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Department of Primary Industries and Regions

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Our ref: CORP F2022/000169

8 August 2022

Hon Nicola Centofanti MLC
Member of the Legislative Council
Parliament House
ADELAIDE SA 5000

Dear Ms Centofanti

Determination under the *Freedom of Information Act 1991*

I refer to your application made under the *Freedom of Information Act 1991* which was received by the Department of Primary Industries and Regions (PIRSA) on 25 May 2022, seeking access to the following:

> *"All Advice Notes, including associated attachments, from the South Australian Research and Development Institute to the South Australian Department of Primary Industries and Regions between 1 May 2018 to 1 May 2022."*

On 25 May 2022, contact was made with your office seeking to narrow the scope of your application. Your application was placed on hold for a period of forty-three days while negotiations were being undertaken with your office.

On 7 July 2022, it was confirmed that your application is revised as follows:

> *"All advice notes, including associated attachments, from the South Australian Research and Development Institute to the South Australian Department of Primary Industries between 1 May 2021 to 1 May 2022 that relate to fishing stocks"*

Accordingly, the following determination has been finalised.

I have located twenty-nine documents that are captured within the scope of your request.

Determination 1

I have determined that access to the following documents is **granted in full**:

Doc No.	Description of document	No. of Pages
1	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 29/9/2021 re Spencer Gulf Prawn Fishery – 2020/21 Stock Status Determination	3

2	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 31/3/2022 re West Coast Prawn Fishery – Sustainability of Fishing in Corvisart Bay	4
3	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 11/5/2021 re Blue Crab Fishery: 2021 Fishery-Independent Survey Results	10
4	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic and Livestock Sciences dated 11/2/2022 re Blue Crab Fishery: Transition from Research to Commercial Pots (Strategic Research Project)	9
5	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 13/9/2021 re Fish Stocks and Marine Parks	2
6	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 18/6/2021 re Southern Garfish Management Arrangements (Mesh Size and Size Limit) from 1/7/2021	7
7	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 19/8/2021 re South Australian Giant Crab Fishery – Commercial Catch Per Unit Effort – 2020/21 Season	2
8	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 23/6/2021 re Gulf St Vincent Prawn Fishery: May 2021 – Fishery Independent Survey Results	9
9	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 22/11/2021 re Gulf St Vincent Prawn Fishery: Impact of Pre-Fishing Surveys before the 2021 Pre-Christmas Fishing Period	2
9a	Attachment to Doc 9 – Independent scientific review of proposed harvest strategy options for the Gulf St Vincent Prawn Fishery dated 20/10/2021	11
10	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 29/9/2021 re Gulf St Vincent Prawn Fishery: Standardised Annual Commercial Catch Per Unit Effort (CPUE)	3
11	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 22/10/2021 re Identification of Marine Scalefish Fishery Gears that Primarily Capture Species that could Tolerate Increased Catches	8
13	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 27/9/2021 re Analysis of Latent Effort and Catch Composition for Gear Types in the MSF	24
14	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 5/8/2021 re Northern Zone Rock Lobster Fishery Quota Carry-over	4

15	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 7/5/2021 re 2020/21 Estimates of Biological Performance Indicators for the Harvest Strategy of the Lakes and Coorong Fishery for Pipi *Donax Deltoides*	8
16	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 26/5/2021 re Biological Implications of Two Harvesting Scenarios for Pipi	5
17	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 27/10/2021 re Proposed Translocation of up to 150T of Small Graded Pipi	7
18	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 21/4/2022 re Risk to Sustainability of Tier 1 MSF Stocks if TACCs were Increased to Incorporate Additional Quota Allocations	16
19	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 27/4/2022 re Risk to Sustainability of Tier 1 MSF Stocks if TACCs were Increased to (1) Incorporate Additional Quota Allocations, and (2) Enable the Carry-over of up to 10% of the Uncaught Quota on each Licence from the 2021/22 Season to the 2022/23 Season	23
20	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 12/11/2021 re Simultaneous Use of Maximum Rock Lobster and Giant Crab Pot Entitlements	3
21	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 10/7/2021 re Removal of Seasonal Closures for Snapper in the South East Region	3
22	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 28/5/2021 re Science used in Estimating the TAC/TACC for Snapper in the South East	4
23	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 9/11/2021 re SZRLF: Fishery-Independent Monitoring Survey September 2021 Results	9
24	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 20/4/2022 re SZRLF: Fishery-Independent Monitoring Survey 2021/22 Results	15
25	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 28/10/2021 re SZRLF: September 2021 Fishing Data	5
26	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 26/11/2021 re West Coast Prawn Fishery – 2021 Fishery Assessment	5

27	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 26/11/2021 re Updated Western Zone Abalone Fishery Harvest Strategy Outcomes and review of Records included in Harvest Strategy Analysis	5
28	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 2/2/2022 re Yellowtail Kingfish	5

Determination 2

I have determined that access to the following document is **refused**:

Doc No.	Description of document	No. of Pages
12	Advice note to Executive Director, PIRSA Fisheries and Aquaculture from SARDI Aquatic Sciences dated 11/7/2021 re Provision of Information for Miscellaneous Commercial Dive Fishery – Scallop	4

Access to the above document is refused pursuant to Clause 12(1) of Schedule 1 of the Freedom of Information Act and Section 124(1) of the *Fisheries Management Act 2007.*

Clause 12(1) states:

> ***"12—Documents the subject of secrecy provisions***
> *(1) A document is an exempt document if it contains matter the disclosure of which would constitute an offence against an Act."*

Section 124(1) of the Fisheries Management Act states:

> ***"124 - Confidentiality***
> *(1) A person engaged or formerly engaged in the administration of this Act or the repealed Act must not divulge or communicate information obtained (whether by that person or otherwise) in the course of official duties except—*
> *(a) as required or authorised by or under this Act or any other Act or law; or*
> *(b) with the consent of the person to whom the information relates; or*
> *(c) in connection with the administration of this Act, the repealed Act or a corresponding law; or*
> *(d) to a law enforcement, prosecution or administrative authority of any Australian jurisdiction, where the information is required for the proper administration or enforcement of an Act or law of such a jurisdiction; or*
> *(e) for the purposes of any legal proceedings arising out of the administration of this Act, the repealed Act or a corresponding law.*
>
> *Maximum penalty: $10 000."*

The document contains confidential commercial catch and effort data which is identifiable as it refers to five or less fishers and was obtained by PIRSA in the course of official duties in administering the Fisheries Management Act.

Accordingly, pursuant to Clause 12(1) of Schedule 1 of the Freedom of Information Act, the release of this document would constitute an offence against an Act.

If you are dissatisfied with this determination, you are entitled to exercise your right of review and appeal as outlined in the attached documentation https://archives.sa.gov.au/finding-information/information-held-sa-government/making-freedom-information-application#Review, by completing the "FOI Application Form for Internal Review of a Determination" and returning the completed form to:

Freedom of Information Principal Officer
Department of Primary Industries and Regions
GPO Box 1671
ADELAIDE SA 5001

or via email PIRSA.FOI@sa.gov.au

In accordance with the requirements of Premier and Cabinet Circular PC045, details of your application, and the documents to which you are given access, will be published in PIRSA's disclosure log. A copy of PC045 can be found at http://dpc.sa.gov.au/__data/assets/pdf_file/0019/20818/PC045-Disclosure-Log-Policy.pdf

If you disagree with publication, please advise the undersigned in writing within fourteen calendar days from the date of this determination.

Should you require further information or clarification with respect to this matter, please contact Ms Lisa Farley, Senior Freedom of Information Advisor on 8429 0422 or email PIRSA.FOI@sa.gov.au.

Yours sincerely

Michelle Griffiths
Accredited Freedom of Information Officer
DEPARTMENT OF PRIMARY INDUSTRIES AND REGIONS

SARDI

Doc 1

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR CRAIG NOELL (SARDI AQUATIC SCIENCES)**

SUBJECT: **SPENCER GULF PRAWN FISHERY – 2020/21 STOCK STATUS DETERMINATION**

DATE: **29 SEPTEMBER 2021**

KEY ISSUES:

- This Advice Note reports on the stock status of the Spencer Gulf Prawn Fishery (SGPF) for the 2020/21 fishing year, as required in the 2021/22 Service Level Agreement (SLA).
- The stock status was determined by application of a revised survey design and harvest strategy in the new Management Plan for the SGPF.
- The weighted mean catch rate for adult prawns for 2020/21 is above the limit and trigger reference points.
- Based on application of the harvest strategy, the fishery is classified as a '**sustainable**' stock.

BACKGROUND:

The new Management Plan for the Spencer Gulf Prawn Fishery (SGPF) (PIRSA 2020) was implemented at the start of the 2020/21 fishing year and includes a revised survey design and harvest strategy. The harvest strategy explicitly links a weighted mean catch rate for adult prawns from three fishery-independent surveys (conducted in October/November, February/March and April) to a stock status classification. It also adopts a consistent stock status terminology to that of the national status reporting framework (Stewardson et al. 2018).

The determination of an end-of-year stock status for the SGPF is important, as each status classification ('sustainable', 'transitional'—'depleting' or 'recovering'—and 'depleted') drives a specific set of decision rules and criteria that are applicable in the following fishing year. Advanced notice of this information before fishing commences provides PIRSA with a clear understanding of the stock status for the fishery and how it was derived. It also provides industry with greater certainty when planning its fishing operations for the year ahead.

RESULTS/DISCUSSION:

The October, March and April survey results from the 2020/21 fishing year were validated (Figure 1). The mean survey catch rates for adult prawns (comprising size grades with less than 20 prawns per pound) from all three surveys were weighted to reflect their relative 'importance' to determine end-of-year stock status (Figure 2). Importance was based on their measure of relative exploitable biomass, recruitment, and timing, using the methodology described in the Management Plan (i.e. weightings of 0.2 for October/November, 0.35 for February/March and 0.45 for April).

For all surveys, the mean catch rate for adult and newly recruited prawns (comprising size grades with more than 20 prawns per pound) exceeded their limit reference points (LRPs; Table 1, Figure 1); noting that the LRP for individual surveys establishes a benchmark for undesirable performance and is not used here in the conventional sense of indicating recruitment impairment of the stock.

The weighted mean catch rate for adult prawns of 4.82 lb min^{-1} places the 2020/21 result above the 'true' LRP for the stock (2.21 lb min^{-1}) and the trigger reference point (3.16 lb min^{-1}).

Based on application of the harvest strategy, the fishery is classified as a '**sustainable'** stock (Table 1, Figure 2).

Table 1. Application of the harvest strategy for the Spencer Gulf Prawn Fishery for determining stock status for the 2020/21 fishing year. Abbreviations: a, adults; r, recruits; CR, mean catch rate; LRP, limit reference point.

Survey	Weighting	aCR (lb min^{-1})	aLRP (lb min^{-1})	rCR (lb min^{-1})	rLRP (lb min^{-1})
Oct 2020	0.20	2.76	>2.50	2.36	>0.78
Mar 2021	0.35	4.30	>3.32	2.38	>1.49
Apr 2021	0.45	6.14	>4.55	2.00	>1.41
Weighted mean		**4.82**			

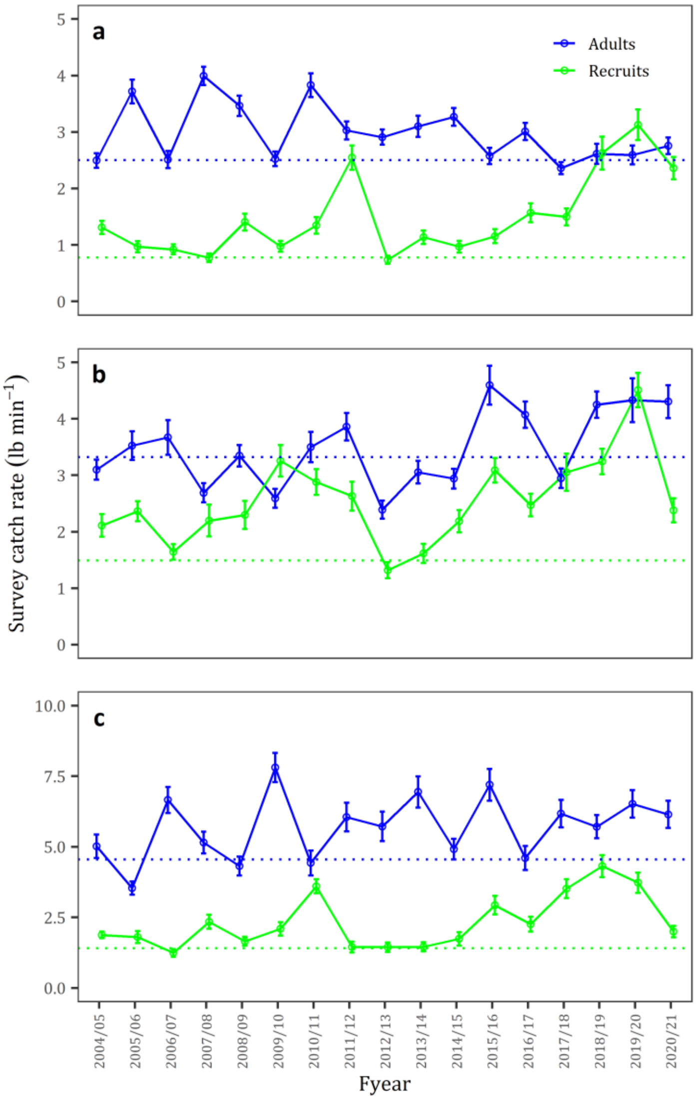


Figure 1. Mean survey catch rate (lb min^{-1}) of adult and newly recruited prawns for a) October/November, b) February/March and c) April stock assessment surveys. Error bars are ± 1 SE. Horizontal (dotted) reference lines indicate limit reference points.

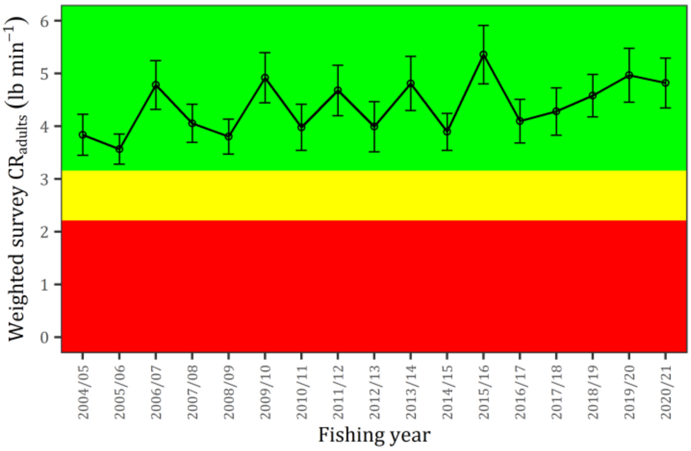


Figure 2. Weighted mean survey catch rate for adult prawns (CR_{adults}, lb min^{-1}) and stock status for the SGPF. Error bars are ± 1 SE. Green = 'sustainable', yellow = 'transitional', red = 'depleted'.

Dr Michael Steer
Research Director, Aquatic Sciences

Disclaimer

Doc 2

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR CRAIG NOELL AND DR CRYSTAL BECKMANN (SARDI AQUATIC SCIENCES)**

SUBJECT: **WEST COAST PRAWN FISHERY – SUSTAINABILITY OF FISHING IN CORVISART BAY**

DATE: **31 MARCH 2022**

KEY ISSUES:

- West Coast Prawn Fishery (WCPF) licence holders have requested access to Corvisart Bay during the post-Christmas fishing period (March–October) when the fishery is classified as sustainable or transitional.
- There has been no post-Christmas fishing in Corvisart Bay since 2008.
- While post-Christmas catch data from Corvisart Bay are limited, the known biology of Western King Prawns, combined with features of the harvest strategy, suggest the risk of fishing Corvisart Bay on the stock from March to October is low.

BACKGROUND:

PIRSA Fisheries and Aquaculture has requested advice on the sustainability of prawn trawling in Corvisart Bay during post-Christmas fishing months.

Corvisart Bay is one of four fishing regions within the WCPF; the others being Ceduna (which is adjacent to Corvisart Bay), Venus Bay and Coffin Bay. The shallow estuarine waters adjacent to Ceduna (Denial Bay to Smoky Bay) are part of a low energy coastline, protected by the islands of the Nutys Archipelago. Fine sediment structure, tidal flats and mangrove forests at Ceduna provide an important juvenile prawn nursery supporting recruitment into the fishery. Nearby Corvisart Bay also has some suitable nursery habitat at Streaky Bay, however, the area is generally more exposed and experiences strong westerly waves and winds. Despite Corvisart Bay's proximity to Ceduna, it is considered by industry to be different from the Ceduna grounds as it is a source of larger prawns (PIRSA 2019), which migrate southwards to Venus Bay.

The current harvest strategy for the WCPF aims to maintain sustainability of the prawn resource by reducing catches of small prawns and protecting spawning prawns while allowing for flexible fishing and accounting for environmental conditions. The harvest strategy provides a limit on the number of nights that may be fished throughout the year (depending on stock status), identifies the regions that may be fished during the post-Christmas (March–October) and pre-Christmas periods (November and December), and specifies the prawn size and catch criteria for each month-region combination (PIRSA 2019).

Corvisart Bay is only identified as a fishing region during the pre-Christmas period; however, the harvest strategy includes a table that specifies size and catch criteria for Corvisart Bay for pre-Christmas and post-Christmas periods (Table 1).

RESULTS/DISCUSSION:

Historically, post-Christmas catches in the WCPF make up an average of 86% of the annual total catch, and since 1987 have been predominantly taken from Venus Bay (almost exclusively since 2007), averaging ~77 t per year (Fig. 2b). In comparison, post-Christmas catches from Ceduna and Corvisart Bay between 1988 and 2005 have been relatively low, averaging ~22 t (25% of total) and 3 t (3% of total), respectively (Fig. 2b). Since 2008, Ceduna and Corvisart Bay have only been fished during the pre-Christmas period (Fig. 2c).

There are few catch and effort data for Corvisart Bay, especially since 2008, to determine the importance of this region to prawn stock sustainability in the WCPF or to inform its inclusion or exclusion for post-Christmas fishing.

Prawns from Corvisart Bay are generally larger than those from the adjacent shallow nursery areas in Ceduna; consequently, Corvisart Bay is not identified as being important for spawning or recruitment (PIRSA 2019). As a result, allowing post-Christmas fishing in Corvisart Bay should maintain existing protections on prawn recruitment.

In addition to size and catch criteria in the harvest strategy, the other primary management control is a limitation to the total number of fishing nights. Consequently, any nights spent fishing in Corvisart Bay will be balanced by fewer nights in other regions.

Given the biology of Western King Prawns on the West Coast and the harvest strategy that limits fishing nights and controls the size of prawns harvested, the risk of post-Christmas fishing in Corvisart Bay is considered to be low.

Dr Stephen Mayfield
A/Research Director, Aquatic and Livestock Sciences

REFERENCES

PIRSA (2019). West Coast Prawn Fishery Harvest Strategy South Australia.

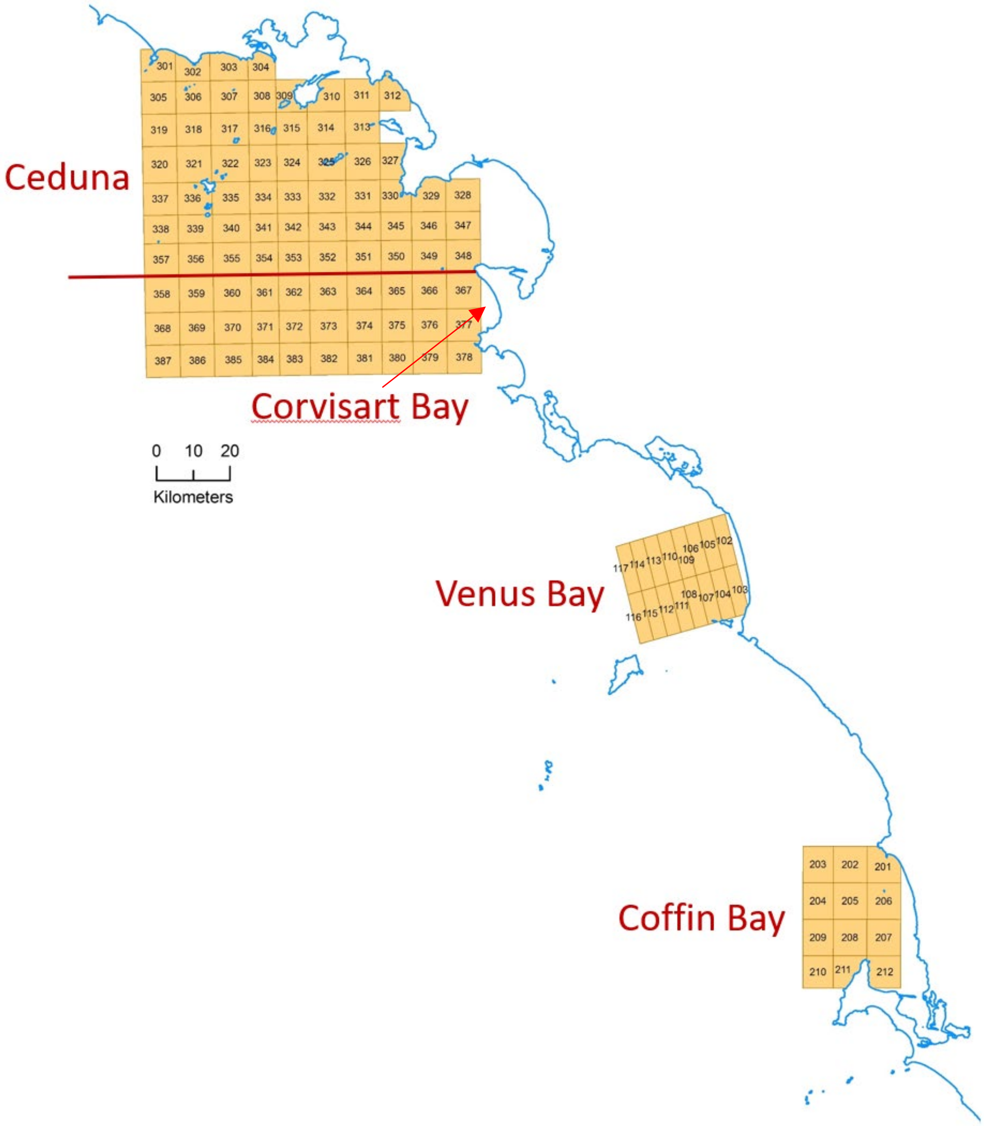
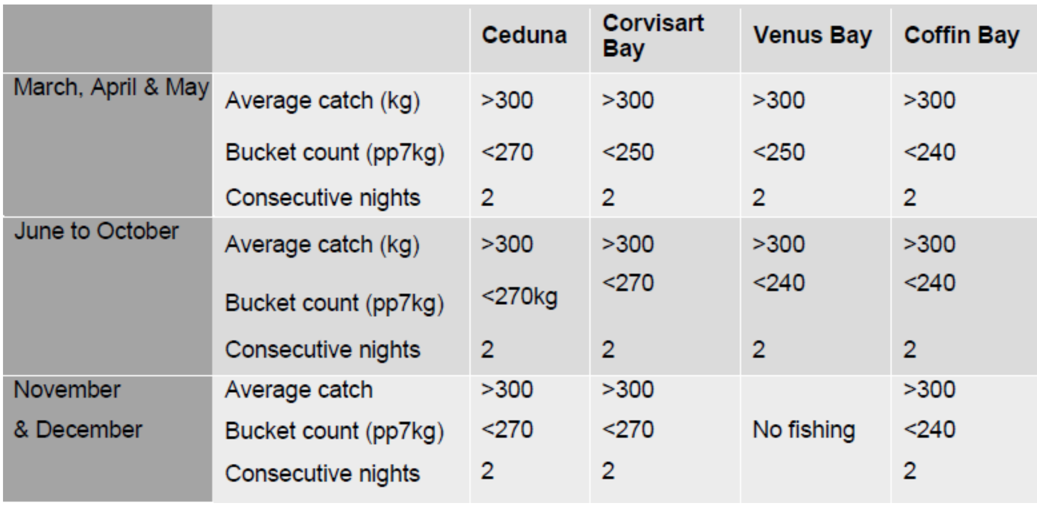


Figure 1. The western coastline of South Australia showing the four regions and fishing blocks within the WCPF.

