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## Fisheries Research Report No. 315

# Shore-based recreational fishing in the Perth Metropolitan area: 2014 – 2021

A. Tate & C. B. Smallwood

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**Enquiries:**

WA Fisheries and Marine Research Laboratories,  
PO Box 20,  
North Beach, WA 6920

Tel: +61 8 9203 0111

Email: [library@fish.wa.gov.au](mailto:library@fish.wa.gov.au)

Website: [fish.wa.gov.au](http://fish.wa.gov.au)

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Department of Primary Industries and Regional Development  
Gordon Stephenson House  
140 William Street  
PERTH WA 6000  
Telephone: (08) 6551 4444  
Website: [dpird.wa.gov.au](http://dpird.wa.gov.au)  
ABN: 18 951 343 745

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## Executive Summary

Recreational fishing is a popular activity in Western Australia, occurring throughout the state from private and charter boats, and from a variety of natural and man-made structures along the shore. Ongoing monitoring of the shore-based recreational fishery is essential to assist with monitoring, management evaluation and stock assessments for nearshore species. Especially for species such as Australian Herring and Southern Garfish who were the focus of recent management changes in 2015 (reduction of bag limit from 30 to 12) and 2017 (closure of Perth Metropolitan waters), respectively.

An on-site roving creel survey to collect effort and catch data from shore fishers has been conducted annually from February – June in the Perth Metropolitan area since 2014. Estimates of fishing effort, catch rate and total catch have been calculated and compared to a 2010 ‘pilot’ survey. Total length and catch-per-fisher for key species retained by shore fishers are compared with distributions from boat fishers using additional data from concurrent phone-diary and boat ramp surveys.

Estimated fishing effort for shore fishers in the Perth Metropolitan area in 2021 was 110,979 fisher hours (95%CI 81,951 – 140,007). This was lower when compared to 2020 (134,578 – 202,195) (although not a significant difference as confidence intervals overlapped) but steady when compared to 2010 (100,771 – 156,926). Fishing effort in both these years was lower than the peak in 2016 (194,926 – 382,931).

The estimated retained catch (in numbers) was 104,338 (95%CI 75,780 – 132,895) in 2021, of which an additional 104,405 (67,735 – 141,074) was released. When compared to 2020, retained (77,632 – 197,011) and released (28,068 – 87,185) catch were steady. However, retained catch in 2021 was lower than in 2010, 2014 and 2017 while released catch was steady across all years. However, the proportion of released catch increased from 17% (2010) to 50% (2021) of the total catch.

More than 50% of fishing parties had caught or released a fish of any species in all survey years, with a high of 74% in 2021. Collectively, the five key species of Australian Herring, Whiting spp. (Family Sillaginidae), Tailor (*Pomatomus saltatrix*), Western Australian Salmon (*Arripis truttaceus*) and Pink Snapper (*Chrysophrys auratus*) were targeted by >40% of shore fishers and comprised >70% of the retained catch in any survey year.

Australian Herring was the most commonly retained species in all years with an estimated retained catch of 9 t (95%CI 5 – 13 t) in 2021, which was lower than in 2010, 2014 and 2017. The release rate across all survey years varied from 5 – 12%. The harvest rate (mean  $\pm$  SE) for this species was  $0.76 \pm 0.05$  fish per fisher day, which was significantly lower in 2010, but remained steady with no significant difference from 2017 to 2021.

Whiting spp. was the second-most commonly retained species with an estimated retained catch of 1 t (95%CI 0 – 1 t) in 2021, which has been steady since 2014. The release rate across all survey years varied from 7 – 23% across. The harvest rate

(mean  $\pm$  SE) for this species in 2021 was  $0.38 \pm 0.04$ , which was significantly lower than 2010, but not significantly different compared to all other years.

The Southern Garfish retained catch was zero in 2021, and has been negligible (< 1 t) since 2014. The retained catch of Tailor, Western Australian Salmon and Pink Snapper have been negligible across all survey years, with the exception of the Western Australian Salmon retained catch between 2015 – 2017, which also saw a corresponding increase in targeting for this species during this time (up to 25%). Although up to 15% of shore fishers targeted Pink Snapper, the majority of catches were released (95 – 99%).

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## 1.0 Introduction

### 1.1 Background

In Western Australia, recreational fishing is highly valued, with 26% of the population participating in this activity in 2019/20 (DPIRD, 2020), which is one of the highest levels of all Australian states and territories (Henry and Lyle, 2003). Recreational fishing occurs throughout the 13,000 km coastline of Western Australia from boats and the shore, using a variety of fishing methods, with highly seasonal patterns of activity (Ryan et al., 2019). Although >3,000 fish species are found in Western Australian waters (Hutchins, 2001), ~ 10% are harvested by recreational fishers, across a range of ecosystems.

Fisheries resources in Western Australia are managed using an ecosystem-based approach with four marine bioregions (North Coast, Gascoyne Coast, West Coast and South Coast) divided into five ecological suites for finfish (estuarine, nearshore, inshore demersal, offshore demersal and pelagic) (Newman *et al.*, 2018). Obtaining information on fishing effort and total catch from all sectors are essential for the management, assessment, and monitoring of these resources.

Due to the diverse and diffuse nature of recreational fishing, off-site surveys, where data are collected from fishers after they have been fishing, and on-site surveys, where data are recorded during a fishing event or straight after fishing has been completed, are used to capture data from this sector. Such surveys have been used widely in Western Australia since the 1970s (Tate et al., 2020b). The introduction of a Recreational Boat Fishing Licence (RBFL) in 2010 enabled the development of an integrated survey to collect data on boat-based recreational fishing (Wise and Fletcher, 2013). The key component is a phone-diary survey that utilises the RBFL as the sampling frame to collect data from boat-based recreational fishers throughout Western Australia.

Collecting similar data for shore-based recreational fishing is more challenging as it is difficult to implement cost-effective surveys over broad scales due to the lack of a licence or sampling frame for this activity. This leads to a reliance on other survey methods, such as roving creel surveys, aerial surveys, or remotely operated cameras (Smallwood et al., 2012; Taylor et al., 2021).

Whiting spp. (*Sillago* spp.) and Australian Herring (*Arripis georgianus*) are the most commonly caught nearshore species caught by boat fishers with 19% and 9% of the total catch by numbers, respectively (Ryan et al., 2019). Catches of these same species from shore fishers are also known to be high, with data from the 2000/01 National Survey indicating that shore fishers can take a higher proportion than boat fishers (Henry and Lyle, 2003). While majority of the catch from shore fishers were nearshore species, demersal species Pink Snapper was also targeted and caught by shore fishers. In addition, the catch from shore fishers for some species, such as Australian Herring, may be equal to or exceed, that for commercial fishers (Smith et al., 2013a). However, until recently there was no regular monitoring of shore-based recreational fishing, with information collected via *ad hoc* roving creel surveys to

meet specific objectives (Ayvazian et al., 1997; Lenanton and Hall, 1976; Smallwood et al., 2012, 2006).

## **1.2 Need**

Recreational fishing is a popular activity in Western Australia, occurring widely from boats and the shore. Ongoing monitoring of the shore-based recreational fishery is essential to assist with management evaluation, resource and stock assessments for nearshore species. In addition, for some nearshore species, the recreational catch from shore fishers is estimated to exceed that for boat fishers. Therefore, to complement regular statewide surveys of boat-based recreational fishers, and to better understand the relationship between these two platforms (*i.e.*, the potential displacement of fishing activity), annual surveys of shore fishers have been undertaken since 2014.

## **1.3 Objectives**

The objective of this report is to provide a summary of the monitoring of shore-based recreational fishing in the Perth Metropolitan area using roving creel surveys conducted annually from 2014 – 2021. These data are compared to a 'pilot' 2010 survey completed using the same design (Smallwood et al., 2012).

Within this, specific aims were to calculate fishing effort and total catch (all species; key species). Key species of interest were identified as Australian Herring, Whiting spp., Southern Garfish, Tailor, Western Australian Salmon and Pink Snapper. For these species, additional metrics were also explored, including standardised harvest rate, which can be used as an index to monitor inter-annual variations in abundance, as well as targeting, and the proportion of fishing parties who catch a fish, which provides a measure of the success of fishing trips. In conjunction with the roving creel surveys, concurrent phone-diary and boat ramp surveys were also used to explore differences between shore and boat fishers in terms of the total length of catches and catch-per-fisher, and the cumulative percentage of shore fishers attaining their daily (*i.e.*, midnight to midnight) bag limit. These analyses assist with evaluating the effect of changes to management regulations relevant to some nearshore indicator species (Appendix 1).



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## 2.0 Methods

### 2.1 Roving creel surveys

A roving creel survey, which involves travelling along a predetermined route conducting instantaneous counts and interviews of recreational fishers, was conducted from April – June 2010 and formed the basis of the ongoing monitoring program (Smallwood et al., 2012). Although this early study used a complementary approach combining roving creel, boat-ramp and remote camera surveys, the ongoing program utilises only the roving creel survey component. These annual surveys use the same stratified, randomised design implemented in 2010 with the only modification being the extension of the survey period from three (April – June) to five months (February – June) (Table 1).

Recreational fishing for nearshore species is undertaken along the entire Western Australian coastline, except for no-take areas or closed seasons established for fisheries management (*i.e.*, Perth Metropolitan waters closed to fishing for Southern Garfish) or conservation purposes (*i.e.*, sanctuary or no-take zones in marine parks). The Perth Metropolitan area from Ocean Reef to Woodman Point was selected as the location of the roving creel survey due to the high levels of fishing effort and large residential population in the West Coast Bioregion (Ryan et al., 2019) (Figure 1). Four indicator species in the nearshore and estuarine habitat (Australian Herring, Whiting spp., Southern Garfish, and Tailor) are all also commonly found throughout this area (DoF, 2011). This survey was timed to coincide with not only peak fishing activity, but also peak catches of key nearshore species, particularly Australian Herring (Ayvazian et al., 1997; Lenanton, 1976; Ryan et al., 2019). There were many platform types within the survey boundary which were classified into three discrete platforms: human-made groynes, jetties, and sandy beaches.

The survey used a stratified, randomised design to collect data from 42 locations within the survey area. A full list of the extent and platform for each survey location can be found in Smallwood *et al.* (2011). Due to the ~60 km length of coastline included in the study area, it was not possible to visit all locations within a 7-hr shift. A subset of 16 to 19 locations was therefore randomly selected for each shift using standard protocols developed in 2010 and continued in all subsequent surveys (Smallwood et al., 2012, 2011). Instantaneous counts of shore fishers were made on arrival at each fishing location. This information was used in the calculation of fishing effort (as fisher hours).

Incomplete trip interviews (fishers interviewed whilst actively fishing from the shore) were then undertaken with a random selection of shore fishers during their fishing trip. Information was collected on the number of people in the fishing party, time spent fishing, species targeted, and species caught, as well as the number of each species retained and released. The retained catch was identified to species level by trained interviewers. However, released catch was identified using more general species or family groupings as their identity could not be verified. This general grouping also applied to target species. For example, if fishers stated they were

targeting 'Garfish' it may have referred to any species from Family Hemiramphidae, such as Southern Garfish or Robust Garfish (*Hemiramphus robustus*). In addition, fishers who could not specify a target species were classified into broad categories such as 'unspecified pelagic fish' or 'unspecified demersal fish' depending on the gear type they were using (*i.e.*, burley float for surface fishing or a sinker for bottom fishing, respectively).

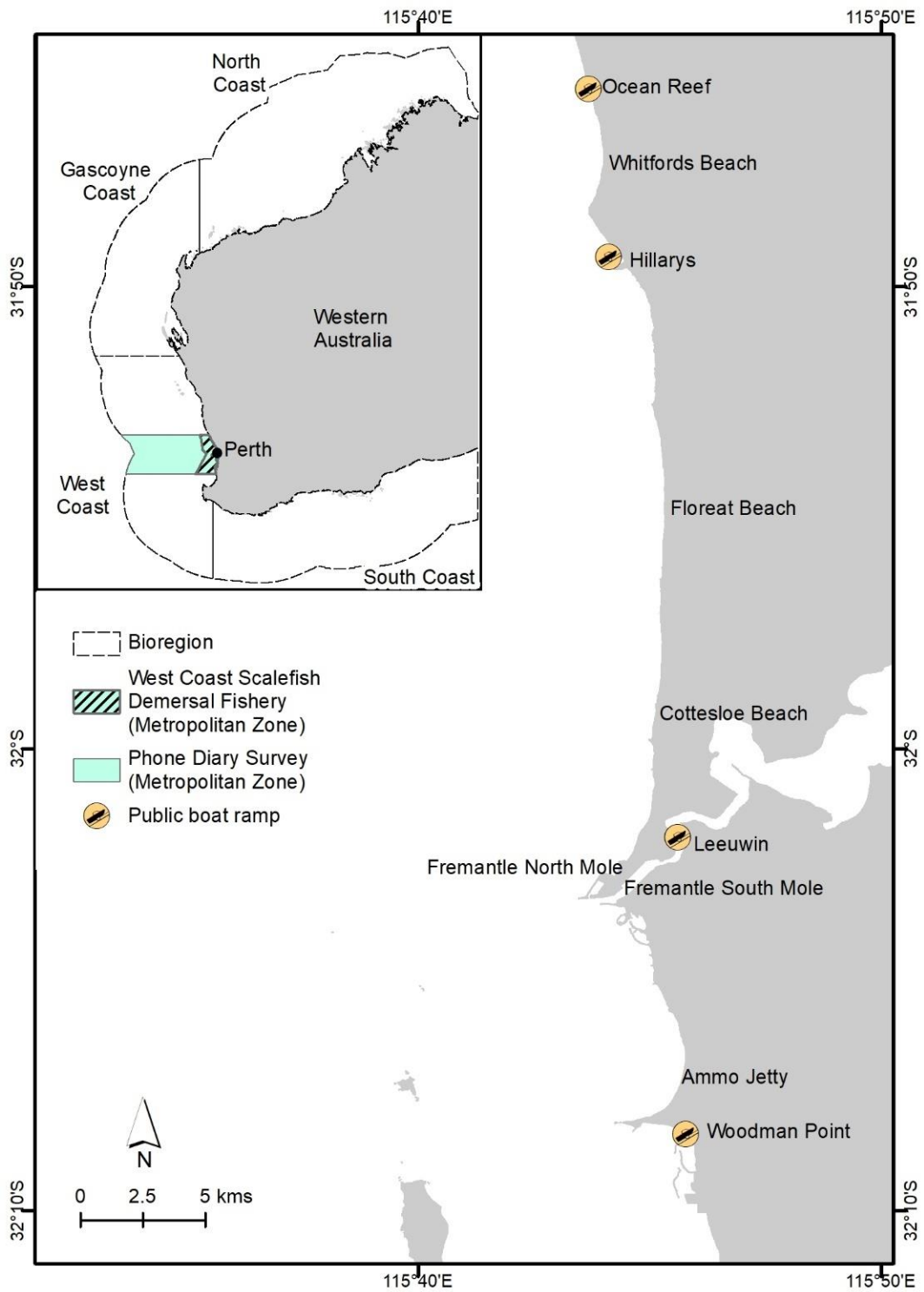
Although the retained catch was identified to species level, to align with standard reporting, Family Sillaginidae included Southern School Whiting (*Sillago bassensis*), Western School Whiting (*S. vittata*), Yellowfin Whiting (*S. schomburgkii*).

Data from incomplete trip interviews were used to estimate total catch (retained plus released) using mean-of-ratios (Smallwood et al., 2012). Standardisation of harvest rate (*i.e.*, retained catches) was undertaken following protocols established in Tate et al. (2020a). Trips of short duration ( $\leq 15$  mins; 21% of interviews) and non-line fishing gear types (*i.e.*, cast nets, drop nets, and pots;  $<0.1\%$  of interviews) were excluded from analyses.

Additional information on the number of fishers and number of retained fish was used to calculate catch-per-fisher and the cumulative percentage of shore fishers attaining the daily bag limit. The proportion of each species targeted by shore fishers and catch success (retained or released) for the preferred species was also calculated.

The variability associated with estimates of fishing effort, catch rate and total catch (by numbers and weight) were provided using Standard Errors (SE) and 95% Confidence Intervals (95%CI). Relative Standard Error (RSE) was calculated by dividing the SE by the estimate of effort. The magnitude of the RSE was used as an indicator of robustness of an estimate. In concordance with reporting of other recreational fishing surveys, if RSE  $>40\%$  then estimates are displayed in bold to indicate it is not considered to be robust (Lyle et al., 2014; Ryan et al., 2019; Webley et al., 2015).

After each interview, a random selection of lengths was measured for key species. Length-weight relationships were then used to convert these random samples to weight, from which an (arithmetic) mean weight was derived (Appendix 3). Statistical comparison using a non-parametric Kruskal-Wallis test revealed significant differences by year for Australian herring and Whiting spp. and therefore the mean weight for each survey year was applied. The remaining species (Southern Garfish, Tailor, and Western Australian Salmon) had small sample sizes ( $<10$  in some years) and the combined mean weight across all survey years was applied, even though all (except Tailor) exhibited significant differences by year. This pooling of data across strata is commonly undertaken to reduce the effect of small sample sizes (Smallwood and Ryan, 2020). These mean weights were multiplied by the estimated retained catch to calculate harvest for these species.



