Fisheries

Effects of different cod-end mesh-sizes (57 mm and 51 mm) on catch in the Gulf St Vincent Prawn Fishery

L.J. McLeay

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PO Box 120 Henley Beach SA 5022

February 2021

Report to Saint Vincent Gulf Prawn Boat Owner's Association Inc.

Government of South Australia
Department of Primary Industries and Regions

SAINT VINCENT GULF
PRAWN BOAT OWNER'S ASSOCIATION INC.

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

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NON-TECHNICAL SUMMARY

- The South Australian Gulf Saint Vincent Prawn Fishery (GSVPF) uses paired demersal otter trawls to target Western King Prawn (*Penaeus (Melicertus) latisulcatus*) in Gulf St Vincent (GSV).
- In the Management Plan for the Gulf St Vincent Prawn Fishery (GSVPF), standardised Fishery Independent Survey (FIS) catch per unit effort (CPUE) is one of three performance indicators in the harvest strategy used to set the Total Allowable Commercial Effort (TACE) in the following season.
- In May 2020, as part of annual stock assessment surveys, data to estimate standardised FIS CPUE were collected from five vessels. In 2019/20, the estimate of standardised FIS CPUE was 22.1 kg.trawl-shot^{-1} (McLeay and Hooper 2020), which is within the trigger reference point range of ≥20.0 to <25.0 kg.trawl-shot^{-1} (PIRSA 2017).
- Information provided to SARDI relating to vessel prawn-trawl configurations used in the May 2020 FIS indicated that four of five vessels had used 57 mm (2 ¼ inch) mesh in the diamond net cod-ends. The other vessel used 51 mm (2 inch) mesh.
- In 2020, members of the Saint Vincent Gulf Prawn Boat Owner's Association (SVGPBOA), through the GSVPF Management Advisory Committee (GSVPF MAC), indicated that the 57 mm (2 ¼ inch) mesh size used by four vessels in the May 2020 FIS reflected a change from the 51 mm (2 inch) mesh used historically.
- The SVGPBOA then requested that experimental trawling be undertaken to test the null hypothesis that FIS CPUE does not vary between the different cod-end mesh sizes of 57 mm (2 ¼ inch) and 51 mm (2 inch).
- Experimental trawling was undertaken over three nights between the 16th and 19th of December 2020 for a total of 31 trawls. Five trawls considered compromised due to fouling, net damage or excessively large bycatch were omitted from the dataset.
- Total catch from the 51 mm cod-end was 18.8% higher than the 57 mm cod-end. Grade data indicated that the differences in the catch between the two cod-ends were due to higher catches of smaller prawns in the 51 mm cod-end. Slightly smaller prawns were also retained in the 51 mm cod-end mesh.
- Estimates of mean nominal CPUE from the two cod-ends were not significantly different (T-test, df=50, t=1.118, P=0.269). However, nominal CPUE (kg/30 minute trawl-shot) from the 51 mm cod-end was higher than the 57 mm cod-end in 22 out of 26 trawls. Mean nominal CPUE from the 51 mm cod-end (26.0 ± 2.8 kg/30 minute trawl-shot) was also 18.2% higher than mean nominal CPUE from the 57 mm cod-end (22.0 ± 2.3 kg/30 minute trawl-shot).

- Data collected in the May 2020 FIS from vessels that used a 57 mm cod-end can be scaled to a 51 mm cod-end using a coefficient of 1.182. This coefficient cannot be applied to data obtained before 2019/20 due to a lack of information on the mesh size used by vessels participating in FIS.
- If data collected in the May 2020 FIS from vessels that used a 57mm cod-end are 'adjusted' using the coefficient of 1.182, the GLM used to standardise FIS CPUE provides an estimate of 24.9 ± 0.2 kg.trawl-shot^{-1} in 2019/20. This estimate is 12.7% higher than the estimate of 22.1 ± 0.2 kg.trawl-shot^{-1} provided by McLeay and Hooper (2020), but within the trigger reference point range (≥20 to <25 kg.trawl.shot^{-1}) for this performance indicator (PIRSA 2017).

Keywords: Western King Prawn, *Penaeus* (*Melicertus*) *latisulcatus*), Prawn trawl, gear trial, Gulf St Vincent.

INTRODUCTION

The South Australian Gulf Saint Vincent Prawn Fishery (GSVPF) uses paired demersal otter trawls to target Western King Prawn (*Penaeus (Melicertus) latisulcatus*) in Gulf St Vincent (GSV). Under the Management Plan for the Fishery (PIRSA 2017), three performance indicators are used to inform the harvest strategy for the fishery in the following season:

1) Standardised annual catch per unit effort (CPUE) (kg.block^{-1}.vessel-night^{-1});
2) Standardised Fishery Independent Survey (FIS) CPUE (kg.trawl-shot^{-1}); and
3) The FIS Recruitment Index (FRI) (recruits.hour^{-1}).

Standardised FIS CPUE (kg.trawl-shot^{-1}) is estimated from data collected during a Fishery Independent Survey (FIS) undertaken in May each year at up to 109 locations. Commercial fishing vessels, with SARDI observers on board, are used to collect the data. Each vessel has a paired prawn-trawl configuration with one side of the trawl comprised of a T-90 mesh cod-end and the other side of the trawl comprising a diamond net mesh cod-end. Under the harvest strategy for the fishery, data from the diamond net mesh cod-end are used to estimate standardised FIS CPUE.

In May 2020, as part of SARDIs annual stock assessment for the GSVPF, data to estimate standardised FIS CPUE were collected from five vessels (FVs *Zadar, Frank Cori, Anna Pearl, Angela Kaye* and *Josephine-K*). An estimate of standardised FIS CPUE for the 2019/20 season was then calculated using data collected from diamond mesh cod-ends. The 2019/20 estimate of standardised FIS CPUE was **22.1 kg.trawl-shot^{-1}** (McLeay and Hooper 2020). This estimate is within the trigger reference point range of ≥20.0 to <25.0 kg.trawl-shot^{-1} defined in the Management Plan for the GSVPF (PIRSA 2017).

Information provided to SARDI relating to vessel prawn-trawl configurations used in the May 2020 FIS indicated that four out of the five vessels had used 57 mm (2 ¼ inch) mesh size in the diamond net mesh cod-end. One vessel (FV *Frank Cori*) used 51 mm (2 inch) mesh size in the cod-end.

In 2020, members of the Saint Vincent Gulf Prawn Boat Owner's Association (SVGPBOA), through the GSVPF Management Advisory Committee (GSVPF MAC), indicated that the 57 (2 ¼ inch) mesh cod-ends used by some vessels in the May 2020 FIS differed from the 51mm (2 inch) that had been used historically. The SVGPBOA then requested that experimental trawling be undertaken to test the null hypothesis that FIS CPUE does not vary between the two cod-end mesh sizes (i.e. 51 mm and 57 mm).