Table 1. Prawn size and catch criteria for at-sea management of fishing runs in the WCPF (reproduced from PIRSA 2019, Table 6).



		Ceduna	**Corvisart Bay**	**Venus Bay**	**Coffin Bay**
March, April & May	Average catch (kg)	>300	>300	>300	>300
	Bucket count (pp7kg)	<270	<250	<250	<240
	Consecutive nights	2	2	2	2
June to October	Average catch (kg)	>300	>300	>300	>300
	Bucket count (pp7kg)	<270kg	<270	<240	<240
	Consecutive nights	2	2	2	2
November & December	Average catch	>300	>300	No fishing	>300
	Bucket count (pp7kg)	<270	<270		<240
	Consecutive nights	2	2		2

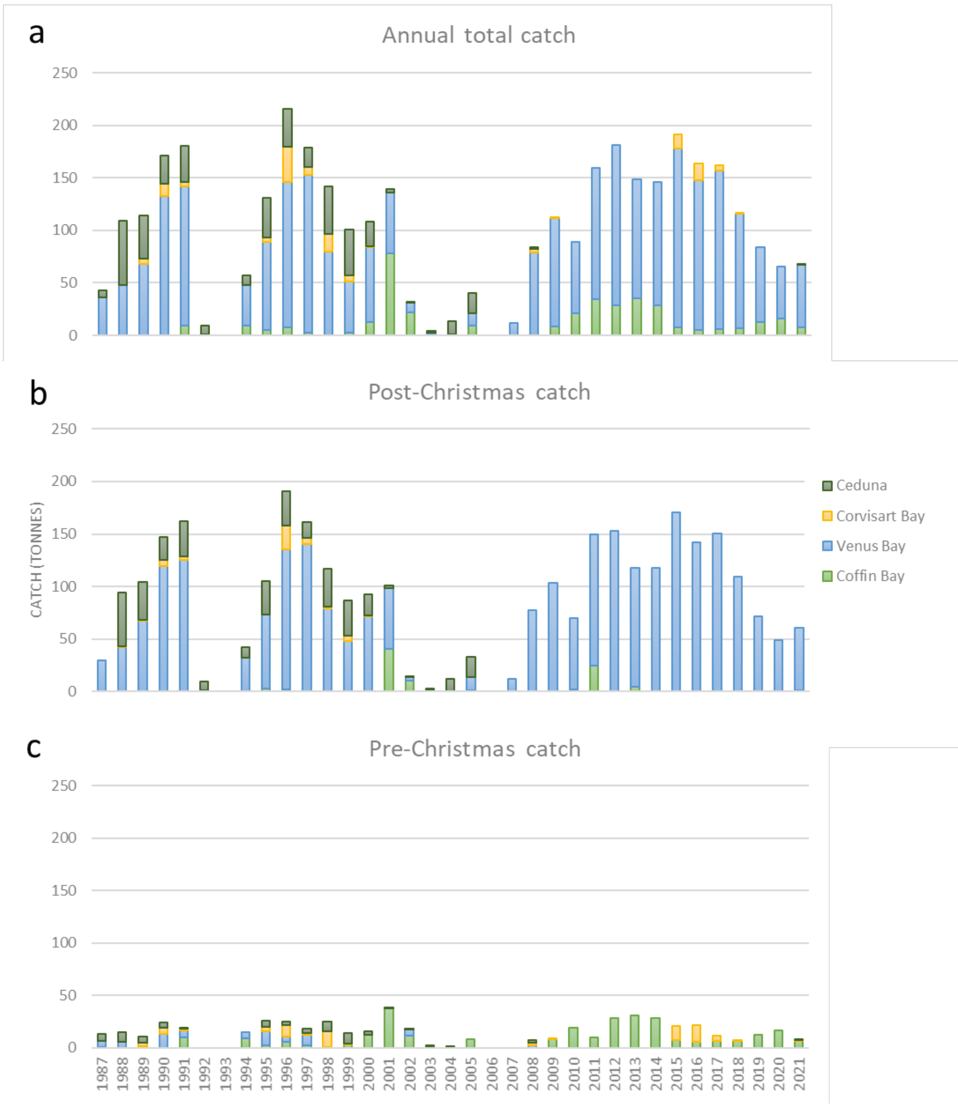


Figure 2. (a) Annual total, (b) post-Christmas and (c) pre-Christmas catch by region of the WCPF since 1987.

ADVICE TO:	**PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**
FROM:	**DR. CRYSTAL BECKMANN (SARDI AQUATIC SCIENCES)**
SUBJECT:	**BLUE CRAB FISHERY: 2021 FISHERY-INDEPENDENT SURVEY RESULTS**
DATE:	**11 MAY 2021**

KEY ISSUES

- The latest fishery-independent surveys (FIS) for the Blue Crab Fishery (BCF) were conducted in Gulf St Vincent (GSV) and Spencer Gulf (SG) during March and April 2021.
- This Advice Note reports on the FIS results, as required in the 2020/21 Service Level Agreement (SLA).
- The FIS catch per unit effort (CPUE; kg.potlift^{-1}) has been plotted against the March/April reference points (RPs) for legal-size CPUE in the Harvest Strategy presented in the Management Plan. Pre-recruit CPUE is also presented.
- In 2021, legal-size CPUE decreased compared to 2020 levels in GSV and SG.
- In GSV, the 2021 legal-size CPUE was the second lowest recorded but above the target RP in the Harvest Strategy. Under the decision rules for TACC setting, legal-size CPUE was between 2.5 and 3.29 t, which equates to a maximum biological sustainable catch of 269.66 t.
- In SG, the 2021 legal-size CPUE was the second lowest value recorded and between the trigger and target RP in the Harvest Strategy. Under the decision rules for TACC setting, legal-size CPUE was between 2.4 and 3.69 t, which equates to a maximum biological sustainable catch of 381.67 t.
- In 2021, pre-recruit CPUE increased compared to 2020 levels for both the GSV and SG zones, with the GSV value the highest on record.

BACKGROUND

From 2002 to 2018, SARDI conducted annual or biennial fishery-independent surveys (FIS) during June/July in the Gulf St Vincent (GSV) and Spencer Gulf (SG) fishing zones of the Blue Crab Fishery (BCF; Appendix Figure A-1) for stock assessment purposes. These surveys provided spatially explicit data on blue crab abundance and population structure using catch rate, crab sex, size, and condition data. At each FIS location, five research small-mesh pots (55 mm) and five commercial larger-mesh pots (90 mm) were set. Data collected include abundance, crab size (carapace width, in mm), sex, condition, bottom water temperature and depth.

March/April FIS have been undertaken from 2015–2021 (except for 2018) in GSV and from 2016–2021 in SG. New performance indicators (PIs) and reference points (RPs) were developed by comparing March/April and June/July data and are available in the Harvest Strategy presented in the Management Plan (PIRSA 2020).

This Advice Note documents the March 2021 FIS results for the GSV and SG zones of the BCF.

RESULTS/DISCUSSION

The 2021 FISs took place in GSV from 14–19 March using MFV *Silver Spectre*, and in SG from 7–12 April using MFV *Pot Luck*. The survey design includes 60 sites in each gulf, with a total of 300 research pots and 300 commercial pots set. This Advice Note reports on research potlifts to inform decision making under the harvest strategy. A total of 294 and 268 research potlifts were successfully sampled in March, in GSV and SG, respectively. Note that due to an accidental loss of equipment on the last day of setting the gear, namely multiple bait poles/bait containers for both research and commercial gear being lost, six sites (equivalent to 30 research and 30 commercial potlifts) were unable to be sampled in SG during April 2021. Overall, the reduced number of sites had minimal impact on CPUE (see Appendix Figure A-2).

Data were entered and validated according to established SARDI protocols. The weights and sex ratios of legal-sized and pre-recruit (undersized) crabs in research pots from all sites are summarised in Table 1 and Table 2. Sex- and gulf-specific weight conversions for each crab length measured were undertaken using the length/weight relationship (Beckmann and Hooper, 2017). Nominal FIS catch per unit effort (CPUE) is calculated as the average weight of legal-size and pre-recruit Blue Crabs per research potlift (small-mesh pots only). The FIS CPUE has been plotted against the March/April RPs for legal-size CPUE (kg.potlift^{-1}) in the Harvest Strategy in Figure 1 and Figure 2. Pre-recruit CPUE (kg.potlift^{-1}) is also presented.

A spatial breakdown of legal-size (legal-size.potlift^{-1}) and pre-recruit abundances (pre-recruits.potlift^{-1}), as well as percentage of females for both pot types (commercial and research pots) within each fishing block are provided in Table A-1 (GSV) and Table A-2 (SG). Environmental data (i.e. tide predictions at Outer Harbour/ Wallaroo and daily weather observations at Adelaide Airport/ Kadina) are provided in Tables A-3, A-4, and A-5.

Gulf St Vincent

In March 2021, legal-size CPUE in GSV was 3.0 ± 0.1 (SE) kg.potlift^{-1}, reflecting a 30% decrease from 2020 (4.3 ± 0.1 [SE] kg.potlift^{-1}) and equivalent to the second lowest value recorded for March/April (Figure 1a).

Legal-size CPUE was above the target RP (2.5 kg.potlift^{-1}) in the Harvest Strategy. Under the decision rules for TACC setting, legal-size CPUE was between 2.5 and 3.29 t, which equates to a maximum biological sustainable catch of 269.66 t.

The CPUE of pre-recruit crabs was 3.6 ± 0.1 (SE) kg.potlift^{-1} in March 2021, a 260% increase compared to March 2020 (1.0 ± 0.0 [SE] kg.potlift^{-1}) and the highest value recorded for March/April (Figure 1b).

Catch during March 2021 was mostly undersize crabs (55.1% of total catch), particularly under-size males (53.7% of total catch; Table 1).

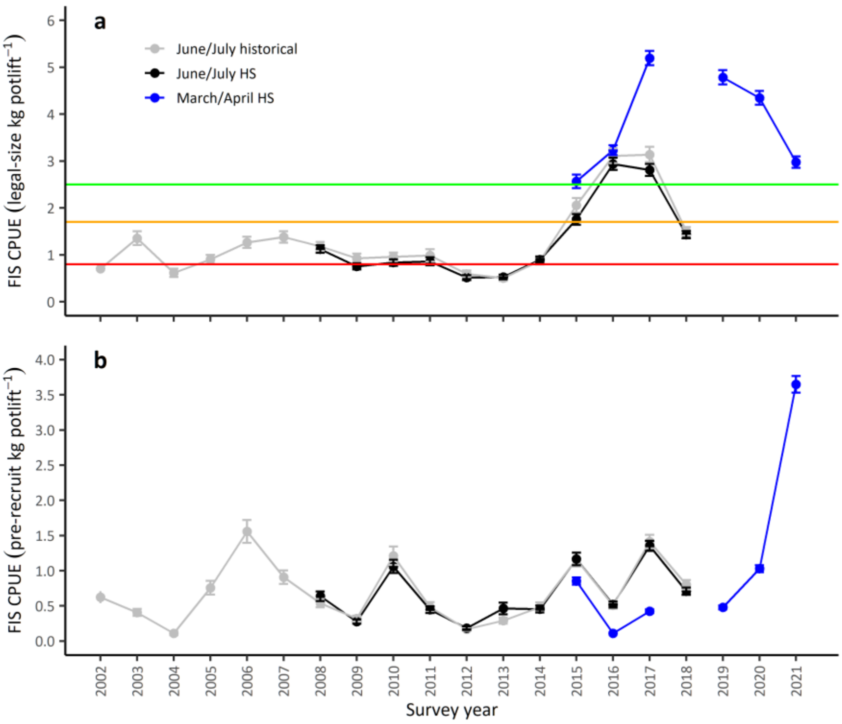


Figure 1. Key fishery-independent outputs used to assess the status of the Gulf St Vincent zone of the Blue Crab Fishery (BCF). Fishery-independent (FIS) catch per unit effort (CPUE) by weight of (a) legal-size crabs (kg.potlift^{-1}), and (b) weight of pre-recruit crabs (kg.potlift^{-1}). Historical sites refer to 37 sites which have not changed since 2003 (excludes new sites) and Harvest Strategy (HS) sites refer to the subset of 60 sites sampled since 2008 (includes new sites). Green, yellow and red lines represent the target, trigger and limit reference points for March/April identified in the draft harvest strategy, see Table 1.1. Error bars, standard error. Note: no FIS was conducted in March/April 2018 or June/July 2019 or 2020.

Table 1. Summary of weight statistics for the March 2021 fishery-independent survey using research pots. SE, Standard error.

Potlifts	Size	Male (kg)	Female (kg)	Total (kg)	CPUE (kg.potlift^{-1})	Harvest strategy output
294	Legal	866 (44.5%)	9 (0.5%)	875 (44.9%)	3.0 ± 0.1 (SE)	269.66 t
	Pre-recruits	1,046 (53.7%)	27 (1.4%)	1,072 (55.1%)	3.6 ± 0.1 (SE)	-

Spencer Gulf

In April 2021, legal-size CPUE in SG was 2.8 ± 0.1 (standard error, SE) kg.potlift^{-1} (Figure 2a). Legal-size CPUE in SG decreased by 44% compared to March 2020 (5.0 ± 0.2 [SE] kg.potlift^{-1}) and was the second lowest value recorded for March/April.

Legal-size CPUE was above the trigger (2.4 kg.potlift^{-1}) RP in the Harvest Strategy. Under the decision rules for TACC setting, legal-size CPUE was between 2.4 and 3.69 t, which equates to a maximum biological sustainable catch of 381.67 t.

The CPUE of pre-recruit crabs was 1.7 ± 0.1 (SE) kg.potlift^{-1} in April 2021, a 55% increase compared to March 2020 (1.1 ± 0.0 [SE] kg.potlift^{-1}) and the third highest value recorded for March/April (Figure 1b).

Catch during March 2021, was dominated by legal-size crabs (61.5% of total catch), particularly legal-size males (57.1% of total catch, Table 2).

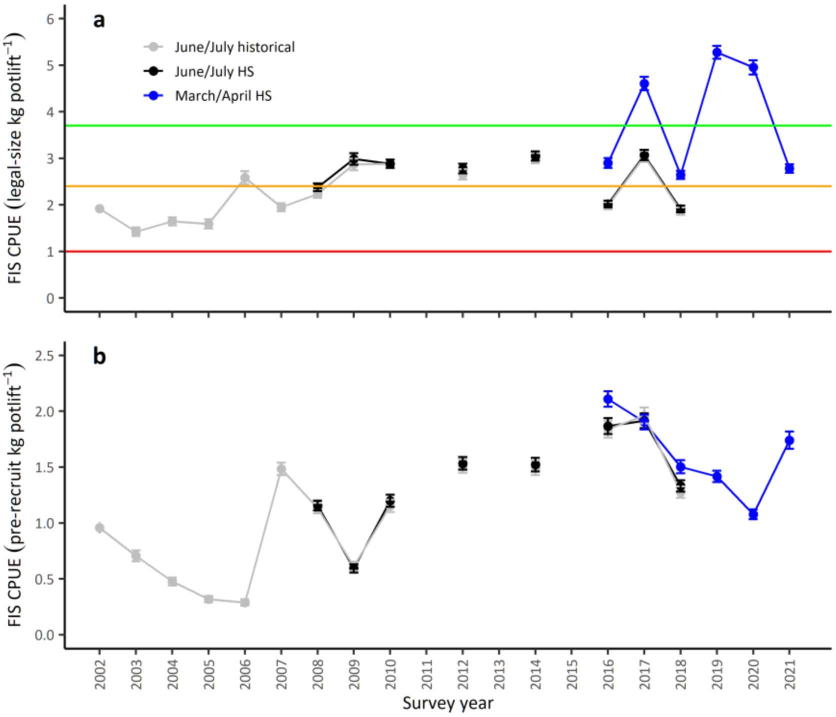


Figure 2. Key fishery-independent outputs used to assess the status of the Spencer Gulf zone of the Blue Crab Fishery (BCF). Fishery-independent (FIS) catch per unit effort (CPUE) by weight of (a) legal-size crabs (kg.potlift^{-1}), and (b) pre-recruit crabs (kg.potlift^{-1}). Historical sites refer to the 52 sites which have not changed since 2003 (excludes new sites) and Harvest Strategy (HS) sites refer to the subset of 60 sites sampled since 2008 (includes new sites). Green, yellow and red lines represent the target, trigger and limit reference points for March/April identified in the Harvest Strategy (see Table 1.1). Error bars, standard error. Note. June/July FIS were not conducted in 2011, 2013, 2015, 2019 or 2020.

Table 2. Summary of weight statistics for the March 2021 fishery-independent survey using research pots. SE, standard error.

Potlifts	Size	Male (kg)	Female (kg)	Total (kg)	CPUE (kg.potlift^{-1})	Harvest strategy output
268	Legal	692 (57.1%)	53 (4.4%)	745 (61.5%)	2.8 ± 0.1 (SE)	381.67 t
	Pre-recruits	395 (32.6%)	71 (5.9%)	466 (38.5%)	1.7 ± 0.1 (SE)	-

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A/Research Director, Aquatic Sciences

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Beckmann, C. L. and Hooper, G. E. (2017). Blue Crab (*Portunus armatus*) Fishery 2015/16. Fishery Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000729-13. SARDI Research Report Series No. 944. 59pp.

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APPENDIX

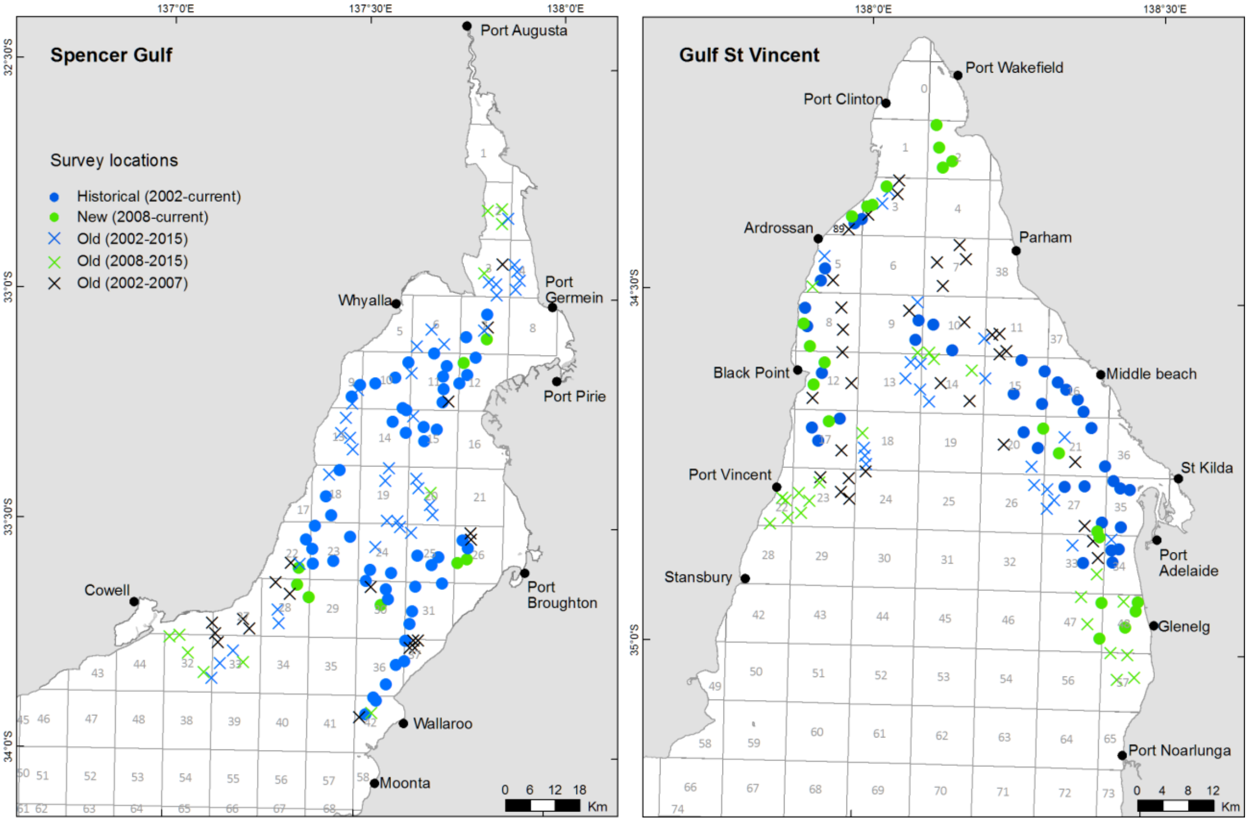

Figure A-1. Research blocks (grid) and fishery-independent survey (FIS) locations in the Spencer Gulf (SG) and Gulf St Vincent (GSV) zones of the Blue Crab Fishery (BCF). Circles represent the 60 sites chosen for the draft interim harvest strategy (green sampled since 2008, blue sampled since 2002), crosses represent standard sites removed from the design from 2016. Old sites sampled from 2002-07 not shown.

