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Differences in Recreational Fishers' Motivations for Utilising Two Estuarine Fisheries

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Abstract: Effective fisheries management requires an understanding of human dimensions. This study elicited the salient motivations for recreational blue swimmer crab and black bream fishing in Western Australia and whether these views differed depending on the fishing location and/or the characteristics of the fisher. Crab fishers were strongly consumption-orientated and aimed to "catch big crabs" and "catch enough crabs to eat". Furthermore, 91% consumed their catch, with only 2% practicing catch-and-release fishing. In contrast, 81% of black bream fishers did so for the sport/challenge, with the strongest motivation being to catch a bream considerably above legal size and with food only selected by 15% of respondents; most fishers released caught fish. The marked differences between the fisheries for the two species, which co-occur in the same estuaries, are likely driven by the accessible nature of the crab fishery, ease of catching crabs, the low cost of fishing equipment, and their taste. Fishing for black bream, however, requires more expensive equipment, patience, and a greater skill level. Fishers considered crabbing to be as important as other fishing and outdoor activities, whereas bream fishers considered bream fishing considerably more important, reflecting the trophy nature of this fishery.

Keywords: *Acanthopagrus butcheri*; consumption-orientated; human dimensions; *Portunus armatus*; social dimensions; trophy

Key Contribution: Recreational fishers targeting two species in the same estuaries elicited different motivations for fishing for each species, but these were consistent among users of those fisheries and the locations where those species were caught.

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1. Introduction

Fisheries are complex social–ecological system, comprising three inter-related elements, (i) the natural system, which includes the ecosystem and the biophysical environment and the fish populations; (ii) the human system, which includes social, economic, and cultural environment as well as the fishing community and those that utilise the fish; and (iii) the fishery management system, which includes research, development, policies, and planning [1,2]. The interactions between the various components are further complicated in estuaries due to the dynamic nature of the physico-chemical environment, the range of deleterious anthropogenic perturbations they are subjected to, the complex lifecycles of many of their species, and their position as transitional systems and thus complex governance structures [3,4]. Sound management is therefore needed to ensure that the structure of the social–ecological system is maintained. However, this has not always been achieved, with Maitland [5] listing "fisheries management" as one of the top ten threats to conservation of fish in rivers and estuaries. Typically, management of these resources has focused on the biological and economic dimensions in an effort to ensure that stocks are sustainable, that

the environment is protected, and that the fishery is profitable [2,6], but there is increasing awareness of the need to understand the human dimensions of fisheries [7,8].

Recreational fishing is defined as that which does not constitute the individual's primary means of meeting basic nutritional needs and includes fish and invertebrates caught and not generally sold or otherwise traded on markets [9]. In industrialised countries, an estimated 10.5% of the population fishes recreationally (~118 million people), with that number rising to around 220 million worldwide [10]. In Australia, recreational fishing is an integral part of the culture and, as of 2003, involved an estimated 3.4 million people—16.8% of the population [11,12]. Participation in the state of Western Australia is greater than the national average at approximately 30% of the population [13]. This high participation, combined with the state's recent rapidly increasing population, has resulted in the estimated number of recreational fishers more than doubling from 315,000 in 1989/90 to 711,000 in 2014/15 [14].

There has been increasing recognition that recreational fishing has widespread appeal across the broad spectrum of society, with participants comprising a diversity of ages, genders, cultures, and socio-economic backgrounds [15–17]. This creates a challenge for management, as incorporating the human dimensions of recreational fishers into management may be confounded by the social complexity inherent in the fishing population [18,19]. Examples of this complexity may include multiple conflicting values, motivations, and priorities that can present significant challenges for managers seeking to identify a preferred policy, or course of action, that addresses both social and ecological fishery management imperatives.

Fisheries management decisions not only impact on the status of fish stocks but also the recreational experience of fishers [20]. The ways in which management measures influence recreational experiences can directly impact on the nature and level of public support for management [21]. This is particularly important for recreational fishers, as they act relatively autonomously, often with limited active management or surveillance, across large geographic areas compared to commercial fishers, who are often required to keep and submit logbooks and subjected to independent human or video observation [4]. As an example, approximately 4000 tonnes of fish are caught annually in South African estuaries, of which 60% is obtained illegally [22]. Management of recreational fisheries tends to rely heavily on encouraging voluntary compliance with regulations, which may be achieved through a number of mechanisms, including through targeted communication strategies [23,24]. Support for the management of a fishery is directly associated with fisher compliance and is central to its effective management.

In this study, we focus on two prized recreational species, the blue swimmer crab (*Portunus armatus*) and the black bream (*Acanthopagrus butcheri*), which are abundant and fished extensively throughout temperate Australian waters. Crabs spawn in the marine environment, and their small juveniles migrate into the lower reaches of estuaries, where they attain sexual maturity and reproduce [3,25]. Individuals reach 2–3 years old, a maximum size of 220 mm carapace width and can weigh up to 600 g [26]. In Western Australia, an estimated 900,000 blue swimmer crabs were caught by recreational boat fishers alone in 2013/14—670,000 in 2017/18—ranking 1st and 2nd in terms of number of catches among all species, respectively [14,27]. Fishers can be boat-based and/or shore-based and employ a range of methods, including baited traps, scoop nets, wire hooks, and their hands. Recreational blue swimmer crab catches are regulated via a minimum size limit of 127 carapace width (CW), which is substantially above the size at 50% maturity, and, at the time of the survey, a daily personal bag (10 crabs), a boat limit (up to 20 crabs depending on the number of licensed fishers), a ban on keeping berried females and a temporal closure over the peak spawning period [28]. For both blue swimmer crabs and black bream, recreational fisheries are only required to have a license if they fish from a boat.

The black bream is a long-lived sparid that grows to a maximum size of 530 mm TL and weight of up to 3.45 kg [29]. In contrast to the blue swimmer crab, black bream are

able to complete their life cycle in the estuary and typically reside in the upper riverine reaches, particularly around woody debris [30,31]. In a state-wide survey of recreational fishers, this species comprised 6% of the total finfish catch, the greatest proportion of any fish species found only in estuaries [14], and is the most commonly-retained fish species in the Swan–Canning Estuary [32]. Recreational fishing for this sparid is conducted using rod and line with both bait and lures from the shore, boats, and kayaks. The minimum total length for retention is 250 mm, with a bag limit of six fish per day [33]. The black bream is highly prized throughout southern Australia and is also the target species in several fishing tournaments.

Fisheries managers require information on the human dimensions of fisheries, with a survey of managers from the Great Lakes in North America stating they are particularly interested in the values, beliefs, attitudes, and behaviours of resource users and can utilise this information to evaluate the effectiveness of management goals [34]. Moreover, understanding the motivations of why people participate in recreational fishing and the characteristics of recreational fishers enables managers to consider the social complexities inherent in fisheries management [18,19]. Thus, this study aimed to elucidate the similarities and differences between the characteristics of recreational blue swimmer crab and black bream fishers in estuaries across south-western Australia and determine why they partake in fishing activities. The results will help determine the extent of any heterogeneity among recreational fishers targeting either species and aid in future management decision-making.

2. Materials and Methods

2.1. Study Area and Fisheries

2.1.1. Blue Swimmer Crab

Recreational blue swimmer crab fishing is centred around four systems located on the west coast of Western Australia, i.e., the temperate Swan–Canning, Peel–Harvey, and Leschenault estuaries—all located within 180 km of each other—and the sub-tropical marine embayment of Shark Bay, 900 km to the north (Figure 1). The Swan–Canning Estuary (55 km^2 in area) is located in the state capital city of Perth (Greater Perth population ~2.1 million) and is a hotspot for recreational fishers targeting a range of crustacean and fish species [35]. Due to its location in a major city, this estuary is highly urbanized and subjected to a range of anthropogenic impacts, including urbanisation and eutrophication [36,37].

The Peel–Harvey Estuary, which at 133 km^2 in area is the largest system in the region, is located ~80 km to the south of Perth and close to the city of Mandurah (population ~100,000). This estuary has a long history of crab fishing [38,39], and its commercial and recreational fisheries are certified by the Marine Stewardship Council as sustainable [40]. However, the recreational crab fishery has one of the highest levels of noncompliance in Western Australia, particularly for the retention of undersize crabs during night-time periods [41]. Leschenault Estuary, which covers an area of 25 km^2 [42], is situated in a more rural area of the state, with only the City of Bunbury (population ~71,000) nearby.

Shark Bay is a large marine embayment (23,000 km^2) in the Gascoyne Region. Its conservation status has been recognised by its declaration as a world heritage site and the inclusion of marine parks and conservation reserves. The area is a hotspot for recreational fishing with catches dominated by pink snapper (*Chrysophrys auratus*), blue swimmer crabs, and grass emperor (*Lethrinus laticaudis*) [43].

2.1.2. Black Bream

Recreational fishing for black bream occurs in the Swan–Canning and Peel–Harvey estuaries on the lower west coast [35,39] but also in a range of estuaries on the south coast of Western Australia (Figure 1), including the Blackwood River Estuary, the Walpole–Nornalup Estuary, and Wilson Inlet [29]. The Blackwood River Estuary (also known as Hardy Inlet) is located near the town of Augusta (population ~1300) on the southwest corner of Western Australia. The estuary covers an area of 13 km^2 and is permanently connected to the

Southern Ocean [44]. Both the town and estuary are popular tourist destinations and host annual black bream fishing tournaments [45].