OBJECTIVES

The objectives of this study were to:

1) Conduct experimental trawls to determine if differences exist between nominal estimates of CPUE obtained from 51 mm and 57 mm mesh diamond net cod-ends.
2) Calculate a coefficient to adjust FIS CPUE data collected from vessels that used 57mm diamond net mesh cod-ends in May 2020; and
3) Use adjusted data in the GLM prescribed in the Management Plan to provide an updated estimate of standardised FIS CPUE for the 2019/20 season.

METHODS

Trawl configuration and experimental trawling

In December 2020, observers met with the skipper of the FV *Anna Pearl* and the net maker from Raptis and Sons Pty Ltd to confirm the trawl configuration. The configuration was established as that in a schematic diagram provided to SARDI by the SVGPBOA (Appendix 1) with the port side of the trawl comprising a 57 mm (2 ¼ inch) diamond net mesh cod-end, and the starboard side of the trawl comprising a 50.8 mm (2 inch) diamond net mesh cod-end. The trawl body on both sides of the trawl was comprised of 51 mm diamond net mesh (Appendix 1).

Experimental trawling was undertaken over three nights between 16th and 19th December 2020 and corresponded to a period when fishing might normally be undertaken (7 days either side of the new moon on 15th December 2020). Trawls were undertaken by the FV *Anna Pearl* at a total of 31 locations. Trawl durations ranged from 27 to 50 minutes but were generally around 30 minutes in length (average: 34±1 minute) (Table 1). Trawling was undertaken in areas known to contain relatively high catch rates of prawns of various sizes (grades). The crew of the vessel assisted with grading and weighing grades of prawns collected from each side of the trawl.

Data were collected by two SARDI observers from each side of the paired trawl (i.e. with cod-end mesh sizes of 57 mm and 51 mm). Data recorded from each cod-end mesh type included:

- Total catch (kg);
- Catch weight (kg) of each grade: U6–U10, 10/15, 16/20, 21–30+ (as per grades used on the FV *Anna Pearl*);
- Prawn size (PP7KG) - measured from a 7kg sample of prawns – ‘bucket count’; and
- Prawn size (Carapace Length (CL) frequency) – measured from a sample 100 prawns.

Data analyses

A total of 31 trawls were undertaken over three nights. Of these, five trawls were compromised due to fouling, net damage or excessively large bycatch (e.g. port net trawl-body torn in Shot 1_6 (3), Table 2) and removed prior to analyses. The removal of these data enabled rigorous comparison of the effects of cod-end mesh sizes on catch efficiency. However, comparisons of catch and CPUE between the two different cod-end mesh sizes for the dataset containing all 31 trawls are also provided in Appendix 2.

Nominal CPUE (kg/30 minute trawl-shot) was calculated for each cod-end mesh type per trawl, grade and overall. Statistical differences in nominal CPUE and prawn size (CL) between the different cod-end mesh sizes were estimated via T-tests in SPSS© (Version 26). SPSS© was also used to check data for assumptions of normality and homoscedasticity using the Shapiro-Wilks’ test and Levene’s test, respectively. Means are reported ± standard error.

A calibration coefficient was then calculated to account for the difference in CPUE observed between the two cod-end mesh sizes. The calibration coefficient was then applied to the nominal CPUE data collected in the May 2020 FIS from the four vessels that used 57 mm mesh cod-ends (Table 1). Calibration coefficients could not be applied to the data collected earlier than 2019/20 due to a lack of information relating to the mesh size used by vessels participating in historical FIS'.

Table 1. Diamond net cod-end mesh sizes used by vessels participating in the May 2020 Fishery Independent Survey.

Fishing Vessel	Master	Diamond mesh size used
Josephine K	A. Kolic	2 ¼ inch (57 mm)
Anna Pearl	D. Barker	2 ¼ inch (57 mm)
Angela K	M. Aston	2 ¼ inch (57 mm)
Zadar	G.C. Saltmarsh	2 ¼ inch (57 mm)
Frank Cori	K. Redman	2 inch (51 mm)

Following application of the calibration coefficient to data collected in the May 2020 FIS', catch and effort data collected in May FIS' since 2004/05 were standardised using the General Linear Model (GLM) prescribed in the Management Plan as per the methods of Noell *et al.* (2015) (McLeay and Hooper 2020).

RESULTS/DISCUSSION

Total catch and catch by grade

For the 26 trawls undertaken over 870 minutes of experimental trawling, a total catch of 759.3 kg and 639.0 kg was recorded from the 51 mm and 57 mm cod-ends, respectively (Table 2). Total catch from the 51 mm cod-end was 18.8% higher than the 57 mm cod-end (Table 2).

Catches in the 51 mm cod-end for each grade measured were also higher than those from the 57 mm cod-end (Table 3): grade 10/15 (prawns per pound) were 6.7% higher; grade 21/30 (prawns per pound) were 55.5% higher (Table 3).

Analyses of grade data indicate that differences in the catch between the two cod-end mesh sizes were a function of the size composition of prawns trawled, with higher catches of smaller prawns taken in the 51 mm cod-end.

Table 2. Experimental trawl summary showing kilograms (kg) caught per grade, total kg caught and number of prawns per 7 kg sample for each cod-end mesh size (51 mm and 57 mm). Trawls compromised by net damage/fouling or excessively large bycatch are flagged in bold italics*.