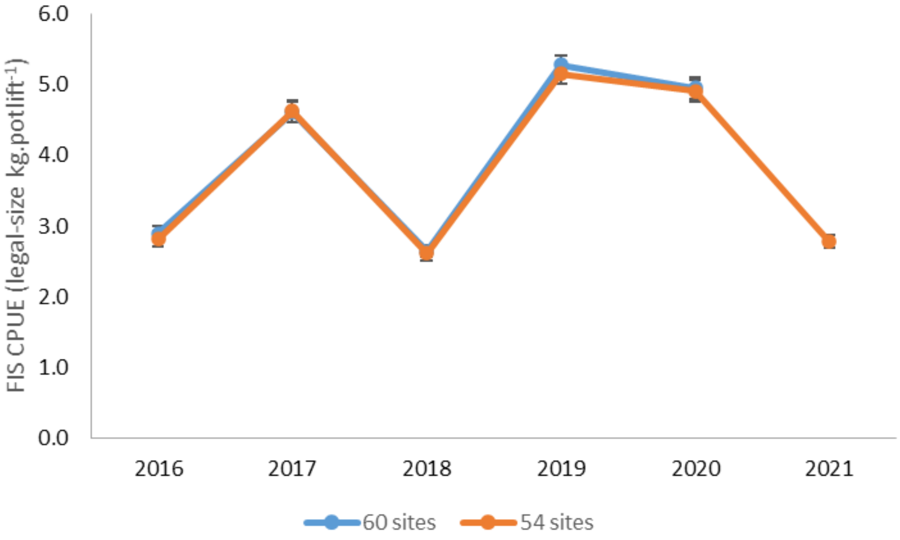

Figure A-2. Fishery-independent (FIS) catch per unit effort (CPUE) by weight of legal-size crabs (kg.potlift^{-1}). Harvest Strategy (HS) sites are indicated by the subset of 60 sites (297–300 potlifts) sampled from 2016–2020, while 54 sites (268 potlifts) reflect the reduced sampling design undertaken during April 2021. Error bars, standard error.

Table A-1. Mean catch rate (legal-sized [L] and pre-recruit [U] crabs per potlift) and sex ratio (%female, F) for commercial and research pots from the March 2021 Gulf St Vincent fishery-independent survey.

	Line A			Line B			Line C			Line D			Total		
Block	Crabs/potlift		%F	Crabs/potlift		%F	Crabs/potlift		%F	Crabs/potlift		%F	Crabs/potlift		%F
	L	U		L	U		L	U		L	U		L	U	
Research															
2	10.0	17.0	0.7%	11.8	13.0	0.8%	6.6	16.6	0.0%	5.0	16.4	0.0%	8.4	15.8	0.4%
3	17.4	25.0	0.0%	5.2	9.6	0.0%	-	-	-	-	-	-	11.3	17.3	0.0%
5	-	-	-	17.8	19.3	0.0%	14.5	11.8	4.7%	-	-	-	16.1	15.5	2.0%
8	13.4	15.4	0.7%	14.4	33.0	1.7%	20.2	12.8	0.0%	12.0	19.3	0.8%	15.2	20.2	0.9%
9	-	-	-	-	-	-	3.8	19.4	-	4.2	16.2	6.9%	4.0	17.8	8.7%
10	-	-	-	7.6	30.0	7.4%	11.0	28.8	-	-	-	-	9.1	29.4	10.1%
12	13.0	15.2	0.7%	12.6	17.4	0.0%	11.2	20.8	4.4%	11.4	20.2	0.0%	12.1	18.4	1.3%
15	7.2	31.2	11.5%	7.2	23.6	1.3%	5.6	27.8	-	13.6	29.8	0.9%	8.4	28.1	6.0%
16	10.8	26.6	1.1%	12.0	27.6	0.5%	6.5	32.3	6.4%	13.2	27.2	0.5%	10.8	28.2	1.9%
17	9.6	11.2	0.0%	7.2	8.4	0.0%	9.8	15.4	1.6%	8.4	11.4	7.1%	8.8	11.6	2.2%
20	-	-	-	7.8	27.6	1.1%	5.8	23.0	1.4%	6.2	27.8	4.7%	6.6	26.1	2.4%
21	23.8	32.8	0.4%	-	-	-	11.0	30.0	0.5%	21.6	23.4	0.0%	18.8	28.7	0.3%
27	14.6	33.6	2.1%	7.2	22.0	2.7%	12.6	21.0	0.6%	13.6	21.0	3.5%	12.0	24.4	2.2%
33	-	-	-	26.6	19.0	0.4%	14.8	20.8	0.6%	-	-	-	20.7	19.9	0.5%
34	19.4	16.4	0.0%	23.4	24.2	0.8%	-	-	-	14.4	13.4	1.4%	19.1	18.0	0.7%
35	23.2	18.6	0.0%	12.6	29.8	0.9%	4.8	25.8	5.2%	11.4	22.6	1.2%	13.0	24.2	1.6%
47	22.0	18.0	1.5%	15.0	7.2	0.0%	-	-	-	-	-	-	18.5	12.6	1.0%
48	23.4	7.4	0.6%	-	-	-	9.4	8.0	0.0%	6.0	21.2	-	12.9	12.2	6.6%
89	6.2	15.4	0.0%	5.4	17.8	5.2%	5.0	20.5	1.9%	8.6	19.2	0.7%	6.4	18.1	1.9%
Commercial															
2	9.4	2.2	0.0%	18.6	3.8	0.0%	10.6	7.4	0.0%	5.6	2.8	2.4%	11.1	4.1	0.3%
3	15.4	3.4	0.0%	10.0	1.2	0.0%	-	-	-	-	-	-	12.7	2.3	0.0%
5	-	-	-	16.3	2.5	0.0%	12.5	2.3	0.0%	-	-	-	14.4	2.4	0.0%
8	13.4	1.8	0.0%	14.6	3.0	1.1%	18.4	1.8	0.0%	16.0	3.0	0.0%	15.6	2.4	0.3%
9	-	-	-	-	-	-	4.4	1.2	17.9%	4.8	1.2	3.3%	4.6	1.2	10.3%
10	-	-	-	5.2	3.0	0.0%	8.3	1.5	0.0%	-	-	-	6.6	2.3	0.0%
12	10.2	1.4	0.0%	15.8	2.0	0.0%	9.0	2.0	0.0%	14.6	0.8	0.0%	12.4	1.6	0.0%
15	3.8	4.4	12.2%	9.6	2.8	0.0%	4.2	0.6	4.2%	10.6	1.2	3.4%	7.1	2.3	4.3%
16	12.2	2.2	0.0%	10.2	1.2	1.8%	7.0	1.8	8.6%	11.0	3.2	0.0%	10.3	2.1	1.7%
17	12.6	1.2	1.4%	12.4	1.0	0.0%	14.6	1.8	1.2%	5.4	0.6	0.0%	11.3	1.2	0.8%
20	-	-	-	7.2	2.4	2.1%	3.2	1.4	0.0%	5.6	2.2	2.6%	5.3	2.0	1.8%
21	16.6	2.0	1.1%	-	-	-	11.4	1.2	1.6%	18.8	1.4	1.0%	15.6	1.5	1.2%
27	12.4	1.8	1.4%	4.4	1.4	0.0%	12.2	1.0	3.0%	13.6	1.4	0.0%	10.7	1.4	1.2%
33	-	-	-	16.6	0.4	0.0%	13.8	1.4	3.9%	-	-	-	15.2	0.9	1.9%
34	17.0	2.2	1.0%	19.2	1.2	0.0%	-	-	-	16.2	2.2	0.0%	17.5	1.9	0.3%
35	18.4	5.0	0.0%	11.2	2.8	0.0%	5.6	2.4	2.5%	13.2	1.8	0.0%	12.1	3.0	0.3%
47	17.6	1.2	0.0%	14.6	0.4	0.0%	-	-	-	-	-	-	16.1	0.8	0.0%
48	24.2	1.4	0.8%	-	-	-	8.6	1.4	6.0%	8.2	1.8	8.0%	13.7	1.5	3.5%
89	13.4	1.8	0.0%	3.6	1.4	0.0%	4.3	2.0	4.0%	7.4	2.2	0.0%	7.3	1.8	0.6%

Table A-2. Mean catch rate (legal-sized [L] and pre-recruit [U] crabs per potlift) and sex ratio (%female, F) for commercial and research pots from the April 2021 Spencer Gulf fishery-independent survey.

	Line A			Line B			Line C			Line D			Total		
Block	Crabs/potlift		%F	Crabs/potlift		%F	Crabs/potlift		%F	Crabs/potlift		%F	Crabs/potlift		%F
	L	U		L	U		L	U		L	U		L	U	
Research															
6	-	-	-	11.0	7.6	2.2%	-	-	-	-	-	-	11.0	7.6	2.2%
7	15.2	8.0	0.5%	-	-	-	11.6	16.6	15.6%	14.8	8.2	1.3%	13.9	10.9	17.5%
9	-	-	-	11.4	18.6	2.4%	-	-	-	5.2	14.2	5.3%	8.3	16.4	7.7%
10	9.0	7.2	5.4%	10.6	15.6	8.2%	-	-	-	13.8	7.2	1.6%	11.1	10.0	15.1%
11	17.0	11.8	5.7%	18.6	6.0	0.6%	11.6	9.4	0.8%	16.0	7.2	2.7%	15.8	8.6	9.8%
12	10.4	10.4	3.7%	9.0	10.6	3.7%	15.0	6.8	1.9%	11.0	13.0	2.3%	11.4	10.2	11.6%
14	5.0	23.0	13.0%	7.4	10.8	4.2%	13.8	11.6	3.1%	11.6	7.6	3.5%	9.5	13.3	23.8%
15	12.8	8.8	1.8%	17.8	15.6	6.2%	19.8	12.0	9.4%	-	-	-	16.8	12.1	17.5%
18	4.0	15.4	4.3%	11.8	17.0	6.0%	-	-	-	10.3	4.0	0.7%	8.6	12.7	11.0%
22	7.4	6.4	5.2%	-	-	-	12.0	23.4	1.6%	4.6	7.8	2.9%	8.0	12.5	9.7%
23	2.0	0.2	0.0%	10.4	1.8	0.5%	4.2	5.8	0.0%	9.8	9.4	5.0%	6.6	4.3	5.5%
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	12.8	11.8	2.3%	10.0	10.2	0.3%	10.4	13.8	2.6%	-	-	-	11.1	11.9	5.2%
26	8.0	15.0	8.3%	12.2	23.4	5.3%	8.2	25.0	1.4%	12.4	12.0	2.2%	10.2	18.9	17.2%
28	-	-	-	-	-	-	5.0	5.2	9.4%	4.0	2.8	0.0%	4.5	4.0	9.4%
30	-	-	-	15.8	2.4	0.0%	-	-	-	12.2	26.8	3.9%	15.0	15.6	3.9%
31	16.6	5.0	0.7%	12.4	5.6	0.0%	9.2	14.0	5.7%	7.8	17.4	2.0%	11.5	10.5	8.4%
36	7.0	1.8	3.4%	-	-	0.0%	-	-	-	11.4	28.4	30.0%	10.2	16.1	33.5%
42	5.0	3.3	0.0%	12.2	6.2	0.5%	6.0	11.8	1.4%	-	-	-	7.9	7.4	1.9%
Commercial															
6	-	-	-	15.4	1.2	4.8%	-	-	0.0%	-	-	0.0%	15.4	1.2	4.8%
7	17.0	1.4	0.4%	-	-	0.0%	14.8	1.0	9.4%	18.6	0.4	2.3%	16.8	0.9	12.0%
9	-	-	-	13.0	2.8	1.4%	-	-	0.0%	11.8	1.8	2.0%	12.4	2.3	3.4%
10	10.4	2.4	7.8%	13.2	0.6	1.8%	-	-	0.0%	16.0	1.2	3.2%	13.2	1.4	12.8%
11	20.6	0.8	1.9%	20.2	0.6	0.2%	21.8	0.4	0.5%	18.0	0.8	1.2%	20.2	0.7	3.8%
12	10.8	0.8	1.5%	16.4	1.2	3.1%	19.4	0.6	1.5%	13.8	1.8	1.9%	15.1	1.1	8.0%
14	9.8	2.0	11.3%	7.0	1.6	2.1%	15.4	1.2	1.3%	10.4	0.6	2.1%	10.7	1.4	16.7%
15	22.0	2.2	1.6%	17.0	1.6	1.9%	19.0	1.6	5.4%	-	-	0.0%	19.3	1.8	8.8%
18	9.8	2.4	1.5%	18.8	2.4	1.5%	-	-	0.0%	19.2	1.6	1.5%	15.9	2.1	4.4%
22	14.0	1.0	3.1%	-	-	0.0%	8.6	1.2	0.6%	5.4	2.0	1.2%	9.3	1.4	5.0%
23	3.0	0.6	0.4%	15.0	1.0	0.4%	8.6	1.4	0.7%	23.0	1.8	4.4%	12.4	1.2	5.9%
24	0.0	0.0	-	0.0	0.0	-	-	-	-	-	-	-	0.0	0.0	-
25	10.6	1.4	0.9%	14.2	1.4	0.4%	14.6	2.4	1.3%	-	-	0.0%	13.1	1.7	2.7%
26	20.0	3.4	12.2%	16.2	4.0	4.6%	13.4	3.6	1.5%	19.2	2.0	2.0%	17.2	3.3	20.3%
28	-	-	-	-	-	0.0%	6.8	0.4	1.3%	7.6	0.6	1.3%	7.2	0.5	2.6%
30	0.0	0.0	0.0%	19.0	1.0	0.0%	0.0	0.0	0.0%	14.6	5.4	3.0%	8.4	1.6	3.0%
31	19.6	1.6	0.0%	22.2	2.8	0.9%	10.0	1.6	2.4%	9.2	0.8	0.3%	15.3	1.7	3.5%
36	9.0	0.6	4.2%	0.0	0.0	0.0%	0.0	0.0	0.0%	17.8	1.4	2.1%	6.7	0.5	6.3%
42	8.0	1.4	1.3%	23.4	2.0	1.3%	9.4	2.2	0.4%	-	-	0.0%	13.6	1.9	3.0%

Table A-4. Tide predictions for Outer Harbour (GSV) during the March 2021 fishery-independent survey (BOM, 2021).

	SUN 14 MAR	MON 15 MAR	TUE 16 MAR	WED 17 MAR	THU 18 MAR	FRI 19 MAR
Low	12:17 AM	12:34 AM	12:55 AM	1:19 AM	1:45 AM	2:09 AM
	0.51 m	0.41 m	0.35 m	0.34 m	0.37 m	0.43 m
High	6:20 AM	6:35 AM	6:54 AM	7:15 AM	7:36 AM	7:55 AM
	2.40 m	2.40 m	2.37 m	2.29 m	2.19 m	2.08 m
Low	12:35 PM	12:45 PM	12:59 PM	1:15 PM	1:31 PM	1:45 PM
	0.28 m	0.27 m	0.26 m	0.28 m	0.32 m	0.36 m
High	6:37 PM	6:51 PM	7:11 PM	7:32 PM	7:52 PM	8:11 PM
	2.26 m	2.38 m	2.47 m	2.52 m	2.55 m	2.55 m

Table A-3. Tide predictions for Wallaroo (SG) during the April 2021 fishery-independent survey (BOM, 2021).

	WED 7 APR	THU 8 APR	FRI 9 APR	SAT 10 APR	SUN 11 APR	MON 12 APR
High	-	12:01 AM	3:16 AM	4:08 AM	4:41 AM	5:08 AM
		1.31 m	1.26 m	1.27 m	1.28 m	1.28 m
Low	10:45 AM	10:48 AM	10:54 AM	11:00 AM	11:08 AM	11:20 AM
	0.45 m	0.50 m	0.55 m	0.58 m	0.59 m	0.58 m
High	9:00 PM	7:47 PM	6:15 PM	5:24 PM	5:20 PM	5:29 PM
	1.30 m	1.17 m	1.16 m	1.25 m	1.38 m	1.51 m
Low	9:55 PM	10:24 PM	10:47 PM	11:08 PM	11:31 PM	11:55 PM
	1.29 m	1.12 m	0.95 m	0.79 m	0.66 m	0.58 m

Table A-6. Daily weather observations at Adelaide Airport during the March 2021 fishery-independent survey (BOM, 2021).

Date	Temps		Rain	Evap	Sun	Max wind gust			9:00 AM						3:00 PM					
	Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSLP
	°C	°C	mm	mm	hours		km/h	local	°C	%	8th		km/h	hPa	°C	%	8th		km/h	hPa
14	9.1	20.5	7	6.6	11.5	SW	43	16:35	14.7	59	1	SSE	11	1025.3	19.1	39	1	SW	30	1024.4
15	10.2	20	0	5.4	6	W	30	11:39	16.3	69	3	NNE	7	1026.9	19.3	69	7	WSW	15	1025.3
16	14.8	23.4	0	3.4	2.1	SW	28	14:42	18.8	71	7	ESE	13	1024.9	22.8	58	7	WSW	19	1022
17	12.7	24.5	0	3.4	11.3	SE	39	22:46	19.2	69	0	NNW	4	1021.6	23.2	64	1	WSW	28	1018.9
18	18.2	29.6	0	6.6	11.3	SE	43	17:10	22.7	57	1	Calm		1022	24.5	63	2	SSW	19	1020.5
19	17.2	32	0	8.6	11.2	SE	50	18:35	24.7	42	2	E	15	1023.8	30.1	27	6	E	28	1020.4

Table A-5. Daily weather observations at Kadina during the April 2021 fishery-independent survey (BOM, 2021).

Date	Temps		Rain	Evap	Sun	Max wind gust			9:00 AM						3:00 PM					
	Min	Max				Dir	Spd	Time	Temp	RH	Cld	Dir	Spd	MSLP	Temp	RH	Cld	Dir	Spd	MSLP
	°C	°C	mm	mm	hours		km/h	local	°C	%	8th		km/h	hPa	°C	%	8th		km/h	hPa
7	8.5	28.2	0			WNW	28	12:34	20.9	46		E	13	1018.8	26.9	31		WSW	19	1014.8
8	8.9	33.5	0			WSW	46	16:09	19.5	45		ENE	11	1011.1	33	15		NNW	22	1006.7
9	16.1	21.5	0			SW	46	15:19	17.2	66		S	28	1014.2	20.5	48		WSW	30	1012.4
10	12.4	21	0.6			SW	65	12:50	15.4	87		S	13	1017.1	19.2	46		SSW	39	1017.3
11	11.8	21.8	0.4			S	44	8:48	16.9	42		S	37	1024.5	19.6	39		SSE	24	1023.4
12	5.2	21.8	0			NNE	41	10:44	14.3	57		ENE	26	1024.7	20.6	31		NNE	24	1018.5

Doc 4

ADVICE TO:	**PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**
FROM:	**DR. CRYSTAL BECKMANN AND DR CRAIG NOELL (SARDI AQUATIC AND LIVESTOCK SCIENCES)**
SUBJECT:	**BLUE CRAB FISHERY: TRANSITION FROM RESEARCH TO COMMERCIAL POTS (STRATEGIC RESEARCH PROJECT)**
DATE:	**11 FEBRUARY 2022**

KEY ISSUES

- The current Harvest Strategy for the Blue Crab Fishery (BCF) includes catch per unit effort (CPUE) of legal-size crabs captured in small-mesh research pots during fishery-independent surveys (FIS) as the key performance indicator to assess stock status and set total allowable commercial catch (TACC).
- PIRSA Fisheries and Aquaculture have requested advice on transitioning from research to commercial pots for obtaining CPUE during FIS.
- There was no significant correlation between commercial pot and research pot CPUE in Gulf St Vincent (GSV), which prevents calibration of reference points and TACC thresholds to reflect commercial pot CPUE.
- There was a significant correlation between commercial pot and research pot CPUE in Spencer Gulf (SG). Re-calibrated reference points and TACC thresholds are presented to reflect commercial pot CPUE.

BACKGROUND

The current Harvest Strategy for the Blue Crab Fishery (BCF) includes performance indicators and reference points based on catch rate (kg/pot) during Fishery-Independent Surveys (FIS) conducted during March/April each year. March/April surveys commenced in 2015 in GSV and 2016 in SG. During 2015, 50 sites were sampled in March/April in GSV while the full survey design (108 sites) was maintained during June/July of 2015. From 2016, 60 survey sites per gulf were sampled during March/April and June/July (except in 2018 as the GSV survey was not undertaken during March/April). Through time, commercial pots have generally increased in size, and larger mesh and escape gaps have become common. Furthermore, several operators have switched from single or double set pots to long–lines, where several pots are attached to a single line. To standardise data collected in the FIS, research pots have remained unchanged with a diameter of 140 cm, a height of 50 cm, and a mesh size of 5.5 cm.

