1.00
Blackwood River	Mean CPUE (legal sized)	N/A	3.85
All Dams	Catch rate of legal-sized marron (no. per trip)	6.06	5.10
	Catch rate of under-sized marron (no. per trip)	4.06	4.29
	% of trips using Drop nets	19.33	23.89
	% of trips using Scoop nets	56.67	46.90
	% of trips using snares	24.00	29.20
Wellington Dam	Mean CPUE (legal sized)	7.13	6.04
Harvey Weir	Mean CPUE (legal sized)	N/A	1.00
Waroona Dam	Mean CPUE (legal sized)	N/A	6.56
Stirling Dam	Mean CPUE (legal sized)	N/A	6.08

Table 5. Sites identified by logbook holders as containing yabbies. Unconfirmed reports of yabbies were reported during the telephone survey indicating yabbies at Big brook Dam, Stirling Dam, Hutt River, Bowes River and around Northam and Toodyay.

Location	1999	2000
Drakesbrook Dam	1 record	1 record
Waroona Dam	1 record	
Hamel Irrigation Area	1 record	
Goodga River	1 record	
Wellington Dam tributaries	1 record	
Black River tributaries	1 record	
Harvey Weir	1 record	
Hutt River	1 record	2 records
Water point dams in the southern forests		1 record

Table 6. Numbers and income generated by sales of Recreational marron licences valid for the 2000 marron season (as of 1 May 2000). Note that the calculations take into account discounted and exemptions of fees for licences. ($0 is due to the issuing of special licences)

Licence Type	Number	Value	Pro-Rata Factor *	Value of Marron Component
Marron Only	10 064	$ 178 830	1	$ 178 830
Marron and Abalone	79	$ 3 060	20/45	$ 1 360
Marron and Netting	160	$ 5 120	20/40	$ 2 560
Marron, Netting and Freshwater Angling	19	$ 770	20/55	$ 280
Marron and Freshwater Angling	834	$ 26 197-50	20/35	$ 14 970
Marron and Rock Lobster	844	$ 35 707-50	20/45	$ 15 870
Marron, Rock Lobster, Abalone and Netting	1	$ 0	20/90	$ 0
Marron, Rock Lobster, Abalone, Freshwater Angling	1	$ 60	20/85	$ 14
Marron, Rock Lobster, Netting	1	$ 0	20/65	$ 0
Umbrella	9 891	$ 507 210	20/105	$ 96 611
Total	**21 894**			**$ 310 495**

* Pro-rata factor is calculated by dividing the cost of a marron licence by the cost(s) of other licences in multiple licences. [Abalone - $ 25; Rock Lobster - $ 25; Netting - $20; Freshwater Angling - $ 15; Marron - $ 20] (May 2000 prices).

Table 7. Summary of telephone survey information from the 1999 and 2000 season. [CPUE = Catch per unit effort. A unit of effort is one trip by one fisher, with a trip being a single night of marroning.]

Data Set	Parameter	1999 Season	2000 Season
Survey Information	# Phone Contacts	245	806
	# Active Licences (estimated)	13 899	11 493.29
	% Total Active Licences	64.8	52.7
	% Of active Marron Licences	N/A	75.1
	% of active Umbrella licences	N/A	25.4
All Waters	Total Number of trips	40 910 (± 1 102)	40 835.64 (± 2 275.67)
Combined	Mean trips/ Licence	2.91 (± 0.19)	3.553 (± 0.20)
	Total number of marron captured	157 966 (± 17 273)	199 670 (± 8 154.88)
	CPUE per trip	3.86 (± 0.27)	4.89 (± 0.20)
	% of trips with no legal marron ("zero-trips")	22.20	18.00
	% of trips resulting in filling bag limit (10 marron)	11.94	26.68
	Mean marron reported per interviewee	11.36 (± 1.24)	17.44 (± 1.20)
All Rivers	Total # Trips to Rivers	26 662 (± 1 302)	28 808.3 (± 1 605.42)
	% of trips using Drop nets	69.17	62.03
	% of trips using Scoop nets	3.33	7.54
	% of trips using snares	27.5	30.43
Warren River	% of river effort to river (% of total effort)	0.90 (0.62)	11.13 (7.85)
Murray River	% of river effort to river (% of total effort)	NA	7.90 (5.54)
Blackwood River	% of river effort to river (% of total effort)	36.4 (23.71)	21.97 (15.49)
All Dams	Total # Trips to dams	12 675 (± 2 570)	12 027.14 (± 950.08)
	% of trips using Drop nets	19.72	24.42
	% of trips using Scoop nets	40.85	22.09
	% of trips using snares	39.44	53.49
Wellington Dam	% of dam effort to dam (% of total effort)	21.43 (7.41)	35.71 (10.52)
Harvey Weir	% of dam effort to dam (% of total effort)	NA	12.61 (3.72)
Waroona Dam	% of dam effort to dam (% of total effort)	NA	18.57 (5.47)
Stirling Dam	% of dam effort to dam (% of total effort)	NA	8.57 (2.52)

Table 8. Mean weights of marron of different sizes based on the measuring gauge supplied to logbook holders. The weights are used to calculate the total tonnage of marron captured by in the RMF based on logbook size distribution data and the results of the telephone survey. Modified from Morrissy 1978b. (* This is an approximate weight for marron larger than class 9 on the gauge

Measuring gauge size-class number	OCL (mm) of gauge class (g)	RCL (mm)	Weight at mid-point
U	50	69.5	108
1	55	76.5	140
2	60	83.4	177
3	65	90.4	221
4	70	97.3	271
5	75	104.3	329
6	80	111.2	393
7	85	118.2	464
8	90	125.1	546
9	95	132.1	635
Above	100	139.0	810*

Table 9. Estimated landings from the Recreational Marron Fishery in 1999 and 2000 with a comparison with the Marron Aquaculture Industry. The two figures for the catch from the current season allow comparisons with long-term data sets which used these estimation techniques. (* Production data for 1999 is a repeat of the 1998 data as insufficient voluntary returns were provided. 2000 data is based on compulsory returns from every licensed marron farmer).

RMF	1999	2000
Estimate based on 125 g pre marron	19.7 (± 2.16)	25.0 (± 1.02)
Estimate based on size and weight distribution of marron	38.6 (± 4.22)	44.8 (± 1.82)
WA Aquaculture Production*	42.0	41.8

Table 10. Rainfall recorded in the south-west of Western Australia for the 1999 calendar year.

Gauging Station	1999 Records (mm)	Long-Term Mean (mm)	1999 Difference Relative to Long-Term Mean
Albany	730.6	804.9	- 74.3 (- 9.23%)
Collie	932.0	948.0	- 16.0 (- 1.69%)
Dwellingup	1323.4	1266.2	+ 56.8 (+ 4.49%)
Cape Leeuwin	972.0	998.7	- 26.7 (- 2.67%)
Pemberton	1283.2	1198.5	+ 84.7 (+ 7.06%)
Perth	822.0	795.5	+ 26.5 (+ 3.33%)
Total	**6063.2**	**6011.8**	**+ 51.4 (+ 0.85%)**