				51mm_codend						57mm_codend						
Date	Location Id	BLOCK_SHOT (replicate)	Trawl minutes	Grade U6-U10	Grade 10/15	Grade 16/20	Grade 21/30	Bucket wt (KG)	Total Catch (KG)	Grade U6-U10	Grade 10/15	Grade 16/20	Grade 21/30	Bucket wt (KG)	Total Catch (KG)	Comments
16/12/2020	1001	1_1 (1)	30.0	6.8	13.5	6.8	0.0	7.0	27.0	5.4	12.9	8.0	0.0	7.0	26.4	
16/12/2020	1002	1_4 (1)	30.0	0.0	10.9	13.3	16.3	7.0	40.5	0.0	11.3	12.6	10.1	7.0	34.0	
16/12/2020	1003	1_5 (1)	30.0	0.0	4.6	8.1	8.9	7.0	21.6	0.0	6.3	6.8	7.6	7.0	20.7	
16/12/2020	1113	1_2	30.0	0.0	12.5	9.0	3.5	7.0	25.0	0.0	11.7	6.5	1.8	7.0	20.0	
16/12/2020	1114	1_3	30.0	0.0	4.5	13.8	16.3	7.0	34.6	0.0	16.1	13.7	6.2	7.0	36.0	
16/12/2020	1004 (1)	1_6 (1)	30.0	18.7	4.3	0.0	0.0	7.0	23.0	12.4	2.3	0.0	0.0	7.0	14.7	
16/12/2020	1004 (2)	1_6 (2)	30.0	2.3	6.4	4.5	0.0	7.0	13.2	2.8	9.5	0.0	0.0	7.0	12.3	
16/12/2020	***1004 (3)****	***1_6 (3)***	32.0													Port net (57mm net) damaged
16/12/2020	1004 (4)	1_6 (4)	35.0	7.4	19.7	9.9	0.0	7.0	37.0	5.0	15.2	5.2	0.0	7.0	25.4	
16/12/2020	***1004 (5)****	***1_6 (5)***	30.0													Bycatch 12 smooth rays (most in port net - 57mm)
17/12/2020	1066	6_X1	30.0					5.5	5.5					6.5	6.5	
17/12/2020	1069	6_X5	27.0					3.5	3.5					2.9	2.9	
17/12/2020	1170	6_X2	30.0					3.5	3.5					4.2	4.2	
17/12/2020	***1001 (2)****	***1_1 (2)***	30.0													X 2 milk crates in port net (57mm)
17/12/2020	1002 (2)	1_4 (2)	30.0	2.9	14.3	18.3	20.0	7.0	55.5	1.8	14.0	18.7	14.0	7.0	48.5	
17/12/2020	1002 (3)	1_4 (3)	35.0	2.9	12.1	17.9	19.6	7.0	52.5	0.0	13.4	13.4	11.6	7.0	38.5	
17/12/2020	***1003 (2)****	***1_5 (2)***	40.0													large metal grate/bed in starboard net (51mm)
17/12/2020	1003 (3)	1_5 (3)	40.0	0.0	13.5	12.5	8.8	7.0	34.8	0.0	10.7	10.7	6.7	7.0	28.0	
17/12/2020	1004 (6)	1_6 (6)	35.0	3.3	8.5	6.2	0.0	7.0	18.0	3.6	8.0	4.4	0.0	7.0	16.0	
17/12/2020	***1004 (7)****	***1_6 (7)***	50.0													large piece of metal in port net (57mm)
18/12/2020	1002 (4)	1_4 (4)	35.0	0.0	11.3	12.5	11.3	7.0	35.0	0.0	9.0	9.0	6.9	7.0	25.0	
18/12/2020	1002 (5)	1_4 (5)	35.0	0.0	16.0	19.7	20.0	7.0	55.7	0.0	19.5	20.6	15.4	7.0	55.5	
18/12/2020	1003 (4)	1_5 (4)	38.0	0.0	11.0	11.6	8.4	7.0	31.0	0.0	8.5	8.5	7.1	7.0	24.0	
18/12/2020	1003 (5)	1_5 (5)	35.0	0.0	29.3	19.7	14.1	7.0	63.0	0.0	17.5	13.3	9.7	7.0	40.5	
18/12/2020	1004 (10)	1_6 (10)	30.0	0.0	7.0	4.9	0.0	7.0	11.9	0.0	9.8	6.2	0.0	7.0	16.0	
18/12/2020	1004 (11)	1_6 (11)	40.0	10.3	15.5	5.2	0.0	7.0	31.0	8.0	14.7	5.3	0.0	7.0	28.0	
18/12/2020	1004 (12)	1_6 (12)	40.0	4.4	11.0	6.6	0.0	7.0	22.0	4.7	9.4	5.5	0.0	7.0	19.5	
18/12/2020	1004 (13)	1_6 (13)	35.0	6.6	17.0	5.9	0.0	7.0	29.5	7.5	13.6	5.4	0.0	7.0	26.5	
18/12/2020	1004 (14)	1_6 (14)	30.0	6.6	13.7	5.5	0.0	7.0	25.8	5.7	12.9	4.4	0.0	7.0	23.1	
18/12/2020	1004 (8)	1_6 (8)	40.0	0.0	13.7	6.8	0.0	7.0	20.5	0.0	11.5	6.5	0.0	7.0	18.0	
18/12/2020	1004 (9)	1_6 (9)	40.0	0.0	24.4	10.4	3.9	7.0	38.7	0.0	18.5	10.3	0.0	7.0	28.8	
		Total	**870.0**						**759.3**						**639.0**	

Table 3. Catch composition by grade for each cod-end mesh size (51 mm and 57 mm). Note grade data does not include trawls where samples of <7kg recorded.

GRADE	51 mm cod-end	57 mm cod-end	
	total catch (kg)	total catch (kg)	% Δ
Grade U6-U10	72.1	56.8	26.9
Grade 10/15	294.7	276.3	6.7
Grade 16/20	229.0	195.2	17.3
Grade 21/30+	151.0	97.1	55.5

Prawn size (PP7KG and CL)

The average bucket count of prawns sampled from the 51 mm cod-end was 293 ± 16 PP7KG (Table 4), which is slightly higher (= smaller prawns) than the estimate of 288 ± 15 PP7KG from the 57 mm cod-end (Table 4). The average size (CL) of prawns from the 51 mm cod-end was slightly smaller (37 ± 1.0 mm CL) than from the 57 mm cod-end (38 ± 1.0 mm CL) (Table 4).

Table 4. Prawn size measured from bucket counts (PP7KG) and measurements of carapace length (CL, mm) for each cod-end mesh size (51 mm and 57 mm) based on data from 26 trawls. Trawls discounted due to fouling or excessive bycatch are flagged in *italics**. Data from BLOCK_SHOT 6_X1, 6_X2, and 6_X5 relating to PP7KG not included due to incomplete sample).

			51 mm codend		57 mm codend	
Date	**Location Id**	**BLOCK_SHOT (replicate)**	**PP7KG**	**CL (mm)**	**PP7KG**	**CL (mm)**
16/12/2020	1001	1_1 (1)	215	41	216	41
16/12/2020	1002	1_4 (1)	378	33	389	32
16/12/2020	1003	1_5 (1)	415	32	343	33
16/12/2020	1113	1_2	304	37	294	37
16/12/2020	1114	1_3	310	37	305	36
16/12/2020	1004 (1)	1_6 (1)	213	41	216	41
16/12/2020	1004 (2)	1_6 (2)	238	39	234	40
16/12/2020	***1004 (3)***	***1_6 (3)***				
16/12/2020	1004 (4)	1_6 (4)	218	41	212	41
16/12/2020	***1004 (5)***	***1_6 (5)***				
17/12/2020	1066	6_X1		39		40
17/12/2020	1069	6_X5		43		44
17/12/2020	1170	6_X2		43		44
17/12/2020	***1001 (2)***	***1_1 (2)***				
17/12/2020	1002 (2)	1_4 (2)	384	33	375	32
17/12/2020	1002 (3)	1_4 (3)	392	33	385	33
17/12/2020	***1003 (2)***	***1_5 (2)***				
17/12/2020	1003 (3)	1_5 (3)	325	34	350	34
17/12/2020	1004 (6)	1_6 (6)	232	39	235	39
17/12/2020	***1004 (7)***	***1_6 (7)***				
18/12/2020	1002 (4)	1_4 (4)	381	32	357	34
18/12/2020	1002 (5)	1_4 (5)	404	32	412	32
18/12/2020	1003 (4)	1_5 (4)	380	33	365	34
18/12/2020	1003 (5)	1_5 (5)	327	33	319	35
18/12/2020	1004 (10)	1_6 (10)	271	37	252	38
18/12/2020	1004 (11)	1_6 (11)	206	41	203	41
18/12/2020	1004 (12)	1_6 (12)	215	40	230	39
18/12/2020	1004 (13)	1_6 (13)	212	40	202	41
18/12/2020	1004 (14)	1_6 (14)	212	41	223	40
18/12/2020	1004 (8)	1_6 (8)	243	38	237	39
18/12/2020	1004 (9)	1_6 (9)	269	37	266	38
		Average	**293**	**37**	**288**	**38**