At each FIS site, five sets of gear were deployed, each set consisting of one commercial pot and one small-mesh pot (except for GSV in July 2012 when only small mesh pots were used). Each set of gear was spaced 150 m apart and, where both pot types were used, pots were separated by 40 m of rope. Since June 2014, pots in GSV have been set along a single line (long line) at each FIS location with sets of gear spaced at 76 m apart. Pots were baited with fresh Australian Salmon, Australian Sardine or Striped Trumpeter and hauled from dawn each day. A global positioning system (GPS) was used to locate the gear, and depth was recorded at each FIS location. The carapace widths (mm) of captured Blue Crabs were measured using Vernier callipers, and details of sex and condition (dead, soft, berried) were recorded.

Catch per unit effort (CPUE) of legal-size crabs captured in small-mesh research pots is the primary performance indicator (PI) used to assess stock status. The key advantage of research pots is that the design is standardised—with respect to pot diameter and mesh size—to provide an index of relative catch rate, enabling comparisons between years. However, as higher catch rates are often observed during March/April, research pots can get over-crowded and higher levels of mortality have been observed. Therefore, PIRSA Fisheries and Aquaculture have requested advice on transitioning to using commercial pots during FIS.

The scope of this advice note is to: (1) assess the statistical differences in CPUE between research and commercial pot types; (2) re-calibrate reference points from research to commercial CPUE relative to March/April surveys, and (3) determine the number of research pots per site that would be required for annual sampling to calibrate CPUE in the context of potential commercial gear changes.

Data were available from research and commercial pots sampled during FIS undertaken during March/April in Gulf St Vincent (GSV) since 2015 and Spencer Gulf (SG) since 2016.

The analysis was undertaken in four phases for each gulf:

1. Determination of the relationship between commercial and research pot CPUE

To determine whether there was a relationship between commercial and research pot CPUE, a linear model was fitted to the observed data. The strength of this relationship was then tested statistically. CPUE was calculated by converting the crab carapace width (CW) to weight using the existing length-weight relationship developed using June/July data, as per the current harvest strategy.

2. Re-calculation of the length-weight (LW) relationship for March/April

As length-weight relationships are known to vary seasonally, there was a need to collect length and weight data from blue crabs sampled during March and April to generate a revised LW relationship. An allometric LW relationship was computed for male and female crabs in GSV and SG. Any outliers were removed from the dataset prior to undertaking the analysis.

3. Re-calculation of CPUE and reference points

As the current harvest strategy uses research pot CPUE values and reference points calculated with the June/July LW relationship, there was a need to ensure that no significant differences were observed when calculating the revised research pot CPUE indices using the March/April LW relationship. Where significant differences were identified, the reference points were re-calibrated using the linear equation. Where there was no significant difference, the existing reference points were deemed appropriate.

Where significant relationships were identified under phase 1, the equations were then used to calibrate the research pot reference points and TACC thresholds to commercial pot CPUE.

4. Determination of the minimum number of research pots per site required for on-going sampling

Research pot CPUE data were examined to determine whether there was a significant relationship between the existing timeseries (i.e. five pots per site) and a reduced subset of pots (i.e. one, two, three or four pots per site) using a Welch's t-test. The position of the sampled pots was randomly selected for this analysis. Once the minimum number of pots was determined, the systematic placement of pots was examined (i.e. one pot sampled per site at positions one, two, three, four and five).

RESULTS/DISCUSSION

1. Gulf St Vincent

1.1 Relationship between commercial and research pot CPUE

The linear model indicated no significant correlation between commercial and research CPUE in GSV (Figure 1.1, Table 1.1).

1.2 Re-calculation of the LW relationship for March/April

Overall, 244 crabs were weighed and measured from GSV (225 males and 19 females). Log-transformed data were fitted to linear models for each sex (Figure 1.2). Despite small sample sizes for females, similar CW ranges were observed for both sexes.

1.3 Recalculation of CPUE and reference points

An identical CPUE trend was observed for the original (June/July LW) and revised (March/April LW) values using research pots (Figure 1.3). Therefore, no changes were required to the reference points developed for research CPUE using the June/July LW relationship.

As there was no significant linear relationship identified between commercial and research pot types, reference points could not be calibrated for commercial pot types in GSV.

1.4 Minimum number of research pots per site required for on-going sampling

When the number of research pots used to calculate CPUE was reduced from five pots to a random selection of one to four pots, there was no significant difference compared to the existing CPUE time series (all pots; Table 1.2). Therefore, the minimum number of pots that could be used to maintain the existing CPUE trend is one pot per site.

When a single pot was selected systematically (i.e. at position 1, 2, 3, 4 or 5), there was no significant difference between CPUE calculated from a single pot compared to the existing CPUE (Table 1.2). For operational reasons, pot 1 or pot 5 is likely to be selected (Figure 1.4). While the CPUE values follow the same trend from 2015-2021 when comparing all pots to a single pot, the Standard Error (SE) increases from a range of 11-16% (all pots) to a range of 23–44% (single pot), whereas increasing the number of pots sampled would reduce this SE.

2. Spencer Gulf

2.1 Examination of the relationship between commercial and research pot CPUE

There was a significant positive correlation between commercial and research pot CPUE for SG. (Figure 2.1).

2.2 Re-calculation of the LW relationship for March/April

Overall, 490 crabs were weighed and measured in SG (409 males and 81 females). Log-transformed data were fitted to linear models for each sex (Figure 2.2). Despite small sample sizes for females in March/April, similar CW ranges were observed for both sexes.

2.3 Recalculation of CPUE and reference points

An identical trend was observed for the original (June/July LW) and revised (March/April LW) CPUE using research pot types (Figure 2.3). Therefore, no changes were required to the reference points developed for research CPUE using the June/July LW relationship.

The linear equation (Table 2.1) was used to reconstruct the reference points and TACC thresholds from research to commercial CPUE (Table 2.2 and 2.3). The re-calibrated reference points for commercial pot CPUE were generally higher than those presented for research pot CPUE in the harvest strategy. The resulting TACC thresholds utilising commercial pot CPUE would have resulted in lower TACCs in 2016 and 2021 compared to the existing harvest strategy TACC thresholds. Identical TACC would have been allocated using the revised RPs in all other years (Figure 2.4).

2.4 Minimum number of research pots required for on-going sampling.

When a single research pot was selected systematically (i.e. at position 1, 2, 3, 4 or 5), there was no significant difference between CPUE calculated from a single pot compared to the existing CPUE (all pots) (Table 2.4). Therefore, the minimum number of pots that could be used to maintain the existing CPUE trend is one pot per site.

As for GSV, pot 1 or pot 5 is likely to be selected for operational reasons (Figure 2.3). While the CPUE values follow the same trend from 2016–2021 when comparing all pots to a single pot, the Standard Error (SE) increases from a range of 9-15% (all pots) to a range of 17–37% (single pot). whereas increasing the number of pots sampled would most likely reduce this error.

Dr Mike Steer
Research Director, Aquatic and Livestock Sciences

Appendix

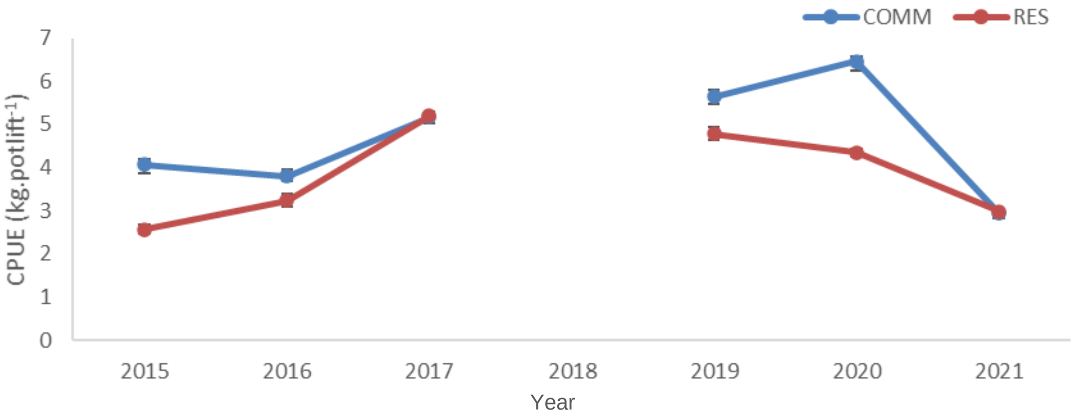

Figure 1.1. Catch per unit effort (CPUE) from commercial and research pots sampled during March/April surveys in Gulf St Vincent (GSV). Error bars, standard error (SE).

Table 1.1. Results of linear regression model for the relationship between average CPUE (catch per unit effort) values from commercial and research pots sampled in Gulf St Vincent (GSV) from 2015–2021. *P<0.05

	df	SS	MS	F	Sig. F	R^2	Equation
Reg.	1	4.9	4.9	5.4	0.081	0.574	y = 0.9234 x + 1.1228
Res.	4	3.6	0.9				
Total	5	8.5					

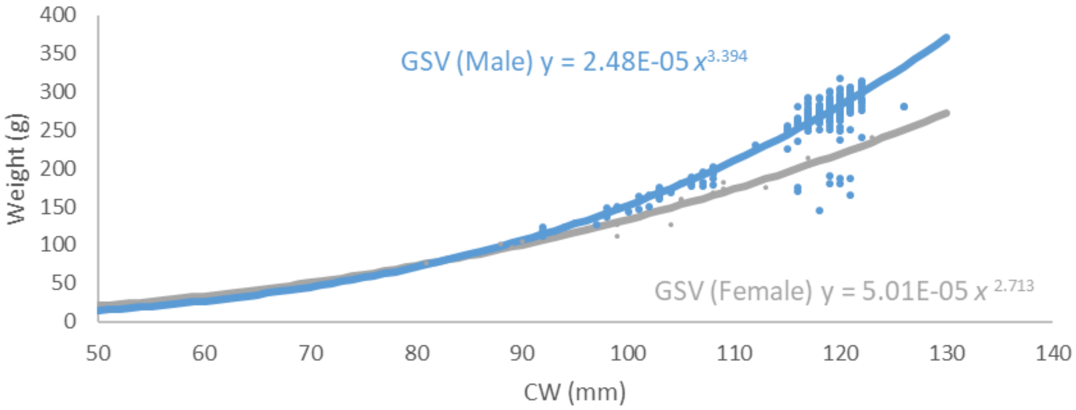

Figure 1.2. Length-weight relationship for Male and Female crabs Gulf St Vincent (GSV) in March/April. CW, Carapace Width.

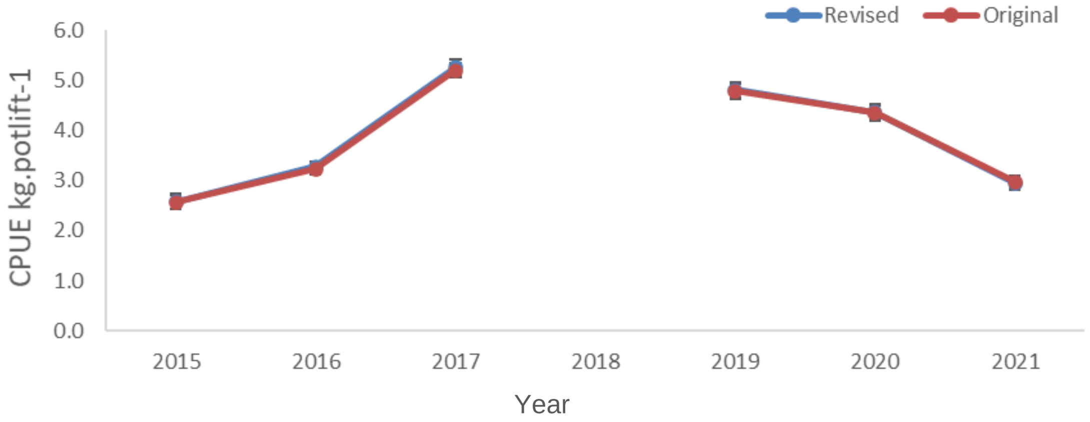

Figure 1.3. Research pot catch per unit effort (CPUE) sampled during March/April surveys in Gulf St Vincent (GSV); calculated using the revised March/April and original June/July length-weight relationships. Error bars, standard error (SE).

Table 1.2. Results of Welch's t-test comparing the existing timeseries (five pots per site) to (a) a subset of pots per site (i.e. 1, 2, 3 or 4 pots) with the position randomly selected (i.e. position 1, 2, 3, 4 or 5) and (b) a single pot systematically placed (i.e. position 1, 2, 3, 4, or 5) for Gulf St Vincent (GSV). *P<0.05

Test	**Position**	**No. of pots**	**t**	**df**	**P-value**
(a)	Random	1	-0.417	494.98	0.677
		2	0.268	554.96	0.789
		3	0.446	592.96	0.656
		4	0.078	595.75	0.938
(b)	1	1	-0.680	483.21	0.497
	2		0.170	482.29	0.865
	3		1.512	503.36	0.131
	4		0.425	509.84	0.671
	5		-1.274	472.12	0.203

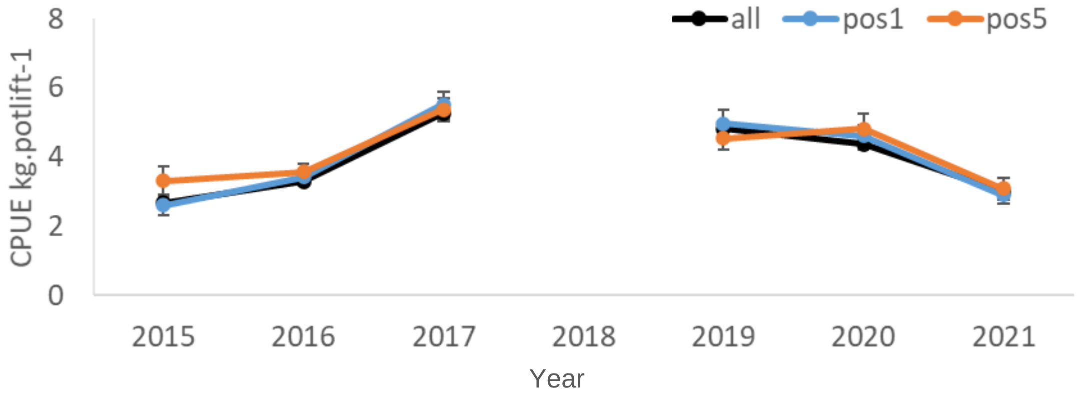

Figure 1.4. Catch per unit effort (CPUE) for all pots and a single pot per site at position 1 and 5 for Gulf St Vincent (GSV). Error bars, standard error (SE).

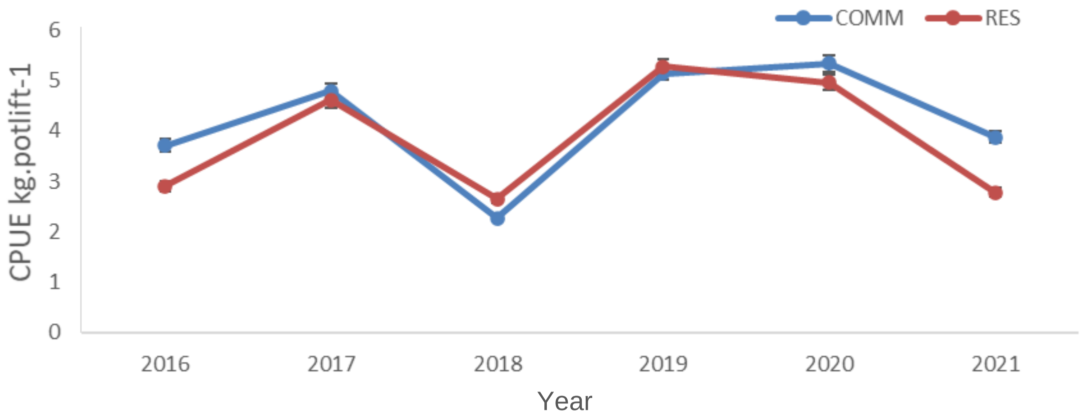

Figure 2.1. Catch per unit effort (CPUE) from commercial and research pots sampled during March/April surveys in Spencer Gulf (SG). Error bars, standard error (SE).

Table 1.1. Results of least squares linear regression model for the relationship between commercial and research pot CPUE in Spencer Gulf (SG). *P<0.05

	df	SS	MS	F	Sig. F	R^2	Equation
Reg.	1	5.2	5.2	15.1	0.018*	0.790	y = 0.8418 x + 0.9366
Res.	4	1.4	0.3				
Total	5	6.6					

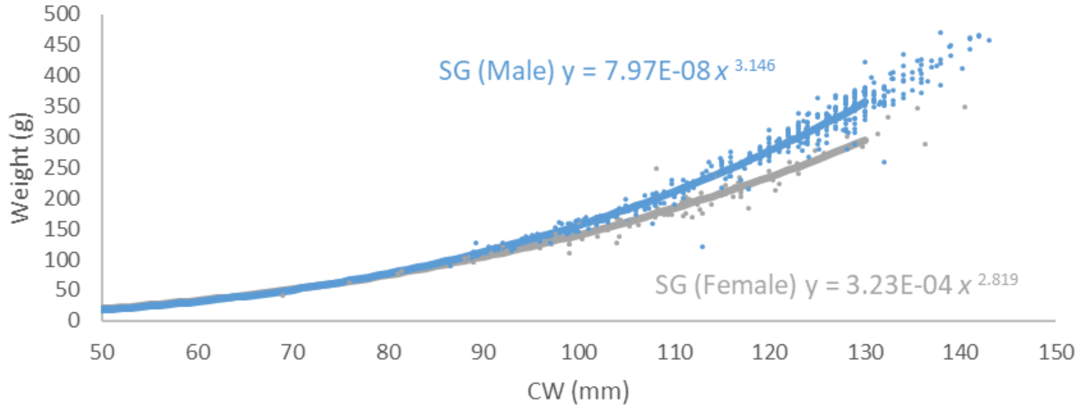

Figure 2.2 Length-weight relationship for Male and Female crabs in Spencer Gulf (SG) in March/April. CW, Carapace Width.

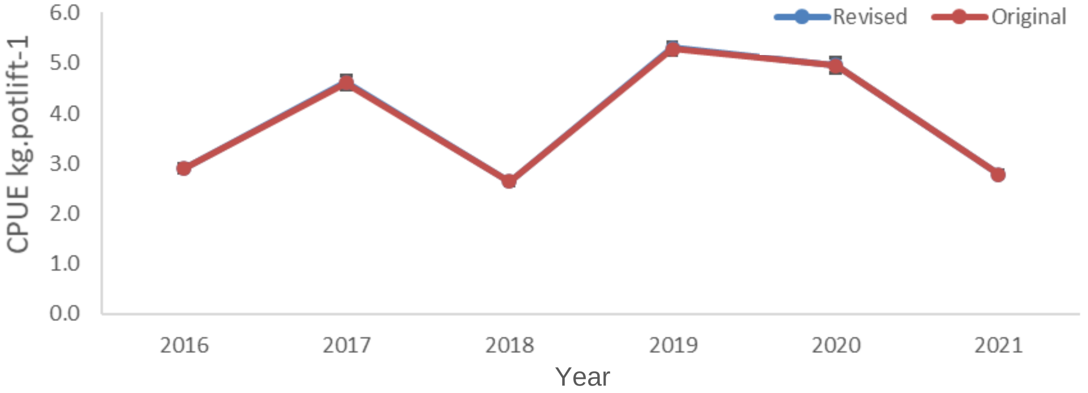

Figure 2.3. Research pot catch per unit effort (CPUE) sampled during March/April surveys in Spencer Gulf (SG); calculated using the revised March/April and original June/July length-weight relationships. Error bars, standard error (SE).

Table 2.2. Summary of existing (research) and re-calculated (commercial) reference points for Spencer Gulf (SG).

Pot type	**Reference Points (kg.potlift^{-1})**		
	Limit	**Trigger**	**Target**
Research	1.0	2.4	3.7
Commercial	1.1	2.6	3.9

Table 2.3. Harvest Strategy Total Allowable Commercial Catch (TACC) decision table showing current research CPUE thresholds and equivalent, re-calculated (from equation in Table 2.1) commercial CPUE values for Spencer Gulf (SG).

TACC (t)	**Research (kg/pot)**	**Commercial (kg/pot)**
458.00	5.0 or above	5.1 or above
419.84	3.47 to 4.99	4.1 to 5.09
381.67	2.4 to 3.69	3.0 to 4.09
305.34	1.7 to 2.39	2.4 to 2.99
229.00	1.0 to 1.69	1.8 to 2.39
0	Below 1.0	Below 1.8

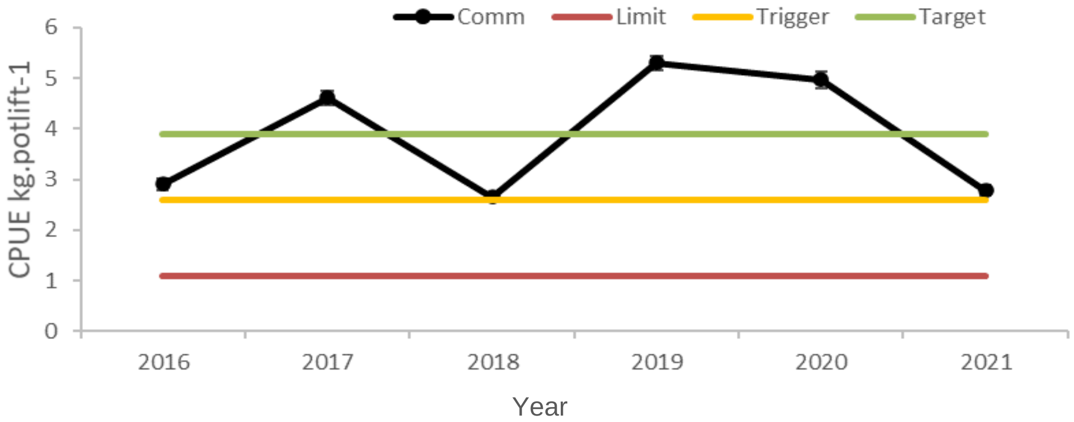

Figure 2.4. March/April survey catch per unit effort (CPUE, kg.potlift^{-1}) from commercial pots calculated using the March/April length-weight (LW) relationship. Recalculated Target (green), trigger (yellow) and limit (red) reference points shown. Error bars, standard error (SE).