8.0 Figures

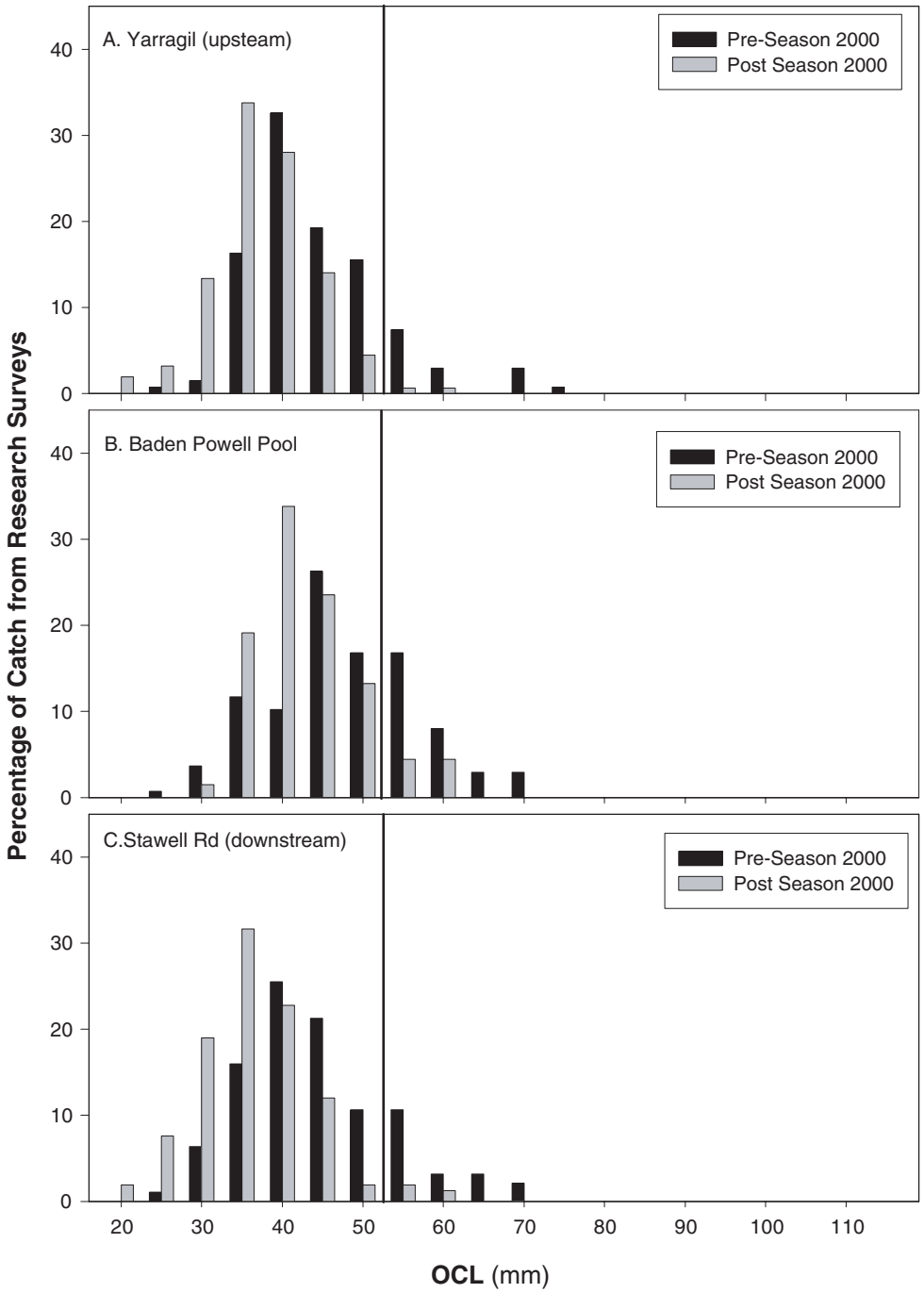


Figure 1. Comparison of pre- and post-season research surveys to Murray River sites for the 2000 season monitoring program.
The vertical line represents the minimum legal size of marron. Note that a majority of marron are well below legal size even prior to the start of the marron season.

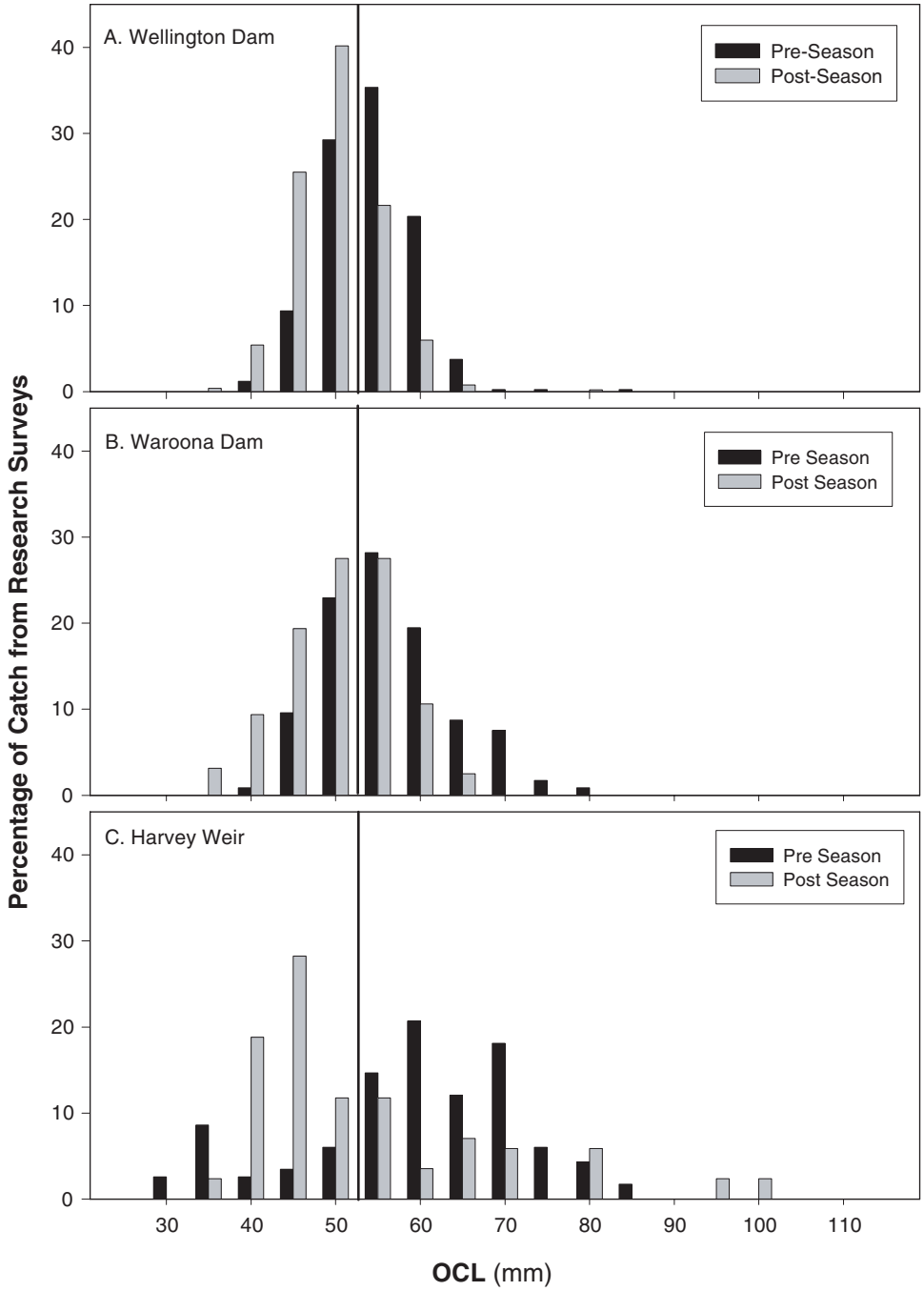


Figure 2. Comparison of pre- and post-season research surveys to dam sites for the 2000 season monitoring program.

The vertical line represents the minimum legal size of marron. Note that the size distribution of marron during the pre-season in Wellington and Woroona Dams is centred around the legal size. However, the abundance of above legal-size marron is low after the season. This indicates a high level of fishing effort and removal of most legal-size marron. Note also the unusual size-distribution of marron within Harvey Weir.

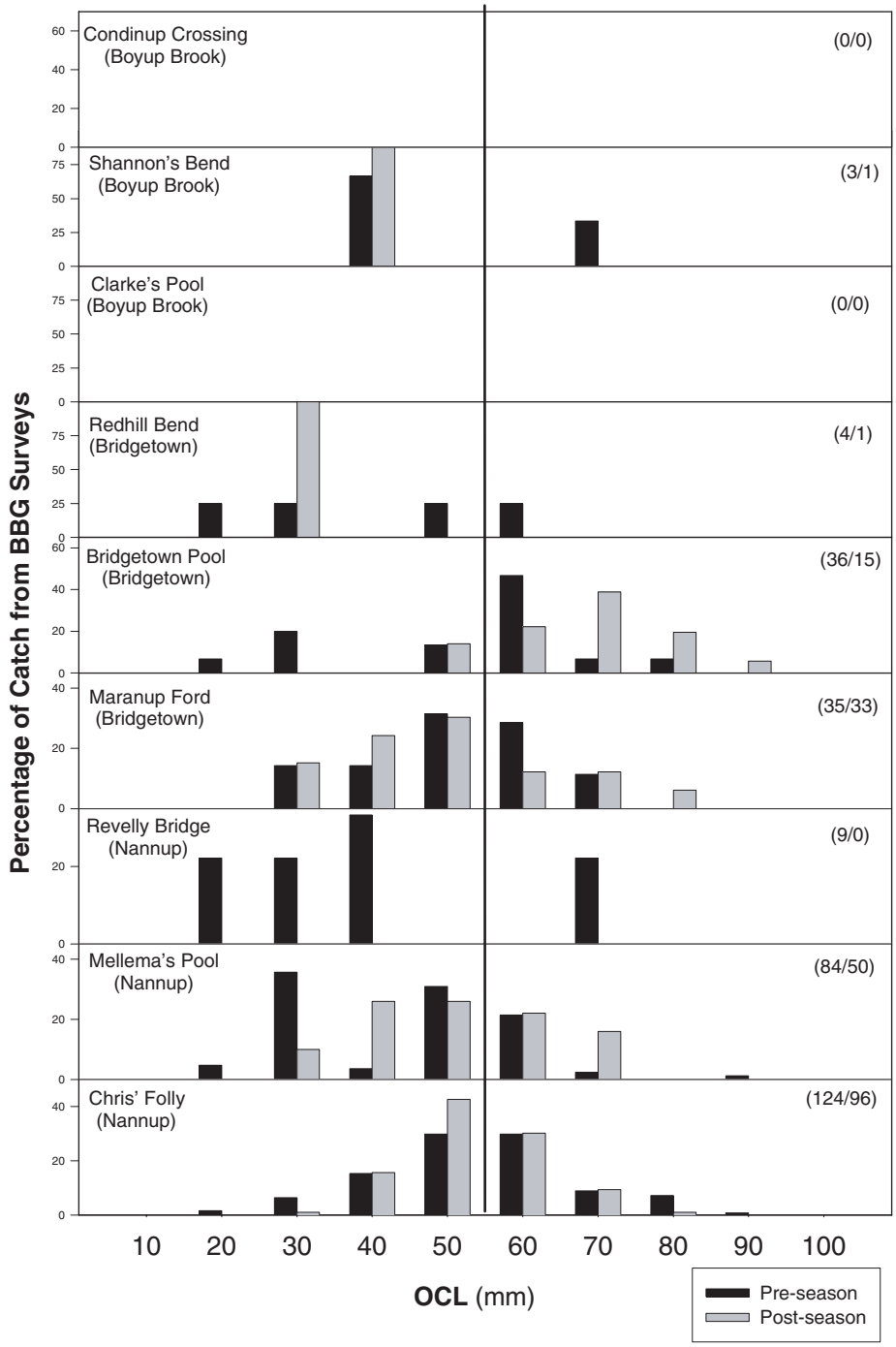


Figure 3. Pre- and post-season marron OCL distributions in the Blackwood River, 2000. Site name and nearest town provided in the top-left of each graph. Numbers in parentheses indicate total number of marron sampled (pre/post season). Vertical line represents approximate minimum size. Note the overall low numbers of marron at most sites and the range of size-distributions from the various sites.