**Figure 1** Key locations relevant to management of nearshore fish species as well as the roving creel survey, boat ramp survey and phone-diary survey.

**Table 1** Description of survey elements. Note: \* indicates where a subset of data has been used from the boat ramp survey and phone-diary survey to best match the spatial scale of the roving creel survey.

Survey elements	Roving creel survey (2010) (Smallwood et al., 2012)	Roving creel survey (2014 – 2021)	Boat ramp survey Ryan <i>et al.</i> (2019, 2017, 2015, 2013)	Phone-diary survey Ryan <i>et al.</i> (2019, 2017, 2015, 2013)
<i>Sampling frame</i>	Spatio-temporal			RBFL holders
<i>Survey period</i>	April – June	February – June	<u>2011/12</u> : March – February; <u>2013/14</u> – 2020/21: January – April	<u>2011/12</u> : March – February; <u>2013/14</u> : May – April; <u>2015/16</u> – <u>2017/18</u> : September – August
<i>Number of survey days</i>	38 days	60 days	<u>2011/12</u> : Ocean Reef, Hillarys, Leeuwin, Woodman Point (4); <u>2013/14</u> – 2020/21: Ocean Reef, Hillarys, Leeuwin, Woodman Point (6-16)	n/a
<i>Length of fishing day (shift times)</i>	14-hr (6am – 1pm; 1pm – 8pm)		<u>2011/12</u> : 11-hr (8am – 7pm); <u>2013/14</u> – <u>2020/21</u> : 4-hr (12pm – 4pm)	24-hr
<b>Stratification</b>				
<i>Month</i>	Equal allocation of 12 days per month		<u>2011/12</u> : February (2), March (2), June (2), July (2), October (3), December (4); <u>2013/14</u> – <u>2020/21</u> : n/a	Stratification by Regional Development Commission
<i>Day type</i>	Equal allocation of weekdays and weekends/public holidays		<u>2011/12</u> : unequal allocation; <u>2013/14</u> – <u>2020/21</u> : Targeted peak activity (weekends/public holidays)	
<i>Time of day</i>	Equal allocation of morning and afternoon shifts		<u>2011/12</u> : n/a; <u>2013/14</u> – <u>2020/21</u> : Targeted peak retrieval times (12 – 4pm)	
<b>Randomisation</b>				
<i>Starting location</i>	Randomly selected		n/a	n/a
<i>Travel direction</i>	Randomly selected		n/a	n/a
<b>Data collection</b>				
<i>Survey locations</i>	42 locations available for selection between Ocean Reef & Woodman Point		4 public boat ramps (Ocean Reef, Hillarys, Leeuwin & Woodman Point)*	
<i>Counts of shore fishers</i>	Instantaneous		n/a	n/a
<i>Interviews</i>	Incomplete trip interviews		Complete trip interviews	Complete trip interviews

## **2.2 Boat ramp surveys**

On-site biological surveys have been completed at a number of public boat ramps in the West Coast Bioregion from January – April during four survey periods to obtain length and weight information (Ryan et al., 2019, 2017, 2015, 2013). Data were collected from boat-based recreational fishers as they returned to the boat ramp at the end of their fishing trip (*i.e.*, complete trip interviews). Key design elements are shown in Table 1. Although the information was collected throughout the West Coast bioregion, only data from four public boat ramps (Ocean Reef, Hillarys, Leeuwin, and Woodman Point) was included in the comparison with length data from the roving creel survey as they were located within the survey extent.

Length data were used to calculate average total length for key species caught by boat fishers, which could be compared with that obtained for shore fishers. Statistical comparison of total lengths between survey year and fishing platform (boat and shore) were completed using a non-parametric Kruskal-Wallis test.

## **2.3 Phone-diary surveys**

Phone-diary surveys have been completed throughout Western Australia during four survey periods, collecting information from boat fishers (Ryan et al., 2019, 2017, 2015, 2013). Diarists were recruited into the phone-diary survey via a screening survey conducted prior to the 12-month survey period. Information on their boat-based fishing activity was then collected via regular phone interviews during this time. Key design elements are shown in Table 1. Although information was collected statewide, only raw data on the number of fishers and retained catch from four public boat ramps (Ocean Reef, Hillarys, Leeuwin, and Woodman Point) was used to calculate catch-per-fisher as they were located within the study area. This was then compared against values obtained for shore fishers.

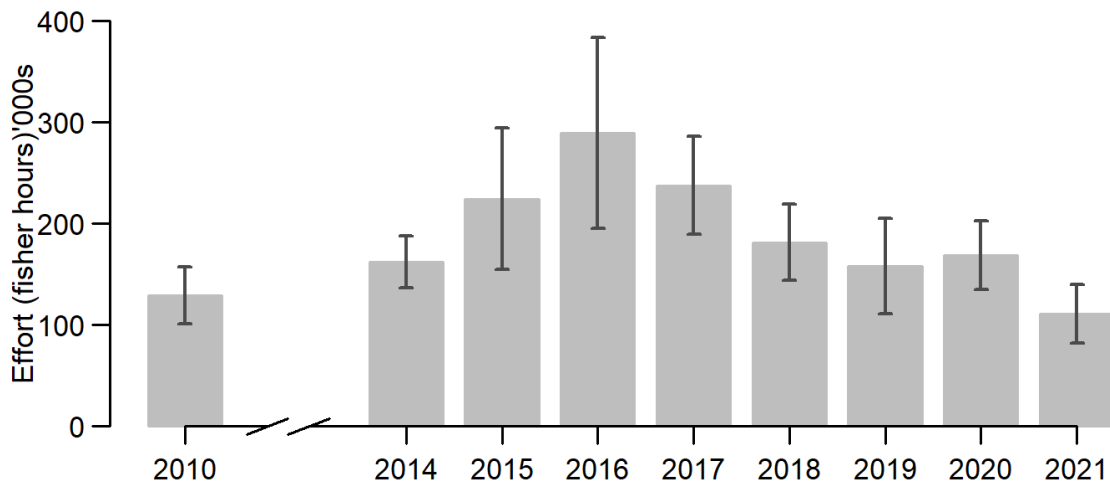
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## 3.0 Results

### 3.1 Fishing effort

Fishing effort for shore fishers in 2021 was 110,979 fisher hours (95%CI 81,951 – 140,007) (Figure 2). This was lower when compared to 2020 (134,578 – 202,195) (although not a significant difference as confidence intervals overlapped) but steady when compared to 2010 (100,771 – 156,926). Fishing effort in both these years was lower than the peak in 2016 (194,926 – 382,931). RSE for all survey years was  $\leq 40\%$  (*i.e.*, robust).

Western Australia's first COVID-19 lockdown occurred in April – May 2020, with travel and capacity restrictions in place during these months. Fishing effort in 2020 was steady when compared to adjacent years.

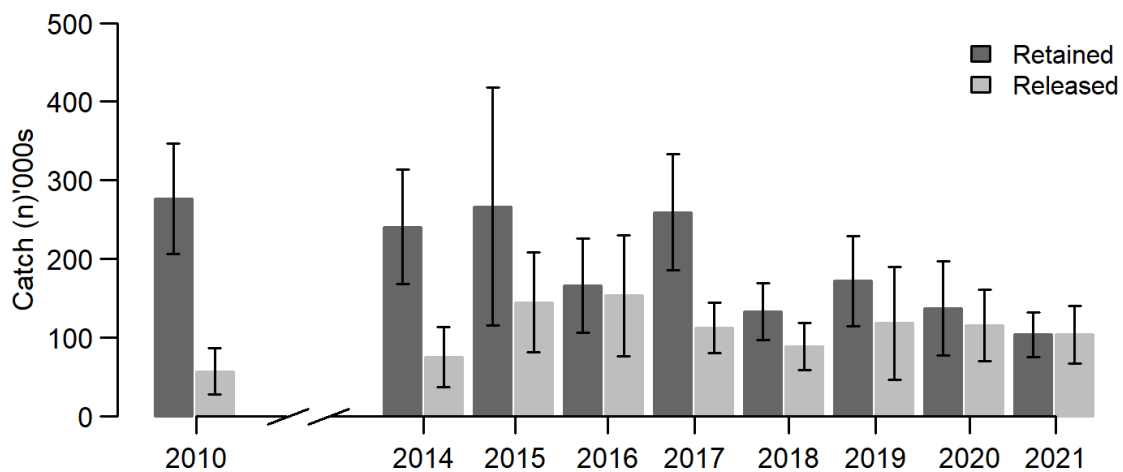


**Figure 2** Estimated fishing effort (in fisher hours) from shore fishers in the Perth Metropolitan area (95%CI) as calculated using data from roving creel survey. Note: 3-month survey duration in 2010.

### 3.2 Catch estimates: all species combined

The retained catch (number of individuals) for shore fishers in 2021 was 104,338 (95%CI 75,780 – 132,895) (Figure 3). The retained catch was steady when compared to 2020 (77,632 – 197,011) (as indicated by overlapping confidence intervals) although was lower than in 2010 (3-months only) (206,849 – 346,836), 2014 (168,159 – 313,633) and 2017 (186,241 – 333,292). RSE was  $\leq 40\%$  for all survey years for retained catch.

An additional 104,405 (67,735 – 141,074) was released in 2021, which was steady across all survey years, including 2010 (28,068 – 87,185). However, the proportion of released catch increased from 2010 (17%) to 2016 (48%) and remained relatively consistent (30 – 45%) until 2021 when 50% of the total catch was released by shore fishers.



**Figure 3** Estimated total catch (in numbers of individuals) from shore fishers in the Perth Metropolitan area (95%CI) as calculated using data from roving creel survey. Note: 3-month survey duration in 2010.

### 3.3 Catch estimates: key species

Shore-based recreational fishers retained 120 species or species groupings across all survey years, of which 111 were teleosts. An additional 119 species or species groupings were released by fishers. Australian Herring was the greatest proportion of retained catch in all survey years (41 – 64%), followed by Whiting spp. (11 – 24%) in all years except 2010, in which Southern Garfish ranked second (17%) (Table 2). Various species from Family Tetradontidae had the greatest proportion of released catch in all survey years. Species such as Australian Herring (5 – 37%), Silver Trevally (2 – 16%) and Pink Snapper (1 – 14%) had variable release rates across survey years.

**Table 2** Percentage of estimated retained catch for each of the top 10 species (with rank in brackets) caught by shore fishers in the Perth Metropolitan area. Note: species were selected based on their combined catch across all survey years, the survey only includes species caught by line fishing (finfish and squid) Note: 3-month survey duration in 2010. \*Perth Metropolitan waters closed to Southern Garfish.

Common name (Scientific name)	2010	2014	2015	2016	2017	2018*	2019*	2020*	2021*
Australian Herring <i>Arripis georgianus</i>	64% (1)	50% (1)	53% (1)	41% (1)	61% (1)	41% (1)	57% (1)	43% (1)	50% (1)
Whiting spp. Sillago spp.	5% (3)	19% (2)	19% (2)	21% (2)	11% (2)	24% (2)	16% (2)	20% (2)	12% (2)
Southern Garfish <i>Hyporhamphus melanochir</i>	17% (2)	1% (8)	2% (7)	<1% (10)	2% (8)	2% (6)	<1 (15)	2% (10)	-
Yellowtail Scad <i>Trachurus novaezelandiae</i>	3% (4)	3% (5)	2% (6)	5% (4)	6% (3)	3% (5)	5% (4)	7% (3)	6% (3)
Squid Teuthoidea	1% (7)	2% (7)	5% (4)	5% (5)	3% (6)	8% (3)	4% (5)	4% (5)	4% (4)
Scaly Mackerel <i>Sardinella lemuru</i>	<1% (11)	11% (3)	6% (3)	3% (6)	-	-	2% (7)	<1% (20)	2% (9)
Western Striped Grunter <i>Pelates octolineatus</i>	-	3% (6)	1% (8)	<1% (16)	4% (4)	5% (4)	5% (3)	7% (4)	3% (6)
Silver Trevally <i>Pseudocaranx georgianus</i> spp.	2% (5)	<1% (14)	1% (10)	<1% (9)	3% (5)	2% (7)	3% (6)	2% (8)	2% (10)
Western Australian Salmon <i>Arripis truttaceus</i>	<1% (13)	<1% (23)	2% (5)	11% (3)	1% (11)	<1% (21)	<1% (23)	-	<1% (20)
Western Butterfish <i>Pentapodus vitta</i>	-	<1% (11)	<1% (13)	2% (7)	1% (10)	2% (9)	<1% (14)	3% (6)	4% (5)



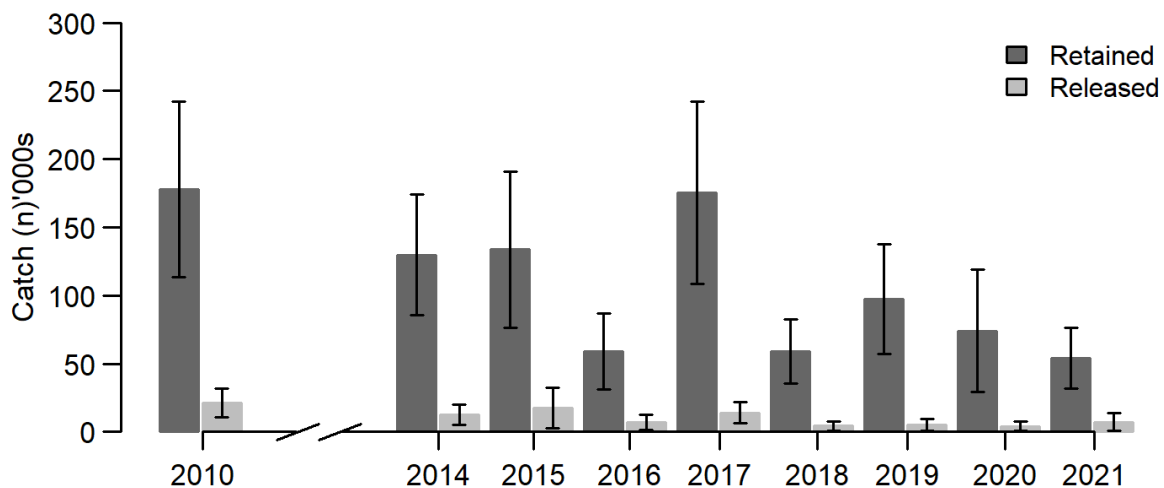
**Table 3** Percentage of estimated released catch for each of the top 10 species (with rank in brackets) caught by shore fishers in the Perth Metropolitan area. Note: species were selected based on their combined released catch across all survey years, the survey only includes species caught by line fishing (finfish and squid) Note: 3-month survey duration in 2010. \*Perth Metropolitan waters closed to Southern Garfish.

Common name (Scientific name)	2010	2014	2015	2016	2017	2018*	2019*	2020*	2021*
<b>Weeping Toadfish</b> <i>Torquigener pleurogramma</i>	26% (2)	14% (2)	50% (1)	46% (1)	11% (4)	14% (1)	15% (2)	45% (1)	40% (1)
<b>Toadfishes</b> <b>Family Tetraodontidae</b>	-	-	-	-	21% (1)	11% (3)	49% (1)	25% (2)	19% (2)
<b>Australian Herring</b> <i>Arripis georgianus</i>	37% (1)	14% (3)	12% (2)	5% (7)	12% (3)	5% (8)	6% (3)	5% (4)	6% (3)
<b>Tarwhine</b> <i>Rhabdosargus sarba</i>	1% (12)	13% (4)	5% (3)	7% (4)	15% (2)	10% (4)	1% (19)	1% (10)	2% (10)
<b>Silver Trevally</b> <i>Pseudocaranx georgianus</i> spp.	16% (3)	10% (5)	4% (5)	8% (2)	6% (6)	6% (6)	4% (6)	2% (8)	2% (14)
<b>Pink Snapper</b> <i>Chrysophrys auratus</i>	1% (10)	7% (7)	1% (13)	6% (5)	9% (5)	14% (2)	5% (4)	2% (7)	4% (4)
<b>Whiting spp</b> <i>Sillago</i> spp.	5% (5)	9% (6)	4% (6)	5% (6)	3% (8)	8% (5)	5% (5)	6% (3)	3% (7)
<b>Silver Toadfish</b> <i>Lagocephalus sceleratus</i>	-	14% (1)	3% (8)	7% (3)	-	2% (13)	-	-	1% (19)
<b>Western Striped Grunter</b> <i>Pelates octolineatus</i>	-	4 (9)	4 (7)	-	2% (11)	5% (7)	1% (17)	3% (6)	3% (6)
<b>Breams</b> <i>Sparidae</i> spp.	-	5% (8)	-	1% (11)	1% (17)	2% (12)	-	1% (11)	3% (8)

The retained and released catches for Australian Herring, Whiting spp., Southern Garfish, Tailor, Western Australian Salmon and Pink Snapper are reported in this section. For all other species, the estimated catches for 2021 are shown in Appendix 4.

### 3.3.1 Australian Herring

The retained catch of Australian Herring in 2021 was 54,038 (95%CI 31,884 – 76,192) and was steady compared to 2020 (29,495 – 118,804) (Figure 4). Retained catches in 2021 were lower compared with 2010 (3-months only), 2014 and 2017. Released catches were steady across all survey years. RSE was  $\leq 40\%$  for all years for retained catch and for released catches in some survey years (2010, 2014, 2017 – 2018). The release rate across all survey years varied from 5% (2019) and up to 12% (2021).