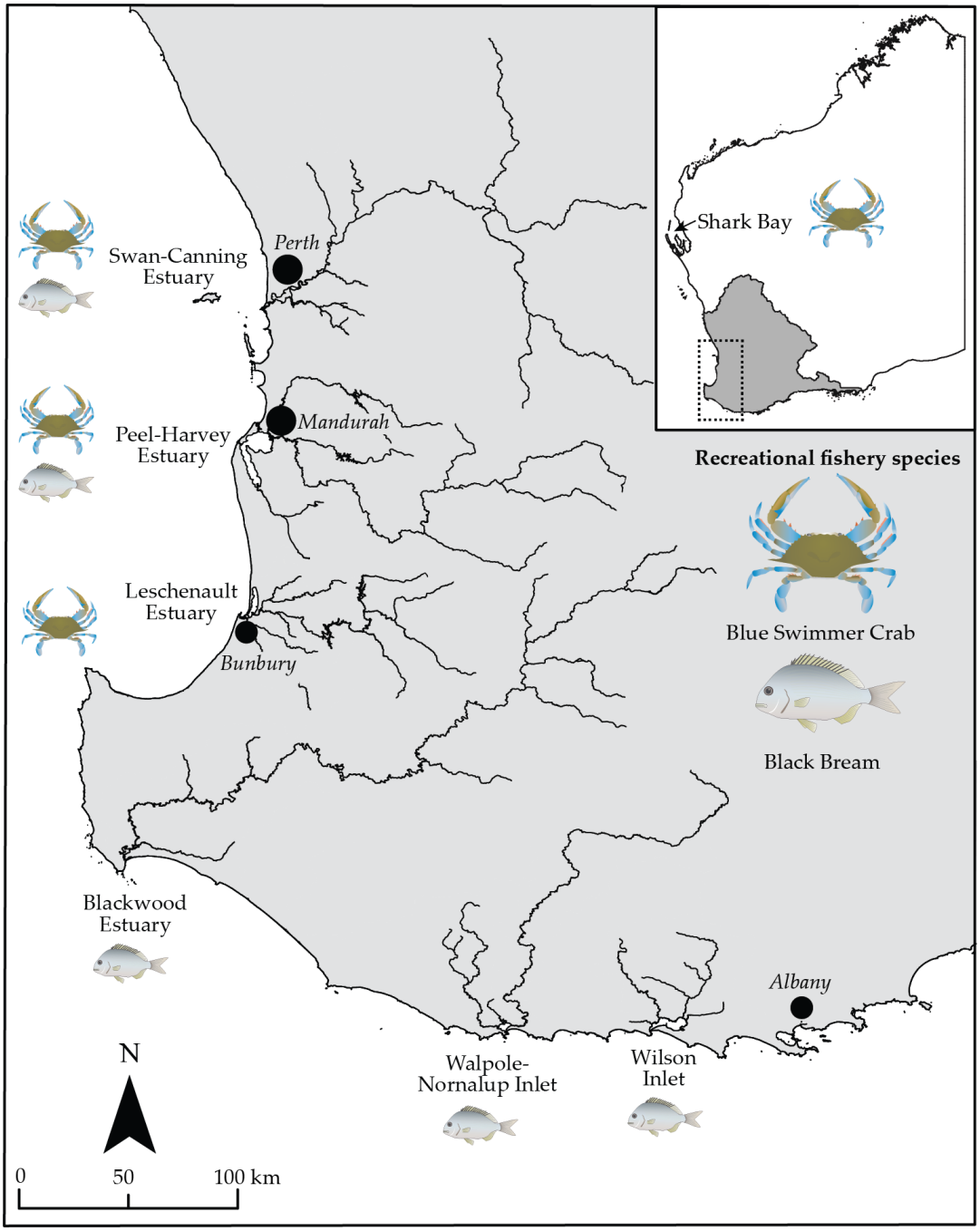

Figure 1. Map of south-western Australia showing the location of the main estuaries where blue swimmer crab and black bream fishing occurs. Inset shows the location of this area in Western Australia and also the location of Shark Bay. Black circles denote cities, the names of which are given in italics.

The Walpole–Nornalup Estuary, ~150 km to the east of Blackwood, is located near the small town of Walpole (population ~450). The system covers 14 km^2 and is unique among estuaries on the south coast of Western Australia, as its waters are listed as a Marine Park [46]. Wilson Inlet is located 60 km further east and adjacent to the town of Denmark (population ~5000). This 48 km^2 estuary is among the largest on the south coast, becomes closed off from the ocean for periods of the year, and suffers from eutrophication [47].

2.2. Social Surveys

The study used two sequential data collection methods, i.e., (Phase 1) face-to-face semi-structured interviews with recreational fishers and (Phase 2) an online questionnaire for recreational fishers. The semi-structured interviews consisted of a series of open-ended questions to gather qualitative data that informed a subsequent closed-question online survey, which generated quantitative data.

The semi-structured interviews (Phase 1) followed the belief elicitation procedures applied by [48]. The open-ended question format was designed to identify salient motivations for fishing in the fishers' own words. The elicitation approach minimised the imposition of researcher assumptions on the types of possible responses, thus providing a more rigorous and representative and less biased collection of fisher responses [49]. To ensure that the questions were clear and did not cause confusion, the survey was pre-tested with a small sample of fishers (n = 7). The pre-test responses were not included in the current study.

Face-to-face interviews were carried out at a range of estuaries used by recreational fishers in south-western Australia in 2017/18. For blue swimmer crab fishers, a total of 18 sites—i.e., jetties, boat ramps and shoreline areas—frequented by crab fishers were sampled in the Swan–Canning, Peel–Harvey, and Leschenault estuaries. Note that sampling was not conducted south of Leschenault Estuary, as this species is less abundant in these waters [41]. For black bream fishers, a total of 34 sites were sampled in the Swan–Canning and Peel–Harvey Blackwood estuaries and the Walpole–Nornalup and Wilson inlets. All surveys were conducted on weekdays and weekends during the main fishing times, i.e., from 06:00 to 10:00 and 12:00 to 16:00, and over the austral summer (December to February), when most fishing for these species occurs [27]. A total of 94 recreational blue swimmer crab fishers agreed to participate in an interview (Swan–Canning = 24; Peel–Harvey = 42; Leschenault = 28). Interviews were conducted with 137 black bream fishers (Swan–Canning = 29; Peel–Harvey = 28; Blackwood = 23; Walpole–Nornalup = 33; Wilson = 24).

The responses were written down by the interviewers using the respondents' own words. A theoretical saturation approach was adopted for belief elicitation. Interviews continued over successive weeks until no new response types were recorded in the sample from each estuary [50]. Theoretical saturation was mathematically confirmed by response accumulation curves [51], which were shown to all reach an asymptote. Additional interviews were conducted once saturation was achieved to ensure that no salient beliefs were overlooked.

Responses were transcribed to a spreadsheet and reviewed to develop categories of response representing salient beliefs. Three researchers independently conducted content analysis to group responses by similar meaning and then identify salient beliefs based on their frequency of occurrence. The most common responses from the semi-structured interviews were used to develop the closed questions and options for the online survey, i.e., questions with a definite answer or a list of choices, using an online survey tool Surveygizmo. Note that this study uses only those data obtained from the closed-question online surveys.

The purpose of the online questionnaires (Phase 2) was to measure the strength and evaluation of salient motivations for fishing for blue swimmer crab and black bream identified in the face-to-face interviews. It is important to reiterate that the closed-question response options were developed based on the salient ideas offered by the recreational fishers themselves (during Phase 1) rather than question response options being imposed on the fishers based on the assumptions of the researchers or managers [48].

The online questionnaire included a brief introduction pertaining to the purpose of the survey, followed by various questions with multiple choice answers. An initial question asking how frequently the fisher had been crabbing/fishing over the previous year was used to filter respondents. If the respondent had not fished within that one-year timeframe, they were automatically transferred to the final page of the questionnaire to complete some basic demographic questions and received a thank you message. Such a

decision was taken because a respondent's recall when answering questions about activities they have performed becomes less reliable as time passes [52,53]. A one-year time frame was considered an acceptable compromise between obtaining an adequate sample size of fishers and the reliability of responses provided. When completing the questionnaire, blue swimmer crab fishers answered the following questions: (i) "how often have you fished for blue swimmer crabs over the last 12 months", (ii) "how long (years) have you been fishing for blue swimmer crabs", (iii) "where do you fish for blue swimmer crabs (i.e., shore and/or on the water)", (iv) "how do you fish for blue swimmer crabs (i.e., drop nets, scoop nets etc)" and (v) "when compared to other blue swimmer crab fishers, what is your self-assessed level of fishing skill?". Where each level of expertise was assigned a numeric value on a scale. For fishing frequency, each category was standardised to number of times per year based on the lowest value in the option range selected, e.g., a fisher who fishes 1–2 days per week would be recorded as fishing 52 times per year. The method of fishing indicated by respondents was coded as follows, 1 = shore only; 2 = both boat and shore, but mainly shore; 3 = both boat and shore equally; 4 = both boat and shore, but mainly boat; and 5 = boat only.

A similar approach was taken for black bream fishers, albeit using slightly different questions to better suit aspects of this recreational fishery, i.e., (i) "how often have you fished for black bream over the last 12 months"; (ii) "how do you most often fish for black bream"; (iii)" If you had to replace the fishing gear you currently use to catch black bream (i.e., rod, reel, tackle and lures) with the same type of gear, about how much would it cost"; (iv) "how long (years) have you been fishing for black bream"; (v) "where do you usually fish from for black bream (i.e., shore, boat, kayak)"; (vi) "when compared to other black bream fishers, what is your self-assessed level of black bream fishing skill" and (vii) "in the last 3 years, have you participated in a black bream fishing competition?".

The salient fishing motivations identified using the semi-structured interviews were presented as a checkbox question, allowing respondents to select more than one option relating to why they fish. A second motivation question identified what made a fishing trip successful. The options incorporated various statements based on interview respondents, and each statement was presented as a rating scale from −3 (strongly disagree) to +3 (strongly agree). These were followed by a suite of questions that focused on what the fisher does with the catch that could be legally retained (i.e., individuals larger than the legal minimum size) and how often this occurs. The final questions sought to determine how important fishing is to the fisher by presenting a hypothetical situation in which fishing for their target species was no longer possible in the estuary in which they conducted most of their fishing activities, and a range of alternative options were presented for spending their time in this scenario.