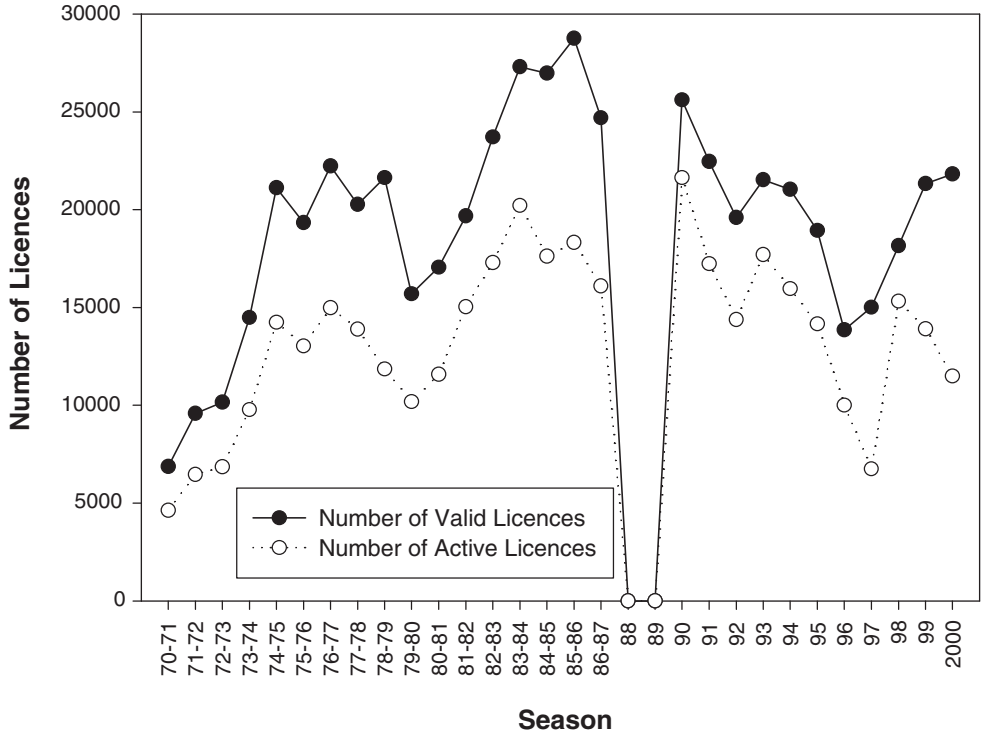


Figure 4a. Number of licence holders in the recreational marron fishery, 1970-2000.

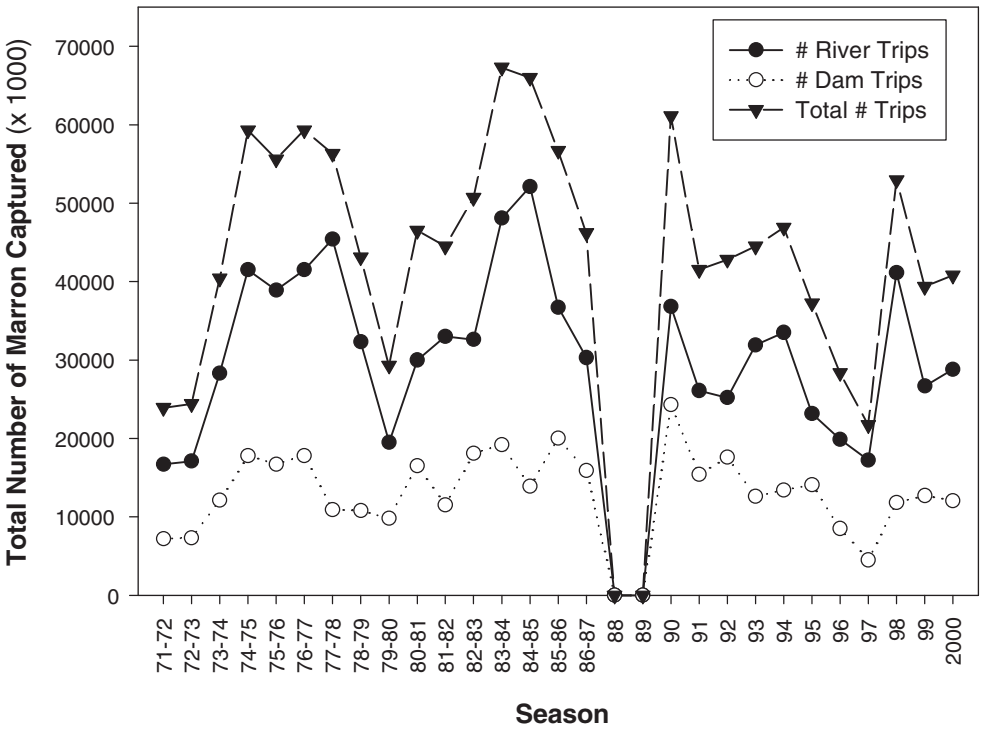


Figure 4b. Estimated number of recreational marron trips calculated from phone survey data.

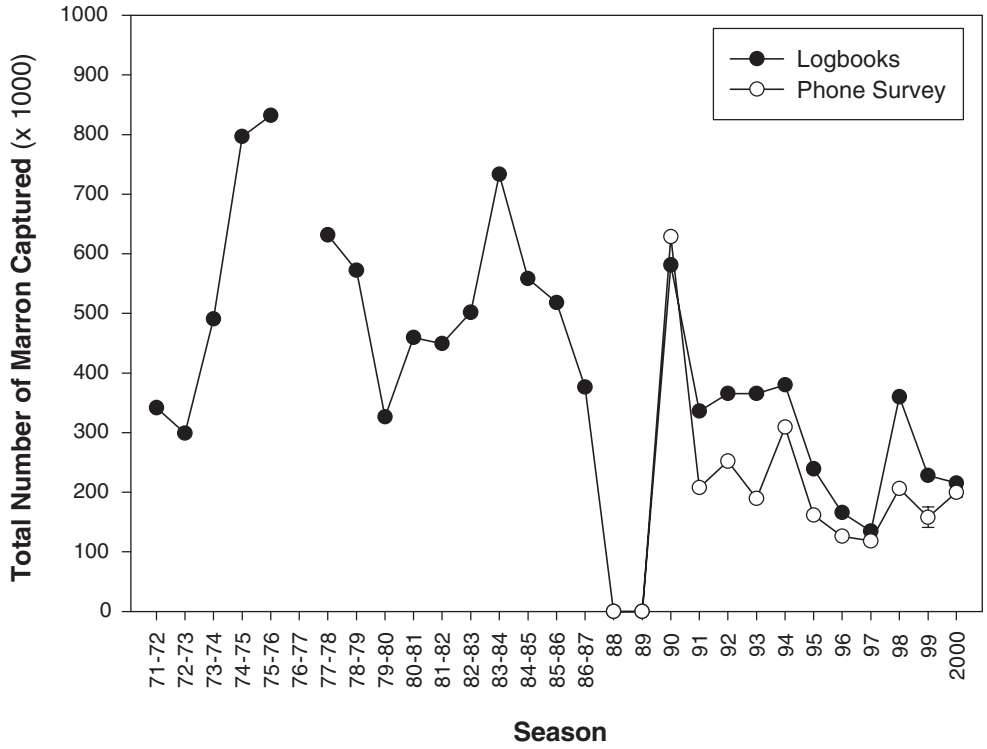


Figure 5. Estimated total catches of marron from logbook and phone survey data.