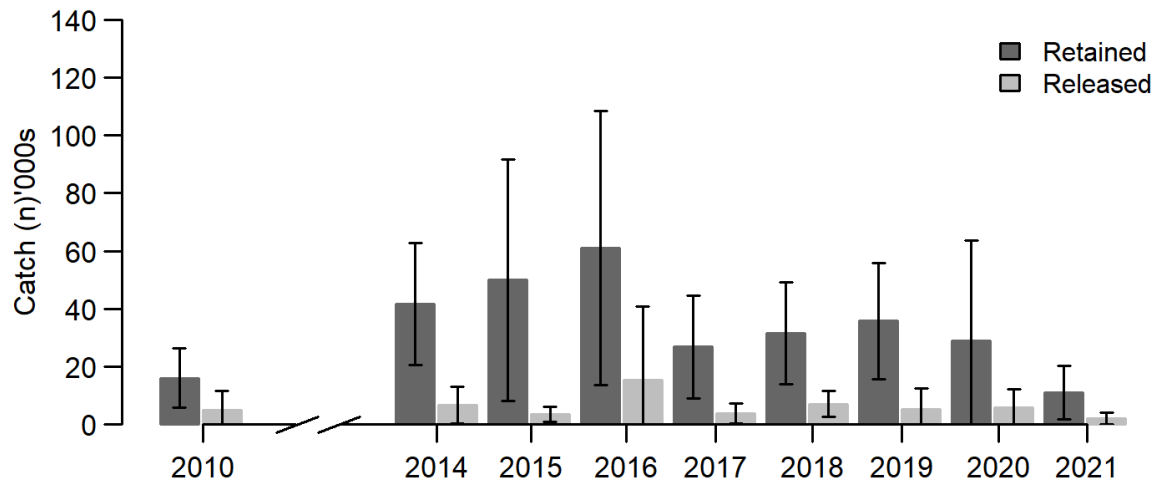


**Figure 4** Estimated retained and released catch (95%CI) for Australian Herring caught by shore fishers in the Perth Metropolitan area, calculated from the roving creel surveys. Note: 3-month survey duration in 2010.

### 3.3.2 Whiting spp.

Whiting spp. (*Sillago* spp.) is a grouping of three Whiting species, of which Southern School Whiting was the dominant species in this group with 94% of the retained catch in 2021. This proportion ranged from 74 – 99% across survey years (Appendix 6).

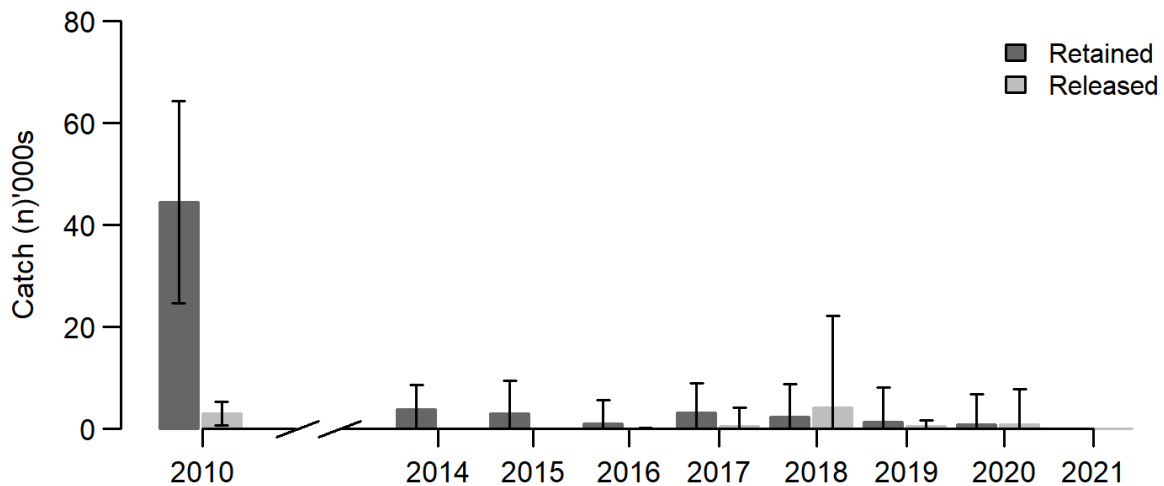
The retained catch of Whiting spp. in 2021 was 11,135 (95%CI 1,795 – 20,475) and was steady across all survey years (Figure 5). RSE was  $\leq 40\%$  for all survey years for retained catch except for 2015 and 2020 and released catches in 2015 and 2018. The release rate was 16% in 2021 and ranged from 7% (2015) to 23% (2010) across all survey years.



**Figure 5** Estimated retained and released catch (95%CI) for Whiting spp. caught by shore fishers in the Perth Metropolitan area, calculated from the roving creel surveys. Note: 3-month survey duration in 2010.

### 3.3.3 Southern Garfish

Fishing for Southern Garfish has been prohibited since June 2017 and there was no retained or released catch of this species in 2021 (Figure 6). RSE was >40% (*i.e.*, non-robust) for all survey years for retained and released catch except for 2010 which had the highest retained catch of any survey year; 44,437 (95%CI 24,600 – 64,275). The release rate varied from 0% (2014, 2015) up to 64% in 2018, before decreasing to <50% in subsequent survey years.



**Figure 6** Estimated retained and released catch (95%CI) for Southern Garfish caught by shore fishers in the Perth Metropolitan area, calculated from the roving creel surveys. Note: (1) 3-month survey duration in 2010, and (2) fishery closed since June 2017.

### 3.3.4 Tailor

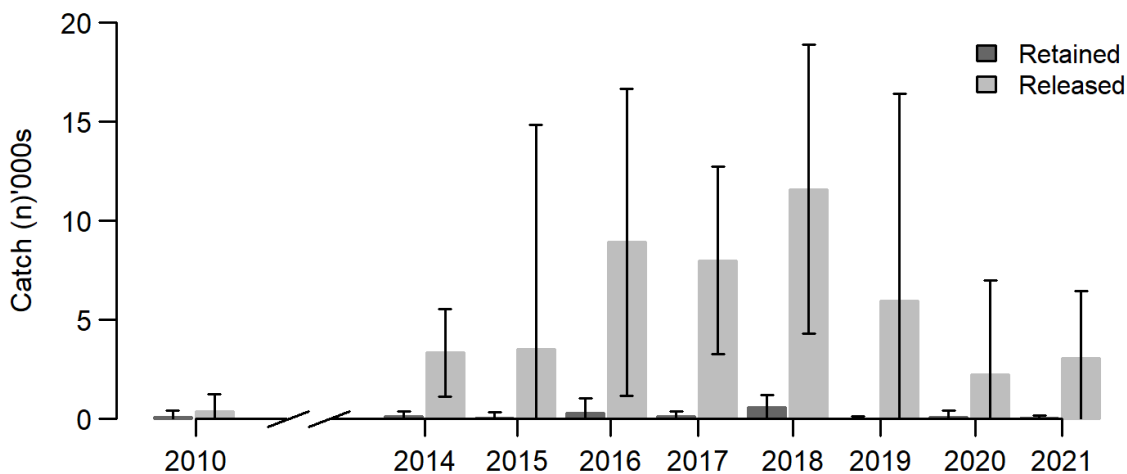
The retained catch of Tailor in 2021 was 1,974 (95%CI 95 – 3,853). Retained catch for this species was negligible across all survey years. RSE was >40% for all survey years for retained and released catches. The release rate was 36% in 2021 and ranged from 13% (2018) – 89% (2019).

### 3.3.5 Western Australian Salmon

The retained catch of Western Australian Salmon in 2021 was 265 (95%CI 0 – 1,612). Retained catch for this species was negligible across all survey years except for a peak in 2016, with 9,546 (0 – 19,620) in 2016. There was no retained or released catch of Western Australian Salmon in 2020. RSE was >40% for all survey years for retained and released catches. The release rate was 31% in 2021 and ranged from 0% (2010) – 66% (2015).

### 3.3.6 Pink Snapper

The retained catch of Pink Snapper in 2021 was 50 (95%CI 0 – 173). Retained catch for this species was negligible, and RSE was >40%, across all survey years. Although highly variable (indicated by large confidence intervals), the released catch was higher than retained in all survey years. RSE was ≤40% for released catch in 2014, 2017 and 2018. The release rate was 98% in 2021 and ranged from 95% (2018) – 99% (2019).

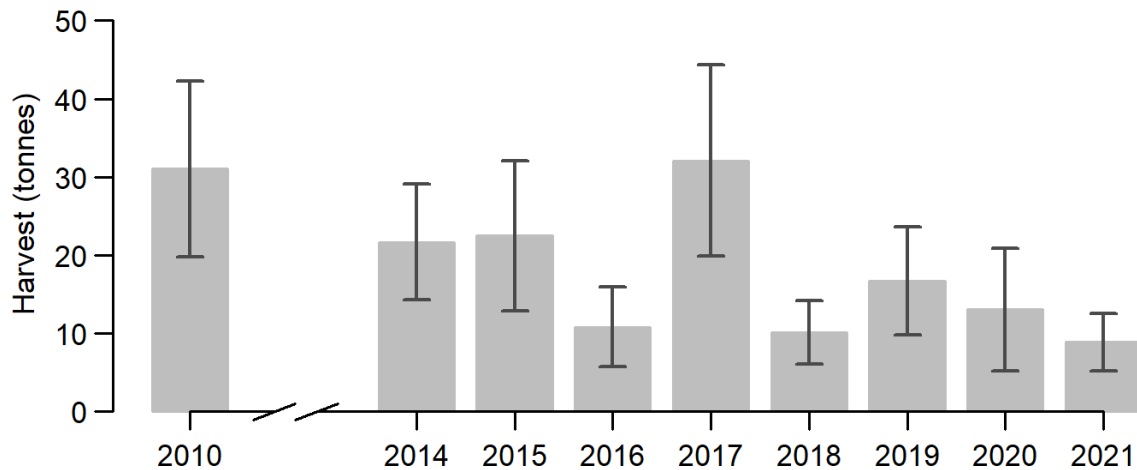


**Figure 7** Estimated retained and released catch (95%CI) for Pink Snapper caught by shore fishers in the Perth Metropolitan area, calculated from the roving creel surveys.

### 3.4 Harvest weights

#### 3.4.1 Australian Herring

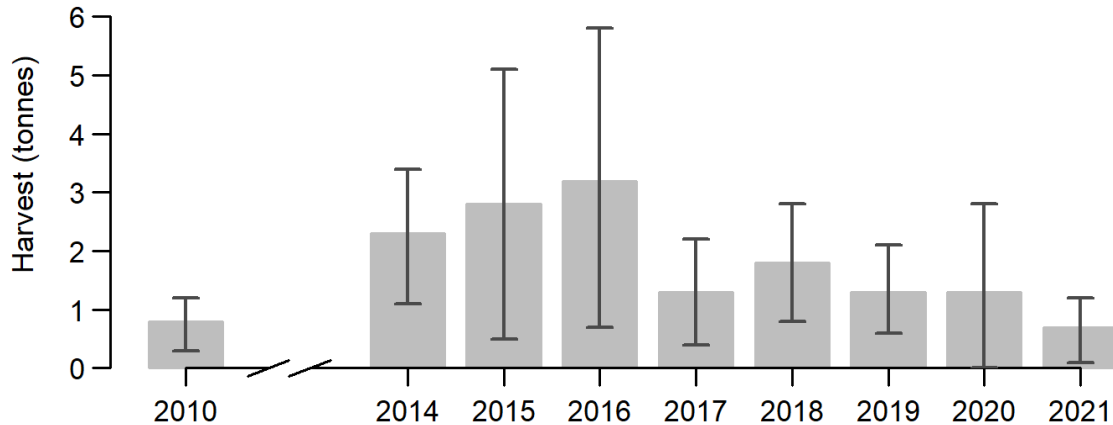
The harvest for Australian Herring in 2021 was 9 t (95%CI 5 – 13 t) and has been steady since 2018 (Figure 8). However, the harvest in 2021 was lower than achieved in 2010 (over a 3-month survey period), 2014 and 2017 with 31 t (95%CI 20 – 42), 22 t (14 – 29) and 32 t (20 – 44), respectively.



**Figure 8** Estimated harvest (95%CI) for Australian Herring caught by shore fishers in the Perth Metropolitan area, calculated from the roving creel surveys.  
Note: 3-month survey duration in 2010.

### 3.4.2 *Whiting spp.*

The harvest for Whiting spp. in 2021 was 1 t (95%CI 0 – 1 t) and has been steady since 2014, although large confidence intervals highlight the high uncertainty associated with harvest estimates (Figure 9). A similar harvest of 1 t (95%CI 0 – 1) was achieved in 2010 over a 3-month survey period.



**Figure 9** Estimated harvest range (95%CI) for Whiting spp. caught by shore fishers in the Perth Metropolitan area, calculated from the roving creel surveys. Note: 3-month survey duration in 2010.

### 3.4.3 *Southern Garfish*

There was no harvest of Southern Garfish in 2021. Harvest between 2014 – 2020 was negligible (0.1 – 1 t) while a harvest of 6 t (95%CI 3 – 9) was achieved in 2010 over a 3-month survey period.

### 3.4.4 *Tailor*

The harvest of Tailor in 2021 was 1 t (95%CI 0 – 2). Harvest has remained negligible for all survey years.

### 3.4.5 *Western Australian Salmon*

The harvest of Western Australian Salmon in 2021 was 2 t (95%CI 0 – 10). Harvest was low except for 2015 – 2017, when a peak of 58 t (95%CI 0 – 119) occurred in 2016, although the large confidence intervals highlight the high uncertainty associated with this estimate.

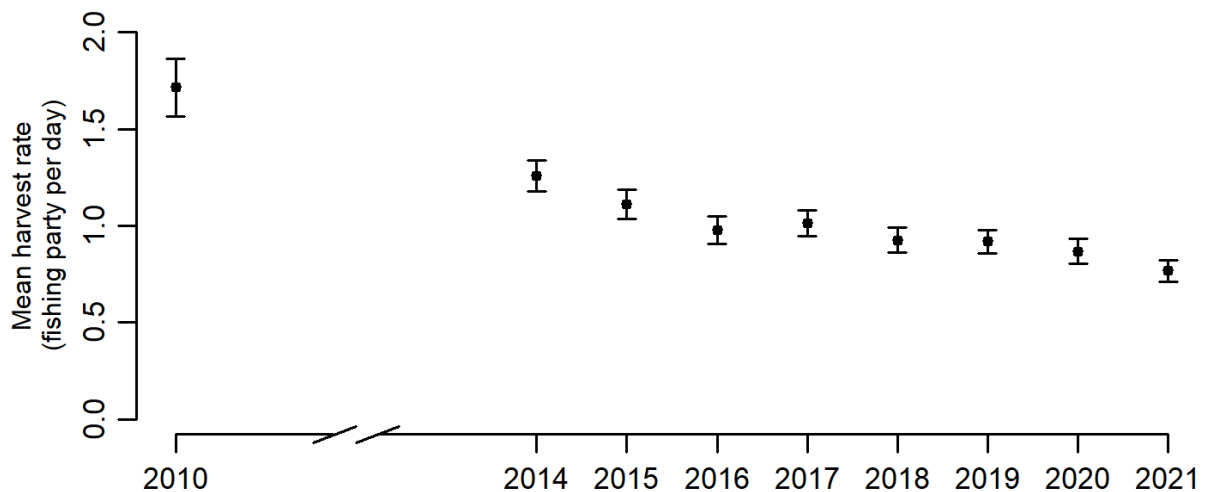
### 3.4.6 *Pink Snapper*

The harvest of Pink Snapper in 2021 was 0.1 t (95%CI 0 – 1). Harvest has remained negligible in all survey years.

### 3.5 Harvest rate

#### 3.5.1 Australian Herring

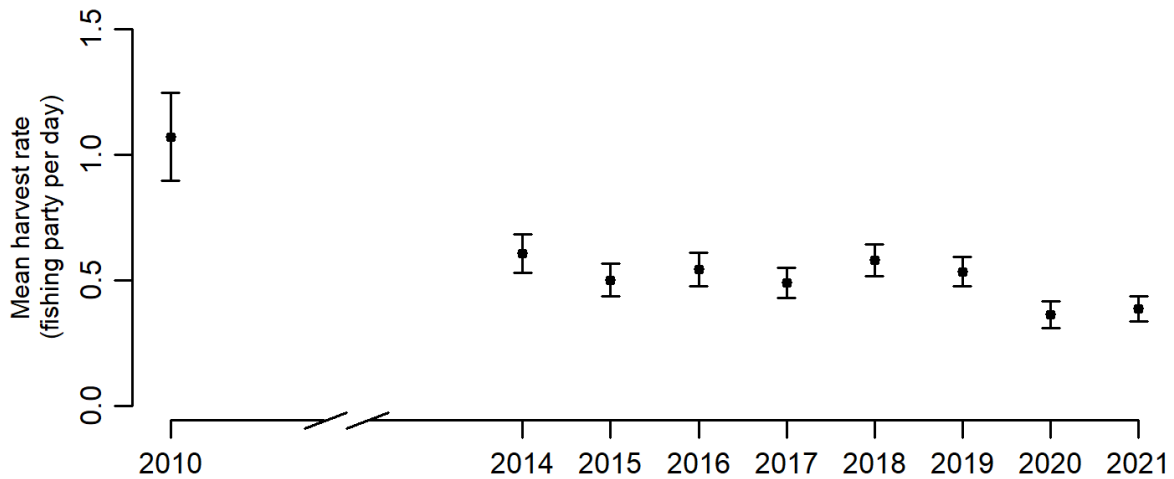
The standardised harvest rate (mean  $\pm$  SE) (retained catches) for Australian Herring in 2021 was  $0.76 \pm 0.05$  fish per fisher day. Harvest rates for this species showed a significant difference between 2010 and 2021 with decline from  $(1.71 \pm 0.15)$  to  $(0.76 \pm 0.05)$  (Figure 10, Appendix 5). There was no significant difference from 2017 ( $1.01 \pm 0.06$ ) to 2021.