The online surveys, one for each species, were designed using the online tool, Surveygizmo and promoted via a press release picked up by local print and broadcast media and advertised using flyers posted on survey sites and convenience stores, bait and tackle stores, and local cafes located on or close to the estuary. Flyers contained the survey URL and a QR code to improve the ease of access. Links were also posted on social media, in particular by Recfishwest (the peak body representing recreational fishers in Western Australia), and on various recreational fishing forums. The online survey for blue swimmer crab fishers was released during the peak period of the crabbing season (i.e., December 2017) and closed in February 2018. As fishers may target multiple species, to avoid survey fatigue, the online survey for black bream was released in May 2018 and closed in July of that year.

2.3. Quantitative Identification of Fisher Groups

The CLUSTER-SIMPROF routine in PRIMER v7 (PRIMER-e, Auckland, New Zealand) [54] was employed to objectively and quantitatively group together blue swimmer crab and black bream fishers that had similar fishing characteristics. Note that this was performed for a subset of all respondents—351 of the 571 blue swimmer crab fishers and for 104 of the

151 black bream fishers—as respondents were required to have answered all questions in the fishing characteristics part of the survey to be included in these analyses.

The numeric values for each of the fisher characteristics for each target species were examined separately using pairwise Draftsman plots and Pearson's correlations to visually assess the extent to which the distribution of values for each of fisher variables were skewed and thus the type of transformation required to ameliorate any such effect and determine whether any pair of variables were highly correlated. As these plots demonstrated that no transformations were required and that none of the variables were correlated ($r = -0.001$ to 0.412 and -0.001 to 0.604 for blue swimmer crab and black bream fishers, respectively), the "raw" data were normalised to place all variables on a common scale and used to construct two Euclidean distance matrices—one for each species.

To identify groups of fishers targeting each species who did not differ significantly in their fishing characteristics and thus represent distinct "fisher groups", each of the above Euclidean distance matrices was, in turn, subjected to hierarchical agglomerative clustering with group-average linking (CLUSTER) and an associated similarity profile (SIMPROF) test [55,56]. This SIMPROF test was performed at each node of the dendrogram to determine whether the group of fishers being subdivided contains significant internal structure ($p < 0.01$).

Each of the Euclidean distance matrices was used to construct a non-metric multidimensional scaling (nMDS) ordination plot to visually display the level of dissimilarity between individual respondents coded for fisher groups [57]. Plots of the means and 95% confidence intervals were constructed for each fisher characteristic to explain quantitatively the differences in fisher groups for each target species.

2.4. Statistical Analyses

In the questions about motivations (i.e., "why do you fish for blue swimmer crabs/black bream"?), what fishers do with their legally-obtained catch (i.e., "using the scale provided, please indicate what you usually do with the legal sized blue swimmer crabs/black bream that you catch"?), their catch rates (i.e., "in terms of numbers caught, when you go blue swimmer crab/black bream fishing, do you"), and the importance of fishing for their target species (e.g., "when compared to other types of fishing, please indicate how personally important the activity of blue swimmer crab/black bream fishing is to you"), respondents selected an answer from a drop-down menu. The resultant count data for each question for each target species were used to calculate the percentage of respondents that selected each option and used to construct a Bray–Curtis similarity matrix. This was then subjected to the CLUSTER-SIMPROF routine to determine if the views of respondents utilising the various fisheries and fisher groups differed from one another [54]. A similar approach was used for answers to the question "thinking about when you go fishing for blue swimmer crabs/black bream, in your opinion, what makes your fishing trip successful?". However, as this asked respondents to rate each option from -3 to +3 rather than tick a box, the data were subjected to the same CLUSTER-SIMPROF routine using a Euclidean distance rather than Bray–Curtis matrix.

3. Results

3.1. Demographics

Recreational blue swimmer crab fisher survey participants were predominantly male (83.9%) and ranged from 18 to over 65 years old, with a modal age group of 35 to 44 years old (27.2%) They had been fishing from <1 to >40 years, with most fishers (60.4%) having >10 years' experience and fewer having 11–20 years (20.0%), 21–39 years (25.6%), and >40 years (19.8%; Supplementary Materials Table S1). Recreational black bream fisher survey respondents were overwhelmingly male (93.4%) and were slightly younger than the blue swimmer crab fishers, with the most represented age groups being 25–34 (24.5%) and 35–44 years old (27.4)—only 2% were older than 65 years old (Supplementary Materials Table S2).

Bream fishers also had a wide range of experience, with the largest percentage (28%) having fished for between 11 and 20 years.

3.2. Fisher Groups

CLUSTER-SIMPROF assigned the 351 crab fishers into seven statistically different fisher groups based on their fishing characteristics (Supplementary Materials Figure S1). The distinctness of the various groups is illustrated by the MDS plots (Figure 2a). Fisher group *a*, located on the left-hand side, was the most distinct and widely separated from the others. Groups *b*, *c*, *d*, and *f* formed a large group of samples on the nMDS plot (centre to right-hand side) that was divided between the quarters with limited intermingling, while fishers in groups *e* and particularly *g* were more dispersed throughout this region of the plot (Figure 2a). The greater amount of variability in fishers in group *f* is shown by their broad spread considering the smaller number of fishers compared to other groups.

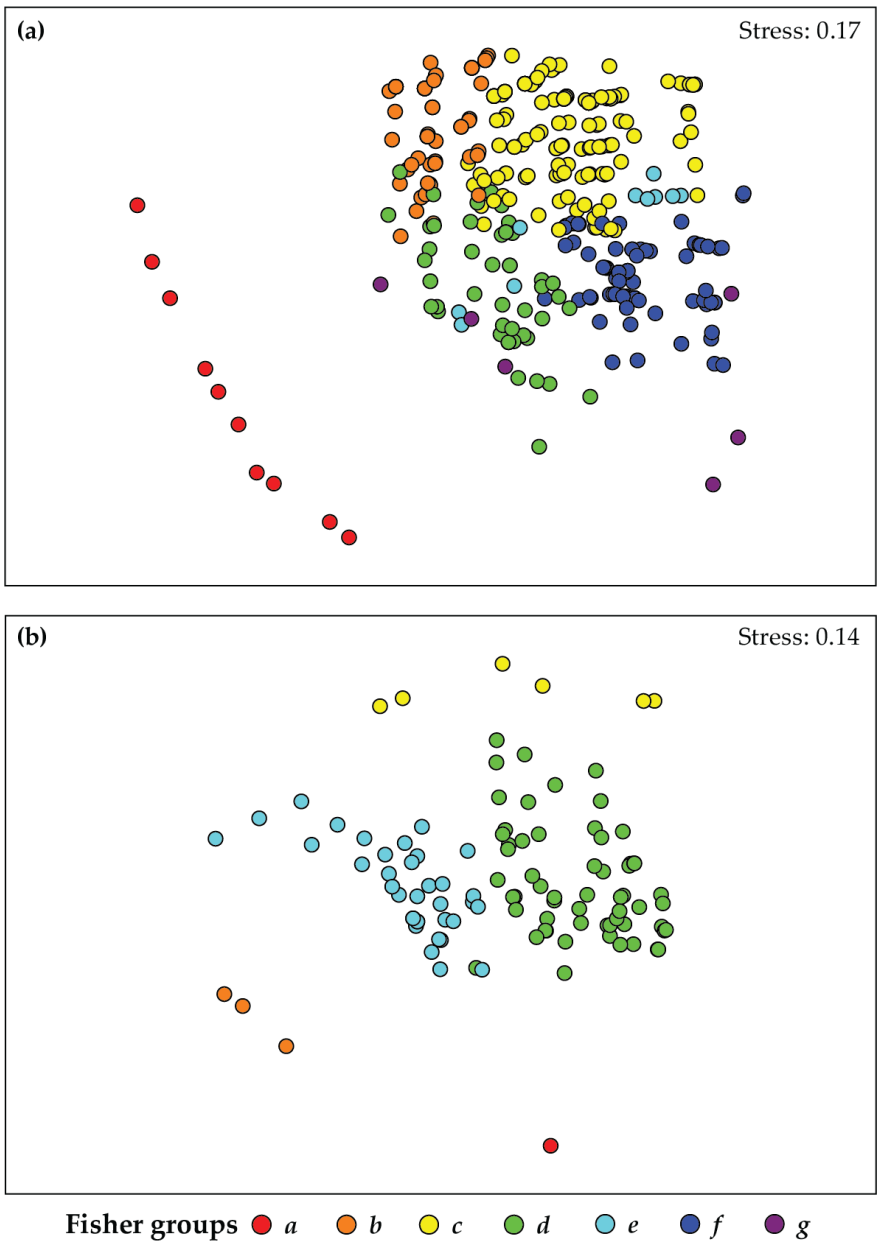

Figure 2. Non-metric multidimensional scaling ordination plots derived from the Euclidean distance matrix of the normalised data for the characteristics of (**a**) blue swimmer crab and (**b**) black bream fishers. Symbols colour coded for the various fisher groups (Supplementary Materials Figures S1 and S2).

Visual interpretation of the mean values of each fisher characteristics allowed the differentiating traits of the various blue swimmer crab fisher groups to be characterised and assigned a name (Table 1; Figure 3). Members of group *a* (frequent fishers) fished far more regularly compared to those in the other groups (i.e., 156 vs. 8–20 times per year) and comprised intermediate and expert fishers. Groups *b* and *c* both comprised boat-based fishers using drop nets who fished, on average, ~16 times per year (Figure 3a). Fishers in these two groups were distinguished based on their experience, with those in *b* having far more fishing experience than those in *c*, i.e., 40 vs. 12 years, respectively). Members in the remaining groups (i.e., *d*, *e*, *f*, and *g*) tended to fish from shore (although this was highly variable in the case of *g*). Those fishers in group *d* were more experienced than those in *e* and *f*, with average years of fishing experience of 24, 7, and 9, respectively (Figure 3c). Commensurate with this, members of *d* proclaimed a greater skill level, with most considering themselves expert. Group *e* and *f* fishers utilised different methods, with those in *e* exclusively utilising drop nets from a jetty (as shore-based fishers), while those in *f* used a range of methods. Finally, members of group *f* were unique in that they predominantly used their hands to catch crabs (Figure 3d).