Catch Per Unit Effort – experimental trawling

Nominal estimates of CPUE (kg/30 minute trawl-shot) were higher from the 51 mm cod-end in 22 of the 26 trawls (Figure 1, Table 5). Differences in nominal CPUE between the two mesh sizes among individual trawls varied from -25.6% (Shot 1_6 (10) to 56.5% (Shot 1_6 (1)) (Table 5).

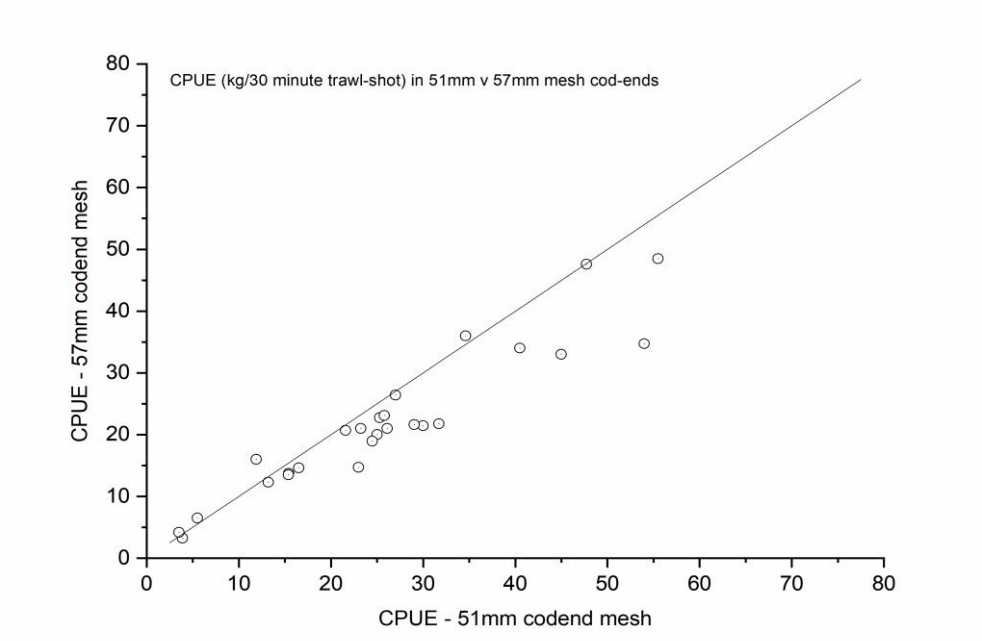

Figure 1. Nominal CPUE estimated from 51 mm and 57 mm cod-end mesh during experimental trawling. Straight line depicts theoretical parity in CPUE between the two mesh sizes.

The average nominal CPUE from the 51 mm cod-end was 26.0 ± 2.8 kg/30 minute trawl-shot, which is 18.2% higher than from the 57 mm cod-end (22.0 ± 2.3 kg/30 minute trawl-shot). However, mean estimates of nominal CPUE from each of the two mesh sizes were not significantly different (T-test, df 50, t=1.118, P=0.269).

Table 5. CPUE (kg/30 minute trawl-shot) by trawl and overall for each cod-end mesh size (51 mm and 57 mm) estimated from 26 trawls.

			51mm codend	57mm_codend	
Loc Id	BLOCK_SHOT (replicate)	Trawl minutes	Catch rate (kg/30 minute shot)	Catch rate (kg/30 minute shot)	% diff (57/51)
1001	1_1 (1)	30	27.0	26.4	2.3
1002	1_4 (1)	30	40.5	34.0	19.1
1003	1_5 (1)	30	21.6	20.7	4.3
1113	1_2	30	25.0	20.0	25.0
1114	1_3	30	34.6	36.0	-3.9
1004 (1)	1_6 (1)	30	23.0	14.7	56.5
1004 (2)	1_6 (2)	30	13.2	12.3	7.3
1004 (3)	1_6 (3)	***32***			
1004 (4)	1_6 (4)	35	31.7	21.8	45.7
1004 (5)	1_6 (5)	***30***			
1066	6_X1	30	5.5	6.5	-15.4
1069	6_X5	27	3.9	3.2	20.7
1170	6_X2	30	3.5	4.2	-16.7
1001 (2)	1_1 (2)	***30***			
1002 (2)	1_4 (2)	30	55.5	48.5	14.4
1002 (3)	1_4 (3)	35	45.0	33.0	36.4
1003 (2)	1_5 (2)	***40***			
1003 (3)	1_5 (3)	40	26.1	21.0	24.3
1004 (6)	1_6 (6)	35	15.4	13.7	12.5
1004 (7)	1_6 (7)	***50***			
1002 (4)	1_4 (4)	35	30.0	21.4	40.0
1002 (5)	1_4 (5)	35	47.7	47.6	0.4
1003 (4)	1_5 (4)	38	24.5	18.9	29.2
1003 (5)	1_5 (5)	35	54.0	34.7	55.6
1004 (10)	1_6 (10)	30	11.9	16.0	-25.6
1004 (11)	1_6 (11)	40	23.3	21.0	10.7
1004 (12)	1_6 (12)	40	16.5	14.6	12.8
1004 (13)	1_6 (13)	35	25.3	22.7	11.3
1004 (14)	1_6 (14)	30	25.8	23.1	11.7
1004 (8)	1_6 (8)	40	15.4	13.5	13.9
1004 (9)	1_6 (9)	40	29.0	21.6	34.4
	Average CPUE		**26.0**	**22.0**	

Mesh size calibration coefficient

The percentage difference in average nominal CPUE estimated between the 51 mm and 57 mm codends provided a calibration coefficient to apply to data collected in the May 2020 FIS from vessels that used a 57 mm diamond net mesh cod-end.