Table 2.4. Results of Welch's t-test comparing the existing timeseries (five pots per site) to (a) a subset of pots per site (i.e. 1, 2 3, or 4 pots) with the position randomly selected (i.e. position 1, 2, 3, 4 or 5) and (b) a single pot systematically placed i.e. position 1, 2, 3, 4, or 5) for Spencer Gulf (SG). *P<0.05

Test	**Position**	**No. of pots**	**t**	**df**	**P-value**
(a)	Random	1	0.272	494.5	0.786
		2	0.133	548.2	0.895
		3	0.253	587.8	0.801
		4	0.102	579.7	0.919
(b)	1	1	-0.468	509.6	0.640
	2		0.894	506.2	0.371
	3		1.672	501.3	0.095
	4		-0.232	480.1	0.817
	5		-1.821	498.2	0.069

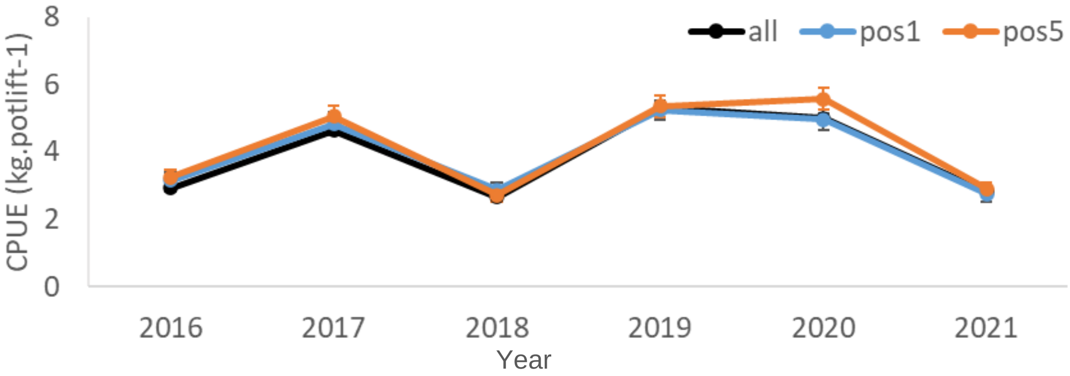

Figure 2.5. Catch per unit effort (CPUE) for all pots and a single pot per site at positions 1 and 5 for Spencer Gulf (SG). Error bars, standard error (SE).

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **A/PROF. ADRIAN LINNANE (SARDI AQUATIC SCIENCES)**

SUBJECT: **FISH STOCKS AND MARINE PARKS**

DATE: **13 SEPTEMBER 2021**

KEY ISSUES

- Advice has been requested as to evidence of direct and clear improvements for key fish stocks (Snapper, King George Whiting, Southern Garfish, Southern Calamari, Abalone, Rock Lobster, Sardine, and Western King Prawns) in South Australian waters as a result of marine park introduction.
- Marine Park implementation included Sanctuary Zones from which all fishing was prohibited.
- Dedicated surveys to examine levels of biomass after Sanctuary Zone introduction have only been undertaken for Rock Lobster. These data were compared to commercial fishery data prior to Sanctuary Zone implementation.
- The Western Kangaroo Island Marine Park was declared as part of South Australia's Representative System of Marine Protected Areas on October 1, 2014. In 2017, surveys were undertaken to analyse: (i) lobster abundance both inside and outside the Sanctuary Zone of the marine park as of 2017 and (ii) potential changes in lobster abundances inside the Sanctuary Zone of the marine park since the area was closed to commercial fishing in 2013.
- In 2017, survey estimates of catch per unit effort (CPUE; as an indicator of lobster abundance) by weight (kg/potlift) and number (number/potlift) of legal-size lobsters were 4.4 and 3.5 times higher, respectively, inside the Sanctuary Zone compared to outside.
- The 2017 Sanctuary Zone survey estimates of CPUE by weight (2.59 kg/potlift) and number (1.73 lobsters/potlift) were 81.1% and 44.2% higher, respectively, than the estimates of CPUE measured from commercial fishery data inside the Sanctuary Zone in 2013.
- Given that commercial fishers have been excluded from Sanctuary Zones since October 2014, there are no data on stock abundance for other species in Sanctuary Zones post implementation.

BACKGROUND

South Australia’s Representative System of Marine Protected Areas were implemented 01 October 2014. Marine Park implementation included Sanctuary Zones from which all fishing was prohibited. Advice has been requested as to evidence of direct and clear improvements for key fish stocks (Snapper, King George Whiting, Southern Garfish, Southern Calamari, Abalone, Rock Lobster, Sardine, and Western King Prawns) in South Australian waters as a result of Sanctuary Zone introduction.

Dedicated surveys to examine levels of biomass after Sanctuary Zones implementation have only been undertaken for Rock Lobster within the Western Kangaroo Island Marine Park as part of the Department of Environment, Water and Natural Resources (DEWNR) Marine Park Monitoring, Evaluation and Reporting Program. Surveys were undertaken in 2017 with the key aims of analysing (i) lobster abundance both inside and outside the Sanctuary Zone as of 2017 and (ii) potential changes in lobster abundance inside the Sanctuary Zone since the area was closed to commercial fishing in 2013.

Given that commercial fishers have been excluded from Sanctuary Zones since October 2014, there are no data on stock abundance for other species in Sanctuary Zones post implementation.

RESULTS/DISCUSSION

In 2017, survey estimates of catch per unit effort (CPUE; as an indicator of lobster abundance) by weight (kg/potlift) and number (number/potlift) of legal-size lobsters were 4.4 and 3.5 times higher, respectively, inside the Sanctuary Zone as compared to outside.

The 2017 marine park Sanctuary Zone survey estimates of CPUE by weight (2.59 kg/potlift) and number (1.73 lobsters/potlift) were 81.1% and 44.2% higher, respectively, than the most recent estimates of CPUE measured from commercial fishery data inside the Sanctuary Zone in 2013.

A previously provided Advice Note detailing survey methodology and additional results is attached.

There are no data on changes in stock abundance for other species in Sanctuary Zones post implementation.

Dr. Michael Steer
Research Director, Aquatic Sciences

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McLeay, L., McGarvey, R., Linnane, A., Feenstra, J. and Hawthorne, P. (2017). Rock Lobster Survey of the Western Kangaroo Island Marine Park – Cape Du Couedic (Sanctuary Zone 3). Report to the Department of Environment, Water and Natural Resources. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000282-1. SARDI Research Report Series No. 962. 38pp.

McLeay, L., Linnane, A., McGarvey, R., Bryars, S., and Hawthorne, P. (2021). Response of a southern rock lobster (*Jasus edwardsii*) population to three years of Marine Protected Area implementation within South Australia. Journal of the Marine Biological Association of the United Kingdom, 1-9. doi:10.1017/S0025315420001332.

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DRS RICHARD MCGARVEY, JONATHAN SMART AND STEPHEN MAYFIELD (SARDI AQUATIC SCIENCES)**

SUBJECT: **SOUTHERN GARFISH MANAGEMENT ARRANGEMENTS (MESH SIZE AND SIZE LIMIT) FROM 1 JULY 2021**

DATE: **18 JUNE 2021**

KEY ISSUES

- Most (~90%) of the commercial Southern Garfish catch in South Australia has been harvested by hauling net fishers, predominantly from northern Gulf St Vincent (NGSV) and northern Spencer Gulf (NSG) stocks.
- Both of these stocks are heavily exploited. The NGSV stock is classified as ‘Depleted’ and the NSG stock is classified as ‘Recovering’.
- In response to poor stock status over the past decade, Southern Garfish have been managed through a series of increases to the mesh size of hauling net pockets, commercial legal minimum length (LML), and annual closures. These arrangements have resulted in reduced harvest fractions, increased mean weight of retained Southern Garfish, and increased profitability for the sector. The current mesh size of the hauling net pocket is 36 mm and the current LML is 26 cm total length (TL). Length-at-maturity is approximately 21 cm TL (Ye et al 2002).
- From 1 July 2021, commercial Southern Garfish management arrangements in the Spencer Gulf (SG) and Gulf St Vincent (GSV) regions will include quotas. Thus, total allowable commercial catches (TACCs), of 100 t and 71 t, respectively, will limit the retained catches of Garfish. TACCs are commonly used in combination with additional management arrangements (e.g. LMLs, gear restrictions, seasonal and spatial closures) to drive sustainability outcomes.
- PIRSA Fisheries and Aquaculture has requested advice on whether changes in hauling net pocket mesh size and a commercial LML, following TACC implementation, would pose a risk to sustainability. Given the stocks are currently classified as ‘Depleted’ and ‘Recovering’, the primary risk from changing hauling net pocket mesh size and commercial LML is impeding stock rebuilding and extending the time period until the stocks would likely be re-classified to ‘Sustainable’.
- The factor most likely to contribute to impeding stock recovery under quota is discard mortality. Discard mortality occurs when sub-legal-sized fish, captured by the fishing gear used, die following release. This means that the biomass removed from the stock during fishing would exceed the TACC, with this additional mortality negatively impacting stock growth and egg production.

- The risks to impeding stock rebuilding and extending the time period until the stocks would likely be re-classified to ‘Sustainable’ from three of the four potential management options were determined based on the proportion of undersize fish that would be vulnerable to capture (and thus discard mortality) using mesh size selectivity and LML. It was not possible to assign a risk ranking to the fourth potential management option (unregulated mesh size and size limit of 23 cm) as there was no information on how mesh size might change from the current 36 mm.
- The risks to impeding stock rebuilding, and extending the time-period until the stocks would likely be re-classified to ‘Sustainable’, for three of the four management options were:
    1. Mesh size of 36 mm and size limit of 23 cm – lowest risk.
    2. Mesh size of 36 mm and size limit of 25 cm – intermediate risk
    3. Mesh size of 32 mm and size limit of 23 cm – highest risk.

BACKGROUND

Most (~90%) of the commercial Southern Garfish catches in South Australia have been harvested by hauling net fishers, predominantly from the northern Gulf St Vincent (NGSV) and the northern Spencer Gulf (NSG) stocks (Drew et al 2021). Both stocks are heavily exploited. The NGSV stock is classified as ‘Depleted’ (i.e. biomass is depleted and recruitment is impaired) and the NSG stock is classified as ‘Recovering’ (i.e. biomass is depleted and recruitment is impaired, but there is some evidence the stock is recovering).

In response, large reductions in exploitation rate since 2012 have been achieved by combinations of (1) garfish hauling net pocket mesh size increases, (2) commercial fishing closures in winter when catchability is highest, and (3) increases in commercial legal minimum length (LML) from 23 cm to 25 cm TL in 2015 and to 26 cm in 2016. These management measures have also resulted in an increased mean weight of retained Southern Garfish and increased beach prices (Figure A1 in Appendix 1). Maintaining a high average weight of captured fish also means that the number of fish that would need to be caught to meet the TACC is reduced.

From 1 July 2021, commercial Southern Garfish harvest management arrangements in the Spencer Gulf (SG) and Gulf St Vincent (GSV) regions will include quotas as part of a reformed Marine Scalefish Fishery. Thus, total allowable commercial catches (TACCs), of 100 t and 71 t, respectively, will limit the retained catches of Garfish. TACCs are commonly used in combination with additional management arrangements (e.g. LMLs, gear restrictions, seasonal and spatial closures) to drive sustainability outcomes.

PIRSA Fisheries and Aquaculture have requested advice on whether four alternative mesh size and/or LML changes, following TACC implementation, would pose a risk to sustainability. The four options were:

- Unregulated mesh size and LML of 23 cm
- Mesh size of 32 mm and LML of 23 cm
- Mesh size of 36 mm and LML of 23 cm
- Mesh size of 36 mm and LML of 25 cm.

RESULTS/DISCUSSION

Given the Southern Garfish stocks targeted by the hauling net sector are classified as ‘Depleted’ and ‘Recovering’, the primary risk from changing hauling net pocket mesh size and LML, in conjunction with TACC implementation, is impeding stock rebuilding and extending the time-period until the stocks would likely be re-classified to ‘Sustainable’.

One important factor that can impede stock recovery under quota is discard mortality. Discard mortality occurs when sub-legal-sized fish, captured in the fishing gear, die following release. These undersize fish lost to discard mortality represent lost recruitment, resulting in lower egg production, lower catches from each recruitment year class, and lower economic return. For some species (e.g. Southern Rock Lobster), discard mortality is low because sub-legal-sized fish are resilient to being released. However, Southern Garfish are highly vulnerable to discard mortality and a high proportion of undersize Garfish die following capture, handling and release (Knuckey et al 2002, Fowler et al 2009).

SARDI undertook hauling net mesh selectivity experiments in 2011 (Steer et al 2011) and 2013. The probability that a Southern Garfish is captured by a hauling net increases with Garfish length. Thus, a larger mesh size allows a higher proportion of smaller Southern Garfish to escape. The length at which half of the Southern Garfish are retained by a given mesh size is defined by $L_{50\%}$. Estimates of $L_{50\%}$ are seasonally variable. The estimates are smaller in summer because females, which dominate the summer catch, are spawning. As spawning females have an enlarged ovary, they are wider in girth which impedes escapement from the hauling net pocket compared to more slender non-spawning Garfish during winter (Steer et al 2011; Figure A2 in Appendix 1).

A logistic curve describes how the selectivity increases with Southern Garfish total length (Figure 1). These were calculated using two parameters, $L_{50\%}$ and r. $L_{50\%}$ was obtained from the linear regressions in Figure A2. A single steepness value of $r = 0.07$ was estimated as the mean from the logistic selectivity curves obtained in the hauling net mesh selectivity experiments of 2011 (Steer et al 2011) and 2013. These logistic curves show the proportions, by total length, of Southern Garfish retained by a hauling net with 32 or 36 mm pocket mesh size.

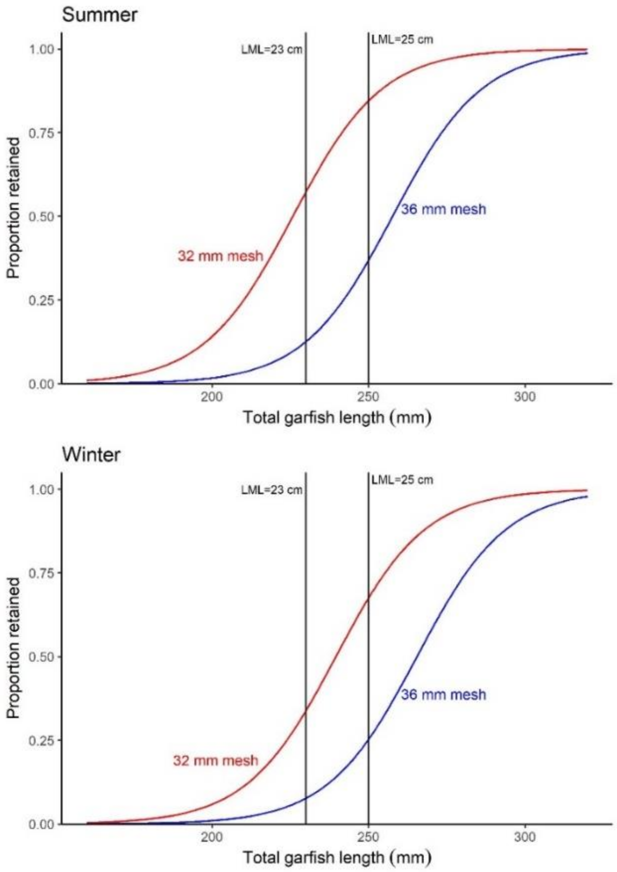

Figure 1. The logistic selectivity curves for two garfish haul net mesh sizes obtained from mesh selectivity experiments undertaken in 2011 (Steer et al 2011) and 2013. Also shown are the two legal minimum legal lengths (23 and 25 cm) for which advice was requested.

The proportions of Southern Garfish retained at the two alternative LMLs (i.e. the intercept of the logistic function at each LML) and mesh sizes proposed, for summer and winter (Figure 1), are shown in Table 1. These values were lowest for the 23 cm LML and 36 mm mesh size option (8% and 13%), and highest for the 25 cm LML and 32 mm mesh size option (68% and 84%).

Table 1. Estimated percentages of Southern Garfish retained at, or just below, two alternative LMLs and mesh sizes, for summer and winter.

	32 mm mesh		36 mm mesh	
	23 cm LML	25 cm LML	23 cm LML	25 cm LML
Summer	57%	84%	13%	37%
Winter	34%	68%	8%	25%

The logistic functions were applied to an assumed Southern Garfish population to estimate the relative ratios between retained and discarded numbers for three of the four LML-mesh size combinations (Figure 2). This assumed Southern Garfish population was obtained from the length-frequency distribution of all Southern Garfish (both Gulfs, and pocket and wing nets, combined) measured during the hauling net selectivity experiments in 2011 (Steer et al 2011) and 2013. There is some uncertainty in this approach as some sub-legal-sized fish may have avoided capture during the 2011 experiments and therefore the proportion of these fish in this assumed population could be underestimated. However, as the alternative LML-mesh size combinations are applied to the same assumed population, this provides a relative comparison among these LML-mesh size combinations.

The estimated minimum proportions, by number and weight, of Southern Garfish that would be discarded were highest for the 25 cm LML and 32 mm mesh size option (range 19 – 40%) and lowest for the 23 cm LML and 36 mm mesh size option (range 1 – 4%; Figure 2; Tables 2 and 3).

The risks to impeding stock rebuilding, and extending the time-period until the stocks would likely be re-classified to ‘Sustainable’, for three of the four management options were:

1. Mesh size of 36 mm and size limit of 23 cm – lowest risk as this option has the lowest discard mortality (Tables 1 and 2).
2. Mesh size of 36 mm and size limit of 25 cm – intermediate risk as discards would be lower than option 3 (32 mm mesh and LML of 23 cm) but a larger LML would produce more discards than option 1 (mesh size of 36 mm and LML of 23 cm).
3. Mesh size of 32 mm and size limit of 23 cm – highest risk as this option has the highest discard mortality (Tables 1 and 2). This could lead to substantial increases in total fishing mortality over that assumed by the TACC.

It was not possible to assign a risk to the fourth potential management option (unregulated mesh size and size limit of 23 cm) as there was no information on how mesh size might change from the current 36 mm.

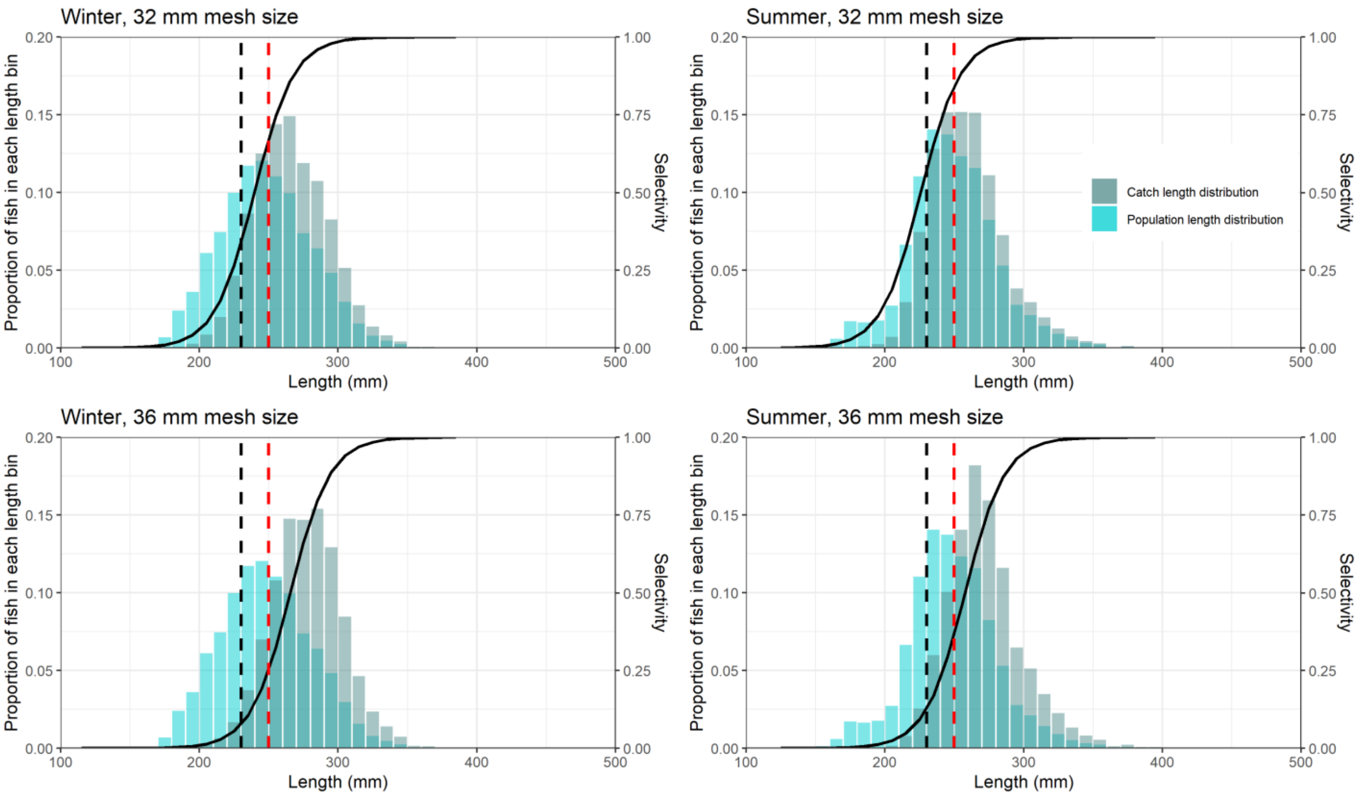

Figure 2. The estimated discard percentages, by length, based on mesh size and seasonal selectivities, for four scenarios: 32mm and 36 mm hauling net pocket mesh sizes in Summer and Winter. The assumed population length distribution is shown as light green bars. The selectivity function for each scenario (Figure 1) is represented by the black line. The light grey bars represent the catch length distribution given the assumed population and the selectivity for each scenario. The proportion of the grey bars below the 25 cm LML (red dashed line) and 23 cm LML (black dashed line) represent the proportion of fish, by number, that would be discarded based on this assumed population.