Table 1. Description of the typical characteristics exhibited by members of each group of (a) blue swimmer crab and (b) black bream fishers identified by CLUSTER-SIMPROF (Supplementary Materials Figures S1 and S2).

Fisher Group	Name	Description	%
(a) blue swimmer crab			
a	Very frequent fishers	Fishers that fish >150 times per year and of intermediate/expert skill level	2.85
b	Experienced boat-based fishers	Fishers that have fished for >40 years, primarily from a boat using drop nets	16.24
c	Inexperienced boat-based fishers	Fishers that have fished for ~10 years, primarily from a boat using drop nets	40.74
d	Relatively experienced, expert shore-based fishers	Expert fishers that have fished for ~25 years, primarily from the shore using a range of methods	13.96
e	Inexperienced shore-based drop net fishers	Fishers that have fished for ~7 years, primarily from a shore using drop nets	2.85
f	Inexperienced, shore-based novice fishers	Novice fishers that have fished for <10 years, primarily from a shore using a range of methods	21.65
g	Bi-monthly, hand fishers	Fishers that fish every two months and catch their crabs by hand	1.71
(b) black bream			
a	Very frequent fishers	Fishers that fish >150 times per year and of intermediate skill level	0.96
b	Very frequent, expert lure fishers	Fishers that fish >150 times per year are of expert skill level, use expensive fishing gear and lures and fish in competitions	2.88
c	Experienced fishers	Fishers that have fished for ~40 years, primarily from a kayak/boat and of intermediate/expert skill, some of whom fish in competitions	5.77
d	Inexperienced intermediate skilled fishers	Intermediate skills fishers that have fished for <10 years, primarily from a kayak using relatively cheap gear and who do not enter competitions	56.73
e	Inexperienced but keen fishers	Intermediate/expert fishers that have fished for <10 years using expensive gear and who fish in competitions	33.65

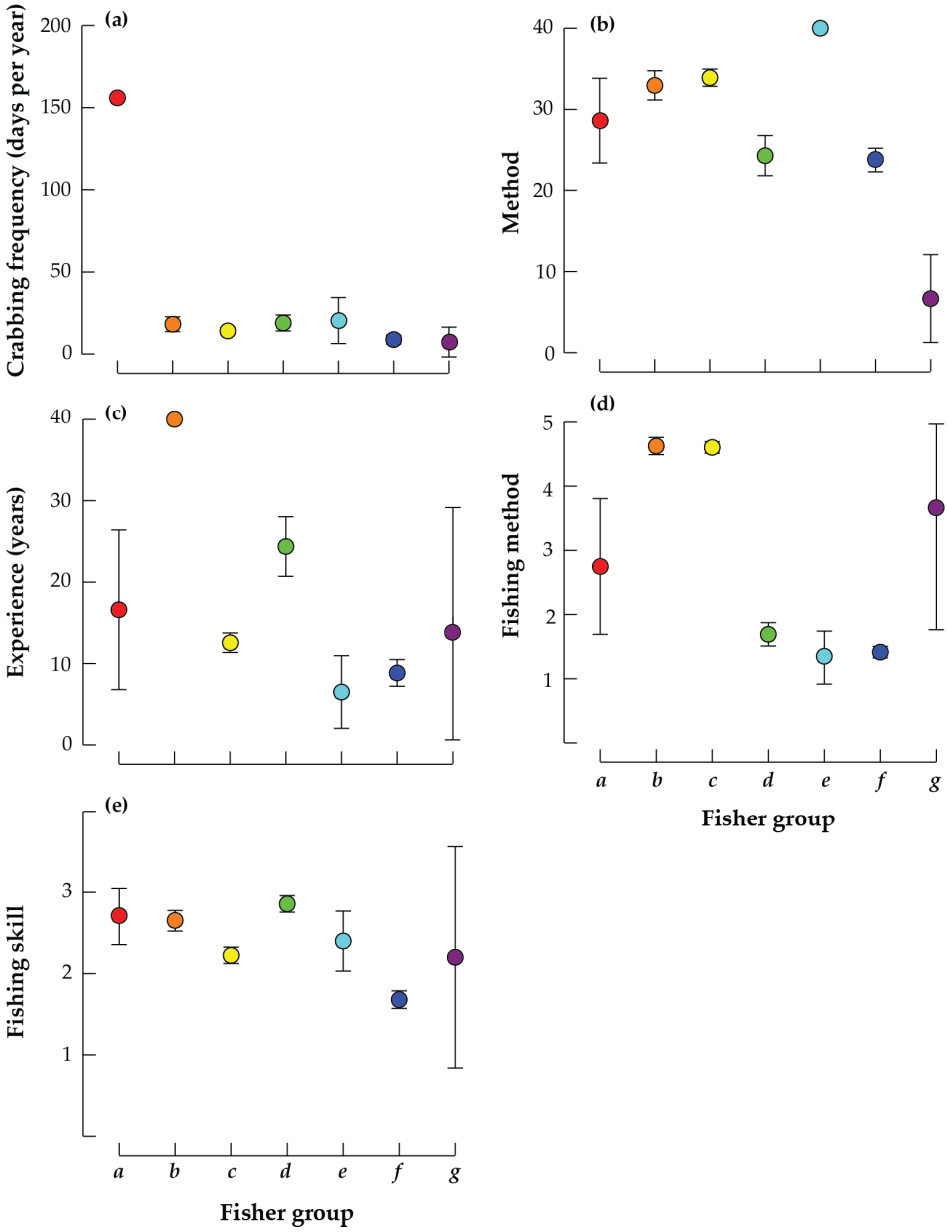

Figure 3. Mean and associated 95% confidence limits for each of the five characteristics, i.e., (**a**) crabbing frequency, (**b**) method, (**c**) experience, (**d**) fishing method and (**e**) fishing skill, used to create the blue swimmer crab fisher groups. Coloured circles represent fisher groups.

The 104 black bream fishers were quantitatively allocated to one of five groups (Supplementary Materials Figure S2), with the points representing fishers being widely separated on the nMDS plot (Figure 2b). Of the basis of their fisher characteristics, group *a* was the most distinct, with the single fisher in this group fishing far more frequently than those in all other groups except *b* (i.e., 150 vs. 18 to 36 times per year; Table 1; Figure 4a). Fishers in groups *a* and *b* were distinguished by the fact that those in *b* use far more expensive gear (rods and lures), are self-proclaimed experts, and fish competitively (Figure 4c,f,g). Group *c* fishers were the most experienced (average = 40 years) and mainly fished from kayaks and boats. The remaining fisher groups (*d* and *e*) comprised the majority of the fishers—i.e., 59 and 35, respectively—and contained fishers that were relatively inexperienced (average = 8 years). Those in group *d* were of intermediate skill level and did not fish in competitions, whereas those in *e* were experts, used more expensive gear, and partook in competitions (Figure 4).

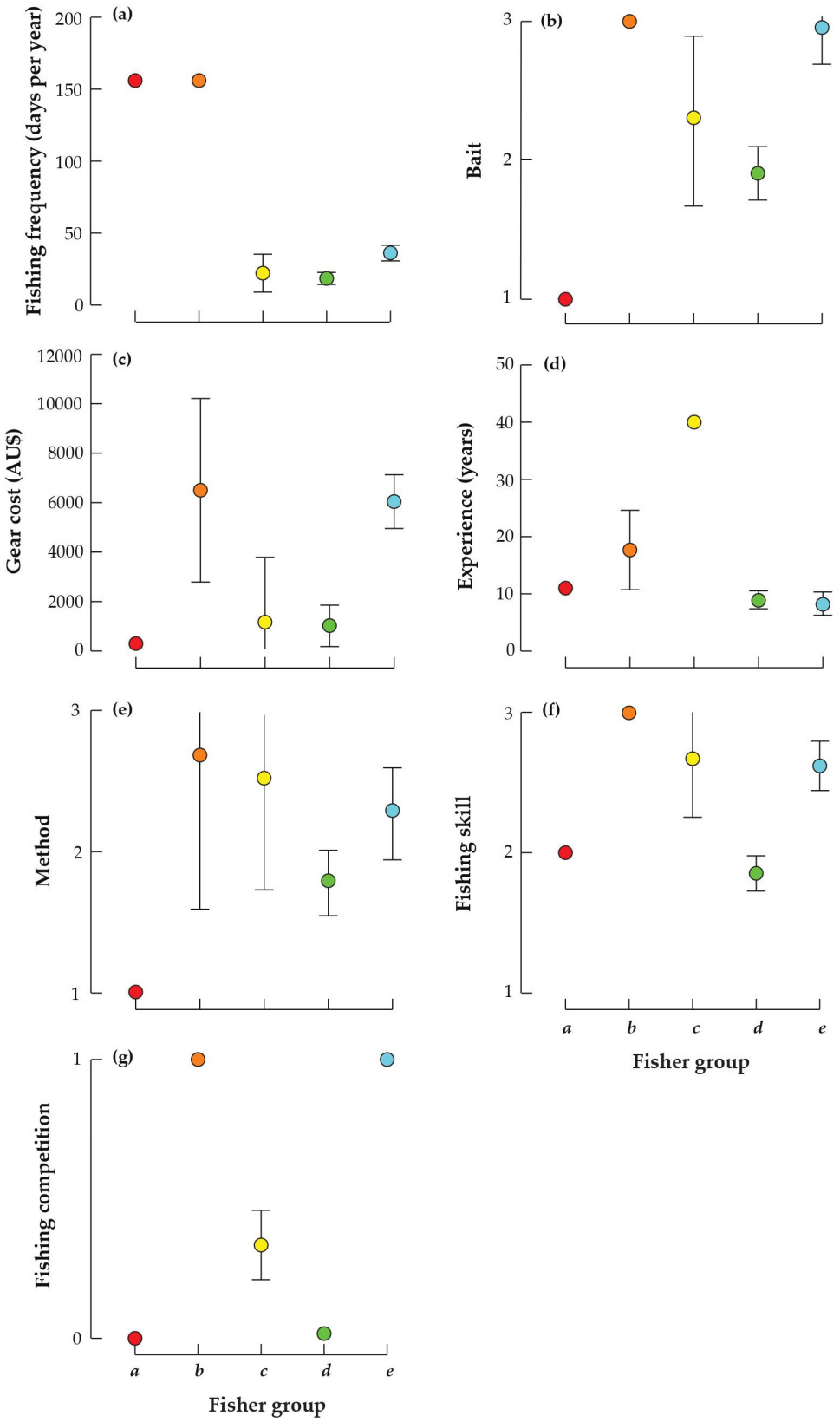

Figure 4. Mean and associated 95% confidence limits for each of the seven characteristics, i.e., (**a**) fishing frequency, (**b**) use of bait, (**c**) fishing gear cost, (**d**) experience, (**e**) method, (**f**) fishing skill and (**g**) competition participation, used to create the black bream fisher groups. Coloured circles represent fisher groups.