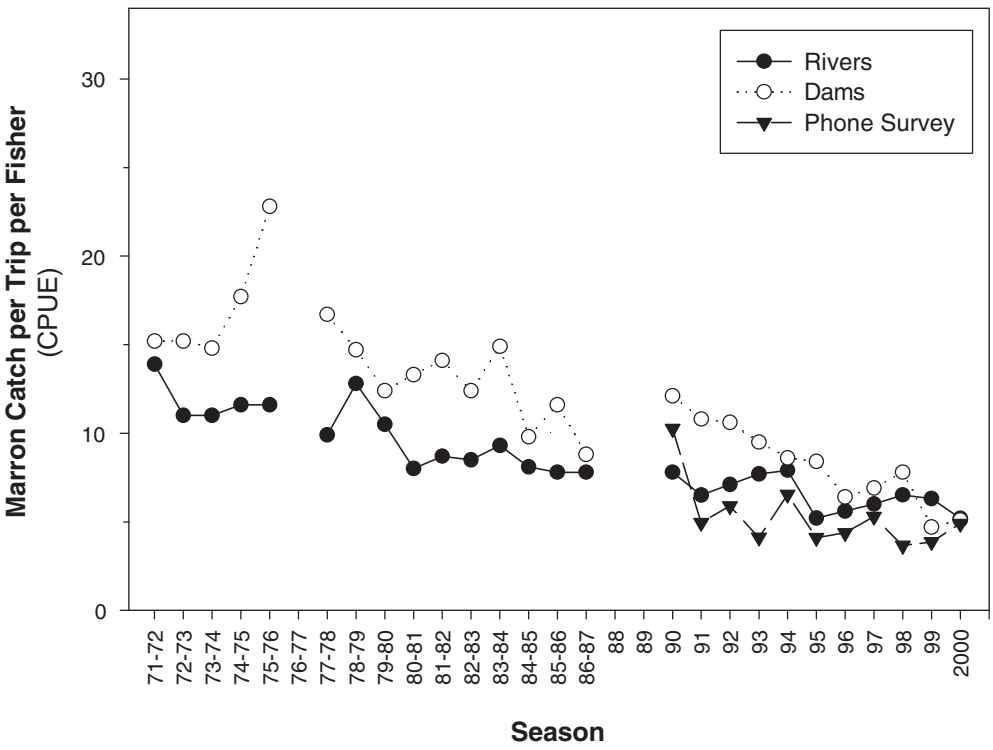


Figure 6. Reported marron catches from logbook holders and phone survey.

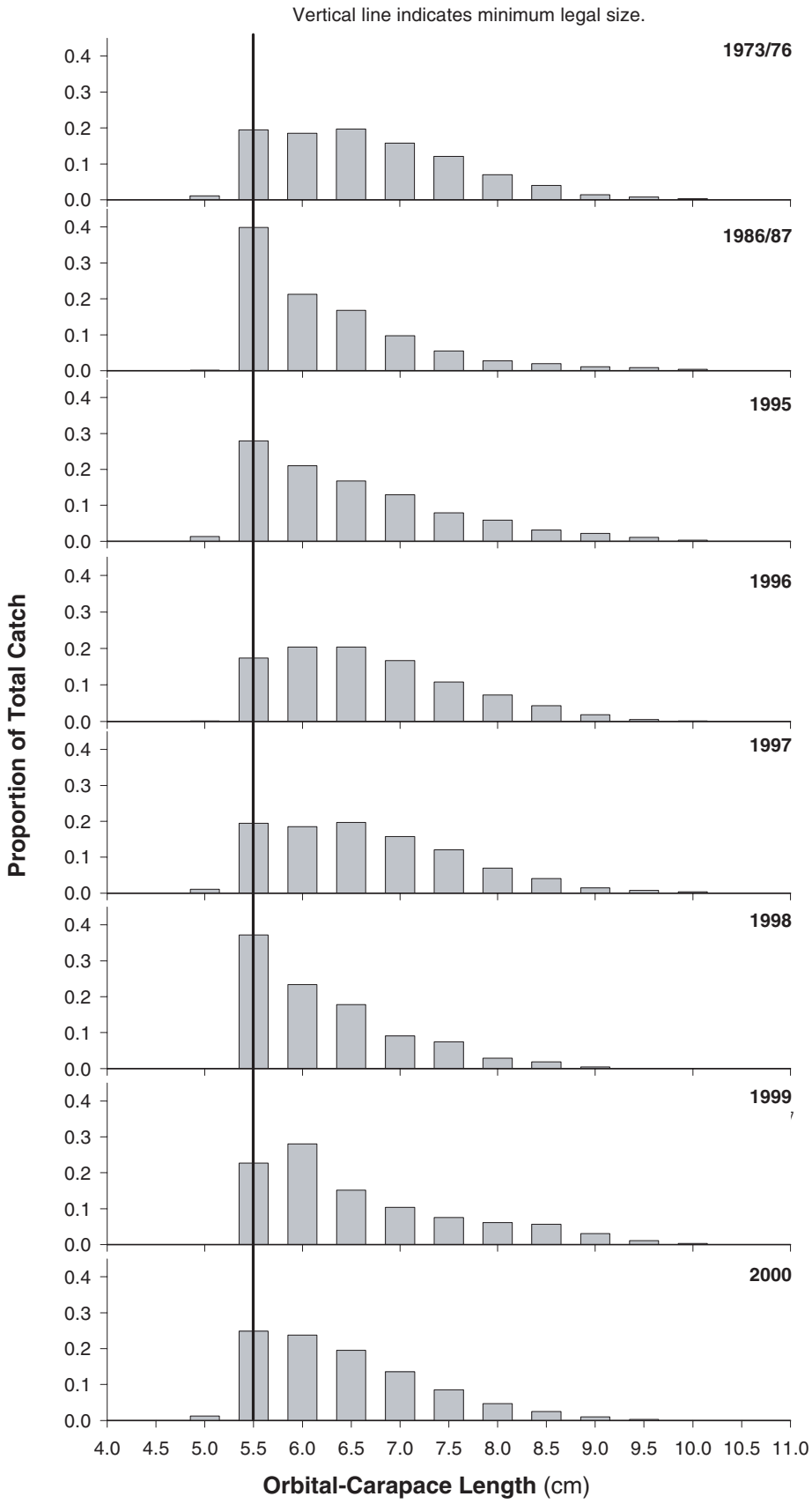


Figure 7. OCL distribution for the marron fishery, 1973-2000.

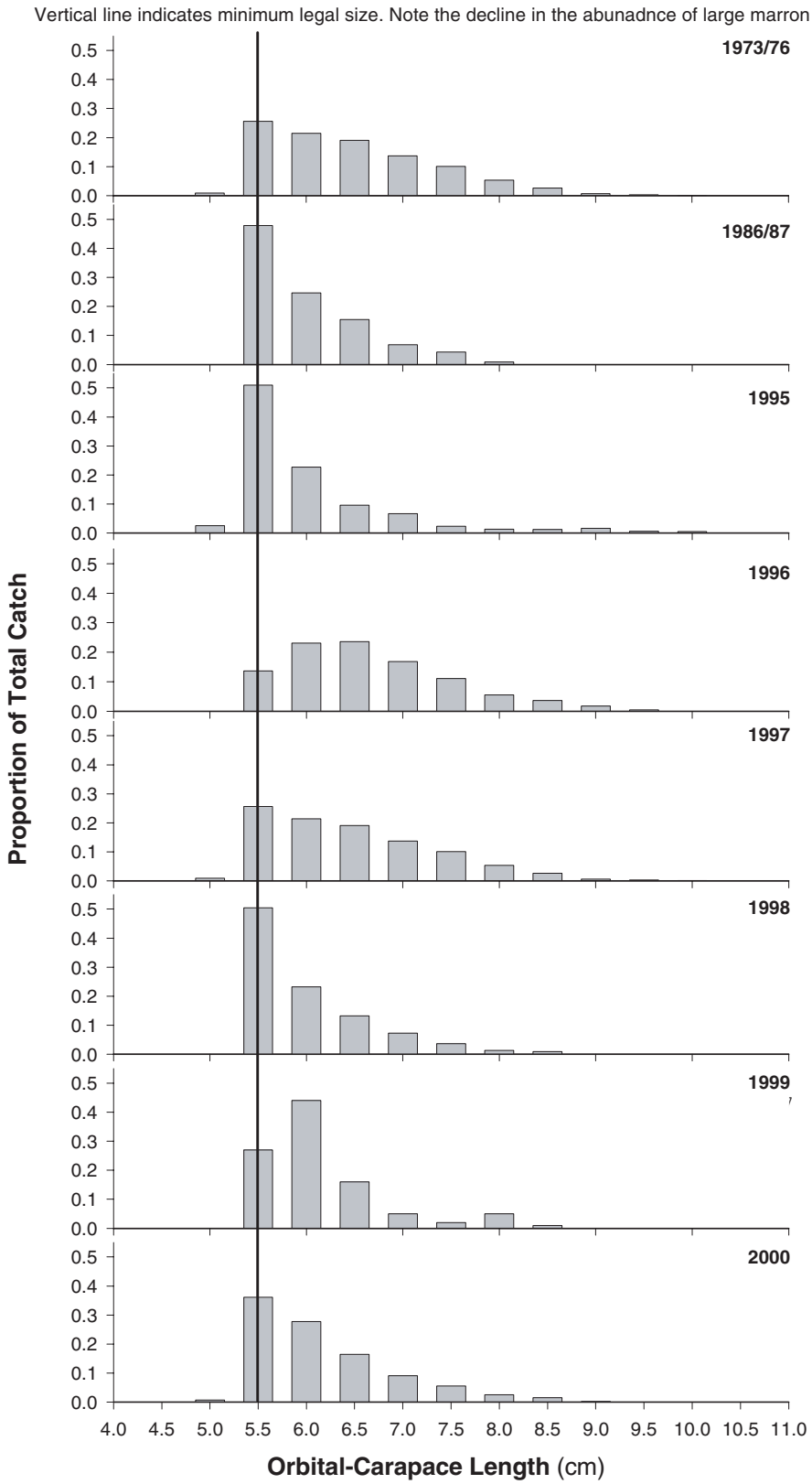


Figure 8. OCL distribution from dams in the marro fishery, 1973-2000.