Table 2. Estimated minimum percentages, by number, of captured Southern Garfish that would be discarded at two alternative LMLs and mesh sizes, for summer and winter.

	32 mm mesh		36 mm mesh	
	23 cm LML	25 cm LML	23 cm LML	25 cm LML
Summer	12%	40%	4%	20%
Winter	8%	29%	3%	13%

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APPENDIX 1

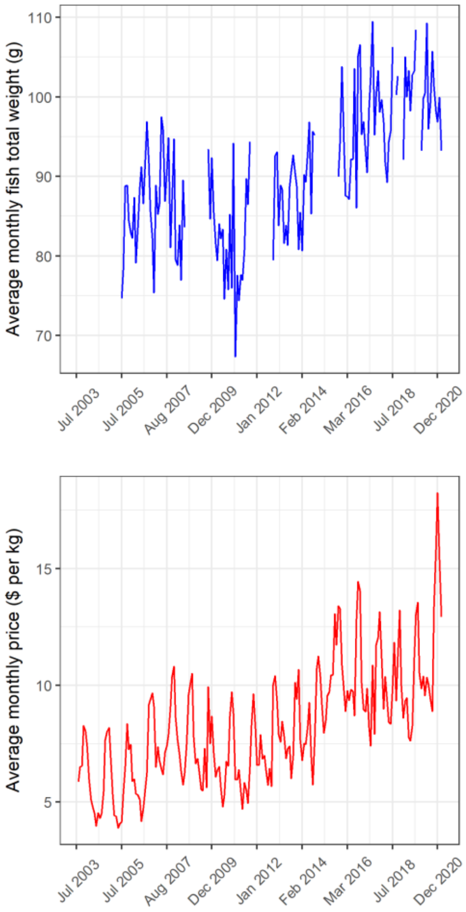

Figure A1. The average monthly weight of individual garfish sampled at SAFCOL fish market between 2005-2021 (Top). The average beach price ($ per kg) of Garfish statewide between 2003-2021 (Bottom).

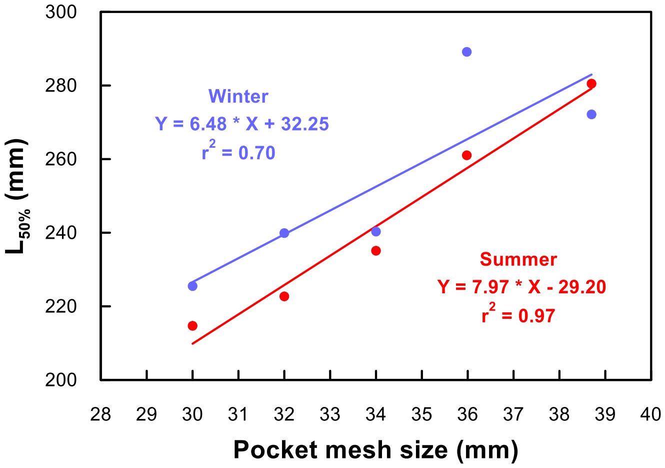

Figure A2. Linear, seasonal relationships between pocket mesh size and Garfish length at 50% selection ($L_{50\%}$).

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR. LACHLAN MCLEAY (SARDI AQUATIC SCIENCES)**

SUBJECT: **SOUTH AUSTRALIAN GIANT CRAB FISHERY – COMMERCIAL CATCH PER UNIT EFFORT – 2020/21 SEASON**

DATE: **19 AUGUST 2021**

KEY ISSUES

- The harvest strategy within the management policy for the Giant Crab Fishery (GCF) identifies five-year average commercial catch per unit effort (CPUE) of legal-size Giant Crab as the primary biological performance indicator (PI). This PI is linked to the decision rules in the harvest strategy (PIRSA 2018).
- In 2020/21, the estimate of five-year average commercial CPUE of legal-size Giant Crab was 2.10 kg/potlift. This was 7.7% above the Trigger Reference Point (RPtrig) of 1.95 kg/potlift defined in the harvest strategy.
- Under the decision rule within the harvest strategy, the Giant Crab stock in South Australia is classified as **‘sustainable’** in 2020/21.

BACKGROUND

The Giant Crab Fishery (GCF) uses steel framed pots to target Giant Crabs (*Pseudocarcinus gigas*) in waters at the edge of the continental shelf in South Australia in a fishing season between 1 October and 31 May in the following year.

The management policy for the fishery provides the overarching management arrangements and harvest strategy for the fishery (PIRSA 2018). The harvest strategy identifies five-year average commercial CPUE of legal-size Giant Crab as the primary biological PI, with reference points for this PI based on targeted catch and effort information from 2000/01 to 2009/10.

To inform the harvest strategy in the following fishing season, the estimate of commercial CPUE of legal-size Giant Crab is calculated as the moving average CPUE of legal-size Giant Crab from the current and previous four fishing seasons. Decision rules are linked to defined Limit, Trigger and Target Reference Points for this PI to guide management arrangements.

This Advice Note reports the estimate of commercial CPUE of legal-size Giant Crab for the 2020/21 season to inform the harvest strategy in the 2021/22 season.

RESULTS/DISCUSSION

The 2020/21 estimate of commercial CPUE of legal-size Giant Crab is derived from catch and effort data submitted through Giant Crab commercial catch logs by seven quota holders. Consequently, the data is not confidential for the 2020/21 season.

In 2020/21, the five-year average commercial CPUE of legal-size Giant Crab was 2.10 kg/potlift, which is 7.7% above the Trigger Reference Point (RP_{trig}) defined for this PI of ≥1.95 kg/potlift (Figure 1).

Under the decision rule within the harvest strategy, which categorises the status of the Giant Crab stock in South Australia (PIRSA 2018), the stock is classified as **'sustainable'** in 2020/21.

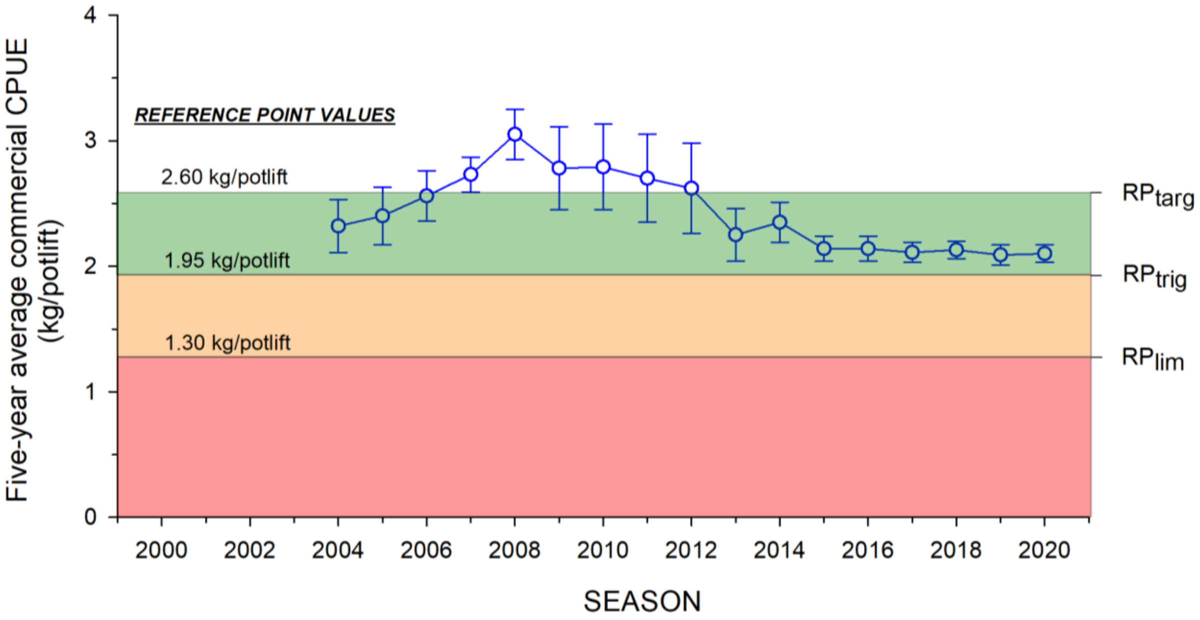

Figure 1. Five-year average commercial CPUE of legal-size Giant Crab caught in the GCF between 2000 and 2020. Values represent a 5-year moving average ± SE. Target Reference Point = RP_{targ}; Trigger Reference Point = RP_{trig}; Limit Reference Point = RP_{lim}. Fishing season refers to the year the fishing season started e.g. 2020 = 2020/21 fishing season.

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR. LACHLAN MCLEAY (SARDI AQUATIC SCIENCES)**

SUBJECT: **GULF ST VINCENT PRAWN FISHERY: MAY 2021 – FISHERY INDEPENDENT SURVEY RESULTS**

DATE: **23 JUNE 2021**

KEY ISSUES

- The 2021 Fishery Independent Survey (FIS) for the Gulf St Vincent Prawn Fishery (GSVPF) was undertaken on 11 and 12 May 2021 between the last quarter and dark phase of the moon.
- FIS data collected from a trawl configuration comprising a 51 mm diamond mesh cod-end and no grid are used to inform the harvest strategy for the GSVPF in 2021/22.
- The estimate of standardised Catch Per Unit Effort (CPUE) from the FIS in May 2021 was 22.1 kg.trawl-shot^{-1}, which is the second lowest estimate on record, and in the trigger reference point range of ≥20.0 to <25.0 kg.trawl-shot^{-1} defined under the current Management Plan.
- The Fishery Recruitment Index (FRI) estimated from the FIS was 800.6 recruits.hour^{-1}, which is in the high reference point range of ≥600 recruits.hour^{-1} defined under the current Management Plan.
- Results of the FIS form part of the analysis for the 2020/21 GSVPF assessment report. When combined with the estimate relating to standardised CPUE obtained from commercial logbook data for the 2020/21 season, the FIS results will inform the setting of the Total Allowable Commercial Effort (TACE) and pre-Christmas fishing effort for the GSVPF in the 2021/22 fishing season.

BACKGROUND

The GSVPF targets Western King Prawn (*Penaeus (Melicertus) latisulcatus*) in waters of Gulf St Vincent, South Australia between 1 November and 31 July of the following year. The performance of the fishery has varied since fishing commenced in 1967, with catches ranging annually between 6 and 630 tonnes (t) since 1968, and two periods of closure occurring between 1991/92 and 1992/1993, and 2012/13 and 2013/14. The fishery re-opened in 2014/15 and in 2019/20 the total harvest was 132.3 t (McLeay and Hooper 2020).

Under the Management Plan for the South Australian Commercial Gulf St Vincent Prawn Fishery (Management Plan) (PIRSA 2017), effective 1 July 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}) obtained from commercial logbook data during the fishing season.
2) Standardised Fishery Independent Survey (FIS) CPUE (kg.trawl-shot^{-1}) estimated from an annual survey in May.
3) Fishery Recruitment Index (FRI) (recruits.hour^{-1}) estimated from the FIS in May. This indicator informs decision rules that set total fishing nights (or catch) for the pre-Christmas period.

This Advice Note reports on the performance indicators measured from the FIS undertaken on 11 and 12 May 2021 using the commercial prawn fishing vessels, *Zadar, Frank Cori, Anna Pearl, Angela Kaye* and *Josephine-K*. Trawl 'shots' of 30 minutes duration were undertaken using a double-rigged demersal otter trawl at pre-defined survey sites among 10 regions of the GSVPF (Appendix, Figure A-1). For the FIS, one side of the trawl was rigged as per current commercial fishing operations with a bycatch reduction grid and T-90 mesh cod-end. The other side of the trawl was rigged as per trawl configurations used historically in FIS' and comprised a 51 mm diamond mesh cod-end and no grid (Appendix, Figure A-2).

One observer from SARDI Aquatic Sciences was on each vessel to record all data from each trawl shot and cod-end type including: shot location, total catch, total catch of each prawn-size grade, trawl duration, tide direction, and the number of prawns in a 7 kg bucket (bucket count). A random sample of 100 prawns was also taken from the diamond mesh cod-end in each shot and measured (carapace length, CL). Following the survey, all data were entered and validated according to established protocols.

Standardised FIS CPUE (kg.trawl-shot^{-1}) and the FRI (recruits.hour^{-1}) were estimated using data collected from diamond mesh cod-ends from a total of 107 completed trawl shots. A Generalised Linear Model (GLM) was used to standardise FIS CPUE for the effects of year-survey (month), region and vessel (Noell *et al*. 2015). The FRI was estimated from the 100-sample of measured prawns, where recruits are defined as prawns ≤32 mm CL (males) and ≤34 mm CL (females) (PIRSA 2017).

T-90 mesh cod-ends with bycatch reduction grids were introduced into the fishery in 2012 to reduce discards. However, the reference levels relating to standardised FIS CPUE (kg.trawl-shot^{-1}) and FRI (recruits.hour^{-1}) described within the Management Plan are derived from historical data collected from 51 mm diamond mesh cod-ends since 2005. Consequently, the estimates of standardised FIS CPUE (kg.trawl-shot^{-1}) and FRI (recruits.hour^{-1}) reported in this Advice Note are derived only from data collected from 51 mm diamond mesh cod-ends because they directly inform the harvest strategy for the fishery in 2020/21. Data from T-90 mesh cod-ends are collected during the FIS to enable potential calibration with data collected from diamond mesh cod-ends in the future.

Information provided to SARDI relating to vessel prawn-trawl configurations used in the May 2020 FIS indicated the use of a 57 mm (2 ¼ inch) cod-end mesh size by some vessels, thereby potentially underestimating standardised FIS CPUE in the 2019/20 season. In response, a gear trial was undertaken by SARDI and industry in December 2020 to compare differences in CPUE between 51 mm and 57 mm cod-end mesh sizes and calculate a coefficient to adjust FIS CPUE data collected in May 2020 (McLeay 2021). The standardised FIS CPUE estimate provided in this Advice Note incorporates the coefficient applied to 2020 data derived from McLeay (2021).

Estimates of raw CPUE expressed as kilograms per hour (kg/h) and pounds per minute (lb/min), and estimates of mean prawn size (prawns per 7kg, PP7KG) are provided for each shot and cod-end type as supplemental information in Table A-1 of the Appendix.

RESULTS/DISCUSSION

A total of 107 of the 109 trawl shots defined under the Management Plan were completed. The estimate of standardised FIS CPUE from the May 2021 survey was 22.2 kg.trawl-shot^{-1}, which is in the trigger reference point range of ≥20.0 to <25.0 kg.trawl-shot^{-1} defined in the Management Plan (Figure 1; PIRSA 2017). With the exception of 2018, CPUE has declined since 2016, with the 2021 estimate the second lowest on record.

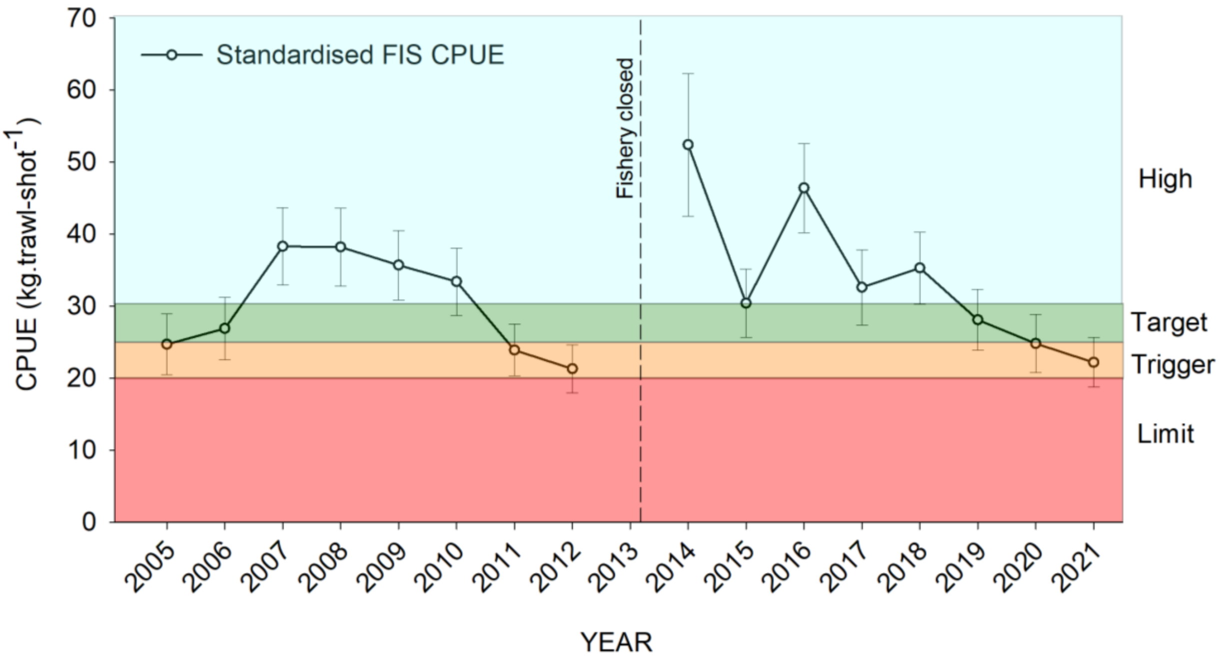

Figure 1. Standardised CPUE from the May FIS between 2005 and 2021. Note, the fishery was closed in 2012/13 and 2013/14, and a reduced survey (n=48 shots) was undertaken in 2014. Error bars are lower and upper 95% confidence intervals.

The FRI estimated from the FIS in May 2021 was 800.6 recruits.hour^{-1} (Figure 2). This estimate is in the high reference point range of ≥600 recruits.hour^{-1} defined in the Management Plan (Figure 2) (PIRSA 2017).

Figure 2. Fishery Recruitment Index (FRI) from the May FIS between 2005 and 2021. Note, the fishery was closed in 2012/13 and 2013/14, and a reduced survey (n=48 shots) was undertaken in 2014. Error bars are ± standard error.

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APPENDICES

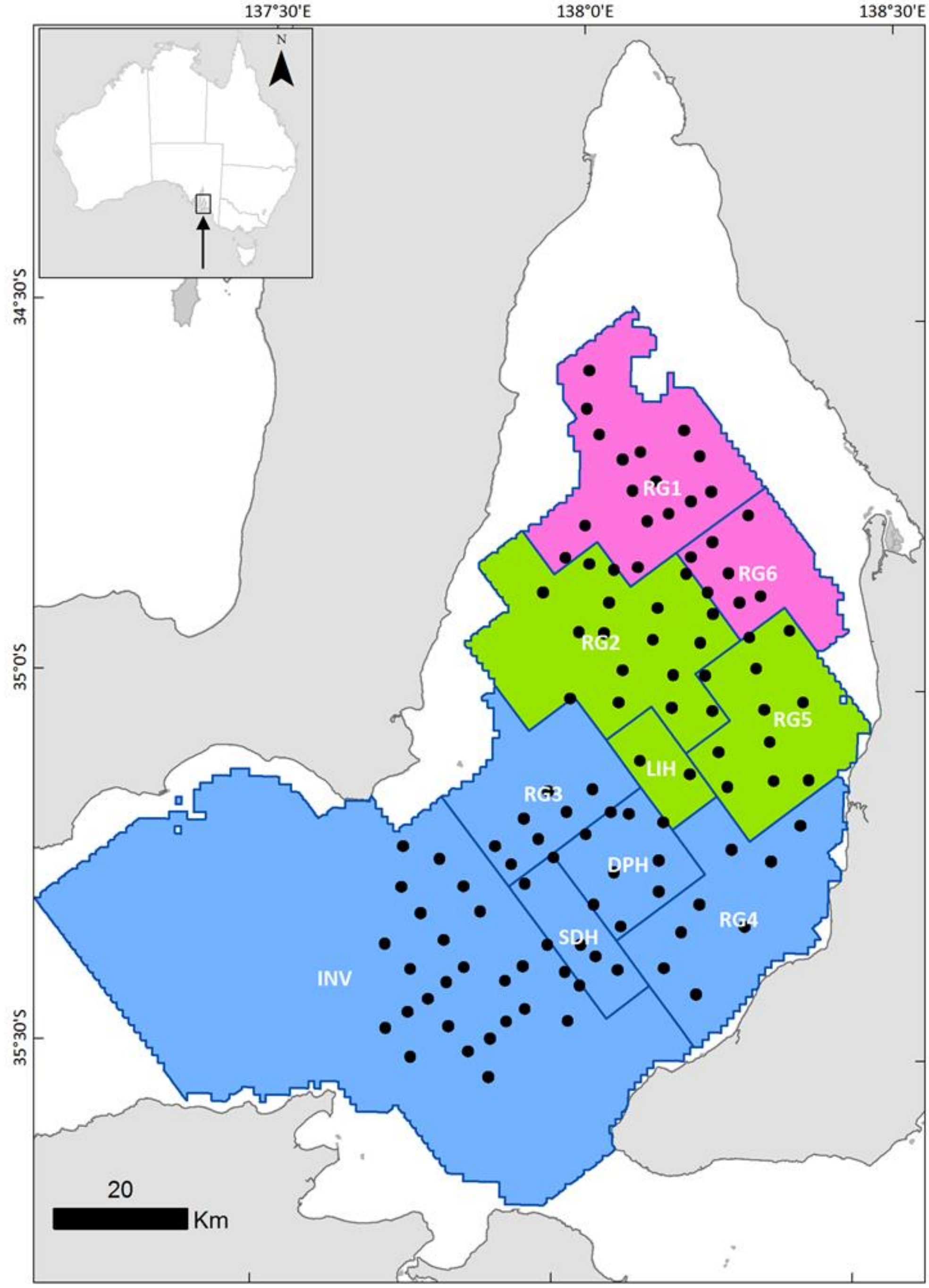


Figure A-1. The 109 survey stations specified in the Management Plan for the South Australian Gulf St Vincent Prawn Fishery. The northern gulf (pink) includes region (RG) 1 and RG6, the central gulf (green) includes RG2, RG5 and little hole (LIH), and the southern gulf (blue) includes deep hole (DPH), southern deep hole (SDH) and Investigator Strait (INV).