The calibration coefficient calculated from the experimental trawl dataset (N=26 trawls) was **1.182.**

Application of the calibration coefficient to May 2020 FIS CPUE

Data collected in the May 2020 FIS from vessels that used a 57 mm cod-end can be scaled to a 51 mm cod-end using a coefficient of 1.182. This resulted in an estimate of nominal FIS CPUE in 2019/20 of 26.1 ± 2.5 kg.trawl.shot^{-1}, which is 16.0% higher than the estimate of 22.5 ± 2.1 kg.trawl.shot^{-1} provided by McLeay and Hooper (2020).

If 'adjusted' data are used in the prescribed GLM to standardise FIS CPUE, the estimate of standardised FIS CPUE in 2019/20 is 24.9 ± 0.2 kg.trawl-shot^{-1} (Figure 2). This estimate is 12.7% higher than the estimate of 22.1 ± 0.2 kg.trawl-shot^{-1} provided by McLeay and Hooper (2020) and within the trigger reference point range (≥20 to <25 kg.trawl.shot^{-1}) for this performance indicator (PIRSA 2017).

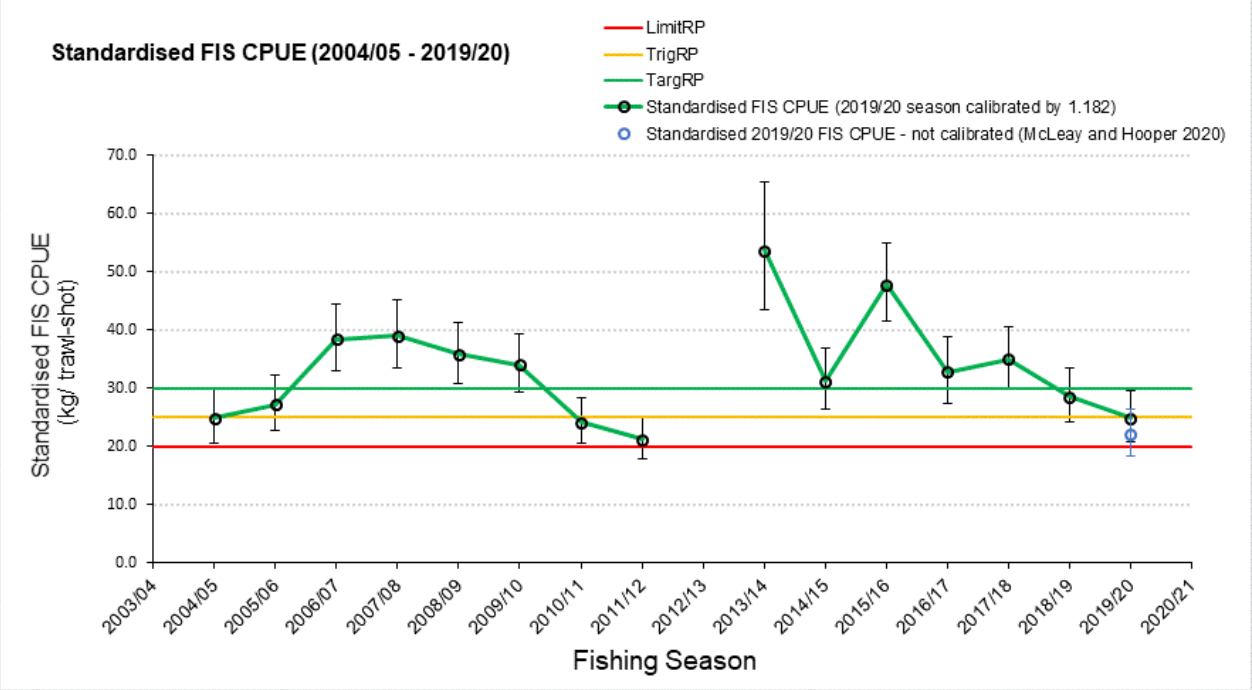

Figure 2. Standardised FIS CPUE between 2004/05 and 2019/20. Note, the coefficient of 1.182 derived from the experimental trawl dataset has been applied (pre-GLM standardisation) to 2019/20 season data only. The estimate of standardised FIS CPUE in 2019/20 as reported in McLeay and Hooper (2020) is also shown (blue circle). Error bars are upper and lower (95%) confidence intervals.

Fishing year-survey, region and vessel were all highly significant variables in the GLM (Table 6). A low overall model goodness-of-fit (adjusted R^2 value 0.14) indicated other unaccounted sources of variability. A total of 14.9% of the deviance in survey catches was explained by the model. The model term 'fishing year-survey' explained 7.7% of the deviance, 'region' explained 5.4% and 'vessel' explained 1.8%, indicating that 85.1% of the deviance was due to unknown factors.

Table 6. Analysis of deviance (Type II test) for the GLM used to standardise FIS CPUE data for the GSVPF. Abbreviations: SS, sum of squares; df, degrees of freedom; *F*, *F*-statistic.

Effect	**SS**	**df**	***F***
Fishing year-survey	274.1	36	9.4***
Region	192.5	7	33.8***
Vessel	65.6	13	6.2***
Residuals	3031.8	3726	NA

Significance: *** $p < 0.001$

CONCLUSION

This study compared the catching efficiency of 51 mm (2 inch) and 57 mm (2 ¼ inch) cod-end mesh sizes in a penaeid trawl. Mean estimates of nominal CPUE measured from each of the two mesh sizes did not differ significantly. However, estimates of nominal CPUE (kg/30 minute trawl-shot) were higher from the 51 mm cod-end in 22 out of 26 trawls. Average nominal CPUE from the 51 mm cod-end was 18.2% higher than the 57 mm cod-end. Differences in the catch efficiency between the mesh sizes are likely to be a function of the size composition of prawns trawled, with relatively higher catches of smaller prawns taken in the 51 mm cod-end.

Data collected in the May 2020 FIS from the four vessels that used a 57 mm cod-end can be scaled to a 51 mm cod-end using a coefficient of 1.182. This coefficient cannot be applied to data earlier than 2019/20 due to a lack of information about mesh size used by vessels participating in historical FIS'. If 'adjusted' data are used in the GLM to standardise estimates of FIS CPUE, the estimate of standardised FIS CPUE in 2019/20 is 24.9 ± 0.2 kg.trawl-shot^{-1}. This estimate is 12.7% higher than the estimate of 22.1 ± 0.2 kg.trawl-shot^{-1} provided by McLeay and Hooper (2020) but within the trigger reference point range (≥20 to <25 kg.trawl.shot^{-1}) for this performance indicator under the harvest strategy (PIRSA 2017).

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Noell, C.J., O'Neill, M.F., Carroll, J.D. and Dixon, C.D. (2015). A bio-economic model for South Australia's prawn trawl fisheries. Final Report. Prepared by the South Australian Research and Development Institute (Aquatic Sciences), Adelaide. CRC Project No. 2011/750. 115pp.