**Figure 10** Standardised harvest rates ( $\pm$ SE) for Australian Herring based on data from the roving creel survey.

### 3.5.2 *Whiting spp.*

The standardised harvest rate (mean  $\pm$  SE) for Whiting spp. in 2021 was  $0.38 \pm 0.04$  fish per fisher day. There was no significant difference in harvest rate across all survey years, however the harvest rates from 2020 ( $0.36 \pm 0.05$ ) and 2021 were lower than 2010 ( $1.07 \pm 0.17$ ) (Figure 11, Appendix 5).



**Figure 11** Standardised harvest rates ( $\pm$ SE) for Whiting spp. based on data from the roving creel survey.

### 3.5.3 *Southern Garfish*

There was insufficient data to calculate standardised harvest rates for Southern Garfish.

### 3.5.4 *Tailor*

There was insufficient data to calculate standardised harvest rates for Tailor.

### 3.5.5 *Western Australian Salmon*

There was insufficient data to calculate standardised harvest rates for Western Australian Salmon.

### 3.5.6 *Pink Snapper*

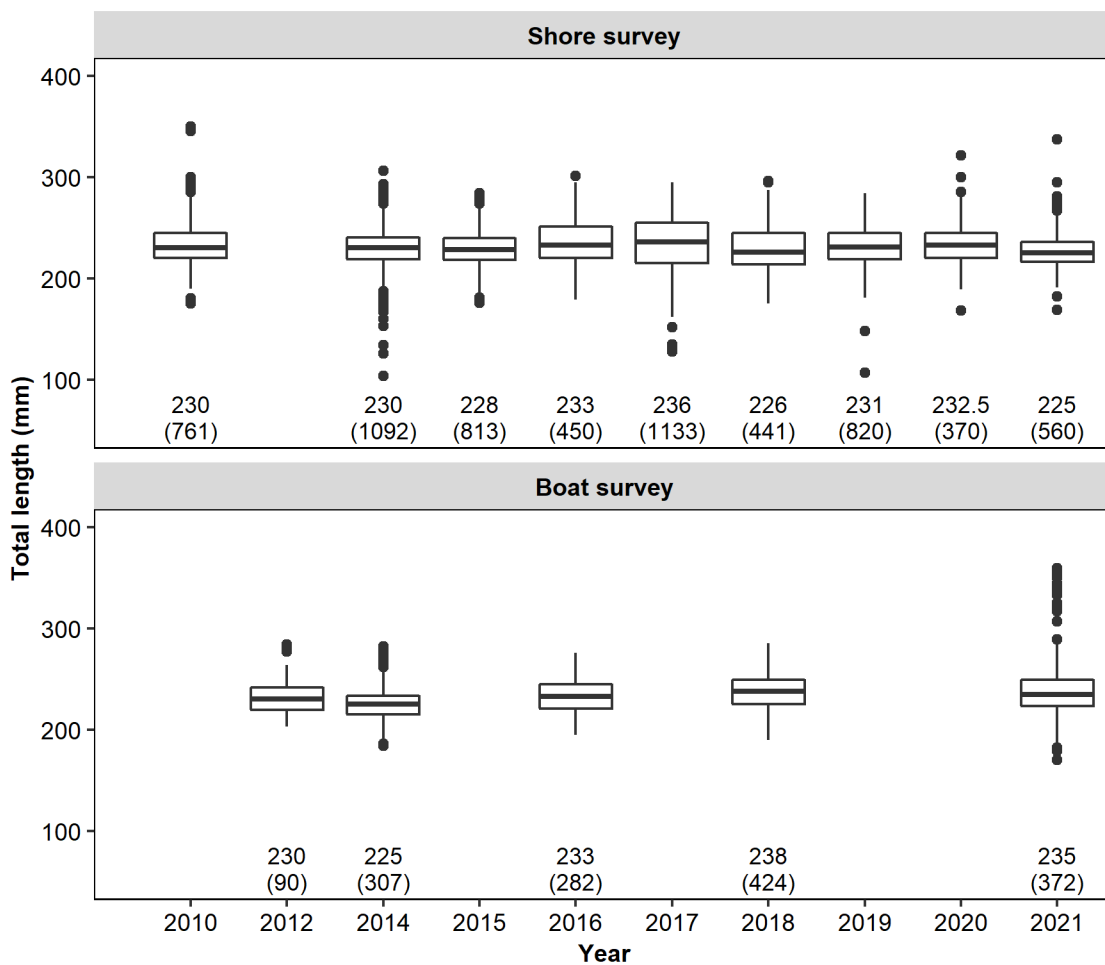
There was insufficient data to calculate standardised harvest rates for Pink Snapper.



### 3.6 Total length

#### 3.6.1 Australian Herring

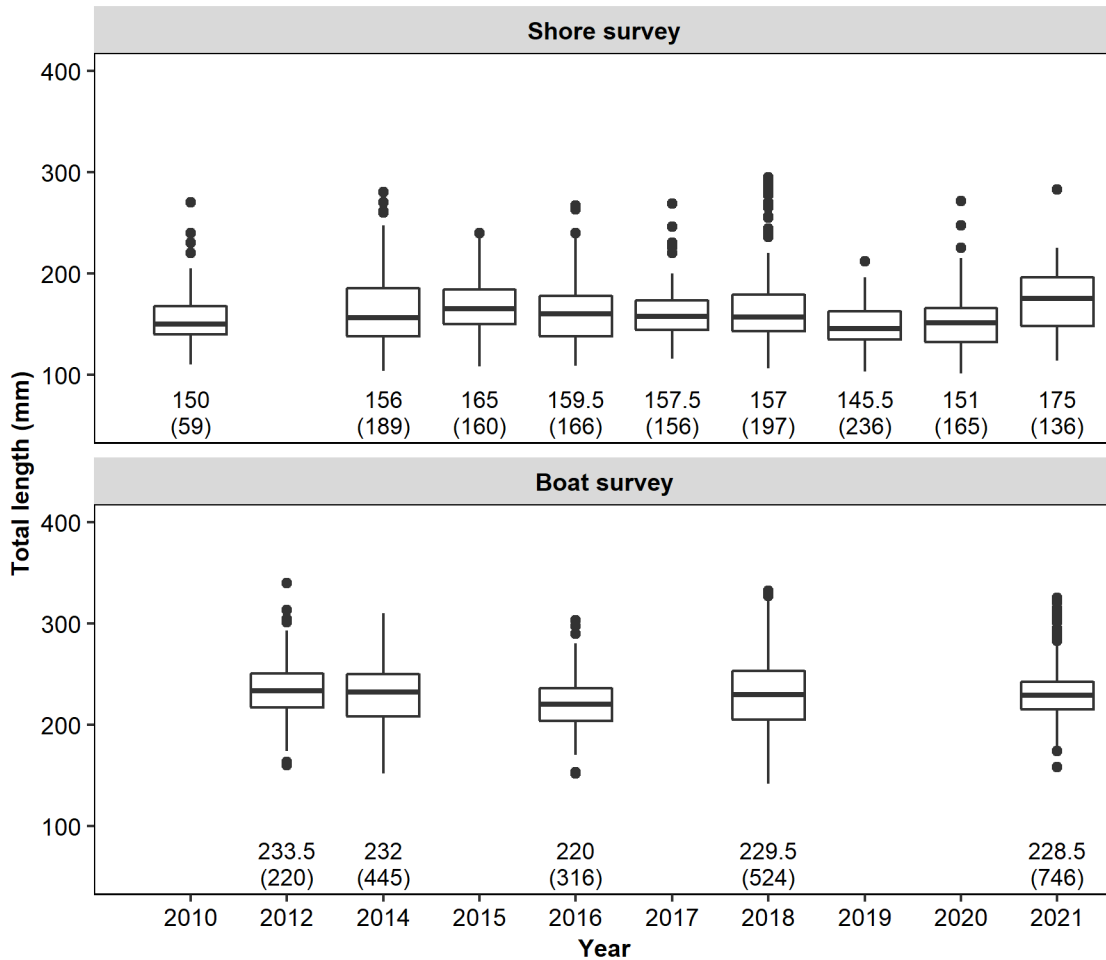
Median total length of Australian Herring for the shore survey in 2021 was 225 mm (Figure 12). There was a significant difference in median total length across survey years for both the boat (225– 238 mm,  $X^2 = 104.28, p < 0.05$ ) and shore (225– 236 mm,  $X^2 = 98.56, p < 0.05$ ) survey. In 2021 there was a significant difference in median length of Australian Herring caught by boat (235 mm) and shore fishers ( $X^2 = 53.11, p < 0.05$ ).



**Figure 12** Length-frequency distribution of Australian Herring caught by shore and boat fishers from roving creel and boat-ramp surveys including median total length (mm) and sample size (n) (in brackets). No minimum size limit for this species.

### 3.6.2 Whiting spp.

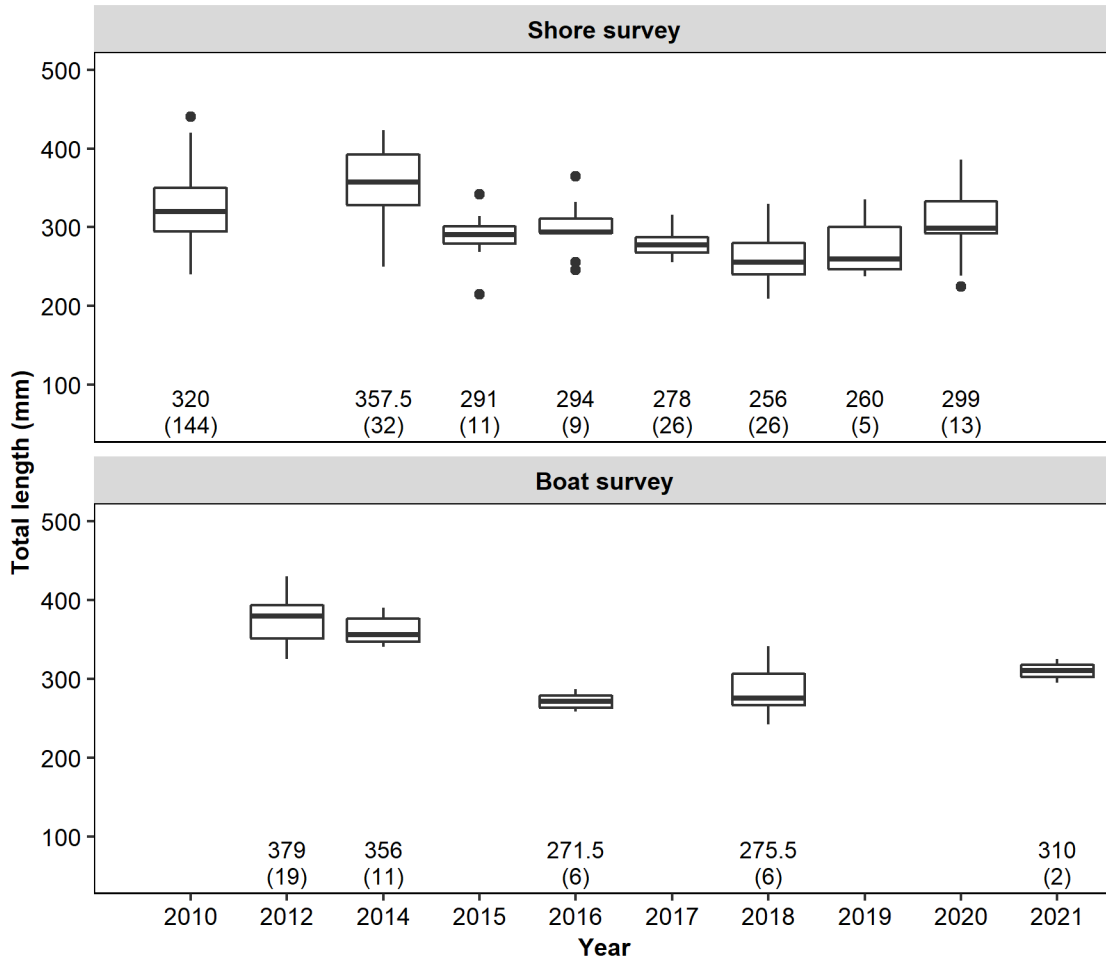
Median total length of Whiting spp. for the shore survey in 2021 was 175 mm (Figure 13). There was a significant difference in median total length across survey years for both boat (220 – 233.5 mm,  $X^2 = 36.16$ ,  $p < 0.05$ ) and shore surveys (145.5 – 175 mm,  $X^2 = 96.36$ ,  $p < 0.05$ ). In 2021 there was a significant difference in median length of Whiting spp. caught by boat (228.5 mm) and shore fishers ( $X^2 = 281.41$ ,  $p < 0.05$ ).



**Figure 13** Length-frequency distribution of Whiting spp. caught by shore and boat fishers from roving creel and boat-ramp surveys including median total length (mm) and sample size (n) (in brackets). No minimum size limit for this species.

### 3.6.3 Southern Garfish

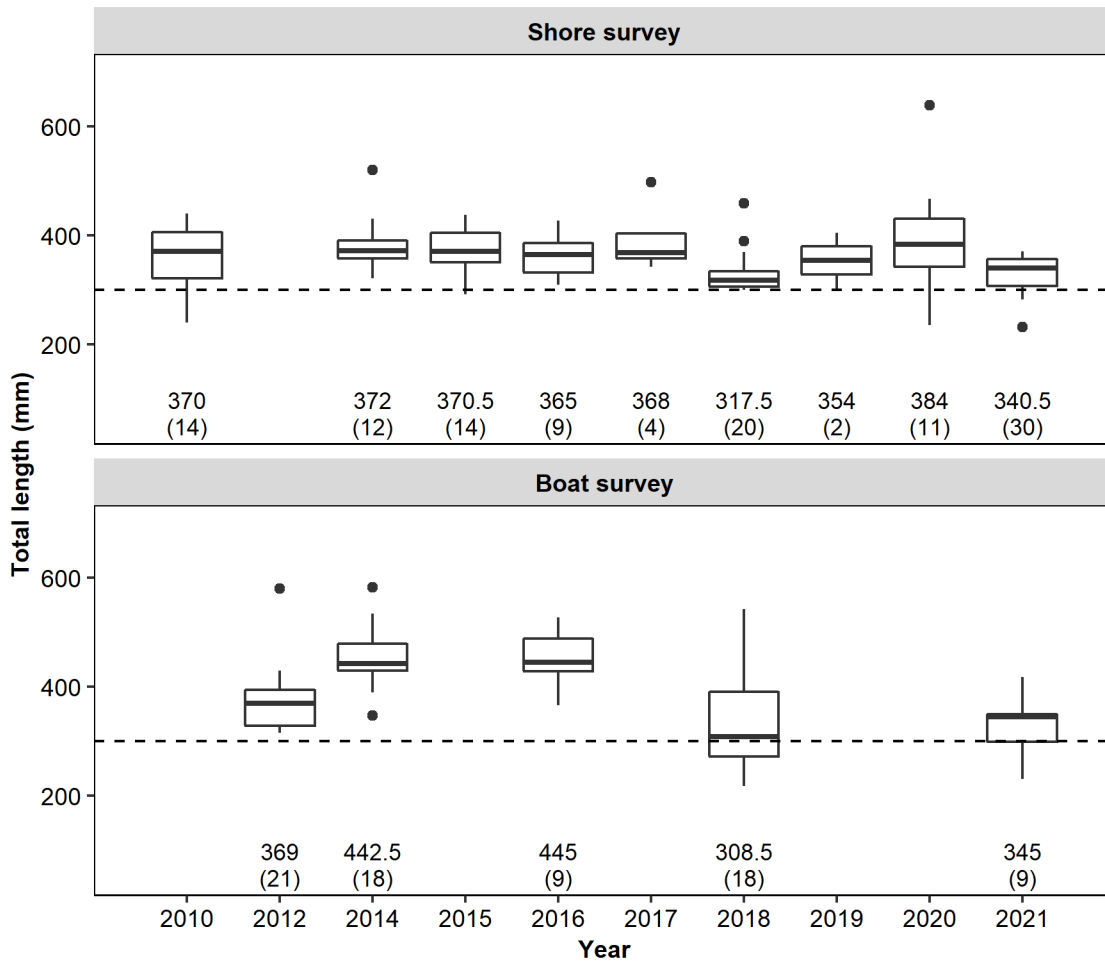
There were no length measurements obtained for Southern Garfish in the 2021 shore survey (Figure 14). There was a significant difference in the median total length of Southern Garfish across survey years for both the boat (271.5– 379 mm,  $X^2 = 27.923, p < 0.05$ ) and shore survey (256 – 357.5 mm,  $X^2 = 93.048, p < 0.05$ ).