Separate linkage trees for blue swimmer crab and black bream, which represent the allocation of individual fishers into the fisher group identified by the CLUSTER and SIMPROF procedures, and the quantitative thresholds of the fisher characteristic(s) that best reflect the division at each branching node of the tree were generated (Supplementary Materials Figures S3 and S4). These trees thus provide a set of quantitative decision rules that enable any new respondent (i.e., someone that did not complete the original survey) to be assigned to a fisher group, noting that in some cases, these fishers may constitute a new group.

3.3. Motivations for Fishing

Based on the online survey, when asked "what is your main motivation to fish for blue swimmer crabs", 92% of all respondents selected "food", making this by far the most common response (Figure 5a; Supplementary Materials Table S3). The next-most-prevalent motivations were "enjoyment of catch", "enjoyment of outdoors" and "pleasure" (65–67%). "Spending time with family" and "spending time with friends" were the least-selected options although still chosen by 51 and 48% of fishers, respectively. These motivations were selected consistently by respondents across the four crab fisheries—i.e., those in the Peel–Harvey, Swan–Canning, and Leschenault estuaries and Shark Bay—with "food" being chosen by between 86 and 94% of respondents, as evidenced by each fishery occurring in the same CLUSTER-SIMPROF group (Supplementary Materials Table S3a). Non-catch-related motivations, such as "enjoyment of the outdoors", were selected less frequently by respondents in Leschenault and Shark Bay but not enough to result in a significant shift in motivations. The homogeneous motivations of recreational blue swimmer crab fishers utilizing different systems was not as pronounced across fisher groups. CLUSTER-SIMPROF detected three different clusters of fisher groups: (i) *a* and *e*; (ii) *b*, *c*, *d,* and *f;* and (iii) *g*. Fishers in groups *a* and *e* were strongly food-motivated (100% of respondents), with almost all other motivations only being selected by up to 50% of respondents. Fishers from the second cluster shared the views representing the overall population, while those in the third cluster (group *g*) were less food-motivated and instead enjoyed spending time with family.

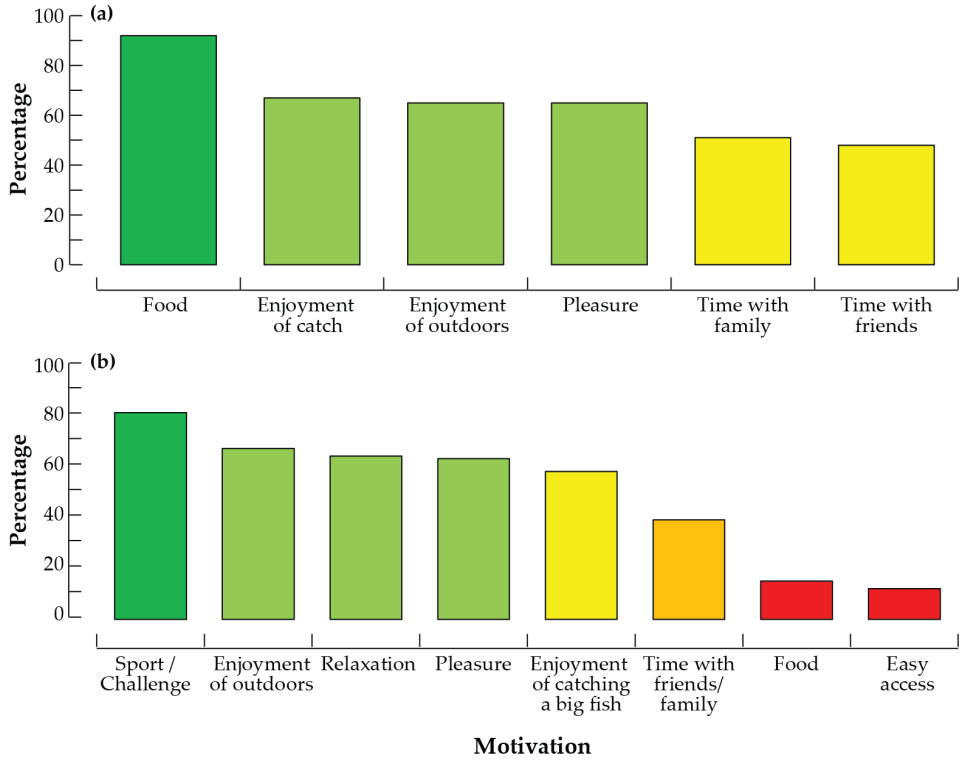

Figure 5. Percentage number of times a salient motivation for (**a**) blue swimmer crab (n = 481) and (**b**) black bream (n = 128) fishing was selected from the closed-question online survey.

When asked "what makes your fishing trip successful?", blue swimmer crab fishers ranked six perceived success metrics for the fishing trip from −3 to +3. Average values ranged from +1.89 to −0.57, with all being positive, i.e., agree, except "catching some crabs" (−0.57 i.e., slightly disagree (Figure 6a). The metrics that received the highest mean scores were "catching enough crabs to eat" and "catching big crabs" (both +1.89), followed by "being with friends/family" and "outdoors". Despite the apparent consumption-orientated nature of the crab fishery, "catching as many crabs as I am legally allowed to" was only rated as +0.43. As with the motivations, the views of the Blue Swimmer Crab fishers overall reflected those of users in each fishery (Supplementary Materials Table S4a). Differences were detected, however, among fisher groups, with those in Group *a* (very frequent fishers) being more food-motivated than those in groups *b*–*f*, while those in *g* (bi-monthly, hand fishers) rated spending time with friends/family and the outdoors as more important than catching crabs.

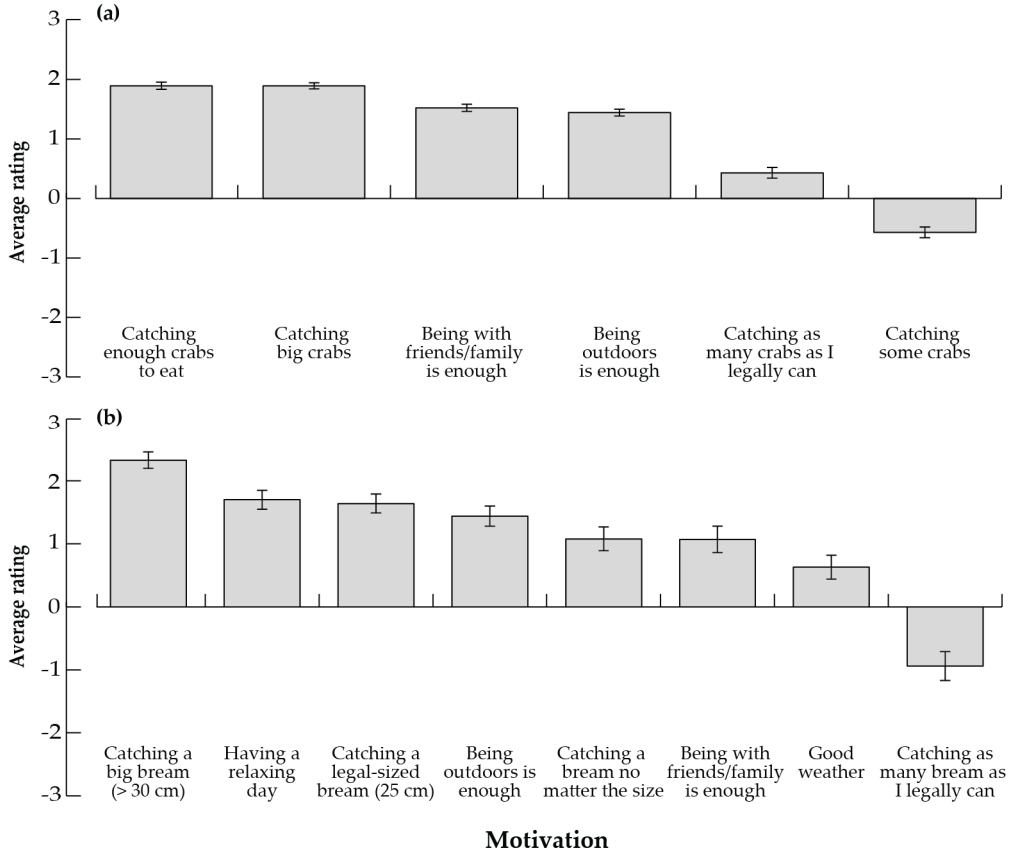

Figure 6. Average ratings (±1 standard error) from −3 to +3 for each salient motivation for (**a**) blue swimmer crab (n = 475) and (**b**) black bream (n = 128) fishing provided in the closed-question online survey.