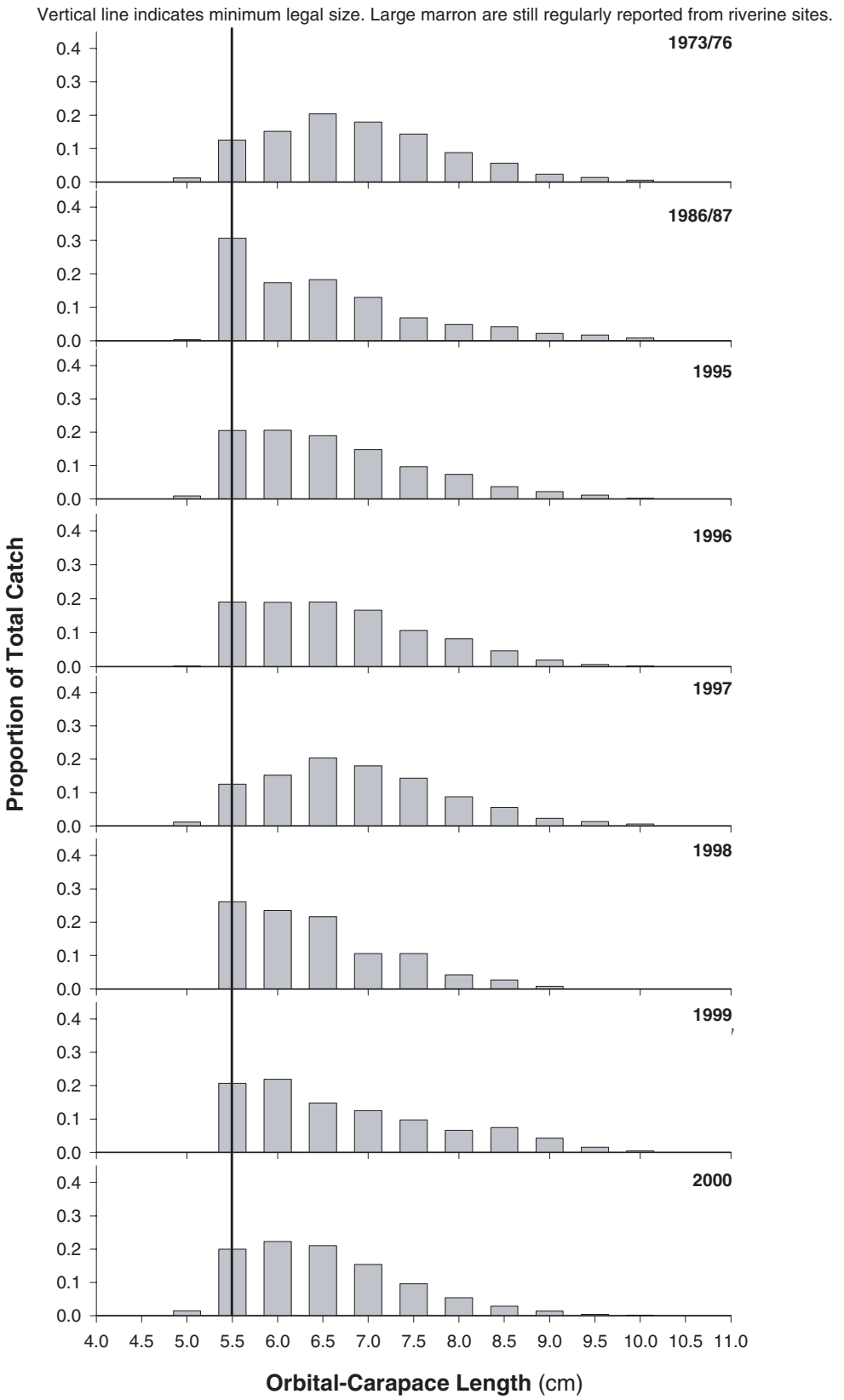


Figure 9. OCL distrbution for rivers in the marron fishery, 1973-2000.

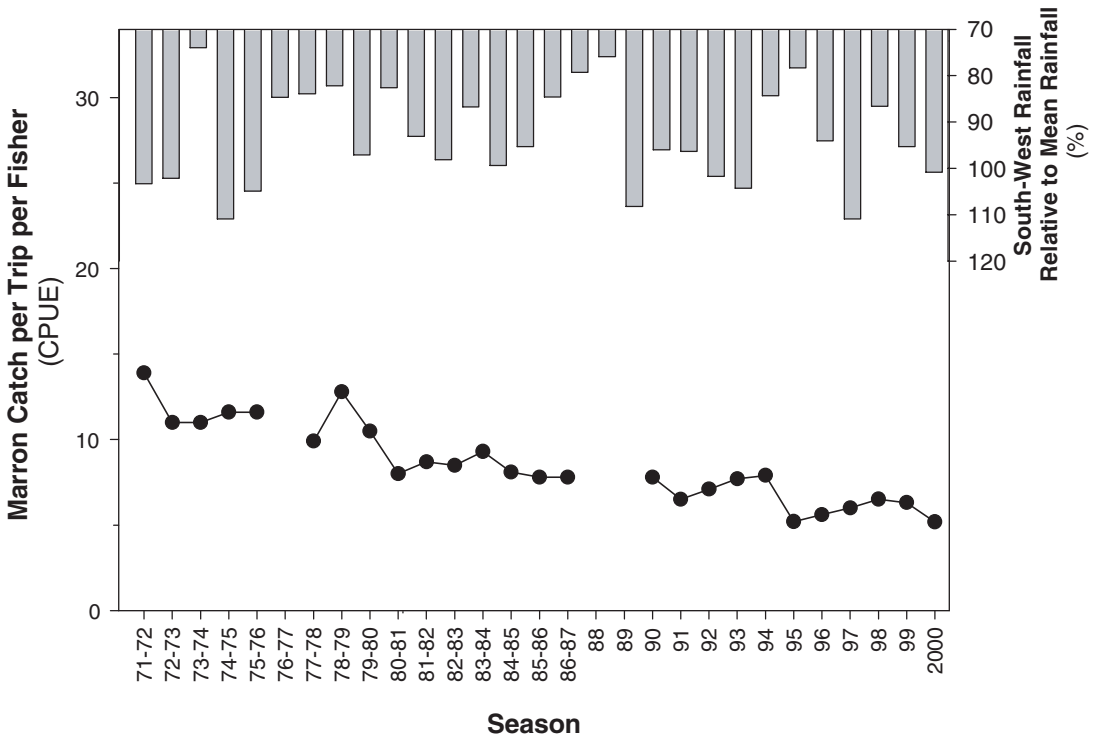


Figure 10. Estimated marron catches from rivers reported by logbook holders and relative rainfall. Note that there does not appear to be a clear relationship with rainfall and marron CPUE.