**Figure 14** Length-frequency distribution of Southern Garfish caught by shore and boat fishers from roving creel and boat-ramp surveys including median total length (mm) and sample size (n) (in brackets). No minimum size limit for this species.

### 3.6.4 Tailor

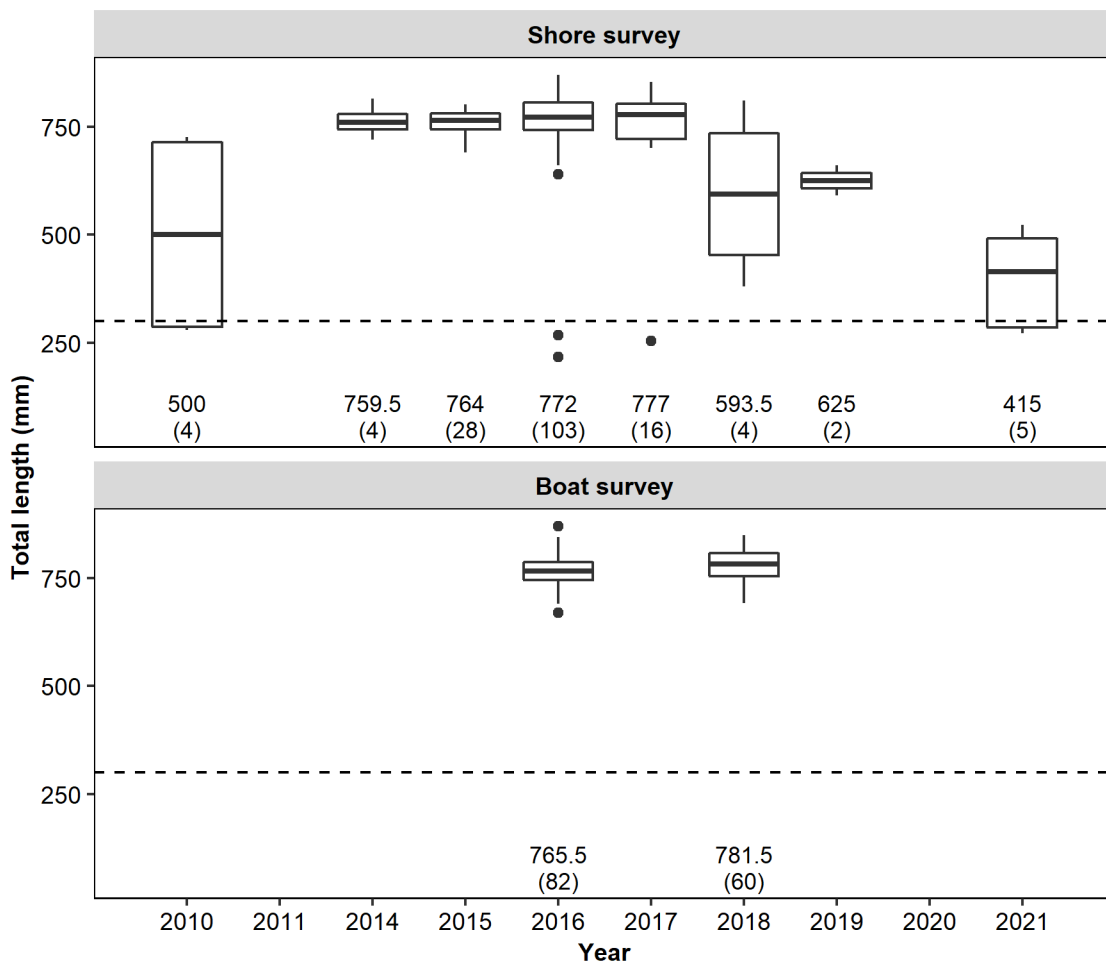
Median total length of Tailor for the shore survey in 2021 was 340.5 mm (Figure 15). There was a significant difference in median total length of Tailor across survey years for both the boat (308.5 – 445 mm,  $X^2 = 31.01, p < 0.05$ ) and shore survey (317.5 – 384 mm,  $X^2 = 25.927, p < 0.05$ ). In 2021 there was no difference in the median length of Tailor caught by boat (345 mm) and shore fishers ( $X^2 = 0.01, p = 0.907$ ).



**Figure 15** Length-frequency distribution of Tailor retained by shore and boat fishers from roving creel and boat-ramp surveys including median total length (mm) and sample size (n) (in brackets). Minimum size limit for this species (300 mm) indicated by dashed line.

### 3.6.5 Western Australian Salmon

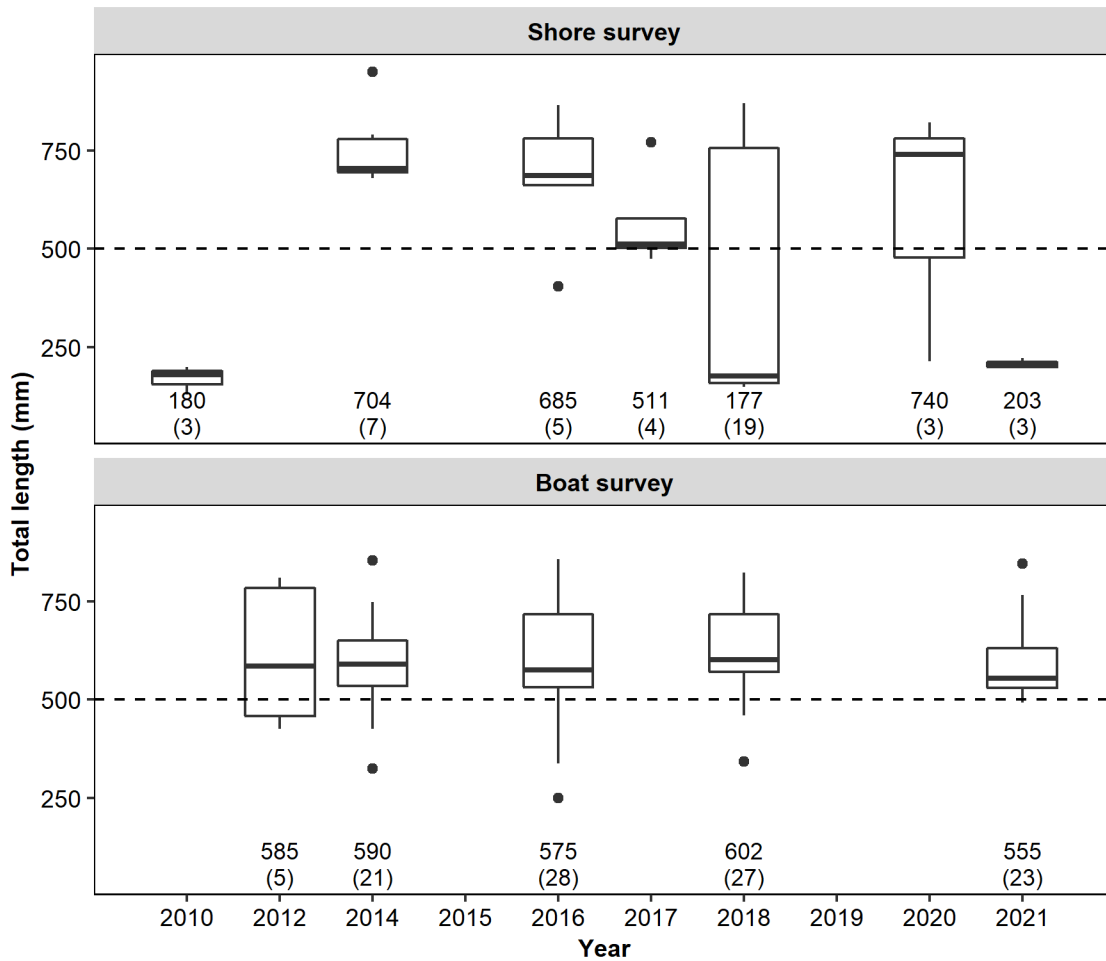
Median total length of Western Australian Salmon for the shore survey in 2021 was 415 mm, the smallest of all surveyed years (Figure 16). There were no length measurements obtained for Western Australian Salmon in the boat survey in 2012, 2014 or 2021, when comparing the difference in median total length of this species across survey years (2016 and 2018) there was a significant difference (765.5 – 781.5 mm,  $X^2 = 7.64, p < 0.05$ ). There was a significant difference in mean total length across survey years in the shore survey (415 – 777 mm,  $X^2 = 30.491, p < 0.05$ ).



**Figure 16** Length-frequency distribution of Western Australian Salmon retained by shore and boat fishers from roving creel and boat-ramp surveys including median total length (mm) and sample size (n) (in brackets). Minimum size limit for this species (300 mm) indicated by dashed line.

### 3.6.6 Pink Snapper

Median total length of Pink Snapper for the shore survey in 2021 was 203 mm (Figure 17). There was no significant difference in median total length of Pink Snapper across survey years for the boat (555 – 602 mm,  $X^2 = 3.11, p = 0.53$ ) or shore survey (180 – 740 mm,  $X^2 = 11.45, p = 0.07$ ). In 2021 there was a significant difference in the median length of Pink Snapper caught by boat (555 mm) and shore fishers ( $X^2 = 7.67, p < 0.05$ ).

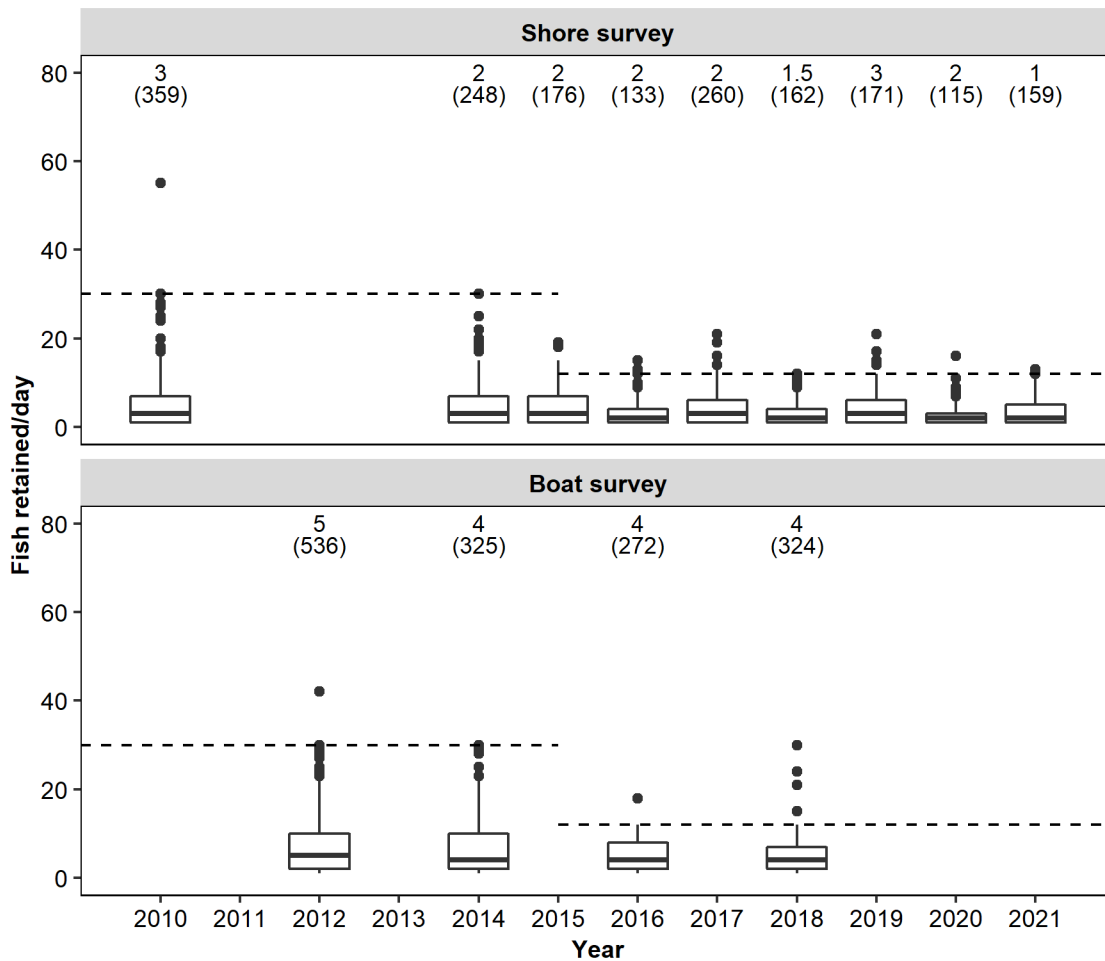


**Figure 17** Length-frequency distribution of Pink Snapper retained by shore and fishers from roving creel and boat-ramp surveys including median total length (mm) and sample size (n) (in brackets). Minimum size limit for this species (500 mm) indicated by dashed line.

### 3.7 Catch per fisher

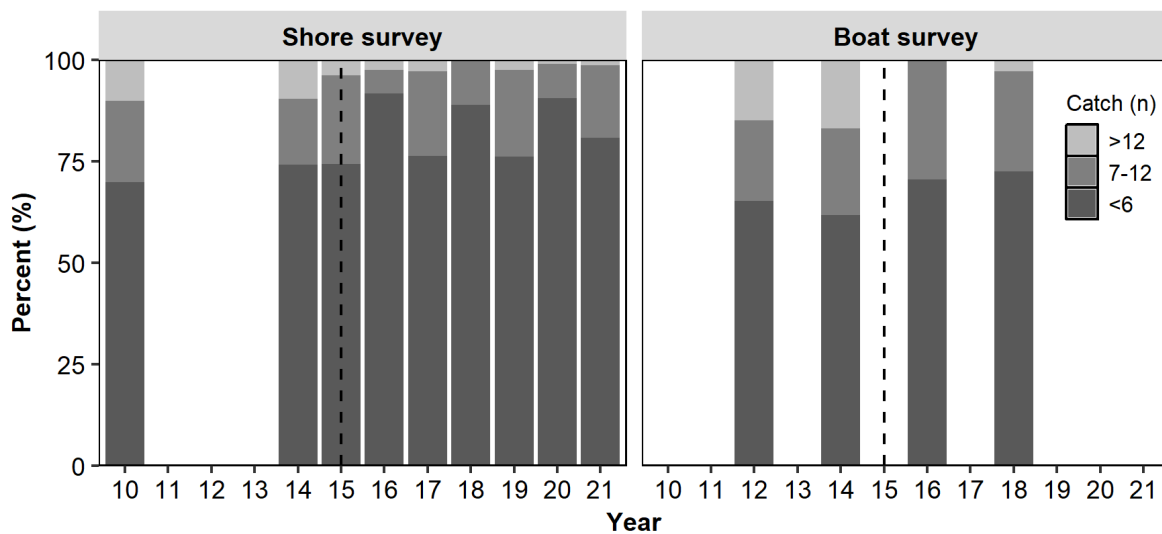
#### 3.7.1 Australian Herring

The median catch for Australian Herring for the shore survey in 2021 was 1 fish retained per fisher day, with a high of 3 achieved in 2010 and 2018 (Figure 18). Overall, the median catch was higher for boat fishers (4 fish retained per day per licensed fisher) than shore fishers (2).



**Figure 18** Catch frequency of Australian Herring retained by shore (fish retained per day per fisher) and boat fishers (fish retained per day per licensed fisher), calculated from raw data collected during roving creel and phone-diary surveys showing median catch per day and number of interviews (in brackets). Individual species daily bag limit (dashed line) reduced from 30 to 12 on 1 March 2015.

Prior to the introduction of a reduced daily bag limit in 2015 (from 30 to 12), <1% of shore and boat fishers were achieving the daily bag limit of 30 fish. The majority of shore (>90%) and boat (>83%) fishers retained <12 fish per day across all survey years (Figure 19). Non-compliance with bag limits was low, with <1% of shore and boat fishers exceeding the bag limit in any survey year. After the introduction of the reduced daily bag limit, the proportion of fishers retaining <12 fish per day was >98% and >97% for shore and boat fishers, respectively. Non-compliance with bag limits was still low after this change with 1% (n=17) of shore fishers and <1% (n=10) of boat fishers exceeding the daily bag limit of 12 fish (Figure 19).