In contrast to the primary consumption-orientated motivation for recreational crabbing, the majority of black bream fishers (81% overall) selected "sport/challenge" as their main motivation, with "food" only selected by 15% of fishers (Figure 5b; Supplementary Materials Table S3b). Other frequently selected motivations were "enjoyment of the outdoors", "pleasure", and "relaxation". These views were shared by fishers utilising the Blackwood, Peel–Harvey, Swan–Canning, and other estuaries and those in different fisher groups. "Catching a big bream" (i.e., >30 cm total length) was the highest-rated of the success metrics (+2.33), with "catching as many bream as I am legally allowed to" rated the lowest, at −0.94 (Figure 6b; Supplementary Materials Table S4b). Other highly rated motivations were "catching a legal sized bream (25 cm)" and "having a relaxing day". In keeping with the motivation for sport/challenge, "catching a bream no matter the size" scored far lower, at +1.08, than "catching a big bream".

The consumption-orientated nature of the crab fishery was evident from responses to the question "What you usually do with the legal sized blue swimmer crabs that you catch?". Overall, 91% of fishers ate their catch (Figure 7a), with this trend occurring in all fisheries (92–100%) and across all fisher groups, albeit being a slightly smaller percentage for those in groups *a* and *g* (Supplementary Materials Table S5a). Only ~2% of fishers practiced catch-and-release fishing for crabs (i.e., always releasing their catch) and ~31% of fishers always retained legal-sized crabs. Crabs were not always consumed by the fisher(s), with 75% of respondents sometimes giving their crabs to others. Black bream fishers rarely always ate their catches, i.e., 9% overall (Figure 7a). Instead, 64% overall never ate a fish they caught, with this value varying across fisheries, being lower in the Blackwood (45%) and "other" estuaries (54) and greater in the Swan–Canning and Peel–Harvey estuaries (69 and 83%, respectively; Supplementary Materials Table S5b). Most recreational black bream fishers (76%) practiced catch-and-release fishing, and if they did retain a fish, it was rarely given away, with 85% of fishers never having done this (Figure 7a). Fishers in Group *e* (expert fishers with expensive gear who fish in competitions) were more likely to practice catch-and-release fishing (and not consume their catch) than those in the other fisher groups (Supplementary Materials Table S5b).

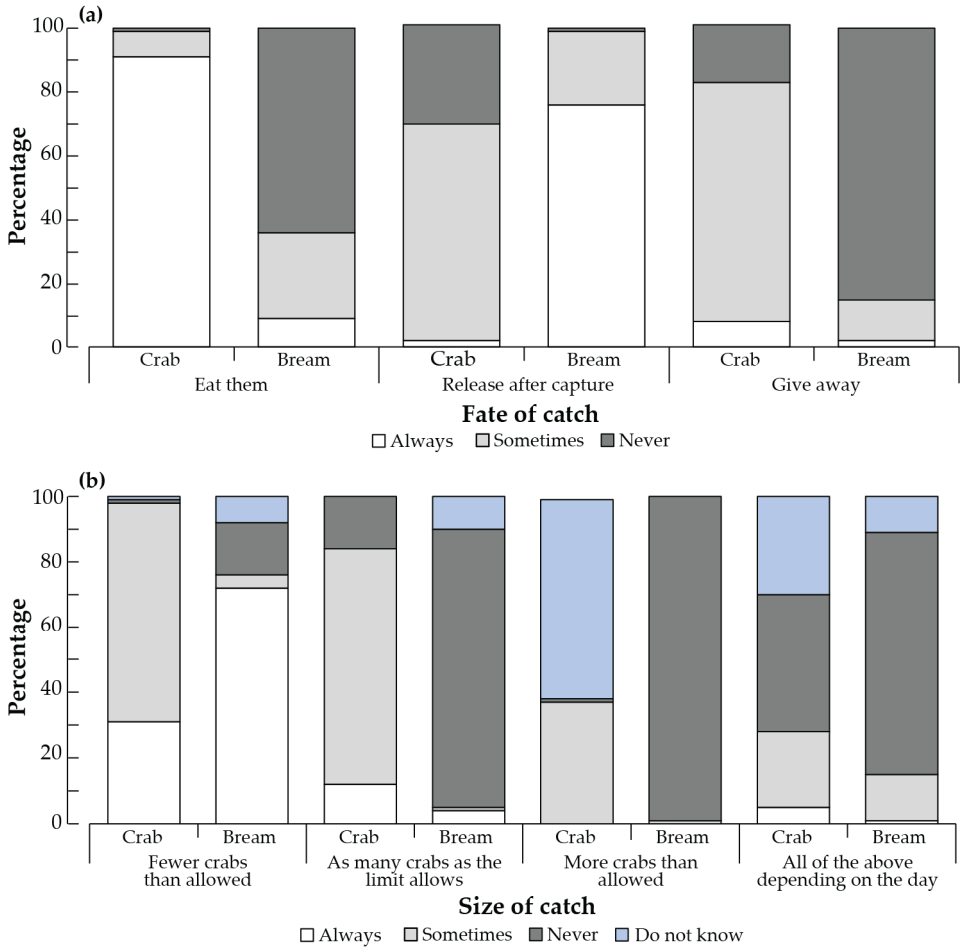

Figure 7. Percentage number of times blue swimmer crab (n = 360) and black bream (n = 107) fishers (**a**) eat, release, and give away legal-sized individuals that they catch and (**b**) catch fewer individuals than allowed (i.e., the bag limit), the number allowed, more than allowed, and multiple options.

When asked about how many individuals of their target species blue swimmer crab and black bream fishers catch, there were marked differences between fishers (Figure 7b; Supplementary Materials Table S6). The vast majority of black bream fishers (99%) "never" caught more fish than allowed (between two and six, depending on the estuary), with this

trend occurring in all fisheries (98–100%). Moreover, 85% of fishers overall, and 82–100% across fisheries, "never" caught as many fish as allowed, with 73% saying they "always" caught fewer fish than allowed. In contrast, 37% of blue swimmer crab fishers admitted to "sometimes" taking more than the bag limit of crabs (note that the bag limit was 10 crabs in all fisheries at the time that this survey was conducted; Figure 7b). Interestingly only 1% of fishers selected that they "never" exceeded the bag limit, with the majority (61% overall and 53–75 in the various fisheries claimed they "don't know" if they had exceeded it (Supplementary Materials Table S6). A small minority (12%) of fishers claimed they "always" obtained the bag limit of blue swimmer crabs, with most (72%) saying they achieved this "sometimes". Generally, the trends for the fishers overall were also reflected across fisher groups (Supplementary Materials Table S6).

3.4. Comparisons to Other Types of Fishing and Outdoor Activities

When asked "Compared to other types of fishing, how important is crabbing to you?", 46% of respondents indicated that fishing for blue swimmer crabs was more important (i.e., "more" and "much more" options combined), with 50% stating it was similar to other types of fishing and only 4% saying it was less so (Figure 8a). These views were fairly consistent across fisheries and fisher groups (Supplementary Materials Table S7a), except for the Leschenault estuary and fishers in group *a*, where a greater proportion of respondents selected "much more important" than "more important". Similar responses were received from fishers when asked to compare crabbing to other types of outdoor recreation; 47% said it was more important, 44% the same, and 10% less so. Crabbing was relatively more important for fishers from the Leschenault estuary and in group *e* (inexperienced, shore-based, and drop net fishers) and less so for those in group *g* (bimonthly, hand fishers, Supplementary Materials Table S7a).

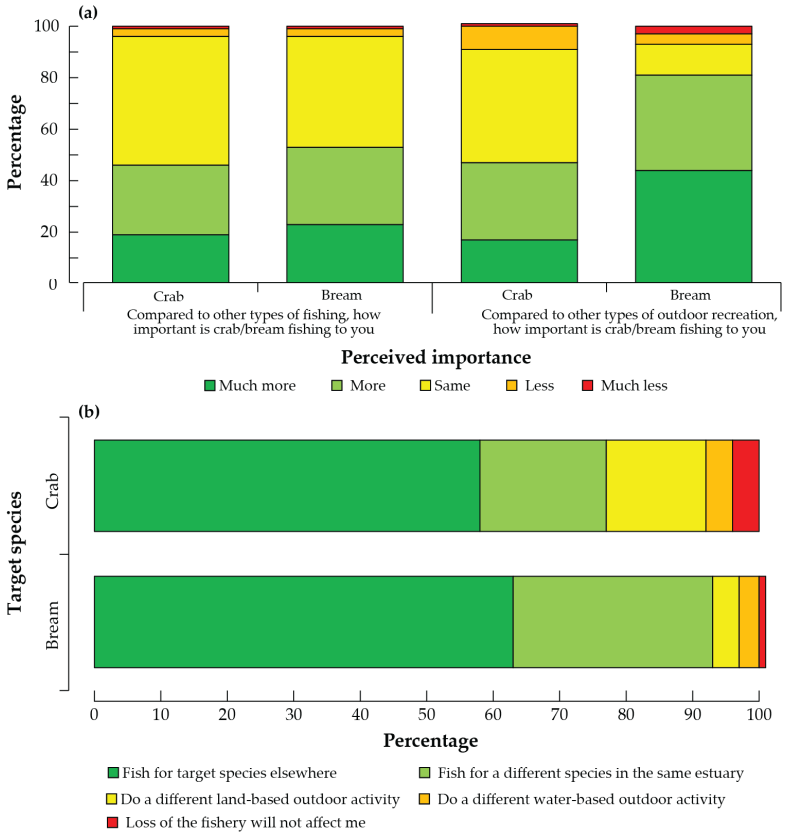

Figure 8. The (**a**) perceived importance of blue swimmer crab (n = 358) and black bream (n = 103) fishing to fishers that target those species and (**b**) percentage of fishers that would undertake different substitute activities if their target species could no longer be fished in the estuary they fish most regularly in.