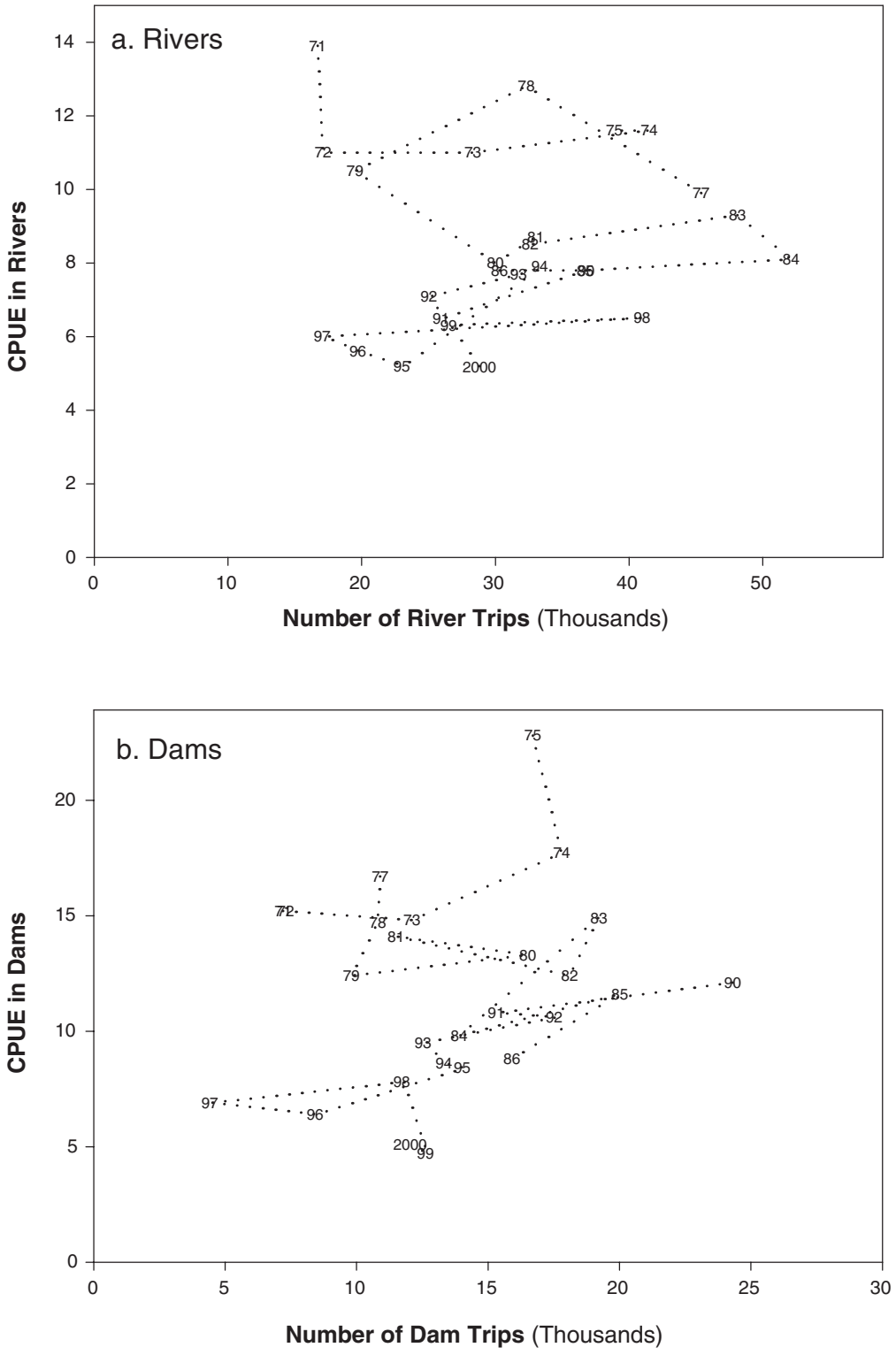


Figure 11. Trends in effort and CPUE throughtime for rivers and dams.
Since the 1990 marron season, the CPUE has remained approximately stable in rivers and dams, despite changes in the number of trips to rivers and dams (effort) and contrasting rainfall. The numbers in the figures refer to the last two digits of the year of the marron season.

9.0 Appendices

APPENDIX A. Ai-Aii
Copy of logbook displaying the detail of the data collected by the logbook holders.

APPENDIX B. Bi-Bvii
Long term OCL Distribution data from various waterbodies. This data represent the most detailed information available for individual waterbodies over the life of the monitoring program (approximately 30 years).

APPENDIX Ai. Page one of the logbook information requested.

Size information

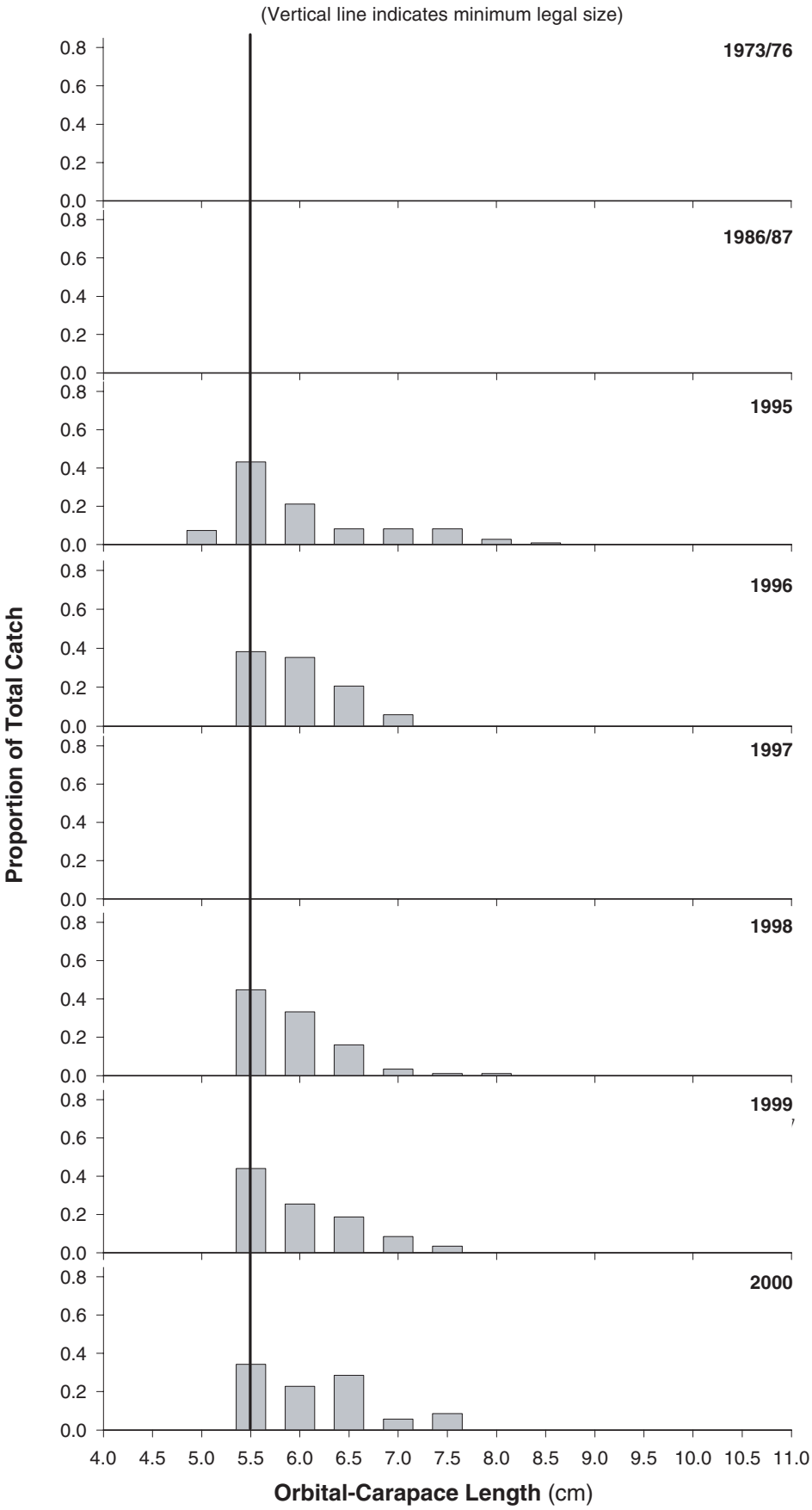
Date of trip	**Name** of stream, lake or dam	**Species** (M, G, K, Y)	**Carapace lengths (from gauge) of marron KEPT (Please use O for each female and X for each male)**									
			U	1	2	3	4	5	6	7	8	9	10