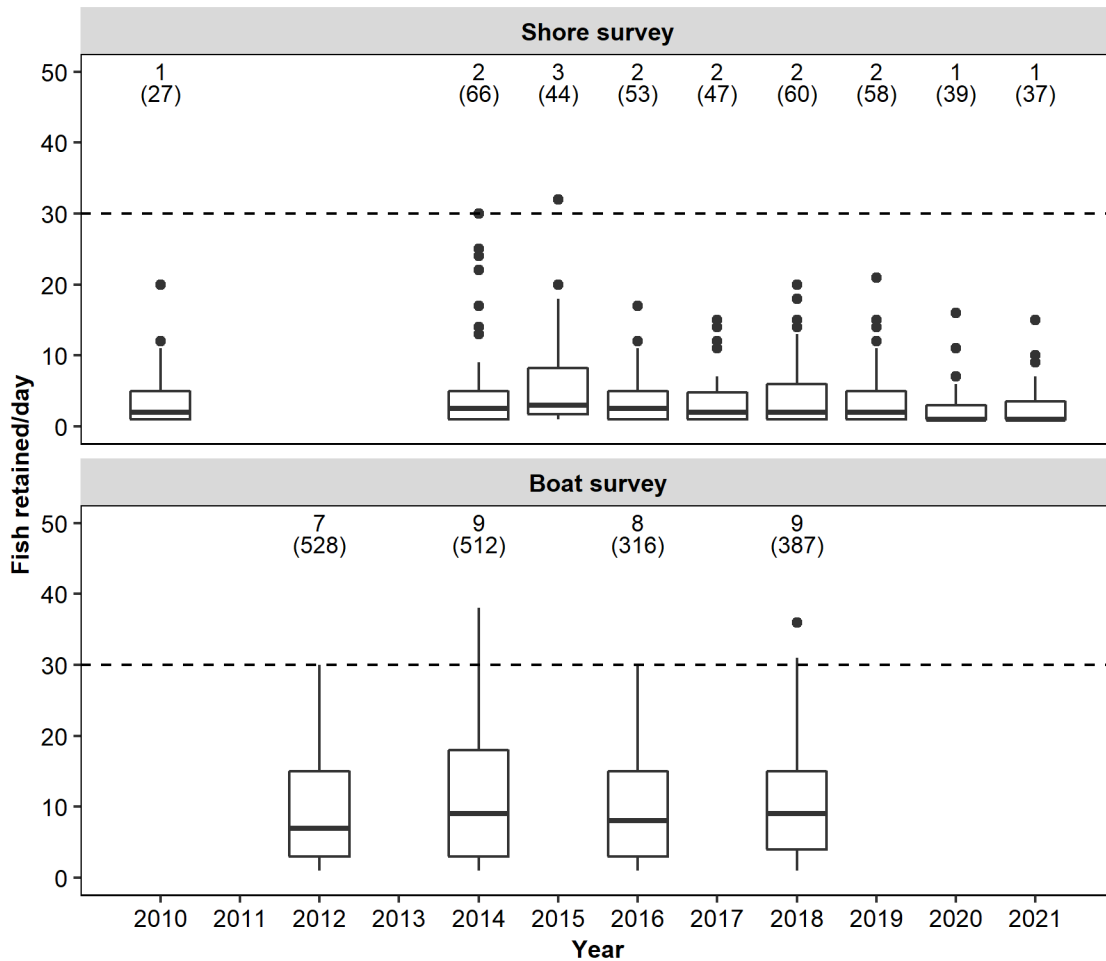


**Figure 19** Percentage fishers attaining each daily catch category of Australian Herring from the roving creel survey of shore fishers (number of fish per fisher day) and phone-diary surveys of boat fishers (number of fish per licence). Individual daily bag limit for Australian Herring reduced from 30 to 12 on 1 March 2015 (dashed line).



### 3.7.2 *Whiting spp.*

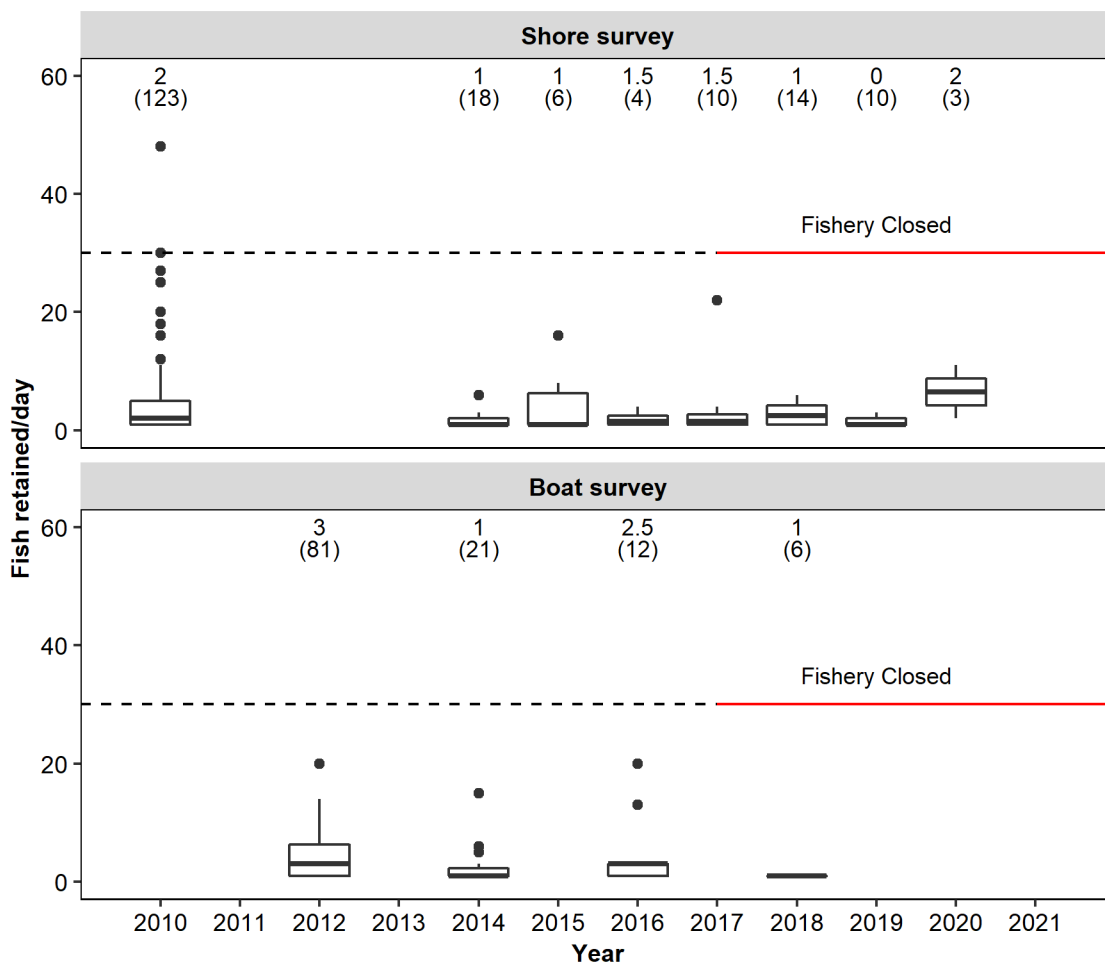
The median catch for *Whiting spp.* for the shore survey in 2021 was 1 fish retained per day per fisher, with a high of 3 achieved in 2015 (Figure 20). The number increased for the boat survey from 7 fish retained per day per licensed fisher in 2012 to 9 in 2018. The overall median catch frequency was higher for boat fishers (8) than shore fishers (2). Non-compliance with bag limits was low, with 1 shore fisher and 4 boat fishers exceeding the daily bag limit of 30 fish.



**Figure 20** Catch frequency of *Whiting spp.* retained by shore (fish retained per day per fisher) and boat fishers (fish retained per day per licensed fisher), calculated from raw data collected during roving creel and phone-diary surveys showing median catch per day and number of interviews (in brackets). The individual species daily bag limit (dashed line) has been 30 since 2010.

### 3.7.3 Southern Garfish

There was no catch for Southern Garfish in the 2021 shore survey (Figure 21). The median catch for the shore survey declined from 2010 (2 fish retained per day per fisher) to 2019 (0). The number of fish retained per day per licensed fisher declined for the boat survey from 3 in 2011 to 1 in 2018. The overall median catch frequency was 2 for both shore and boat fishers. Non-compliance with bag limits was low, with <1% (n = 1) of shore fishers and no boat fishers exceeding the daily bag limit of 30 fish from 2010 until 2017 when fishing for this species in the survey area closed. However, 39% of shore fishers (n = 13) and 15% (n = 5) of boat fishers retained catch of this species after the closure commenced.



**Figure 21** Catch frequency of Southern Garfish retained by shore (fish retained per day per fisher) and boat fishers (fish retained per day per licensed fisher), calculated from raw data collected during roving creel and phone-diary surveys showing median catch per fisher day and number of interviews (in brackets). Individual species daily bag limit (dashed line) was 30 until the fishery was closed in Perth Metropolitan waters in June 2017 (red line).

### **3.7.4 Tailor**

Across all survey years, the median catch for Tailor caught by shore fishers was 1 fish retained per day per fisher and 2 for boat fishers. Non-compliance with bag limits was low, with no shore fishers and 1 boat fisher exceeding the daily bag limit of 8 fish.

### **3.7.5 Western Australian Salmon**

Across all survey years, the median catch for Western Australian Salmon was 1 for both shore and boat fishers. Non-compliance with bag limits was low, with 1 shore fisher and 2 boat fishers exceeding the daily bag limit of 4 fish.

### **3.7.6 Pink Snapper**

Across all survey years the median catch for Pink Snapper was 1 for boat fishers and <1 for shore fishers. Non-compliance with bag limits was low, with 2 shore fishers and no boat fishers exceeding the daily bag limit of 2 fish.

## **3.8 Targeting**

The top target species (across all survey years) were unspecified demersal fish (27%), Australian Herring (25%), Western Australian Salmon (9%), Pink Snapper *Chrysophrys auratus* (8%), unspecified pelagic fish (6%), Tailor (5%), Whiting spp. (5%), Squid (Family Teuthoidea, 5%), Mulloway (*Argyrosomus japonicas*, 1%) and Silver Trevally (*Pseudocaranx georgianus*, 1%) (Table 4).

Overall, 74% of fishing parties had caught (retained or released) a fish in 2021. This was an increase from previous survey years where 53 – 63% of fishing parties had caught a fish. Target species were not specified by 32% of fishing parties. Of these, 45% and 46% of fishers targeting unspecified demersal and pelagic fish, respectively, did not catch a fish. Fishing parties that did catch a fish when targeting unspecified demersal fish species predominantly caught Toadfish (6%), Australian Herring (6%), Tarwhine (5%) and Pink Snapper (4%). Successful fishers targeting unspecified pelagic fish predominantly caught Australian Herring (14%), Toadfishes (Tetraodontidae, 7%), Southern Garfish (4%) and Silver Trevally (3%).

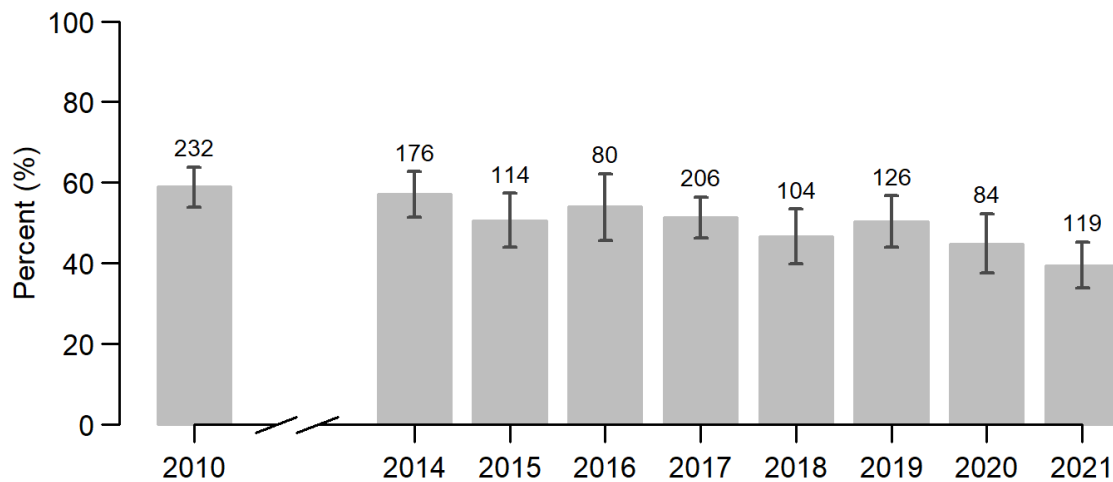
**Table 4** Top species targeted by shore fishers in the Perth Metropolitan area and the percentage of fishing parties targeting each one (with rank in brackets). Note: species were selected based on their combined targeting across all survey years. Note: \* Perth Metropolitan waters closed to Southern Garfish fishing.

	2010	2014	2015	2016	2017	2018	2019	2020	2021
<b>Unspecified Demersal Fish</b>	20% (2)	36% (1)	28% (1)	26% (1)	27% (2)	32% (1)	19% (2)	26% (1)	24% (2)
<b>Australian Herring</b> <i>Arripis georgianus</i>	35% (1)	26% (2)	21% (2)	13% (3)	30% (1)	18% (2)	28% (1)	25% (2)	30% (1)
<b>Western Australian Salmon</b> <i>Arripis truttaceus</i>	5% (6)	3% (8)	12% (3)	25% (2)	14% (3)	7% (4)	6% (7)	3% (9)	1% (10)
<b>Pink Snapper</b> <i>Chrysophrys auratus</i>	<1% (14)	3% (7)	8% (4)	9% (4)	6% (4)	12% (3)	15% (3)	15% (3)	8% (3)
<b>Unspecified Pelagic Fish</b>	14% (3)	5% (4)	5% (7)	7% (5)	4% (5)	4% (8)	3% (8)	3% (8)	5% (7)
<b>Tailor</b> <i>Pomatomus saltatrix</i>	7% (4)	6% (3)	7% (5)	3% (8)	3% (7)	5% (7)	7% (6)	5% (6)	7% (5)
<b>Whiting spp.</b> <i>Sillago spp</i>	3% (8)	4% (5)	5% (8)	5% (6)	4% (6)	6% (5)	7% (5)	5% (5)	6% (6)
<b>Squid</b> <i>Teuthoidea</i>	4% (7)	4% (6)	6% (6)	3% (9)	3% (8)	6% (6)	7% (4)	6% (4)	7% (4)
<b>Mulloway</b> <i>Argyrosomus japonicas</i>	1% (10)	2% (11)	2% (9)	1% (11)	1% (10)	1% (11)	1% (10)	<1% (13)	1% (11)
<b>Silver Trevally</b> <i>Pseudocaranx georgianus</i>	2% (9)	<1% (24)	<1% (16)	<1% (14)	1% (9)	1% (10)	1% (9)	<1% (22)	2% (9)
<b>Garfish spp. <i>Hyporhamphus melanochir</i> &amp; <i>Hemiramphus robustus</i></b>	5% (5)	1% (12)	1% (10)	<1% (16)	<1% (15)	<1% * (18)	<1% * (20)	1% * (11)	<1% * (21)

### 3.8.1 Australian Herring

Australian Herring was one of the most frequently targeted species in any survey year (Table 4). In 2021, this species was targeted by 30% (n = 341) of shore fishing parties. All survey years, except 2016 (13%, n = 215) and 2018 (18%, n = 324), were within the range of 20 – 30%, with a maximum of 35% (n = 516) in 2010.

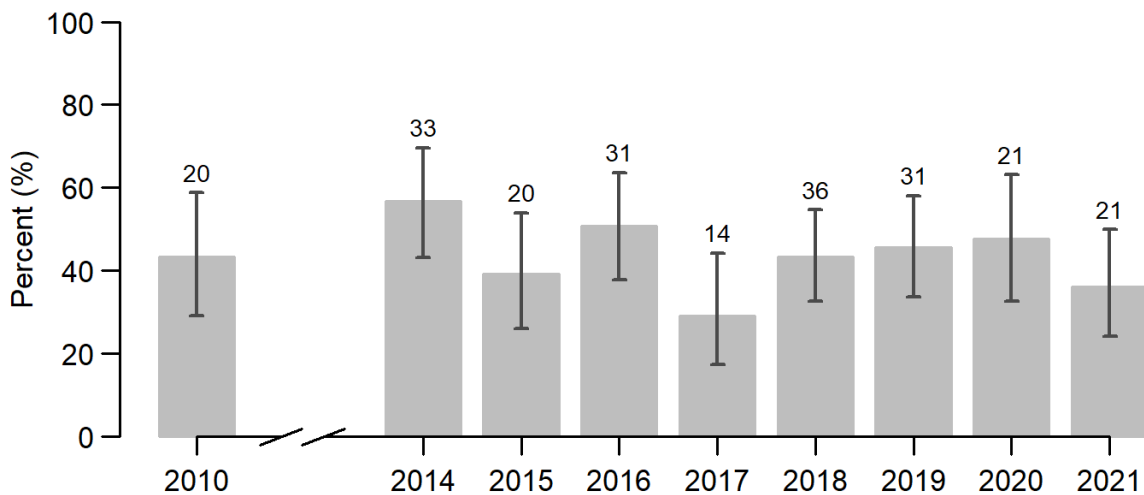
In 2021, 39% (n = 119, 95% CI 34 – 45%) of shore fishing parties targeting Australian Herring were successful in catching (retained or released) one or more of this species (Figure 22). This trend remained steady across all survey years (as indicated by overlapping confidence intervals).



**Figure 22** Proportion (95%CI), and number (indicated at top of each bar) of shore fishing parties successful in catching (retained or released) an Australian Herring when targeting this species

### 3.8.2 *Whiting spp.*

Whiting spp. were targeted by 6% (n = 68) of shore fishing parties in 2021, which was within the range of all previous years (3 – 7%) (Table 4). In 2021, 36% (95% CI 24 – 50%) of shore fishing parties targeting Whiting spp. were successful in catching one or more of this species. This trend remained steady across all survey years (Figure 23).