In response to a hypothetical scenario in which blue swimmer crab fishing was not able to be conducted at a given location where respondents fished, the majority of respondents (58% overall and 42–70% across fisheries and fisher groups) indicated that they would switch location to continue to catch crabs, as opposed to only 19% who said they would target a different species (Figure 8b). The importance of crabbing was further emphasised by only 4% of respondents selecting the option "loss of the fishery would not affect me". While these views were consistent across fisheries and fisher groups, fishers in group *g* (the bi-monthly hand fishers) provided a slightly different range of responses (Supplementary Materials Table S7a). The group *g* fisher respondents were more likely to "do a different water-based outdoor activity", (i.e., not fishing) in response to the scenario.

Overall, 43% of black bream fishers considered bream fishing to be more important than other types of fishing, with only 4% disagreeing (Figure 8b). This view was common across all fisheries except the Blackwood, where fewer people considered it as more important (Supplementary Materials Table S7a). Respondents in fisher groups *c* and *d* (experienced fishers with intermediate to expert skill and inexperienced fishers with intermediate skill) rated bream as more important than other outdoor recreational activities, which was similar to the overall bream fishers' sample response. In contrast, a higher percentage of fishers in groups *b* and *e* (very frequent, expert lure fishers and inexperienced but keen fishers) felt it was "much more important" than other outdoor recreational activities. These scores were similar to those from the blue swimmer crab fishers. However, while ~50% of fishers considered crabbing to be more important than other types of outdoor recreational activities, this value was higher for black bream fishers at 81% (Figure 8b). Almost two thirds (63%) of black bream fisher respondents would target black bream in another system if their local fishery was unavailable, with 30% switching to another species (Figure 8b). Fishing is clearly their preferred type of recreation, as very few selected non-fishing land- or water-based activities, and only 1% indicated that the "loss of the fishery would not affect me".

4. Discussion

Recreational fishing has widespread appeal across the broad spectrum of society with participants comprising a diversity of ages, genders, cultures, and socio-economic backgrounds [15–17]. This diversity makes incorporating human dimensions into the management of recreational fisheries, which are already complex social-ecological systems, difficult [18,19]. For example, Arlinghaus et al. [58] stated that "An old adage of human dimension studies on recreational fisheries is that the average angler only exists in research reports". Research from the USA and Germany has demonstrated that recreational fishers in a given area can be divided into subpopulations, with fishers in these groups expressing different beliefs, attitudes and preferences regarding fisheries access and management [59,60]. While some work has been conducted in Australia, studies have typically occurred at a fairly broad level. For example, Young, Foale, and Bellwood [12] compared the motivations of recreational fishers in Australia to those of subsistence fishers in the Solomon Islands. Although the average angler may not exist [58], understanding the key characteristics of fishers can help inform effective management [18,19]. Thus, this study aimed to elucidate the similarities and differences between the characteristics of recreational blue swimmer crab and black bream fishers in estuaries across south-western Australia and determine why they partake in fishing activities. The results will help determine the level of heterogeneity among recreational fishers utilising each of the two iconic fisheries and aid in future management decision making.

4.1. Identification of Recreational Fisher Groups

Methodologies to characterise fishers were first derived in the 1970s and typically entailed using variable-based approaches centred around a specialization [17,59]. One of the most well-used examples of this approach was that developed by Salz et al. [61]. This index utilized theory and an a priori method to generate the index items. Items were derived

from the four characteristics (i.e., orientation, experiences, relationships, and commitment) used by [62] to place participants in a particular subworld [63]. A closed question for each characteristic was written, with responses belonging to the various specialization levels (least, moderately, very, and highly), and included in a short survey. In these variable-based approaches the focus is on the relationships among variables (e.g., avidity, experience, specialization), however, an alternative approach is to focus on the relationships between individuals; this is termed person-focused [64]. Thus, although variable-based approaches have provided useful insights into the nature of fisher motivations, person-focused approaches are more suited to examining the extent of heterogeneity present in a population of recreational fishers and group individuals into categories [17,64].

Studies using a person-centred approach to grouping recreational fishers have typically employed various types of cluster analysis, e.g., [65,66], or latent class analysis, e.g., [17,67]. Many of the cluster-analysis-based approaches do not, however, demonstrate statistically that the resultant groups represent distinct fisher groups or whether any groups contain more than one type of fisher (i.e., explore heterogeneity within groups). The approach used in this study, i.e., the use of a SIMPROF test in conjunction with CLUSTER, provides an entirely quantitative and thus objective methodology for assigning fishers to groups. This methodology has traditionally been used in ecological studies to group habitat types and faunal communities together and to construct food webs [56,68,69] but has also been used to understand stakeholder perceptions of marine species diversity [70].

Given the well-recognised diversity of recreational fishers and their views (see above), it is possible that a survey may not capture the entirety of this diversity. The use of LINKTREE, however, provides quantitatively defined thresholds at each node of the linkage tree that were most important for separating fishers into their respective groups. This also provides a set of simple, numeric decision rules for assigning any new recreational fisher to an existing fisher group, or—if their characteristics are different—a new group of fishers [68]. This is useful for social surveys as, providing the questions and answers remain the same, the survey can be repeated in different areas (fisheries or regions of the world) or repeated temporally—for example, as part of a regular state-wide recreational fishing surveys that operate in several Australian states—and the results aggregated rather than having multiple iterations of the fisher groups.

4.2. Motivation for Fishing Recreationally

4.2.1. Blue Swimmer Crab

Six salient motivations were identified by recreational blue swimmer crab fishers. These were activity-specific, catch-related and consumption-orientated (i.e., "food" and "enjoyment of catch") and also included, general, non-catch-related motivations, namely "enjoyment of outdoors", "pleasure", "spending time with family and friends". The range of motivations identified is similar to those in a study of German anglers [60] and a meta-analysis of seventeen surveys of freshwater and saltwater fishers in the USA [71]. While the multiple motivations may reflect a heterogenous experience, our results demonstrate that the main motivation for fishing was to obtain food. This option was selected by 92% of all fishers compared to 67 to 48% for the others. Moreover, this motivation was strongly held by and common across fishers utilising each of the four blue swimmer crab fisheries (86–93%) and across six of the seven fisher groups (90–100%).

The consumption-orientated nature of these fishers was further reinforced by their answers to the question "what makes a fishing trip successful?". Across all respondents and those utilising particular fisheries and in fisher groups, the motivations with by far the highest ratings were "catching enough crabs to eat" and "catching big crabs". Interestingly, "catching some crabs" received a negative rating and may suggest that there is a threshold number of crabs a fisher needs to obtain before a trip can be deemed a success. Reaching the bag limit of crabs was rated as only slightly positive but had amongst the highest variability among motivations, perhaps indicating that reaching this target was important for a subset

of respondents but not for all. Non-catch motivations were all rated as positive but with lower ratings than some of the catch-related ones.

The strength and consistency of catch-related motivations for blue swimmer crab fishers is likely due to a history of exploiting crab resources in Western Australia, their palatability, and their catchability. Firstly, recreational crabbing has been documented in newspapers as occurring in the region at least since European settlement in 1829, and since the 1900s, crabbing parties have been organised where crabs were caught and cooked on estuary shorelines [72]. There is even an annual Crab Festival held in Mandurah (Peel–Harvey estuary) which attracts ~100,000 people and where large quantities of blue swimmer crabs are consumed. These popular family activities are often fondly remembered and passed on from generation to generation, as occurred for the recreational prawning in the Swan–Canning and Peel–Harvey estuaries [73,74].

Blue swimmer crabs are also readily accessible using inexpensive equipment by people of all ages, fitness levels, and experience levels. Crabs in shallow waters are easily reached by shore-based recreational fishers wading on the extensive shallow sand flats using their hands or a scoop net. Moreover, those crabs in deeper waters can be targeted by drop nets and crab pots from jetties and by boat-based fishers. Finally, catching crabs is relatively easy compared to catching a finfish species, such as black bream, using rod and line (see later). When approached, crabs often either immediately burrow into the sediment or remain in position and raise their chelae in self-defence and thus are easy to capture. The wide range of people with varying skills levels could explain why the motivations for recreational blue swimmer crab fishing are relatively consistent across demographics and fisher characteristics. These characteristics of the blue swimmer crab fishery contrast with many other studies, in which fishers require more specialised equipment and/or higher skill levels to catch fish [75].

While catching larger-sized fish is a common focus for recreational fishers as a means of obtaining a sense of achievement and/or social prestige, it seems that crab fishers focus on size for a different reason. That is, the preference for catching large crabs is more likely to be driven by flesh yield rather than social prestige. It is noteworthy that most crab fishers consumed their own catch (91% overall), a characteristic common across all crab fisheries and fisher groups surveyed. Furthermore, catching enough crabs to eat was the most common motivation identified by the survey. Consumption as the main outcome of a catch indicates a focus on maximising the flesh able to be extracted from the crabs. The proportion of flesh available increases above the legal minim size with commercial processors report that the average yield for a legal sized crab (~127 mm) is 35%. This motivation and fate of crabs contrasts markedly with the black bream fisheries, for which catching a large fish was the main motivation and releasing the fish after capture was the most common outcome. In addition, there are formal competitions with economic and material rewards focused on catching the largest bream as well as social media showcasing large-sized black bream caught. There are no organized crabbing competitions for which catching a large crab is rewarded. Thus, the consumption-focused motivations of crab fishers means that large crabs are preferred not necessarily for the prestige but because large crabs more effectively provide enough crab flesh to eat within the confines of the bag limit.

Despite respondents stating that reaching their bag limit of 10 crabs was not among the strongest motivators, 37% admitted having, at some point, retained more crabs than legally allowed. The results in the current study are supported by those from a survey on noncompliance, in which 22% of respondents self-reported that their average catch exceeded the bag limit of 10 crabs [76]. Monitoring indicates that the Peel–Harvey estuary has relatively high rates of noncompliance for Western Australia, with 20% of all reported enforcement issues in Western Australia being from this estuary [41]. At a broader scale, there were 6462 incidents of noncompliance relating to blue swimmer crabs in the Peel–Harvey estuary between 2009 and 2019, compared to 2884 across the whole of South Australia over

the same time period [77]. Exceeding the bag limit and the taking of undersized crabs is highly likely to be related to the consumption-orientated motivations of fishers.