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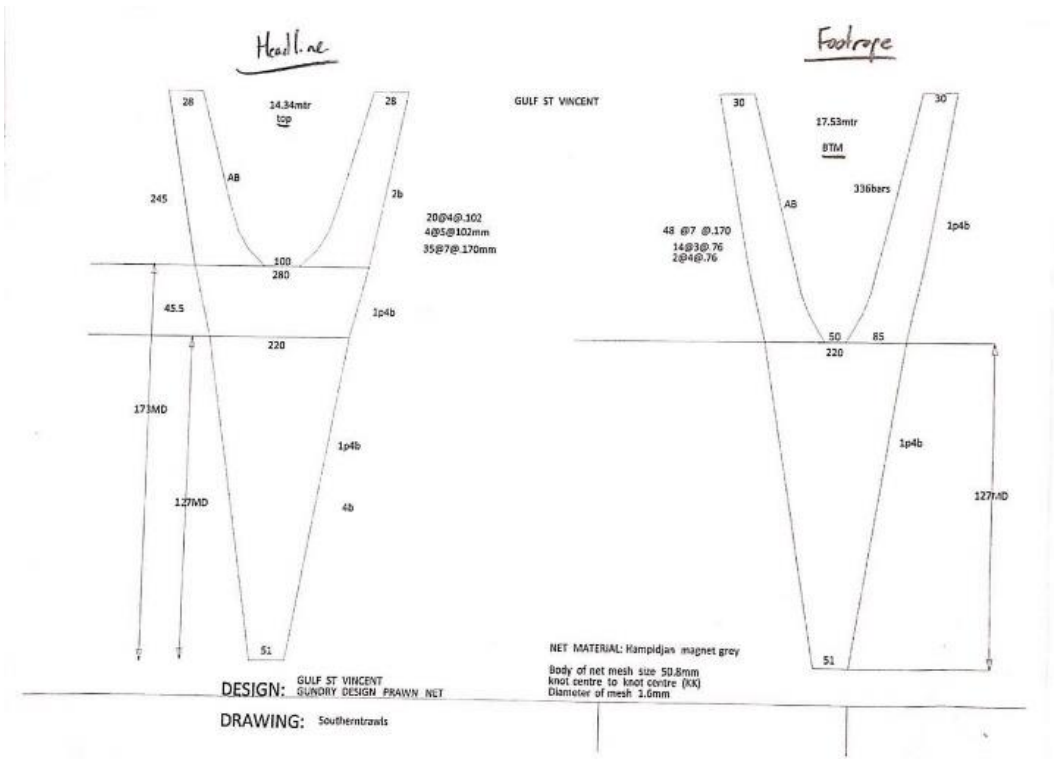
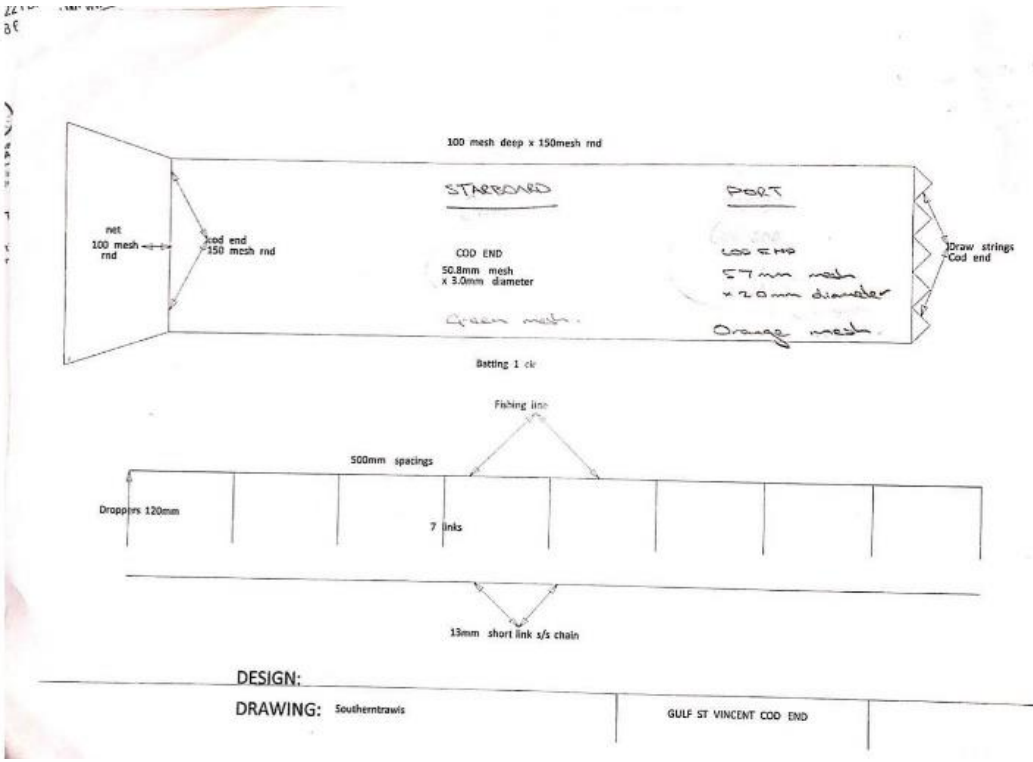
APPENDICES

Appendix 1. Trawl configuration diagram





Appendix 2. Summary analyses based on the dataset of 31 trawls

Note – analyses include the five trawls considered compromised due to fouling, net damage or excessively large bycatch.

Total catch

For the 31 trawls undertaken over 1052 minutes of experimental trawling, a total catch of 974.3 kg and 797.4 kg was recorded from the 51 mm and 57 mm cod-ends, respectively (Table A1). Total catch from the 51 mm cod-end was 22.2% higher than in the 57 mm cod-end (Table A1).

Table A1. Experimental trawl summary showing kilograms (kg) caught per grade, total kg caught and number of prawns per 7 kg sample for each cod-end mesh size (51 mm and 57 mm). Trawls compromised by net damage/fouling or excessive large bycatch are flagged in bold italics*.