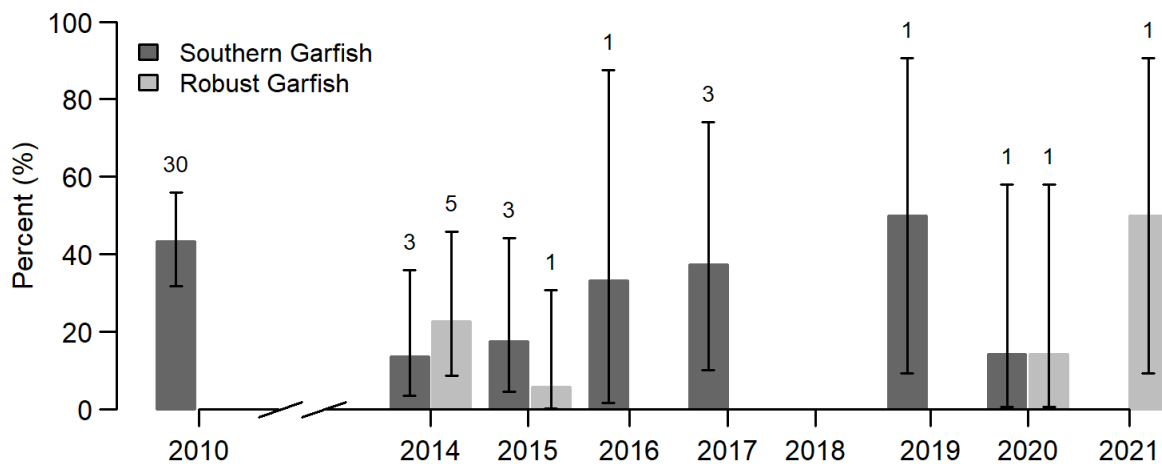


**Figure 23** Proportion (95%CI) and number (indicated at top of each bar) of shore fishing parties successful in catching (retained or released) a Whiting spp. when targeting this species.

### 3.8.3 *Garfish spp.*

Fishing parties targeting Garfish spp. included all species from Family Hemiramphidae, namely Southern Garfish and Robust Garfish (*Hemiramphus robustus*), which are distributed in Perth Metropolitan waters. Garfish spp. were targeted by 5% of shore fishing parties in 2010 but this proportion has declined to <1% in all subsequent survey years (Table 4).

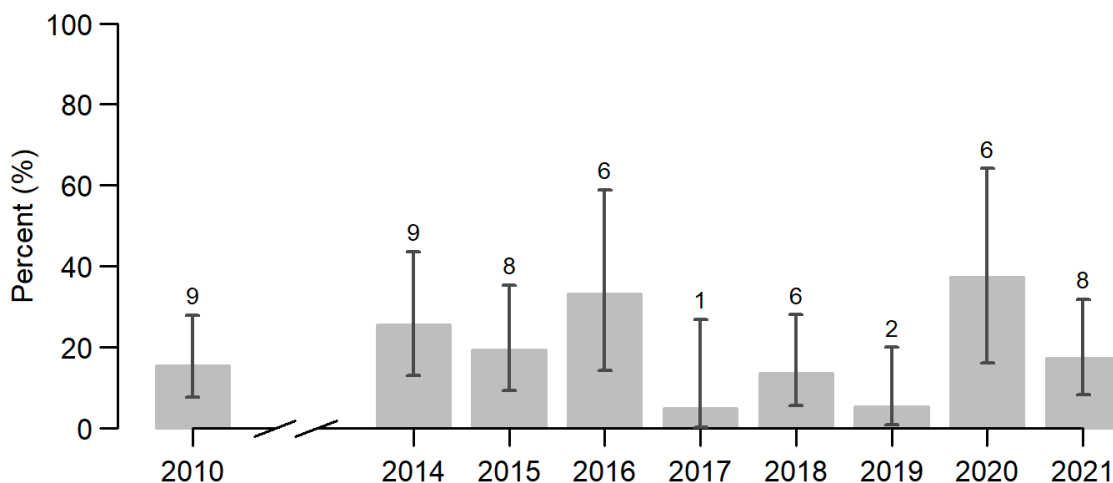
In 2021, no shore fishing parties targeting Garfish spp. (n=2) were successful in catching a Southern Garfish, however one fishing party was successful in catching Robust Garfish (Figure 24). The success of shore fishers in catching (retained or released) a Southern Garfish was variable across all survey years, and small numbers of fishers were successful in catching Southern Garfish during the closure (Figure 24).



**Figure 24** Proportion (95%CI) and number (indicated at top of each bar) of shore fishing parties successful in catching (retained or released) Southern or Robust Garfish when targeting Garfish spp. (*H. melanochir* and *H. robustus*).

### 3.8.4 Tailor

Tailor were targeted by 7% (n=88) of shore fishing parties in 2021, which was the highest of all survey years (3 – 7%) (Table 4). In 2021, 17% (n=8) of shore fishing parties targeting Tailor were successful in catching one or more of this species (Figure 25).

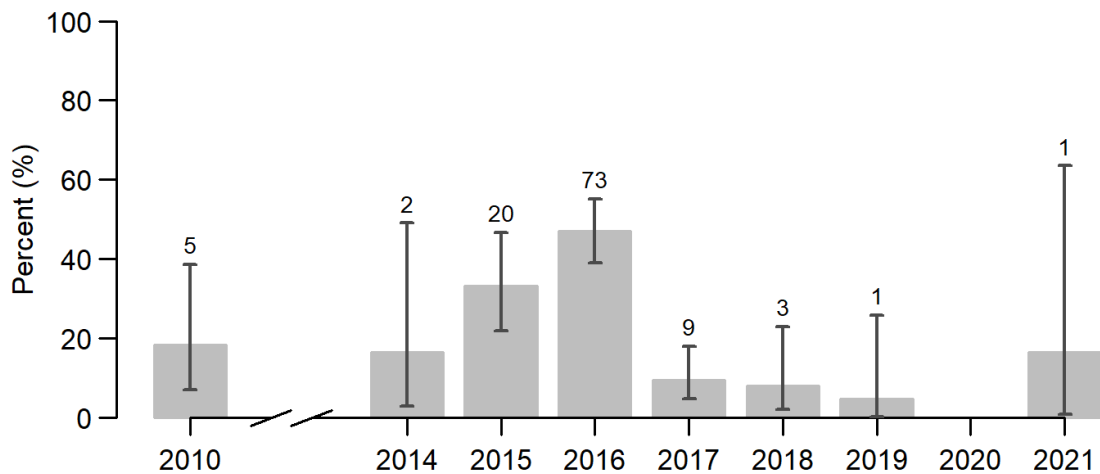


**Figure 25** Proportion (95%CI) and number (indicated at top of each bar) of shore fishing parties successful in catching (retained or released) Tailor when targeting this species.

### 3.8.5 Western Australian Salmon

Western Australian Salmon were targeted by 1% (n=16) of shore fishing parties in 2021 (Table 4). The proportion targeting this species varied between survey years, with a peak of 25% (n=406) in 2016, with all others between 3 – 14%.

In 2021, only 1 fishing party targeting Western Australian Salmon was successful in catching a fish (17%). The success of fishers catching this species was low from 2017 – 2020 (0 – 9% fishers targeting) compared with earlier surveys from 2010 – 2016 (16 – 47%) (Figure 26).



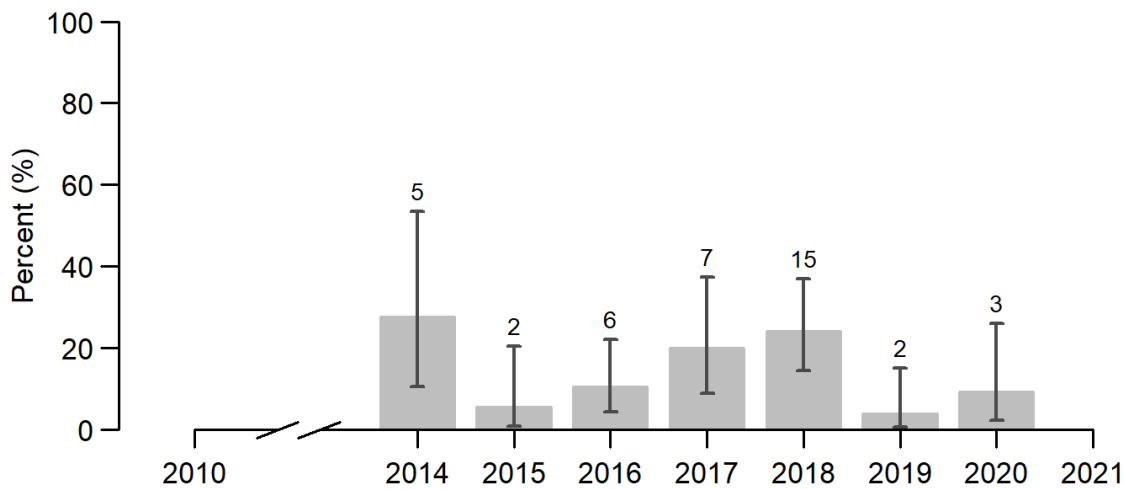
**Figure 26** Proportion (95%CI) and number (indicated at top of each bar) of fishing parties successful in catching (retained or released) a Western Australian Salmon when targeting this species.



### 3.8.6 Pink Snapper

Pink Snapper were targeted by 8% (n=98) of shore fishing parties in 2021 and has been the third most frequently targeted species annually since 2018 (12 – 15%) (Table 4). This has increased from 2010 where <1% of fishing parties were targeting this species.

In 2021, no fishing parties targeting Pink Snapper were successful in catching a fish. The success of fishers catching this species was low from 2019 – 2020 (0 – 9%) when compared with earlier surveys in 2014 (28%), 2017 (20%) and 2018 (24%), although the variability was high in all survey years (Figure 27).



**Figure 27** Proportion (95%CI) and number (indicated at top of each bar) of fishing parties successful in catching (retained or released) a Pink Snapper when targeting this species.

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## 4.0 Discussion

Unlike boat-based recreational fishing, there are no statewide estimates of total catch and effort for shore-based recreational fishing in Western Australia. *Ad hoc* roving creel surveys had been used prior to 2014 to provide intermittent data on fishing effort and total catch to meet specific research objectives (Tate et al., 2020b). However, since 2014 a roving creel survey has used a consistent spatio-temporal sampling frame to provide annual estimates of fishing effort, total catch and standardised harvest rate for key nearshore species (Australian Herring, Whiting spp., Southern Garfish, Tailor, Western Australian Salmon and Pink Snapper) in the Perth Metropolitan area. The five-month survey period was selected as it covers a large proportion of the peak period of fishing activity in this area.

### 4.1 Trends in the nearshore shore-based recreational fishery

Fishing effort by shore fishers in the Perth Metropolitan area has been relatively consistent across all survey years, however, there has been some decline since a peak in 2016. A possible reason for this peak could be fishing activity related to the strong Western Australian Salmon migration in that year, as indicated by increased targeting and harvest of this species.

Fishing effort did not decrease in April – May 2020 when restrictions on outdoor non-work gatherings were in place during the first-wave of COVID-19 (Government of Western Australia, 2020). Although recreational fishing was initially discouraged, it was a permitted activity for fishing parties from the same household during this time (Ryan et al., 2021). This study showed fishing effort from shore fishers in 2020 was consistent with adjacent years (2019 and 2021).

Australian Herring has contributed the highest proportion of retained catch in all survey years (up to 41 – 64%). The catch trends for this species therefore broadly reflect catch trends for all species combined with 2010, 2014 and 2017 significantly higher than in 2021. Whiting spp. was the second ranked species in all years except 2010, where this position was held by Southern Garfish. This was similar to boat fishers, in which Australian Herring and Whiting spp. contributed the highest proportions to the total catch (by numbers) for the Metropolitan zone across the 12-month survey period (Ryan et al., 2019). Silver Trevally and Squid were other species frequently caught (retained or released) by both shore and boat fishers, while Yellowtail Scad (*Trachurus novaezelandiae*), Scaly Mackerel (*Sardinella lemuru*), and Western Striped Grunter and Western Butterfish ranked consistently in the top-ten species caught by shore fishers only.

The overall (all species combined) release rate by shore fishers increased over time from 17% in 2010 up to 50% in 2021. Release rates for Pink Snapper by shore fishers were the highest of the key species (95 – 99%) whereas boat fishers in the Perth Metropolitan Zone release rates ranged from 70 – 78% (Ryan et al., 2019, 2017, 2015, 2013). Release rates for Australian Herring by shore fishers was lower (5 – 12%) than boat fishers (15 – 24%) across all surveyed years. A similar pattern

was also seen for Whiting spp. with 7 – 23% released by shore fishers and 20 – 24% released by boat fishers. Although the reason for releasing fish is unknown for shore fishers, the main reason identified by boat fishers for releasing Australian Herring and Whiting spp. was “too small”, which relates to the fish being too small in terms of personal preference (Ryan et al., 2019). However, the main reason for releasing Pink Snapper was “undersize”, which indicates catches below the Minimum Legal Limit (MLL).

Australian Herring was also the most frequently targeted (13 – 35%) species in all survey years. Fishing parties targeting this species were also successful in catching one or more during their fishing trip (31 – 45%). Of the 6% of the shore fishing parties targeting Whiting spp., 21 – 47% were successful in catching a fish. The targeting preferences of shore fishing parties also changed depending on the availability of a species, such as occurred in 2016 which was a particularly strong year for the migration of Western Australian Salmon. This resulted in both targeting and catches of this species increasing. The reasons for recreational fishing are varied, from catching a feed, to relaxing, and although fishers may be satisfied with their fishing trip without catching a fish (Frijlink and Lyle, 2010; Ogier et al., 2018) understanding the likelihood of catching a fish may be a useful measure of angler satisfaction.

A previous study of national recreational fishing catch used off-site survey methods to estimate catch and effort of boat and shore-based fishing, finding catches of nearshore species were higher from shore fishers than boat fishers (Henry and Lyle, 2003). However, the differences in the spatial and temporal frame of the current roving creel and phone diary surveys do not allow for an ongoing comparison between the harvest of key species which may be caught by boats and the shore, such as Pink Snapper. Each survey method achieves its desired objectives by providing estimates of fishing effort and total catch at broad (phone-diary survey) and small-scales (roving creel survey). Without additional sampling of shore fishers, direct comparison of the proportion of catch obtained from each fishing platform cannot be undertaken. Implementing on-site surveys across broad-scales are generally cost-prohibitive while without a licence, off-site methods are not able to be applied to this fishery.

## **4.2 Management**

The management arrangements for many nearshore species in the West Coast Bioregion are focused on bag and size limits, with few spatial and temporal closures (Department of Primary Industries and Regional Development, 2021). An exception to this is the closure of Perth Metropolitan waters to fishing for Southern Garfish in 2017 (Smith et al., 2017).

There are MLL in place for three of the focus species for this report; Tailor, Western Australian Salmon and Pink Snapper. Compliance with MLL was high, especially for Tailor and Western Australian Salmon, with less than 10% of random length measurements in both the boat and shore survey being undersize. For Pink Snapper, 23% of those retained were undersized. Juvenile Pink Snapper have similar biological characteristics to Tarwhine (*Rhabdosargus sarba*) and Black bream

(*Acanthopagrus butcheri*) which could explain the higher non-compliance for this species in the shore survey, where the likeness could confuse less avid fishers catching these species.

The daily bag limit for Australian Herring was reduced from 30 to 12 in 2015 (Smith *et al.*, 2013a). Prior to the introduction of bag limit changes, very few shore or boat fishers were achieving the daily bag limit of 30 fish (less than <1%). However, >90% were achieving the proposed daily bag limit of 12 fish. Reduction in the daily bag limit therefore affected very few recreational fishers. The proportion of fishers achieving the daily bag limit since 2015 has remained relatively consistent (>98%).

Compliance with bag limits for other key species was very high with <1% of fishers exceeding the daily bag limit for Whiting, Tailor, Western Australian Salmon and Pink Snapper. However, 6% of fishers were non-compliant with bag limits and spatial closures for Southern Garfish. There was no catch for this species in 2021, with negligible catches (<1 t) from 2014 – 2020. This could be for a number of reasons including, misidentification with the closely related Robust Garfish, lack of awareness of the closure, or deliberate ignoring of fishing rules.

There have been no recent changes to the management regulations to Whiting spp., Tailor and Western Australian Salmon. The long-term monitoring of these, and other nearshore species, is important to provide an understanding of changes in catches over time, and to be incorporated into stock assessments and inform potential changes to management. There is also a need to understand catches of demersal species, such as Pink Snapper, that are caught from boats and the shore.

The current roving creel survey is undertaken in a single location (Perth Metropolitan area) which is assumed to be representative of broader stocks and fishing activity. However, many of these nearshore species are distributed across both the West Coast and South Coast bioregions, which have different management arrangements for some species. Additional survey locations could be selected in these bioregions to monitor and compare fishing effort, catch rate and total catch with the existing roving creel survey.

There are a broad range of environmental, biological variables and management changes that can affect recreational fishing. The significant annual variability in the catches of some species may be linked to environmental rather than management changes. Similar to data obtained from commercial fisheries, fishery-dependent data from shore-based recreational fisheries are subject to influential factors that can affect variability in harvest rate. These indices can be used for assessing the status of individual species or a fishery, and in some cases, as indicators of stock abundance. The harvest rate for Australian Herring and Whiting spp. is lower in 2021 when compared to 2010. These results are consistent with fishery independent and dependent sampling around the same time (Smith *et al.*, 2017; Smith *et al.*, 2013a).