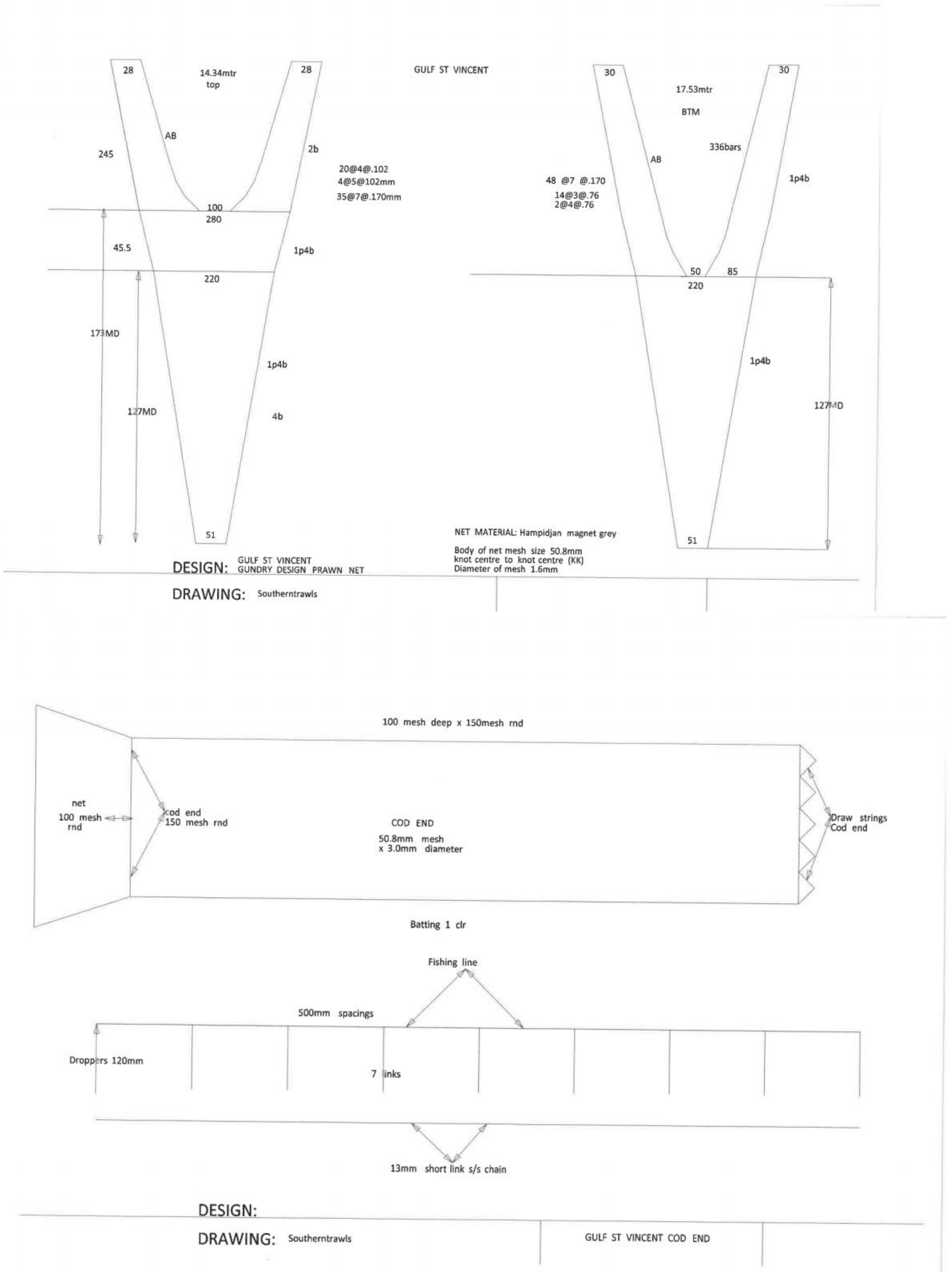


Figure A-2. Diagram of trawl configuration specifications for 51 mm diamond mesh cod-end and no grid used in FIS' in the GSVPF since 2005.

Table A-1. Raw data from survey shots completed as part of the FIS for the Gulf St Vincent Prawn Fishery in May 2021. ‘Incomplete’ survey shots refer to shots where gear was damaged or shot was fouled.

		Diamond mesh cod-end			T-90 mesh cod-end		
SHOT_ID	SHOT_No	kg/h	lb/min	PP7KG	kg/h	lb/min	PP7KG
1002	1_4	158.5	5.8	392	113.9	4.2	374
1003	1_5	82.4	3.0	302	72.7	2.7	283
1004	1_6	166.0	6.1	362	93.6	3.4	311
1005	1_7	144.0	5.3	408	83.2	3.1	375
1006	1_10	50.0	1.8	403	29.6	1.1	368
1007	1_11	66.0	2.4	425	34.3	1.3	412
1008	1_12	66.1	2.4	453	35.7	1.3	395
1009	1_16	*incomplete*			25.5	0.9	212
1010	1_19	89.9	3.3	418	53.8	2.0	386
1011	1_20	64.2	2.4	412	116.0	4.3	371
1012	1_21	58.6	2.1	360	23.3	0.9	344
1013	1_25	121.7	4.5	384	82.4	3.0	370
1014	1_26	125.2	4.6	295	92.3	3.4	280
1015	1_28	249.2	9.1	261	247.0	9.1	269
1016	2_2	4.1	0.2	362	3.7	0.1	320
1017	2_8	179.4	6.6	281	194.3	7.1	273
1018	2_9	63.9	2.3	296	41.2	1.5	271
1019	2_11	56.8	2.1	301	45.0	1.7	274
1020	2_13	113.4	4.2	243	79.7	2.9	235
1021	2_14	109.3	4.0	314	76.2	2.8	294
1022	2_15	115.2	4.2	217	94.0	3.4	197
1023	2_17	54.5	2.0	255	33.1	1.2	281
1024	2_20	61.9	2.3	208	50.0	1.8	193
1025	2_21	53.7	2.0	221	39.4	1.4	216
1026	2_23	46.9	1.7	226	52.4	1.9	229
1027	2_28	61.4	2.3	363	54.3	2.0	374
1028	2_29	59.4	2.2	291	56.8	2.1	278
1029	2_31	52.8	1.9	182	55.5	2.0	192
1030	2_34	67.2	2.5	235	61.5	2.3	302
1031	2_35	45.9	1.7	275	88.1	3.2	280
1032	3_2	25.5	0.9	157	19.0	0.7	172
1033	3_3	52.4	1.9	161	38.2	1.4	176
1034	3_4	58.0	2.1	186	41.7	1.5	178
1035	3_5	17.2	0.6	158	13.0	0.5	140
1036	3_6	28.9	1.1	171	24.7	0.9	170
1037	3_7	25.6	0.9	173	23.4	0.9	164
1038	3_8	49.4	1.8	178	32.0	1.2	175
1039	3_9	19.6	0.7	182	11.6	0.4	174
1040	3_10	31.1	1.1	205	24.0	0.9	202
1041	3_11	64.6	2.4	184	*incomplete*		
1042	3_12	31.3	1.1	186	24.0	0.9	169
1044	4_4	2.0	0.1	434	*incomplete*		
1045	4_6	5.0	0.2	595	2.8	0.1	
1046	4_7	7.9	0.3	361	4.7	0.2	314
1047	4_9	12.8	0.5	423	9.0	0.3	328
1048	4_10	10.3	0.4	354	4.0	0.1	365
1049	4_11	22.7	0.8	197	16.8	0.6	203
1051	4_15	3.8	0.1	357	5.1	0.2	219
1052	4_18	12.8	0.5	228	17.5	0.6	219
1053	5_1	not surveyed					
1054	5_3	1.3	0.0	170	1.3	0.0	153
1055	5_4	4.5	0.2	155	7.0	0.3	153
1056	5_5	25.6	0.9	295	16.8	0.6	202
1057	5_6	26.4	1.0	228	16.8	0.6	220
1058	5_7	53.4	2.0	259	56.6	2.1	267

		Diamond mesh cod-end			T-90 mesh cod-end		
SHOT_ID	**SHOT_No**	**kg/h**	**lb/min**	**PP7KG**	**kg/h**	**lb/min**	**PP7KG**
1059	5_8	56.3	2.1	287	61.9	2.3	290
1060	5_9	29.4	1.1	204	26.4	1.0	204
1061	5_10	75.5	2.8	187	78.1	2.9	189
1062	5_11	14.4	0.5	191	16.6	0.6	199
1063	5_13	14.5	0.5	246	6.5	0.2	243
1064	5_14	24.0	0.9	281	25.3	0.9	259
1065	5_15	12.8	0.5	327	14.6	0.5	296
1066	6_X1	35.2	1.3	190	13.6	0.5	200
1067	6_X10	15.6	0.6	201	4.8	0.2	140
1068	6_X12	44.6	1.6	184	35.4	1.3	189
1069	6_X5	127.2	4.7	174	65.2	2.4	171
1070	6_X6	50.0	1.8	152	34.4	1.3	161
1071	6_X7	9.0	0.3	140	7.8	0.3	133
1072	6_X8	61.0	2.2	180	55.9	2.0	288
1073	6_X9	58.4	2.1	182	39.2	1.4	188
1074	DH_1	27.8	1.0	183	21.5	0.8	203
1075	DH_2	42.4	1.6	264	42.8	1.6	234
1076	DH_3	60.5	2.2	192	46.2	1.7	236
1077	DH_4	56.6	2.1	192	56.4	2.1	175
1078	DH_6	57.2	2.1	201	44.8	1.6	188
1079	DH_7	38.4	1.4	155	21.2	0.8	123
1080	DH_8	64.0	2.3	244	33.6	1.2	231
1081	IS_3	17.9	0.7	302	8.2	0.3	304
1082	IS_4	2.8	0.1	300	1.0	0.0	263
1083	IS_9	3.7	0.1	98	0.8	0.0	272
1084	IS_11	6.0	0.2	261	8.8	0.3	204
1085	IS_12	17.6	0.6	197	23.2	0.9	202
1086	IS_13	28.7	1.1	252	25.6	0.9	230
1087	IS_14	1.8	0.1	*incomplete*	1.3	0.0	362
1088	IS_16	3.1	0.1	404	1.1	0.0	325
1089	IS_21	3.9	0.1	307	3.9	0.1	250
1090	IS_23	27.3	1.0	222	33.3	1.2	217
1091	IS_30	14.4	0.5	229	13.5	0.5	205
1092	IS_31	36.1	1.3	208	41.2	1.5	199
1093	IS_32	16.4	0.6	274	12.3	0.5	212
1094	IS_33	3.5	0.1	336	3.3	0.1	332
1095	IS_34	4.5	0.2	297	2.2	0.1	288
1096	IS_35	2.5	0.1	260	1.8	0.1	250
1097	IS_41	9.0	0.3	227	6.0	0.2	219
1098	IS_50	24.9	0.9	222	25.7	0.9	214
1099	IS_51	26.8	1.0	202	20.0	0.7	203
1100	IS_90	48.8	1.8	226	29.6	1.1	220
1101	IS_92	16.4	0.6	218	8.4	0.3	215
1102	IS_94	13.2	0.5	238	18.8	0.7	229
1103	IS_95	35.5	1.3	204	42.8	1.6	202
1104	IS_96	11.6	0.4	191	11.4	0.4	181
1105	LH_1	10.4	0.4	192	7.0	0.3	180
1106	LH_2	65.0	2.4	211	58.5	2.1	194
1107	SDH_1	39.6	1.5	219	28.0	1.0	215
1108	SDH_2	72.4	2.7	194	40.0	1.5	191
1109	SDH_3	74.4	2.7	224	47.2	1.7	213
1110	SDH_4	44.8	1.6	178	28.0	1.0	180
1111	SDH_5	32.0	1.2	182	20.8	0.8	177
1112	SDH_6	75.2	2.8	192	55.2	2.0	181

Doc 9

ADVICE TO:	**PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**
FROM:	**DR CRAIG NOELL AND DR LACHLAN MCLEAY (SARDI AQUATIC SCIENCES)**
SUBJECT:	**GULF ST VINCENT PRAWN FISHERY – IMPACT OF PRE-FISHING SURVEYS BEFORE THE 2021 PRE-CHRISTMAS FISHING PERIOD**
DATE:	**22 NOVEMBER 2021**

KEY ISSUES:

- The Gulf St Vincent prawn stock is current classified as **‘sustainable’**.
- PIRSA Fisheries and Aquaculture has requested advice on potential impacts to the sustainable stock status of allowing the Gulf St Vincent Prawn Fishery (GSVPF) to undertake six pre-fishing survey nights in addition to the 45 nights allocated to the fishery for the 2021 pre-Christmas fishing period.
- Analysis of historic pre-Christmas catch rates suggests that six pre-fishing survey nights is comparable to 1.8 commercial fishing nights. Allowing the six pre-fishing survey nights would increase the effective level of effort from 45 to 46.8 nights (45 + 1.8; 4%) for the pre-Christmas fishing period.
- Given the current stock status, this increase in effort of 4% for the 2021 pre-Christmas period is likely to be low risk to the sustainability of the Gulf St Vincent prawn stock.

BACKGROUND:

In the most recent stock assessment report for the Gulf St Vincent Prawn Fishery (GSVPF), the Gulf St Vincent prawn stock is classified as **‘sustainable’** (McLeay and Hooper 2021). PIRSA Fisheries and Aquaculture has requested advice on the potential impacts to the Gulf St Vincent prawn stock of allowing the GSVPF to undertake six pre-fishing survey nights in addition to the 45 nights already allocated to the fishery for the 2021 pre-Christmas fishing period. The proposed pre-fishing survey would involve three vessels over two nights and cover all 109 stock assessment survey locations.

RESULTS/DISCUSSION:

Comparative analysis of fishery-independent survey (FIS) and commercial fishing data during the pre-Christmas fishing period (available from 2004 to 2010) demonstrate that one survey night is equivalent to 0.61 commercial fishing nights in terms of trawl hours (i.e. 4.64 h/7.65 h), and the mean nominal catch rate from surveys was half the catch rate typically obtained during fishing (i.e. 45 kg h^{-1}/90 kg h^{-1}). This suggests that six pre-fishing survey nights is comparable to 1.8 commercial fishing nights (6 x 0.61 x 0.5), and gives a combined total potential effort in the GSVPF of 46.8 nights for the pre-Christmas fishing period.

On consideration of the current status of the GSVPF (McLeay and Hooper 2021), along with a recent independent review which suggested that the fishery has been lightly exploited (see Appendix), this increase in effective effort of 4% for the 2021 pre-Christmas period is likely to be low risk to the sustainable status of the Gulf St Vincent prawn stock.

Dr Mike Steer
Research Director, Aquatic Sciences

References

McLeay, L. J. and Hooper, G. E. (2021). Gulf St Vincent Prawn *Penaeus* (*Melicertus*) *latisulcatus* Fishery 2020/21. Fishery Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2007/000782-11. SARDI Research Report Series No. 1114. 45p.

Appendix

Independent scientific review of proposed harvest strategy options for the Gulf St Vincent Prawn Fishery, by Tony Smith, Independent Scientific Consultant, 20 October 2021.

Independent scientific review of proposed harvest strategy options for the Gulf St Vincent Prawn Fishery

Tony Smith, Independent Scientific Consultant

20 October 2021

Background

The Gulf St Vincent Prawn Fishery (GSVPF) is managed under an empirical harvest strategy based on trends in commercial catch rates and survey indices. The current harvest strategy was implemented in 2017 and a proposed new harvest strategy has been under development for implementation in 2021. An independent scientific review of the work to date was proposed and discussed with this consultant on 11 October. The terms of reference for the review were agreed on 14 October and the review commenced on the same day. The terms of reference are at Attachment 1, with the main focus as follows:

"The review is to provide advice and recommendations on a range of components of the proposed harvest strategy, particularly with respect to the monitoring program; application and potential limitations of the bio-economic assessment model; limit and target reference points (and associated risk levels); and associated harvest decision rules."

This report provides the outcome from this scientific review.

Information provided and considered

The main information provided for the review was a document provided by Annabel Jones, PIRSA, titled "Draft harvest strategy for Gulf St Vincent Prawn Fishery – Information for independent review". This provided a brief summary of the process to date for developing the new harvest strategy, a summary of key changes to the current harvest strategy, and a set of figures and tables, including four options (A to D) for selection of reference levels for commercial CPUE and survey CPUE.

Further information provided during the course of the review included:

- The most recent (draft) stock assessment report for the fishery from SARDI (McLeay and Hooper, September 2021)
- 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.
- The most recent EconSearch economic report on the fishery (EconSearch, June 2021)
- An email sent to the Research Sub-Committee by Neil MacDonald on 14 October outlining views on the harvest strategy
- 5 PowerPoint presentations made to the Research Sub-Committee by Craig Noell and Lachie McLeay (April to October 2021)
- Additional Figures and information provided by Craig Noell during the course of the review (mostly concerning recent analyses with the bioeconomic model)

Following consideration of this information, I held discussions on Monday 17 October with the following to discuss my initial conclusions:

- Ian Knuckey
- Cathy Dichmont
- Craig Noell
- Annabel Jones
- Neil MacDonald

Key findings from the review

1. Current status of the resource

The terms of reference for this review do not directly require review of the stock assessment but the status of the stock is directly relevant to the selection of both limit and target reference levels for the indicators used in the harvest strategy. Moreover, the terms of reference do require consideration of the application and limitations of the bioeconomic assessment model, and it turns out that this model provides important information about stock status and suitable reference points.

The current harvest strategy is an “empirical” harvest strategy, in the sense that it uses information directly from trends in fishery indicators to inform management decisions, rather than relying on stock status estimates from models. This approach can be very robust provided that the indicators chosen reflect changes in the abundance of the resource, and provided that the target and limit reference points for those indicators are appropriately selected. The two key indicators for the present harvest strategy are commercial CPUE and fishery independent survey (FIS) CPUE and there are long time series available for both indicators. An additional indicator, a pre-recruit index from the FIS, is also used in the harvest strategy to inform pre-Christmas nights, and also helps to determine stock status for the Status of Australian Fish Stocks (SAFS) classifications. The SARDI stock assessment reports (such as McLeay and Hooper 2021) are based on analysis and interpretation of these empirical indicators. The GSV prawn stock is currently assessed as “sustainable” but this is mainly due to the level of the pre-recruit index. Without this index, it would be classified as transitional depleting because both CPUE indicators (commercial and FIS) are below trigger levels and trends are declining. It is proposed that the new harvest strategy no longer use this pre-recruit index as it does not seem to be very informative.

The bioeconomic model for the fishery was developed in 2015 (Noell et al, 2015). It comprises two parts – a size-based stock assessment model to describe the biology, and an economic component to consider the economic implications of different harvest strategies. I am unclear on its role in developing the current harvest strategy in 2017, but it has been updated in 2021 and results from the model have been presented in the process of revising the current harvest strategy. The terms of reference for this review require consideration of its suitability (application and limitations). The current application of the model is not yet available as a report, but the material provided by Craig Noell (power points and additional figures) allows a general assessment of the model’s robustness and usefulness for informing the new harvest strategy.

The biological component of the model is a sophisticated but also fairly standard model for prawn fisheries and has been used previously (and currently) to assess eastern king prawns off Queensland.

The model has been published and reviewed previously and I do not provide an in-depth review of the model here. I am satisfied that the form of the model is fit for purpose, but the key consideration is how well it fits the data used to inform it, particularly the trends in abundance for the two CPUE indicators and the trends in the size composition data for the stock. In brief, the model seems to fit the trends in the data well. There are some aspects that could benefit from further clarification in a published report, but the model, considered as a stock assessment model, is fit for purpose. One concern raised in the 2015 report is a potential lack of contrast in the data, particularly lack of contrast in fishing effort over the past several decades in the fishery. However, there are in fact two periods of important contrast in this time series, notably the two periods of fishery closure, in the early 1990s and around 2013 and 2014. The CPUE responses to both closures are quite notable and quite informative about the dynamics and productive potential of the stock. There have also been several cycles in CPUE over the past 25 years of the fishery. Overall, I do not think that lack of contrast is a major problem for this model. I have spent less time considering the economic component of the bioeconomic model, but the form of this is again pretty standard and there are good economic data available for this fishery thanks to the EconSearch monitoring and analyses.

Given that the bioeconomic model generally looks fit for purpose, what does it tell us about the history of exploitation of the resource and perhaps more importantly about the selection of reference levels for the CPUE indicators for the new harvest strategy? I attach Figure 1 provided by Craig Noell which helps address these points. Two further figures show the time series of catch and effort for the fishery (Figure 2) and the time series of standardized CPUE for the FIS and the commercial fishery (Figure 3).