				51mm_codend						57mm_codend						
Date	Location Id	BLOCK_SHOT (replicate)	Trawl minutes	Grade U6-U10	Grade 10/15	Grade 16/20	Grade 21/30	Bucket wt (KG)	Total Catch (KG)	Grade U6-U10	Grade 10/15	Grade 16/20	Grade 21/30	Bucket wt (KG)	Total Catch (KG)	Comments
16/12/2020	1001	1_1 (1)	30.0	6.8	13.5	6.8	0.0	7.0	27.0	5.4	12.9	8.0	0.0	7.0	26.4	
16/12/2020	1002	1_4 (1)	30.0	0.0	10.9	13.3	16.3	7.0	40.5	0.0	11.3	12.6	10.1	7.0	34.0	
16/12/2020	1003	1_5 (1)	30.0	0.0	4.6	8.1	8.9	7.0	21.6	0.0	6.3	6.8	7.6	7.0	20.7	
16/12/2020	1113	1_2	30.0	0.0	12.5	9.0	3.5	7.0	25.0	0.0	11.7	6.5	1.8	7.0	20.0	
16/12/2020	1114	1_3	30.0	0.0	4.5	13.8	16.3	7.0	34.6	0.0	16.1	13.7	6.2	7.0	36.0	
16/12/2020	1004 (1)	1_6 (1)	30.0	18.7	4.3	0.0	0.0	7.0	23.0	12.4	2.3	0.0	0.0	7.0	14.7	
16/12/2020	1004 (2)	1_6 (2)	30.0	2.3	6.4	4.5	0.0	7.0	13.2	2.8	9.5	0.0	0.0	7.0	12.3	
16/12/2020	***1004 (3)****	***1_6 (3)***	32.0	5.9	28.8	18.4	0.0	7.0	53.1	4.5	16.6	10.9	0.0	7.0	32.0	Port net (57mm net) damaged
16/12/2020	1004 (4)	1_6 (4)	35.0	7.4	19.7	9.9	0.0	7.0	37.0	5.0	15.2	5.2	0.0	7.0	25.4	
16/12/2020	***1004 (5)****	***1_6 (5)***	30.0	8.6	27.4	12.8	0.0	7.0	48.9	6.6	15.9	10.4	0.0	7.0	32.9	57mm)
17/12/2020	1066	6_X1	30.0					5.5	5.5					6.5	6.5	
17/12/2020	1069	6_X5	27.0					3.5	3.5					2.9	2.9	
17/12/2020	1170	6_X2	30.0					3.5	3.5					4.2	4.2	
17/12/2020	***1001 (2)****	***1_1 (2)***	30.0	9.6	23.3	9.6	0.0	7.0	42.5	7.4	20.9	9.2	0.0	7.0	37.5	X 2 milk crates in port net (57mm)
17/12/2020	1002 (2)	1_4 (2)	30.0	2.9	14.3	18.3	20.0	7.0	55.5	1.8	14.0	18.7	14.0	7.0	48.5	
17/12/2020	1002 (3)	1_4 (3)	35.0	2.9	12.1	17.9	19.6	7.0	52.5	0.0	13.4	13.4	11.6	7.0	38.5	
17/12/2020	***1003 (2)****	***1_5 (2)***	40.0	1.3	7.3	12.0	7.3	7.0	28.0	0.0	7.9	11.9	9.2	7.0	29.0	large metal grate/bed in starboard net (51mm)
17/12/2020	1003 (3)	1_5 (3)	40.0	0.0	13.5	12.5	8.8	7.0	34.8	0.0	10.7	10.7	6.7	7.0	28.0	
17/12/2020	1004 (6)	1_6 (6)	35.0	3.3	8.5	6.2	0.0	7.0	18.0	3.6	8.0	4.4	0.0	7.0	16.0	
17/12/2020	***1004 (7)****	***1_6 (7)***	50.0	11.0	22.1	9.3	0.0	7.0	42.5	8.8	14.2	4.1	0.0	7.0	27.0	large piece of metal in port net (57mm)
18/12/2020	1002 (4)	1_4 (4)	35.0	0.0	11.3	12.5	11.3	7.0	35.0	0.0	9.0	9.0	6.9	7.0	25.0	
18/12/2020	1002 (5)	1_4 (5)	35.0	0.0	16.0	19.7	20.0	7.0	55.7	0.0	19.5	20.6	15.4	7.0	55.5	
18/12/2020	1003 (4)	1_5 (4)	38.0	0.0	11.0	11.6	8.4	7.0	31.0	0.0	8.5	8.5	7.1	7.0	24.0	
18/12/2020	1003 (5)	1_5 (5)	35.0	0.0	29.3	19.7	14.1	7.0	63.0	0.0	17.5	13.3	9.7	7.0	40.5	
18/12/2020	1004 (10)	1_6 (10)	30.0	0.0	7.0	4.9	0.0	7.0	11.9	0.0	9.8	6.2	0.0	7.0	16.0	
18/12/2020	1004 (11)	1_6 (11)	40.0	10.3	15.5	5.2	0.0	7.0	31.0	8.0	14.7	5.3	0.0	7.0	28.0	
18/12/2020	1004 (12)	1_6 (12)	40.0	4.4	11.0	6.6	0.0	7.0	22.0	4.7	9.4	5.5	0.0	7.0	19.5	
18/12/2020	1004 (13)	1_6 (13)	35.0	6.6	17.0	5.9	0.0	7.0	29.5	7.5	13.6	5.4	0.0	7.0	26.5	
18/12/2020	1004 (14)	1_6 (14)	30.0	6.6	13.7	5.5	0.0	7.0	25.8	5.7	12.9	4.4	0.0	7.0	23.1	
18/12/2020	1004 (8)	1_6 (8)	40.0	0.0	13.7	6.8	0.0	7.0	20.5	0.0	11.5	6.5	0.0	7.0	18.0	
18/12/2020	1004 (9)	1_6 (9)	40.0	0.0	24.4	10.4	3.9	7.0	38.7	0.0	18.5	10.3	0.0	7.0	28.8	
		Total	**1052.0**						**974.3**						**797.4**	

Catch Per Unit Effort

Nominal estimates of CPUE (kg/30 minute trawl-shot) were higher from the 51 mm cod-end in 26 out of 31 trawls (Table A2). Differences in nominal CPUE between the two mesh sizes varied among individual trawls from -25.6% (Shot 1_6 (10)) to 65.9% (Shot 1_6 (3)) (Table A2).

The average nominal CPUE from the 51 mm cod-end was 27.8 ± 2.6 kg/30 minute trawl-shot, which is 21.4% higher than from the 57 mm cod-end (22.9 ± 2.0 kg/30 minute trawl-shot). However, mean estimates of nominal CPUE from each of the two mesh sizes were not significantly different (T-test: df 60, t=1.509, P=0.137).

Table A2. CPUE (kg/30 minute trawl-shot) by trawl and overall for each cod-end mesh size (51 mm and 57 mm) estimated from 31 trawls.