#### **4.3 Future research**

Roving creel surveys of shore fishers are required to continue to help inform management of nearshore species until more cost-effective catch and effort data for shore-based recreational fishing are available. Several areas have been identified

which could further assist with improving the knowledge of shore-based recreational fishing including; recent statewide surveys of Recreational Boat Fishing Licence holders which have collected data on their shore fishing activity, catch reconstruction (utilising a variety of data and information sources to construct a time series of catch estimates) and further development of an index of standardised harvest rate for key species.

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## 7.0 Appendices

**Appendix 1** Summary of changes to management arrangements of recreational catches of key nearshore finfish species in the West Coast bioregion.

Year	Bag Limit	MLL	Spatial closure
<b>Australian Herring <i>Arripis georgianus</i></b>			
1913		152mm	
1937		178mm	
1986		180mm	
1991	40		
2009	30		
2015	12		
<b>Tailor <i>Pomatomus saltatrix</i></b>			
1913		230mm	
1973		229mm	
1975		250mm	
1991	20	250mm	
1995	8	250mm	
2003	8	300mm	
2009	8	300mm (2 fish over 500mm)	
<b>Whiting spp. <i>Sillago</i> spp.</b>			
1913		230mm	
1960		216mm	
1975		220mm	
1991	40		
2009	30		
2013	30		
<b>Southern Garfish <i>Hyporhamphus melanochir</i></b>			
1959		230mm	
1991	40	230mm	
2009	30		
2013	30		
2017			Perth Metropolitan waters
<b>Western Australian Salmon <i>Arripis truttaceus</i></b>			
1913		241mm	
1975		230mm	
1977		300mm	
1979	5	300mm	
1991	4	300mm	
<b>Pink Snapper <i>Chrysophrys auratus</i></b>			
1913		279mm	
1974		380mm	
1975	10	380mm	
1992	8	410mm	
1996	8	410mm (2 fish over 700mm)	
2003	4	410mm	Cockburn Sound (15 Sep to 31 Oct)
2005	4	410mm (1 fish over 700mm)	Cockburn and Warnbro Sound (1 Oct to 31 Jan)
2008	2	450mm (1 fish over 700mm)	
2009	2	500mm (1 fish over 700mm)	West Coast Bioregion (15 Oct to 15 Dec)

**Appendix 2** Summary table for each survey year, survey days, number of interviews, fish measured fish, retained fish in the roving creel surveys.

<b>Year</b>	<b>Survey days</b>	<b>Instantaneous fisher counts (n)</b>	<b>Interviews (n) (Av/day)</b>	<b>Retained (n)</b>	<b>Measurements (n)</b>
<b>2010</b>	38	15,592	1,640 (31)	3,744	1,083
<b>2014</b>	60	17,068	1,729 (24)	2,649	1,581
<b>2015</b>	60	21,265	1,532 (21)	1,707	1,219
<b>2016</b>	60	31,118	1,738 (25)	1,200	901
<b>2017</b>	60	26,006	2,012 (26)	2,022	1,567
<b>2018</b>	60	19,145	1,845 (25)	1,394	926
<b>2019</b>	60	9,986	1,302 (18)	1,574	1,329
<b>2020</b>	60	10,067	1,169 (18)	878	791
<b>2021</b>	60	7,179	1,408 (23)	1,253	1,041

**Appendix 3** Mean weight (in grams) for key nearshore species obtained in each survey year for the roving creel (shore) survey and boat ramp (boat) surveys completed between 2010 - 2021.

Note: length-weight equations used to convert random length samples obtained during the roving creel survey to weight are indicated in the table.

Year	Shore survey				Boat survey			
	n	median	mean	±95%CI	n	median	mean	±95%CI
<b>Australian Herring [W=1.44*10<sup>-5</sup>TL<sup>2.94</sup> (Gaughan et al., 2006)]</b>								
2010	761	166	175	3.3				
2011/12					109	128	132	4.8
2014	1,092	166	167	2.5	304	116	120	3.4
2015	813	162	168	2.7				
2016	450	172	184	4.8	279	128	131	3.1
2017	1,133	179	183	3.2				
2018	441	157	172	5.7	421	140	139	2.8
2019	820	168	172	2.7				
2020	370	171	176	4.6				
2021	560	155	164	3.2	358	126	126	5.1
<i>Combined</i>	<i>6,440</i>	<i>166</i>	<i>173</i>	<i>1.2</i>	<i>1,471</i>	<i>127</i>	<i>130</i>	<i>1.8</i>
<b>Whiting spp. [W=1.3*10<sup>-5</sup>TL<sup>2.964</sup> (Smallwood et al., 2018)]</b>								
2010	59	37	47	8.5				
2011/12					237	111	118	5.6
2014	189	41	54	5.4	472	101	103	3.6
2015	160	49	56	4.3				
2016	168	44	53	5.8	343	88	93	3.6
2017	160	44	49	4.0				
2018	197	42	58	6.7	566	94	102	3.7
2019	236	34	37	1.9				
2020	166	37	44	4.7				
2021	137	58	61	5.8	893	98	100	2.7
<i>Combined</i>	<i>1,472</i>	<i>41</i>	<i>50</i>	<i>1.7</i>	<i>2,511</i>	<i>97</i>	<i>102</i>	<i>1.6</i>
<b>Southern Garfish [W=5.2724*10<sup>-7</sup>TL<sup>3.3520</sup> (Smith et al., 2017)]</b>								
2010	144	132	147	10.3				
2011/12					27	124	127	13.5
2014	32	190	196	25.7	17	111	108	10.6
2015	11	96	97	18.9				

Year	Shore survey				Boat survey			
	n	median	mean	±95%CI	n	median	mean	±95%CI
2016	9	99	110	29.6	15	92	101	12.9
2017	26	82	85	6.9				
2018	26	62	71	11.8	6	88	99	29.0
2019	5	66	86	38.3				
2020	13	105	118	30.2				
2021					2	114	114	22.5
<i>Combined</i>	266	118	134	8.1	67	112	112	7.4
<b>Tailor [<math>W=0.7 \cdot 10^{-5} TL^{3.0415}</math> (Smith et al., 2013b)]</b>								
2010	14	454	445	101.6				
2011/12					21	434	527	125.9
2014	12	461	532	149.0	18	842	853	134.4
2015	14	455	488	84.9				
2016	9	435	447	97.0	9	703	825	173.4
2017	4	446	590	343.6				
2018	20	285	336	64.7	18	256	402	148.8
2019	2	422	422	343.0				
2020	11	507	669	362.9				
2021	30	352	334	31.8	20	372	370	42.4
<i>Combined</i>	116	383	438	47.9	86	438	565	69.2
<b>Western Australian Salmon [<math>W=1.3 \cdot 10^{-6} TL^{3.36}</math> (Gaughan et al., 2006)]</b>								
2010	4	2,594	2,678	2,773.1				
2011/12								
2014	4	6,204	6,355	1,084.5	1	4,619	4,619	
2015	28	6,327	6,230	283.4				
2016	103	6,551	6,549	296.9	81	4,499	4,506	123.4
2017	16	6,695	6,171	990.0				
2018	4	3,122	3,637	3,243.9	58	4,646	4,681	152.4
2019	2	3,262	3,262	1,189.7				
2020								
2021	5	814	887	614.6				
<i>Combined</i>	166	6,382	6,081	296.3	140	4,574	4,579	96.0
<b>Pink Snapper [<math>W=9.2 \cdot 10^{-5} TL^{2.6884}</math> (Smallwood et al., 2018)]</b>								
2010	3	106	97	55.6				

Year	Shore survey				Boat survey			
	n	median	mean	±95%CI	n	median	mean	±95%CI
2011/12					5	2,492	3,528	2,385.3
2014	7	4,161	5,168	1,454.8	21	2,375	2,586	627.1
2015	1	3,942	3,942					
2016	5	3,866	4,207	2,061.3	27	2,323	2,880	671.9
2017	4	1,758	2,564	1,790.0				
2018	19	102	2,480	1,362.8	27	2,476	3,094	568.1
2019	1	3,100	3,100					
2020	3	4,758	3,732	3,595.3				
2021	3	147	157	30.4	23	2,039	2,508	592.8
<i>Combined</i>	46	3,201	2,904	792.6	103	2,323	2,825	313.3

**Appendix 4** Estimated annual catch (total, retained and released numbers) and proportion released in roving creel surveys conducted in the Perth Metropolitan area in 2021. Note: values in bold indicate RSE>40% (i.e., non-robust).

Reporting group	Common Name	Scientific Name	Retained	SE	Released	SE	% Rel
Boxfish	Boxfishes	Ostraciidae - undifferentiated	0		29		100
	Western Smooth Boxfish	<i>Anoplocapros amygdaloides</i>	312		0		0
Bream	Breams	Sparidae - undifferentiated	0	0	<b>2,738</b>	<b>2,513</b>	100
	Pink Snapper	<i>Chrysophrys auratus</i>	<b>51</b>	<b>64</b>	<b>3,352</b>	<b>1,854</b>	98
	Tarwhine	<i>Rhabdosargus sarba</i>	<b>2,088</b>	<b>2,168</b>	<b>1,489</b>	<b>934</b>	42
Bullseye	Bronze Bullseye	<i>Pempheris analis</i>	<b>28</b>	<b>77</b>	0	0	0
	Bullseyes & Beach Salmons	Pempheridae, Leptobramidae - undifferentiated	0		83		100
Butterfishes Pomfrets	Butterfishes & Pomfrets	<i>Stromateidae</i> - undifferentiated	0		1,261		100
Cardinalfishes Longfin Pikes	Cardinalfishes & Longfin Pikes	Apogonidae, Dinolestidae - undifferentiated	33		0		0
Catfish	Estuary Cobbler	<i>Cnidoglanis macrocephalus</i>	<b>9</b>	<b>48</b>	<b>78</b>	<b>431</b>	90
Cephalopods	Squid	Order Teuthoidea - undifferentiated	<b>4,244</b>	<b>1,924</b>	<b>205</b>	<b>284</b>	5
	Cuttlefish	<i>Sepia</i> spp.	<b>365</b>	<b>641</b>	<b>160</b>	<b>392</b>	31
	Gould's Squid	<i>Nototodarus gouldi</i>	<b>767</b>	<b>2,269</b>	<b>36</b>	<b>197</b>	4
	Octopuses	Octopodidae - undifferentiated	<b>62</b>	<b>282</b>	<b>97</b>	<b>230</b>	61
	Southern Calamari	<i>Sepioteuthis australis</i>	<b>624</b>	<b>695</b>	0	0	0
Crab	Blue Swimmer Crab	<i>Portunus armatus</i>	62		0		0
	Crab	<i>Pleistacantha</i> sp.	0		27		100
Drummer	Silver Drummer	<i>Kyphosus sydneyanus</i>	<b>114</b>	<b>262</b>	<b>1,248</b>	<b>5,634</b>	92
	Western Rock Blackfish	<i>Girella tephraeops</i>	<b>617</b>	<b>1,193</b>	<b>67</b>	<b>370</b>	10

Reporting group	Common Name	Scientific Name	Retained	SE	Released	SE	% Rel
Flathead	Southern Bluespotted Flathead	<i>Platycephalus speculator</i>	220	720	0	0	0
	Yellowtail Flathead	<i>Platycephalus westraliae</i>	35		0		0
Garfish	Garfishes	Hemiramphidae - undifferentiated	0		144		100
	Southern Garfish	<i>Hyporhamphus melanochir</i>	0		36		100
	Three-By-Two Garfish	<i>Hemiramphus robustus</i>	232	596	214	966	48
Grunter	Sea Trumpeter	<i>Pelsartia humeralis</i>	148	376	1,543	6,518	91
	Striped Grunters	Terapontidae - undifferentiated	3,369	3,298	2,351	2,013	41
	Western Striped Grunter	<i>Pelates octolineatus</i>	3,834	1,763	4,220	3,963	52
Guitarfish	Guitarfishes	Rhinobatidae - undifferentiated	0		52		100
Herring	Scaly Mackerel	<i>Sardinella lemuru</i>	1,542	1,437	0	0	0
Leatherjacket	Horseshoe Leatherjacket	<i>Meuschenia hippocrepis</i>	416		0		0
	Sixspine Leatherjacket	<i>Meuschenia freycineti</i>	180	728	0	0	0
	Triggerfishes & Leatherjackets	Balistidae, Monacanthidae - undifferentiated	0	0	1,559	8,012	100
Mackerel	Blue Mackerel	<i>Scomber australasicus</i>	180	599	0	0	0
Moonfish & Batfish	Western Pomfred	<i>Schuettea woodwardi</i>	62		0		0
Mullet	Sea Mullet	<i>Mugil cephalus</i>	15		0		0
	Yelloweye Mullet	<i>Aldrichetta forsteri</i>	221	89	0	0	0
Pike	Snook	<i>Sphyraena novaehollandiae</i>	779	876	250	387	24
	Yellowtail Barracuda	<i>Sphyraena obtusata</i>	88	45	0	0	0
Rays	Ray	<i>Dasyatidae spp.</i>	144	563	610	1,453	81
Salmon Herring	Australian Herring	<i>Arripis georgianus</i>	56,524	12,013	7,889	3,492	12

Reporting group	Common Name	Scientific Name	Retained	SE	Released	SE	% Rel
	Western Australian Salmon	<i>Arripis truttaceus</i>	269	646	150	233	36
Sharks	Bronze Whaler	<i>Carcharhinus brachyurus</i>	0		34		100
	Gummy Shark	<i>Mustelus antarcticus</i>	0		208		100
	Port Jackson Shark	<i>Heterodontus portusjacksoni</i>	0		62		100
	Whaler & Weasel Sharks	Carcharhinidae, Hemigaleidae - undifferentiated	0		58		100
Tailor	Tailor	<i>Pomatomus saltatrix</i>	2,180	1,163	1,277	959	37
Threadfin Bream	Western Butterfish	<i>Pentapodus vitta</i>	2,803	1,083	2,431	1,356	46
Toadfish	Silver Toadfish	<i>Lagocephalus sceleratus</i>	0		1,152		100
	Toadfishes	Tetraodontidae - undifferentiated	94	178	22,485	8,371	100
	Weeping Toadfish	<i>Torquigener pleurogramma</i>	1,145	715	40,399	9,731	97
Trevally	Amberjack	<i>Seriola dumerili</i>	110		0		0
	Silver Trevally	<i>Pseudocaranx georgianus</i> spp. complex	2,407	1,461	1,637	1,928	40
	Yellowtail Scad	<i>Trachurus novaezelandiae</i>	6,711	4,606	104	178	2
Tuskfish Wrasse	Baldchin Groper	<i>Choerodon rubescens</i>	0		46		100
	Brownspotted Wrasse	<i>Notolabrus parilus</i>	1,162	1,881	212	304	15
	Wrasses	Labridae - undifferentiated	0	0	2,369	2,391	100
Whiting	King George Whiting	<i>Sillaginodes punctatus</i>	36		0		0
	Whiting spp.	<i>Sillago</i> spp ( <i>S. bassensis</i> , <i>S. vittata</i> , <i>S. schomburgkii</i> )	12,161	4,795	2,307	1,037	16



**Appendix 5** Final Generalised Linear Models with preferred variables and error distribution to describe the harvest rate of nearshore species (Australian herring and Whiting spp.), where bold values indicate significance  $p < 0.05$ ).

<b>Australian herring Tweedie model (power variance 1.1)</b>				
<b>Parameter</b>	<b>Category</b>	<b>Estimate</b>	<b>Std Error</b>	<b>p-value</b>
Intercept		0.578	0.127	<b>&lt;0.001</b>
Survey year	2021			
	2020	-0.239	0.17	0.174
	2019	0.137	0.151	0.365
	2018	-0.329	0.171	0.054
	2017	0.042	0.154	0.781
	2016	-0.657	0.190	<b>&lt;0.001</b>
	2015	0.334	0.147	<b>0.023</b>
	2014	0.276	0.147	0.060
	2010	0.432	0.167	<b>0.009</b>
Targeted	Targeted			
	Non-target	-2.258	0.104	<b>&lt;0.001</b>
Time of Day	Afternoon			
	Morning	0.489	0.077	<b>&lt;0.001</b>
<b>Whiting spp Tweedie model (power variance 1.9)</b>				
<b>Parameter</b>	<b>Category</b>	<b>Estimate</b>	<b>Std Error</b>	<b>p-value</b>
Intercept		0.636	0.351	0.070
Survey year	2021			
	2020	0.494	0.434	0.255
	2019	0.079	0.405	0.844
	2018	0.181	0.401	0.239
	2017	0.181	0.405	0.654
	2016	0.702	0.404	0.823
	2015	0.605	0.405	0.135
	2014	0.649	0.404	0.108
	2010	-0.041	0.521	0.937
Targeted	Targeted			
	Non-target	-3.286	0.239	<b>&lt;0.001</b>

**Appendix 6** Percentage of retained catch for each Sillago species (*S. bassensis*, *S. vittata* *S. schomburgkii*) within the aggregated Whiting spp. group across all survey years.

	2010	2014	2015	2016	2017	2018	2019	2020	2021
Southern School Whiting <i>Sillago bassensis</i>	99%	95%	99%	98%	98%	85%	95%	74%	94%
Western School Whiting <i>Sillago vittata</i>	1%	5%	1%	2%	-	15%	5%	26%	5%
Yellowfin Whiting <i>Sillago schomburgkii</i>	-	-	-	-	2%	-	-	-	1%