APPENDIX Aii. **Page two of the logbook data requested.**

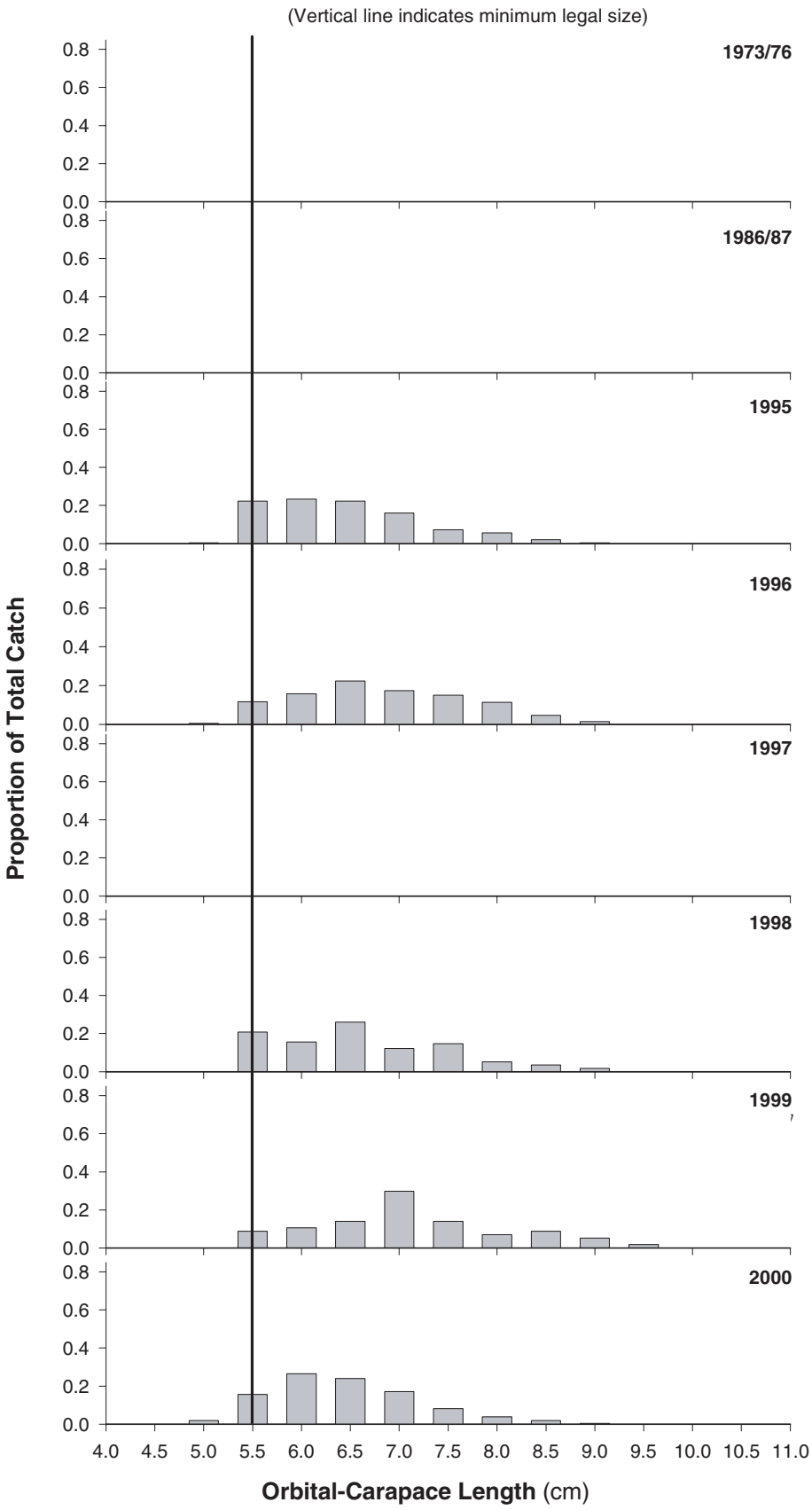
Catch and effort information

Date of trip	**Name** of stream, lake or dam	**Species** (M, G, K, Y)	**Time 1st drop net** or bait enters water	**Time 1st net pulled** or fishing started along baits	**Time last net/bait fished** or fishing stopped	**Length of bank** fished (metres)	**No. of marroners** who made the catch	**No. of under-sized** marron caught and returned to water	DROP NETS				SCOOP NETS				SNARES			
									No. of nets used	No. legal size		No. times line of nets pulled → 1 ← 2	No. of nets used	No. legal size		No. of passes along line of baits → 1 ← 2	No.	No. legal size		No. of passes along line of baits → 1 ← 2
										Kept	Put back			Kept	Put back		Snares / Baits	Kept	Put back	

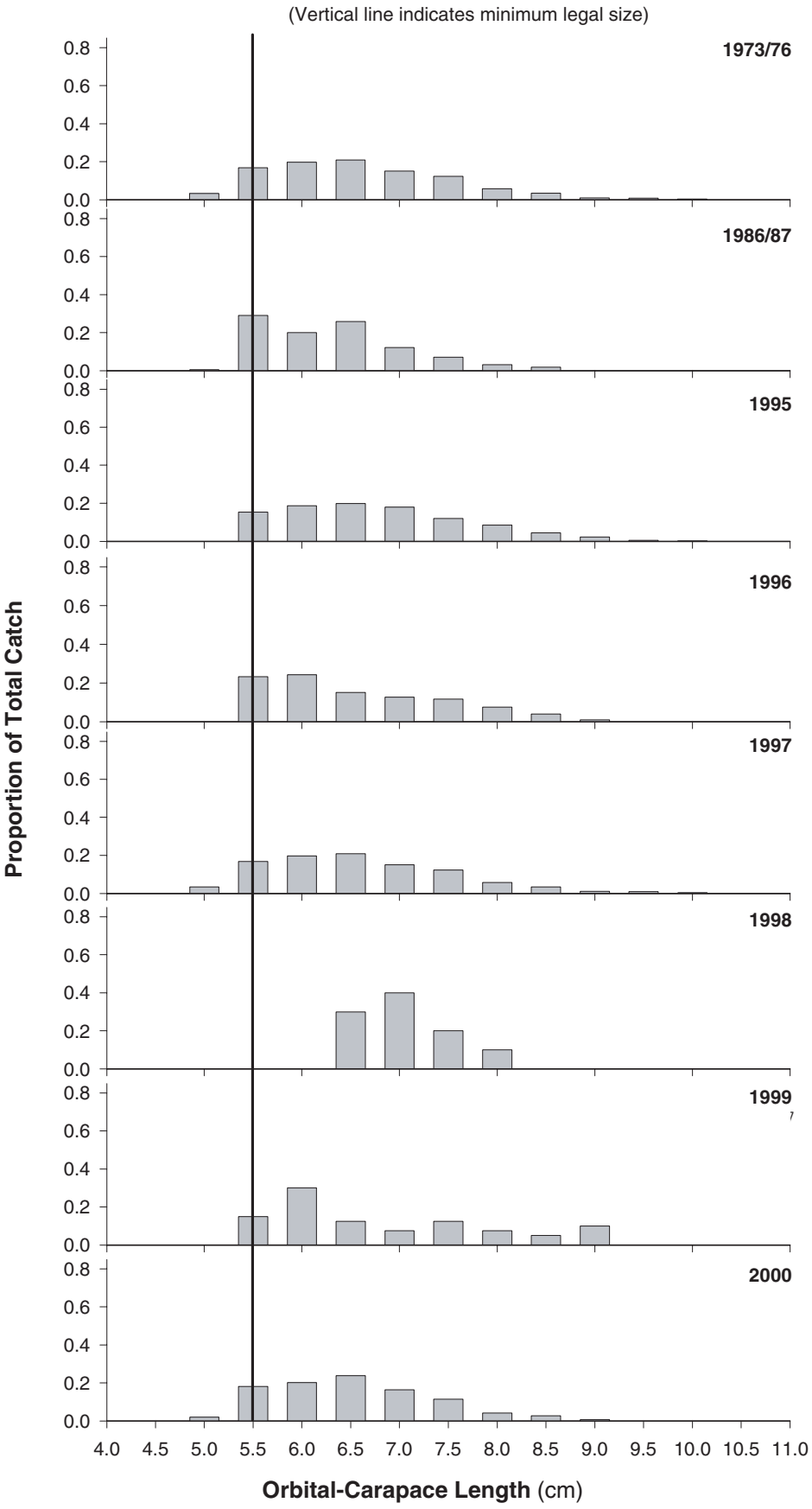
APPENDIX Bi. OCL Distribution for the Murray River, 1973-2000.



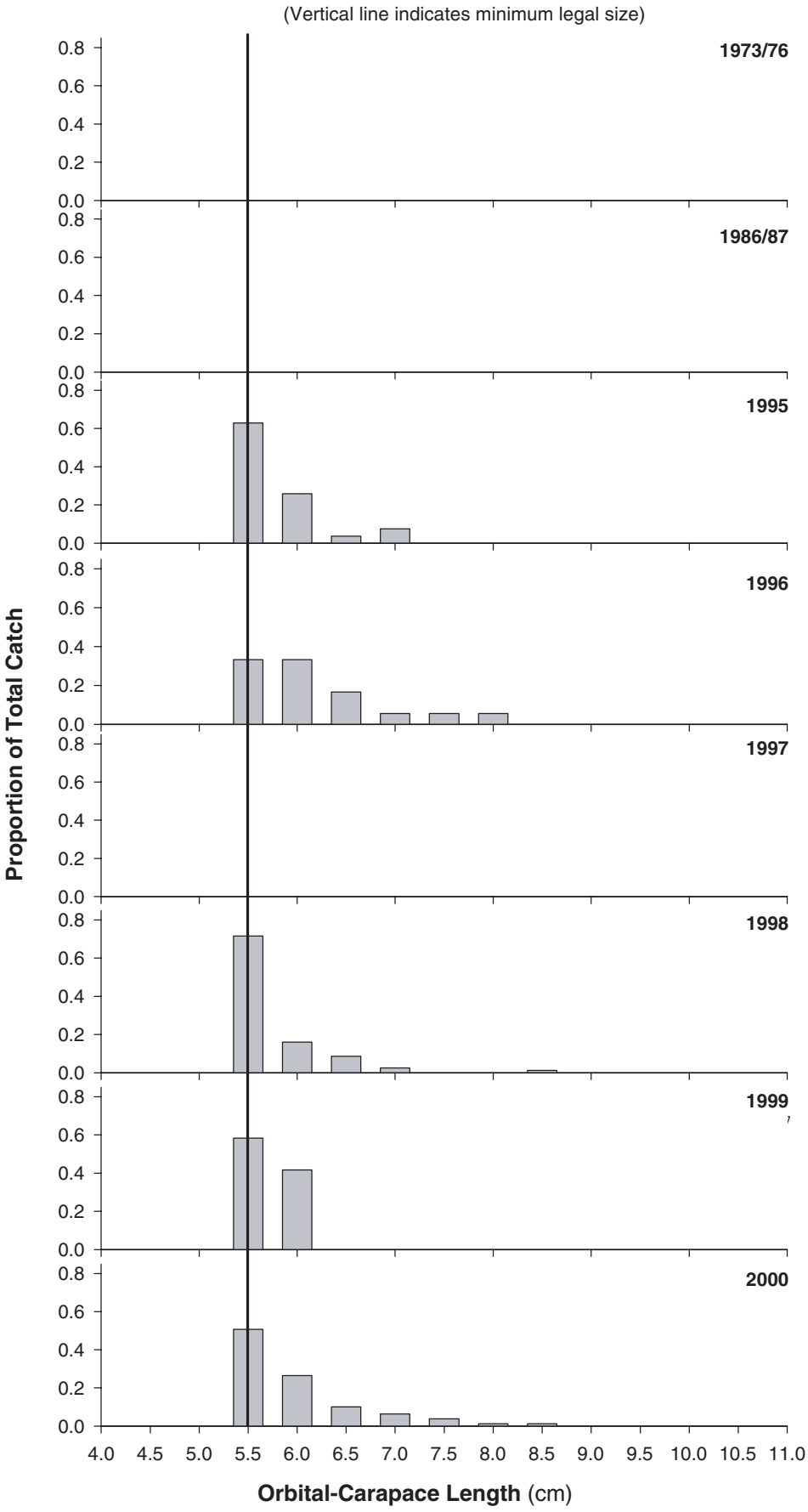
APPENDIX Bii. OCL Distribution for the Blackwood River, 1973-2000.