			51mm codend	57mm_codend	
Loc Id	BLOCK_SHOT (replicate)	Trawl minutes	Catch rate (kg/30 minute shot)	Catch rate (kg/30 minute shot)	% diff (57/51)
1001	1_1 (1)	30	27.0	26.4	2.3
1002	1_4 (1)	30	40.5	34.0	19.1
1003	1_5 (1)	30	21.6	20.7	4.3
1113	1_2	30	25.0	20.0	25.0
1114	1_3	30	34.6	36.0	-3.9
1004 (1)	1_6 (1)	30	23.0	14.7	56.5
1004 (2)	1_6 (2)	30	13.2	12.3	7.3
1004 (3)	1_6 (3)	***32***	***49.8***	***30.0***	65.9
1004 (4)	1_6 (4)	35	31.7	21.8	45.7
1004 (5)	1_6 (5)	***30***	***48.9***	***32.7***	49.6
1066	6_X1	30	5.5	6.5	-15.4
1069	6_X5	27	3.9	3.2	20.7
1170	6_X2	30	3.5	4.2	-16.7
1001 (2)	1_1 (2)	***30***	***42.5***	***37.5***	13.3
1002 (2)	1_4 (2)	30	55.5	48.5	14.4
1002 (3)	1_4 (3)	35	45.0	33.0	36.4
1003 (2)	1_5 (2)	***40***	***21.0***	***21.8***	-3.4
1003 (3)	1_5 (3)	40	26.1	21.0	24.3
1004 (6)	1_6 (6)	35	15.4	13.7	12.5
1004 (7)	1_6 (7)	***50***	**25.5**	**16.2**	57.4
1002 (4)	1_4 (4)	35	30.0	21.4	40.0
1002 (5)	1_4 (5)	35	47.7	47.6	0.4
1003 (4)	1_5 (4)	38	24.5	18.9	29.2
1003 (5)	1_5 (5)	35	54.0	34.7	55.6
1004 (10)	1_6 (10)	30	11.9	16.0	-25.6
1004 (11)	1_6 (11)	40	23.3	21.0	10.7
1004 (12)	1_6 (12)	40	16.5	14.6	12.8
1004 (13)	1_6 (13)	35	25.3	22.7	11.3
1004 (14)	1_6 (14)	30	25.8	23.1	11.7
1004 (8)	1_6 (8)	40	15.4	13.5	13.9
1004 (9)	1_6 (9)	40	29.0	21.6	34.4
	Average CPUE		**27.8**	**22.9**	

Mesh size calibration coefficient

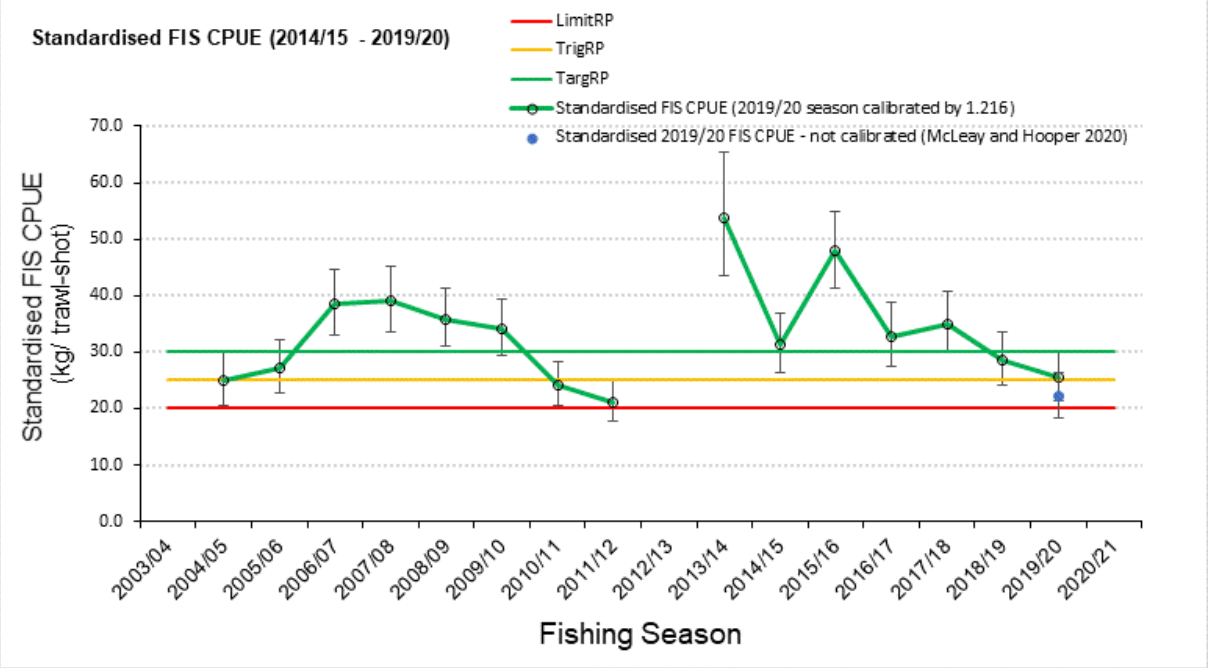
The calibration coefficient calculated from the experimental trawl dataset based on 31 trawls was **1.216.**

Application of the calibration coefficient to May 2020 FIS CPUE

Data collected in the May 2020 FIS from vessels that used a 57 mm cod-end can be scaled to a 51 mm cod-end using a coefficient of 1.216. This resulted in an estimate of nominal FIS CPUE in 2019/20 of 26.8 ± 2.6 kg.trawl.shot, which is 19.1% higher than the estimate of 22.5 ± 2.1 kg.trawl.shot provided by McLeay and Hooper (2020).

If 'adjusted' data are used in the prescribed GLM to standardise FIS CPUE, the estimate of standardised FIS CPUE in 2019/20 is 25.5 ± 0.2 kg.trawl-shot^{-1} (Figure A1). This estimate is 15.4% higher than the estimate of 22.1 ± 0.2 kg.trawl-shot^{-1} provided by McLeay and Hooper (2020) and in the target range (≥25 to <30 kg.trawl.shot^{-1}) for this performance indicator (PIRSA 2017).

Figure A1. Standardised FIS CPUE between 2004/05 and 2019/20 using the coefficient of 1.216 derived from the experimental trawl dataset of 31 trawls.



Fishing year-survey, region and vessel were all highly significant variables in the GLM (Table A3). A low overall model goodness-of-fit (adjusted R^2 value 0.14) indicated other unaccounted sources of variability. A total of 14.9% of the deviance in survey catches was explained by the model. The model term 'fishing year-survey' explained 7.7% of the deviance, 'region'

explained 5.4% and ‘vessel’ explained 1.8%, indicating that 85.1% of the deviance was due to unknown factors.

Table A3. Analysis of deviance (Type II test) for the GLM used to standardise FIS CPUE data for the GSVPF using the calibration coefficient calculated from 31 trawls. Abbreviations: SS, sum of squares; df, degrees of freedom; *F*, *F*-statistic.

Effect	**SS**	**df**	***F***
Fishing year-survey	273.5	36	9.4***
Region	192.6	7	33.8***
Vessel	65.7	13	6.2***
Residuals	3033.1	3726	NA

Significance: *** $p < 0.001$