Despite the diversity of recreational crab fishers and complexity associated with managing the human dimensions of fisheries [15,16], the catch-related, consumption-oriented motivation of crab fishers represents a common theme across all fisher groups and each of the four fisheries. Thus, the challenge of managing a broad spectrum of fisher types may be mitigated by focusing on the motivations of fishers rather than the demographics and other fisher characteristics. Several authors note that management focused on motivation types rather than segmentation based on demographics and other characteristics are more likely to result in desirable management outcomes in the recreation context as motivation is of primary importance in terms of response to management actions [78–80]. Communication strategies may need to vary depending of the demographic group of fishers [81].

4.2.2. Black Bream

Of the eight salient motivations identified by recreational black bream fishers, the most common was "sport/challenge", while "food" was amongst the least selected. As with blue swimmer crab, these motivations were common across all black bream fisheries and fisher groups. It is also relevant that 100% of fishers in group *b* (very frequent, expert lure fishers) selected "enjoyment of catching a big fish" as a motivation. Moreover, when rating motivations, "catching a big bream (>30 cm)" and "catching a legal-sized bream (25 cm)" ranked first and third, respectively, and the lowest-ranked (8th) was "catching as many bream as I am legally allowed to". A similar result was found for fishing taimen (*Hucho taimen*), a salmonid that can reach >150 cm in length and weigh >50 kg, where recreational fishers preferred to catch fewer trophy-size fish rather than greater numbers of smaller fish [82]. These data strongly indicate that black bream is a trophy-motivated fishery for which the experience of catching a large fish is more important than retention and consumption of the fish [83,84].

Black bream fishers rated being outdoors as a significant component of their recreational experience, with "enjoyment of the outdoors", "pleasure", and "relaxation" all selected by around 60% of respondents. As with "sport/challenge" motivations, these results were fairly homogenous across the black bream fisheries and fisher groups. The enjoyment of the outdoors and relaxation may relate to the nature of black bream fishing. Rod-and-line fishing for black bream is relatively passive, particularly if using bait rather than lures. Black bream fishers may spend a significant time focusing on their surroundings while waiting for fish to strike their hook. In contrast, crabbing is a relatively more active fishing method, i.e., wading through water looking down at the benthos to spot crabs or dropping and retrieving pots from a jetty or a boat. Thus, recreational crab fishers spend, on average, less time fishing than those targeting black bream [85].

Being a trophy-orientated rather than consumption-orientated fishery, relatively few black bream fishers ate their catch (9% of respondents). Instead, 76% always practiced catch and release, with a further 27% doing this sometimes. Similarly, 75% of recreational red drum (*Sciaenops ocellatus*) fishers in the south-eastern USA release individuals, up from 17% in the 1980s [86], and Atlantic bluefin tuna (*Thunnus thynnus*) fishers in the Hatteras (North Carolina, USA), with a low consumptive orientation, were more likely to have a positive attitude toward catch and release fishing and were also more likely to release all individuals caught [87].

The trophy-orientated nature of black bream fishing in Western Australia could reflect that fact that black bream are one of the larger species present in the upper reaches of estuaries in the region [88,89] and are known to fight hard once hooked relative to their size. Other trophy species present in these waters are the mulloway (*Argyrosomus japonicus*), which reaches up to 200 cm (but typically individuals in estuaries are up to 100 cm), and the bull shark (*Carcharhinus leuca*) [37]. However, these species are less numerous, and fishing for them is often conducted using more specialist (heavier) fishing gear and undertaken

at night, making it less accessible and therefore less of a family activity. Biological studies have shown that the abundance and biomass of black bream in the deeper waters of the Swan–Canning Estuary have declined as fish have moved away from hypoxic waters into the more oxygenated shallow waters [31,88]. This reduces the area of the estuary in which fishers are likely to catch black bream but also increases density-dependent effects and slows growth rate [88,90]. Thus, there are fewer larger black bream, reducing the frequency of catching a trophy-sized fish. The increase rarity may further foster the catch and release mentality by helping to preserve the largest individuals.

In addition to a catch-and-release philosophy, the lack of consumption of black bream may be related to their spatial location within estuaries and perceptions on their cleanliness. Black bream typically reside in the upper reaches, where the effects of estuarine degradation, such as poor water quality and algal blooms, are more pronounced [91,92]. These deleterious conditions can lead to high-profile fish kills in which black bream often suffer mortality [93]. Finally, black bream are susceptible to epizootic ulcerative syndrome—or "red spot disease" [94]—which is caused by an endemic fungus and presents as red lesions or deep ulcers, which would make fish unattractive to consume.

4.3. Management Implications

The perceived importance of both fisheries was shown by the fact that if the fishery were not available, fishers for both species would target those species in other systems, which could be related to their reputation as iconic fisheries and the fact that the experiences they offer are hard to replicate, albeit slightly less so for crabs. Crabbing is an activity suitable for people with a wide range of ages and physical fitness, requires little skill, and utilises cheap equipment. Thus, its readily accessible compared to western rock lobster (*Panulirus cygnus*) fishing, which is also very popular in Western Australia [14]. However, craypots are more expensive than drop or scoop nets (i.e., AUD ~150 vs. AUD 25), and as this fishing is located in marine waters, a larger and more expensive boat is typically required. The most analogous crustacean fishing experience in estuarine waters in the region is that of the western school prawn (*Metapenaeus dalli*) and western king prawn (*Penaeus* (=*Melicertus*) *latisulcatus*) [73,74].

In contrast, there is no direct replacement for black bream fishing in the upper reaches of estuaries during daylight hours, as mulloway and bull sharks are generally targeted at night using specialist gear. Fishers would need to head downstream to shallow areas and partake in "flats fishing", in which species such as tailor (*Pomatomus saltatrix*) and members of the Platycephalidae and Sillaginidae could be targeted [32].

Understanding the common motivations for fishing recreationally can better inform effective management [8]. Motivations for both blue swimmer crabs and black bream were fairly consistent among fishers utilising each estuary and mostly among fisher groups. However, motivations differed markedly between species despite the fact that the species co-occur in the same estuaries and that it is possible that an individual fisher completed the survey for both species. These findings suggest that in Western Australia, the motivations for fishing for blue swimmer crab and black bream are fixed and fairly homogenous, perhaps due to the iconic and longstanding nature of fishing for each species.

Given that blue swimmer crab fishers are strongly consumption-orientated, any management options that restrict their ability to catch enough crabs to eat—e.g., significantly lowering the bag limit or introducing a maximum size limit—are likely to be unpopular. Such a change could result in an increase in noncompliance with fishery regulations, which is already relatively high in the Peel–Harvey estuary [77]. A survey of Western Australians' engagement in recreational, commercial, and charter fishing strongly supported the use of sanctions for breaches in fishing regulations, with the authors noting that greater community involvement in determining penalties and developing strategies to increase monitoring and enforcement may have a positive effect on compliance [95]. In contrast, management mechanisms that ensure fishers will catch enough crabs to eat while ensuring the sustainability of the population, e.g., current bag limits, will likely be supported. Similarly, with

sport/challenge being the most common motivation of recreational black bream fishers and with most of these fishers practicing catch-and-release fishing, a decrease in bag limits or introducing a maximum size limit could potentially be popular management approaches if stocks are under pressure, as they would not impinge on the ability to fish for sport.

Recreational crabbing is generally accessible to people of all ages fitness levels and typically not considered to be more important than other recreational activities. This could influence the low level of investment in fishing gear by recreational blue swimmer crab fishers and result in relatively low resistance to management changes despite the high number of recreational fishers crabbing in the region. In contrast, recreational black bream fishing requires significant effort and specialist equipment and is regarded as an irreplaceable recreational activity by its fishers. This could potentially result in high resistance to management changes if they are not supported by the recreational fishing community targeting this species, and a co-management approach may be useful. Moreover, research in Europe suggests that recreational fishers can be sensitive to declines in catch rates, trophy sizes, and/or access, potentially leading to conflict with other fishers and user groups [96], and that involving fishers in government decision-making enhanced the likelihood of regulatory success [97].

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/fishes8060292/s1. Table S1: Number of responses (*n*) and the frequency of occurrence (%) of responses about the demographics of blue swimmer crabs and black bream fishers; Table S2: Number of responses (*n*) and the frequency of occurrence (%) of responses about the characteristics of blue swimmer crabs and black bream fishers; Figure S1: Dendrogram derived from CLUSTER-SIMPROF analysis of the five fisher characteristics of blue swimmer crab fishers; Figure S2: Dendrogram derived from CLUSTER-SIMPROF analysis of the seven fisher characteristics of black bream fishers; Figure S3: Linkage tree and associated quantitative thresholds for assigning blue swimmer crab fishers to their appropriate fisher group; Figure S4: Linkage tree and associated quantitative thresholds for assigning black bream fishers to their appropriate fisher group; Table S3: Percentage number of times a salient motivation for (a) blue swimmer crab and (b) black bream fishing was selected from the closed-question online survey; Table S4: Average rating (X) and standard error (SE) from −3 to +3 for each salient motivation for (a) blue swimmer crab and (b) black bream fishing provided in the closed-question online survey; Table S5: Percentage number of times (a) blue swimmer crab and (b) black bream fishers eat, release, and give away legal-sized individuals that they catch; Table S6: Percentage number of times (a) blue swimmer crab and (b) black bream fishers catch, fewer target individuals than allowed (i.e., the bag limit), the number allows, more than allowed, and multiple options; Table S7: Perceived importance of (a) blue swimmer crab and (b) black bream fishing to fishers that target those species and the percentage of fishers that would undertake different substitute activities if their target species could no longer be fished in the estuary they fish most regularly in.

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