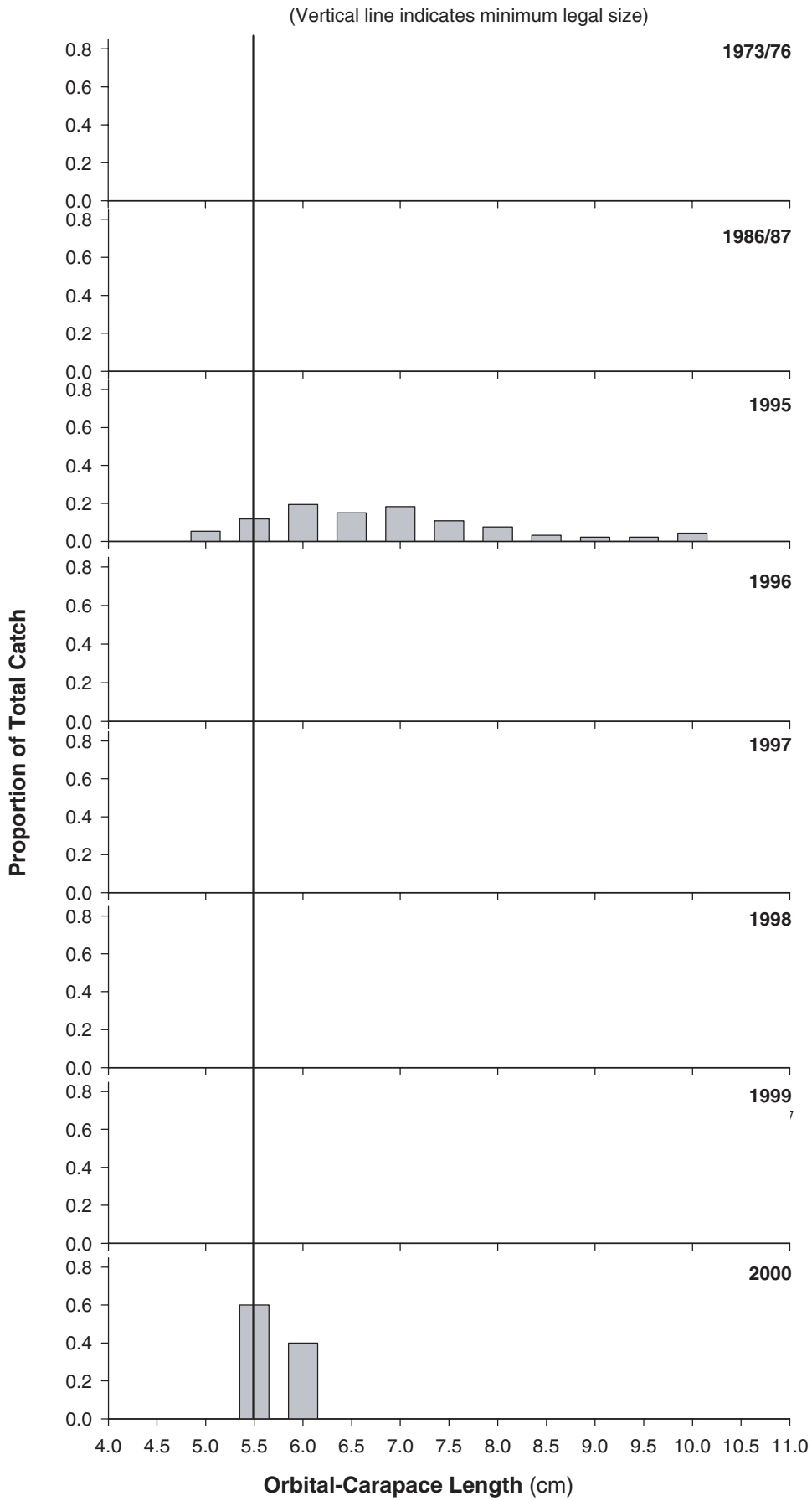
APPENDIX Biii. OCL Distribution for the Warren River, 1973-2000.



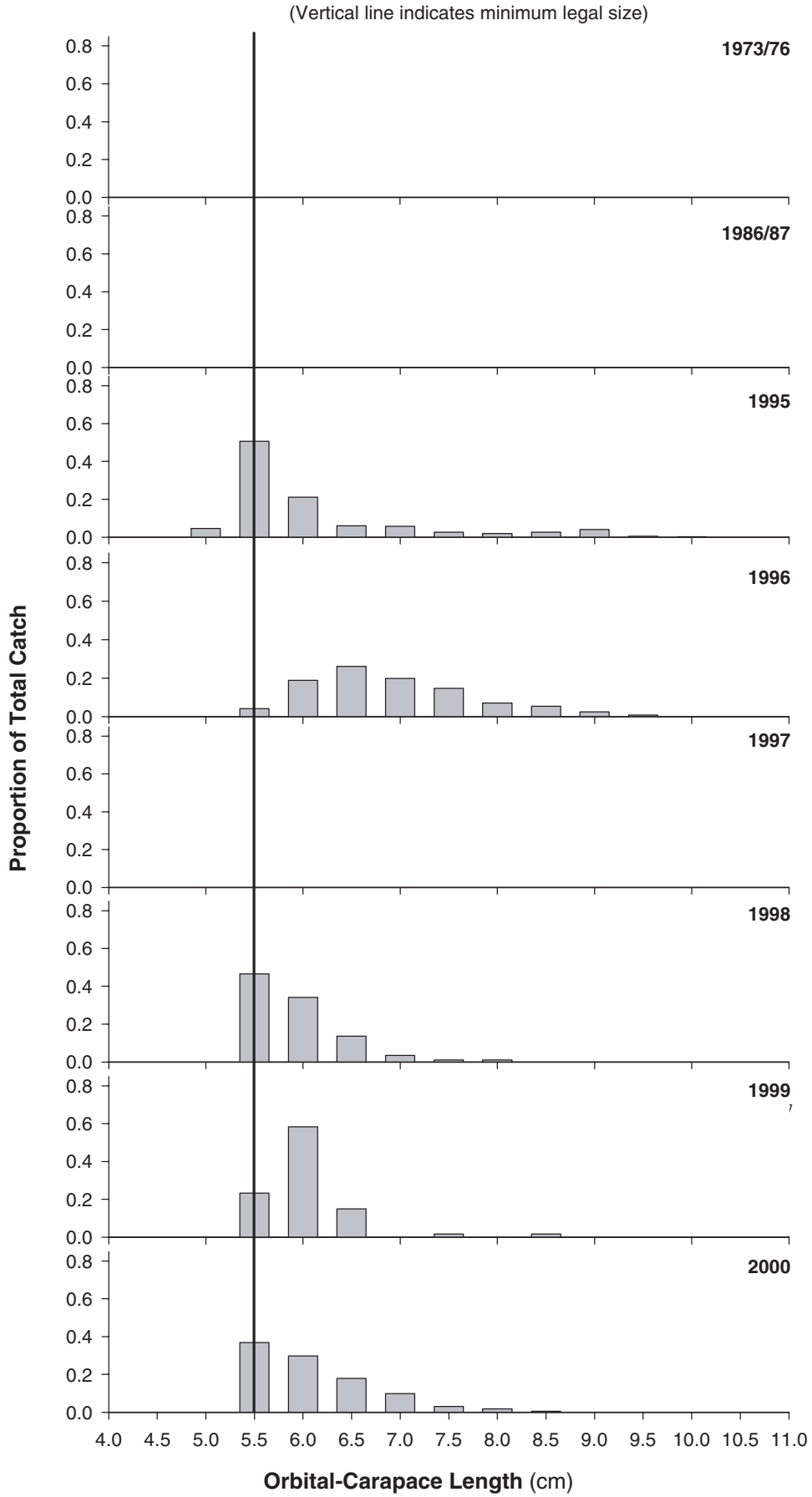
APPENDIX Biv. OCL Distribution for Waroona Dam, 1973-2000.



APPENDIX Bv. OCL Distribution for Harvey Weir, 1973-2000.



APPENDIX Bvi. OCL Distribution for Stirling Dam, 1973-2000.



APPENDIX Bvii. OCL Distribution for Wellington Dam, 1973-2000.