Figures 1, 2 and 3 seem to tell a consistent story. The high effort and catches during the 1970s and early 1980s (Figure 2) drove the biomass down to quite low levels by the mid-1980s (Figure 1). The subsequent reduction in effort and catch, and the fishery closure in the early 1990s, allowed the stock to recover strongly by the mid-1990s, and subsequent relatively low levels of effort and catch have maintained the stock at high relative biomass (fluctuating between 60% and over 100% of unfished levels) for the past 25 years. The fluctuations in CPUE over that latter period can be explained by fluctuations in recruitment (Figure 1) but the stock has been consistently above most conventional target levels (proxy, 50% of unfished levels) for that entire period of time, despite the fluctuations. This pattern of biomass is not inconsistent with the patterns in commercial CPUE over the past 25 years (Figure 3), which shows that CPUE, while quite variable, has never dropped below about half its maximum level. This assumes that CPUE is a reasonable index of relative abundance, and in fact the patterns in CPUE (both commercial and FIS) are what drives the pattern of time series of biomass and egg production seen in the model. The fishery closures, particularly that in 2013 and 2014, are important because the CPUE following the closure is likely to be close to the CPUE corresponding to unfished levels, which helps set a “scale” for relative abundance.

The conclusion from the bioeconomic modelling is that the stock has been relatively lightly fished for the past 25 years or so. I have tried to show that this conclusion is not inconsistent with the trends in commercial CPUE over this same period. The overall fits to the size composition data (not shown here) are at least not inconsistent with this view.

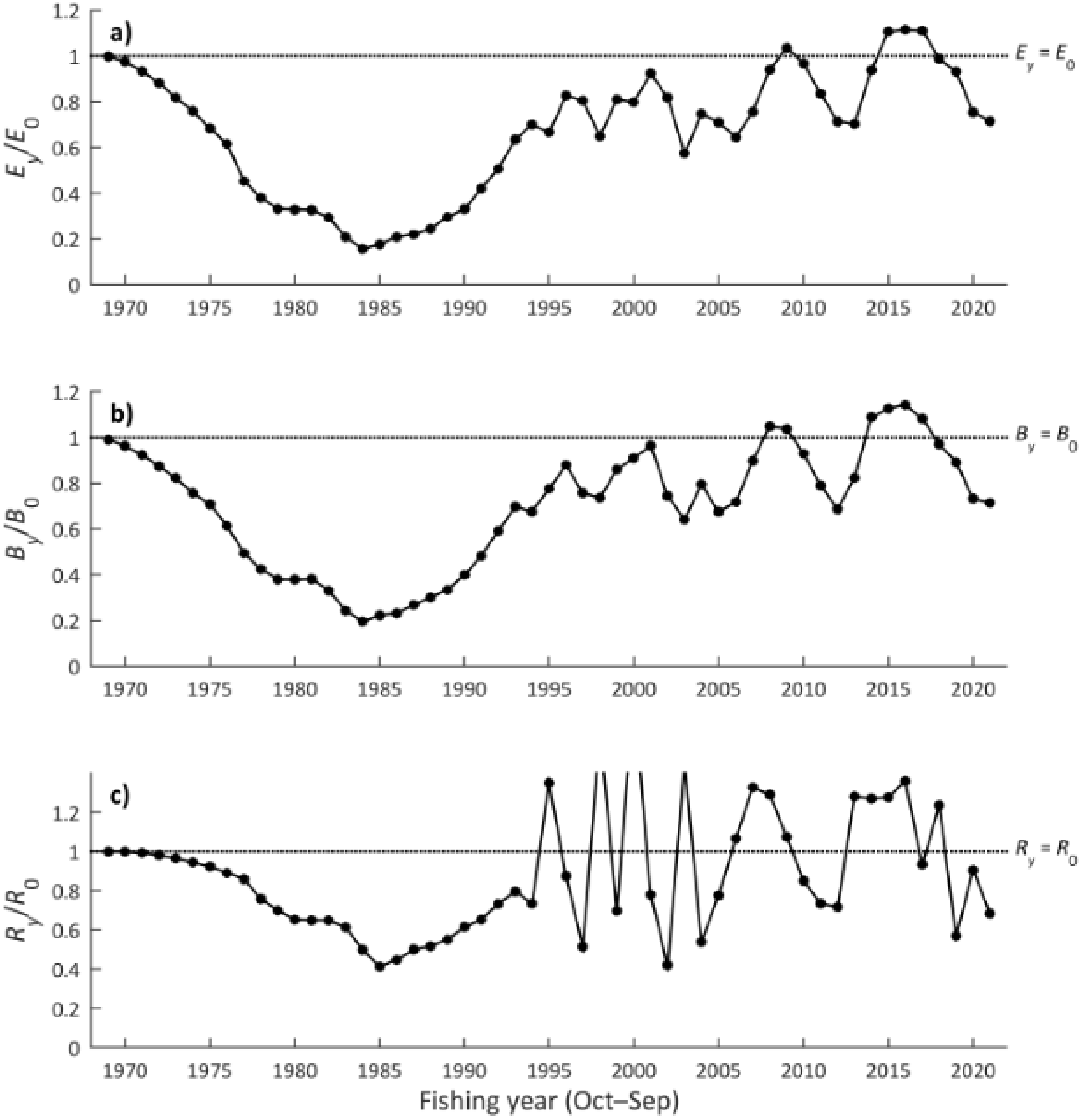


Figure 1. Output of the bioeconomic model showing time series of egg production E, biomass B and recruitment R since the start of the fishery (source C Noell)

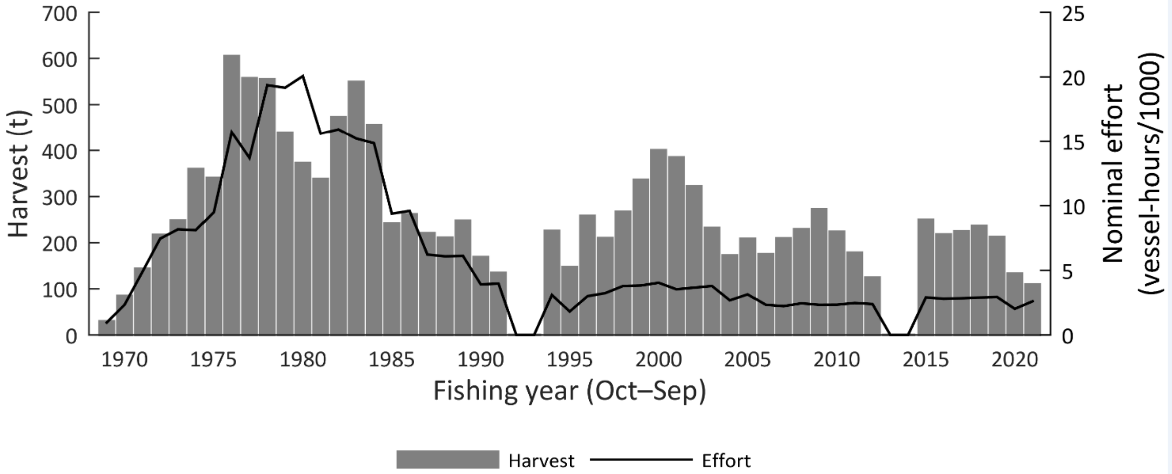
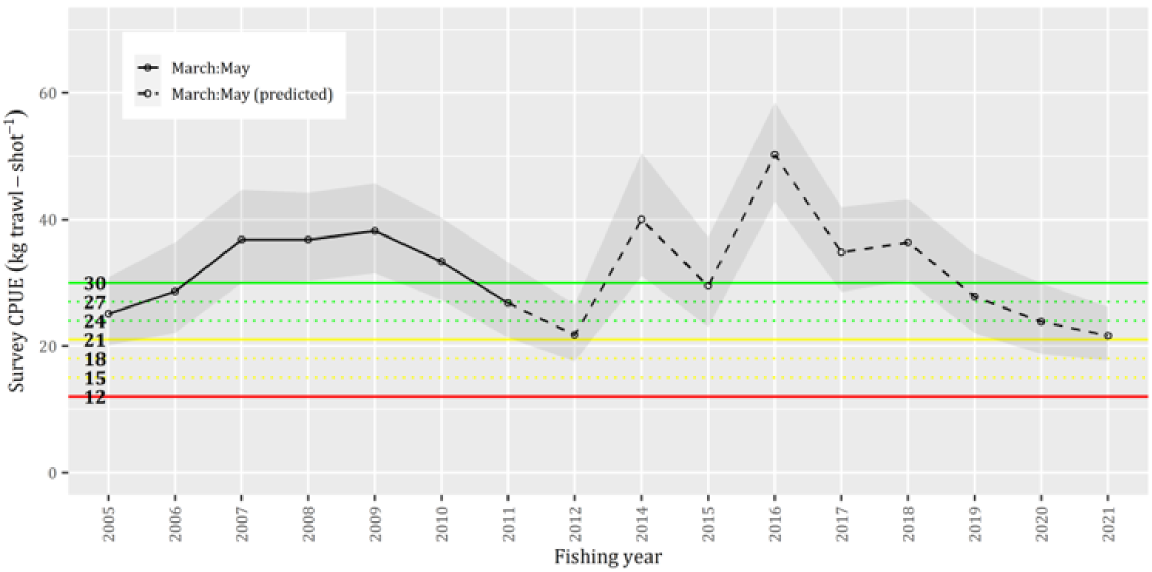


Figure 2. Time series of catch and effort for the fishery (source A Jones, document sent for review).

FIS CPUE (kg/trawl shot)



Commercial CPUE (kg/trawl shot)

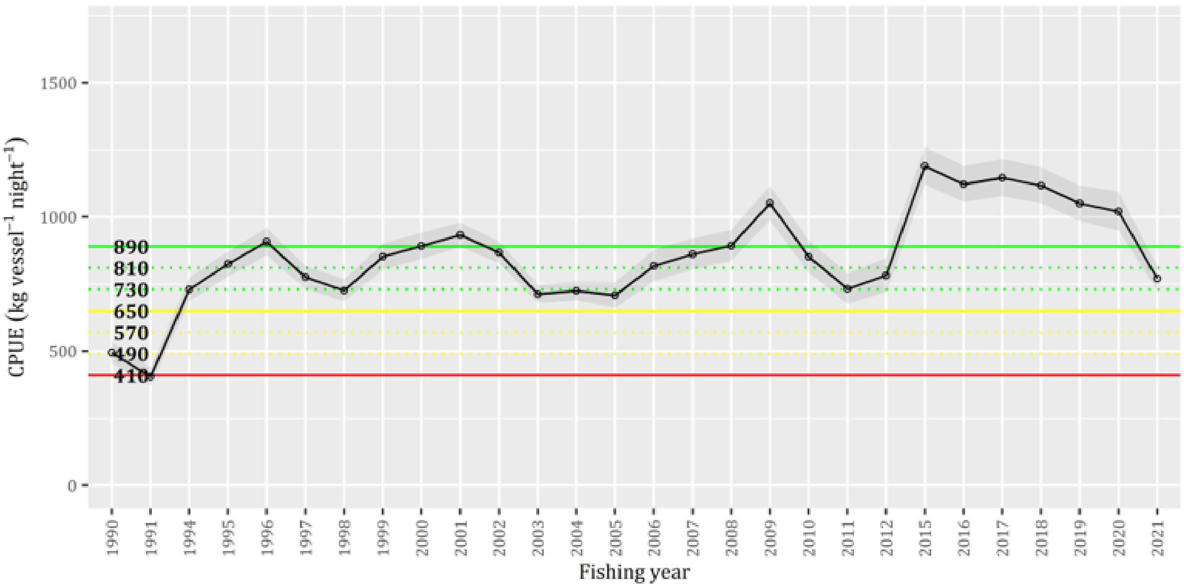


Figure 3. Time series of FIS and commercial CPUE (standardized) (source A Jones, document sent for review)

2. Implications for selecting reference points

To date, the reference levels for CPUE for the GSVPF have been derived empirically, as is common for many fisheries, by looking back over the time series history of indicators such as CPUE and setting the limit reference level at close to or just below the lowest point in the time series and the target at a level within the time series that seems to correspond to a "healthy" level for the stock. Trigger reference levels, if used, sit somewhere between the target and the limit. This approach has generated the reference levels adopted in the current harvest strategy, and also inform the assessments of stock status in the SARDI assessment reports, such that the SAFS status and the harvest strategy settings are mutually consistent. This approach to selecting reference points is appropriate for moderately to heavily exploited stocks.

If the findings from the bioeconomic model outlined in the previous section are credible, a reconsideration of reference levels is required for this fishery. The bioeconomic model can be used to calculate standard reference levels directly, such as those corresponding to maximum sustainable yield (MSY) and maximum economic yield (MEY). Results from the bioeconomic model are shown in Figure 4 and Table 1 below.

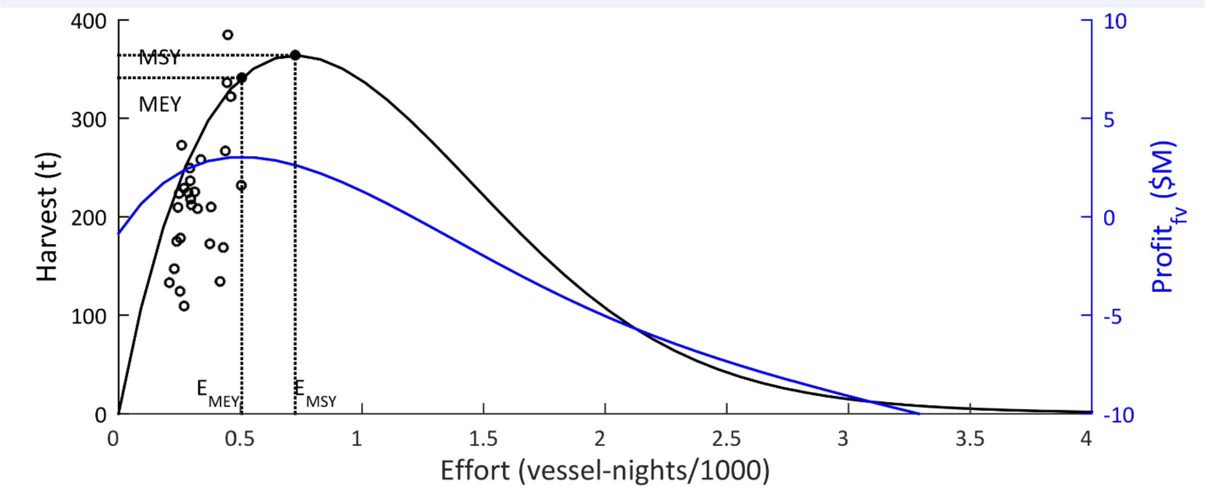
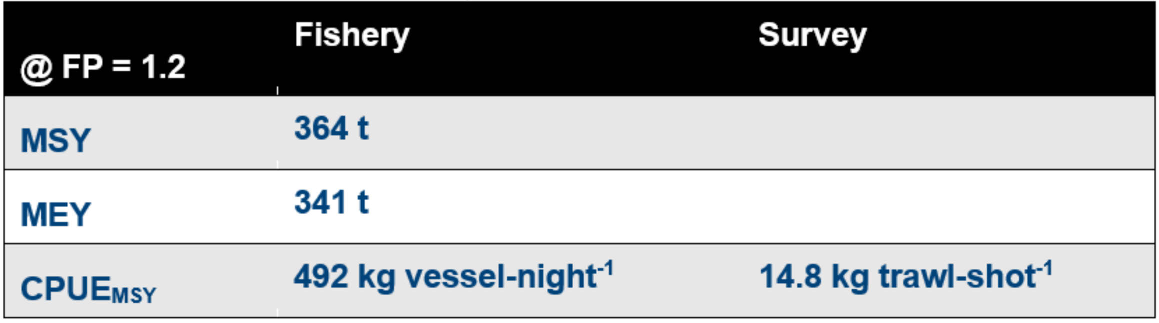


Figure 4. Equilibrium yield curves for harvest and profit relative to fishing effort (vessel nights) from the bioeconomic model (source C Noell).

Table 1: Bio-economic model estimates of MSY, MEY and CPUE_{MSY}.



@ FP = 1.2	Fishery	Survey
MSY	**364 t**	
MEY	**341 t**	
CPUE_{MSY}	**492 kg vessel-night^{-1}**	**14.8 kg trawl-shot^{-1}**

Table 1. Catch and CPUE reference levels from the bioeconomic model (Source A Jones, document sent for review)

Figure 4 shows what are called equilibrium yield and profit curves for the fishery as a function of fishing effort (vessel nights). Profit (the blue curve) is maximized at about 500 nights of effort and catch (black curve) at about 700 nights. These levels are far in excess of recent levels of effort in the fishery, consistent with the view that the resource has been lightly fished for some time. The small circles in the figure correspond to catch and effort levels actually observed since about 1992. Further calculations from the bioeconomic model provided by Craig Noell indicate that the biomass at MSY is about 40% of unfished levels and the biomass at MEY is at about 54% of unfished levels. These levels are quite consistent with findings from many other fish stocks (Punt et al, 2014). Table 1 shows the catch levels expected at MSY (364 t) and MEY (341 t) and also the CPUE at the MSY reference level (492 kg per vessel night for commercial CPUE and 14.8 kg per trawl shot for the FIS).

The various reference levels just discussed are clearly different from those applied in the recent history of the fishery. For example, limit reference levels for biomass or indices of biomass such as CPUE are often set at half MSY levels which would place them at about 250 kg per vessel night (commercial) and 7.4 kg per trawl shot (FIS). Target levels at MSY would be just below all recent levels of CPUE based on an MSY target, but somewhat higher (within but at the lower end of the range of observed values) for an MEY target. The biomass at MEY (54%) is also just below levels predicted from the bioeconomic model over the past 25 years (Figure 1). Finally, the MEY levels of effort predicted by the model (500 nights) are well above any levels observed in the fishery over the past 15 years, which have generally ranged between 250 and 300 nights (except for the two-year closure).

3. Implications for the harvest strategy

What are the implications of the discussion of reference levels and longer-term stock status for the new harvest strategy?

First, this hinges critically on interpretations from the bioeconomic model. I have indicated that I think the results from this model are generally credible, but the recent results are quite new and have not been written up. I have undertaken a quick review within the constraints of time available (less than a week) and the information available, but I would encourage the results to be written up formally and subject to further technical review. Nevertheless, I think that there is sufficient credibility in the model to inform several aspects of the proposed new harvest strategy.

Relative to the current settings in the decision table for number of nights in the harvest strategy, I would propose that the maximum number of nights be increased and that the reference levels (target and limit) for both CPUE time series (commercial and FIS) be set at lower levels. The key question for both effort and reference levels is by how much.

Very large changes in management arrangements and settings in a short period of time are generally not desirable. I would not recommend moving immediately to the MEY settings predicted by the bioeconomic model but a move in the direction is I believe called for and could be undertaken at reasonable (low) levels of risk. One way to think about this is to consider the relative biomass levels in Figure 1. These have fluctuated for several decades at or above about 60% of unfished levels with no long-term downward trend. A relatively low risk strategy would be to aim, for the period of the next harvest strategy, for a target of 60% unfished biomass, which is still above the calculated MEY target (54%) and well above the MSY target (40%). The bioeconomic model could be used to calculate what effort levels (number of nights) would on average hold the stock at 60% unfished levels (still a very conservative target). The model could also predict expected CPUE levels at this level of biomass (commercial and FIS) and these could be set as target levels. Limit levels could be set at half these levels, or at slightly higher levels if more precaution is desired. A limit at 40% of unfished levels (corresponding to estimated MSY levels) should be quite conservative.

To be quite clear, I am in favour of continuing with the current empirical indicator approach to the form of the harvest strategy and the (proposed 8 by 8) form of the decision table, based on the same two CPUE indicators, but with revised reference levels and maximum number of nights. I have not considered the issue of pre-Christmas nights in any detail but note that the issue of too few nights should alleviate with higher maximum nights and lower targets.

It is important for industry in particular to realize that adopting the strategy just proposed will lead to lower average catch rates in the fishery. The trade-off is that the strategy will increase the number of nights available for fishing and should result in higher average catch levels, though these will continue to fluctuate as before. The overall risk to the stock should be low because the form of the decision table still requires that effort be quickly reduced if the stock declines to lower levels of CPUE than expected.

The longer-term strategy for managing the fishery would involve continued close monitoring using the commercial and fishery independent indicators and continued monitoring of size composition, more frequent updates to the bioeconomic model (every two to three years), and gradual changes to the harvest strategy every five years or so, learning by experience from the new settings in the harvest control rules. If a decision is made to adopt something like the strategy I have suggested, a review of performance after 3 years may well be appropriate.

Concluding comments and recommendations

This review has not played out as I expected going into it. Given the problematic history of the fishery, and several periods of complete closure, I was not expecting to conclude that the stock has generally been above commonly adopted reference levels. This conclusion hinges largely on the results from the bioeconomic modelling and I have not been able to undertake a full technical review of this. Nevertheless, the fits of the model to the data look generally good, the modelling approach itself is standard, and as I have indicated in section 1 of the key findings, interpretation of the commercial CPUE is not inconsistent with a view that the stock has fluctuated at quite healthy levels for several decades, following clear evidence for overfishing in the last century.

My comments and conclusions should not be taken as being critical of past analysis and management of the fishery. The approach to harvest strategies and analysis, based on trends in indicators, is consistent with approaches that have worked well in many other fisheries and have been widely adopted.

My key recommendation is that the Research Sub-Committee and the MAC consider the suggestion I have made above about selecting suitable targets, limits and effort levels, as indicated in the text underlined in section 3 above. This essentially involves selecting an agreed biomass target (relative to unfished levels) and estimating maximum effort levels and CPUE reference levels corresponding to such a target, using the bioeconomic model. Given that this would represent a substantial change to the current harvest strategy settings (but not to the overall form of the strategy), a review of performance under the revised harvest strategy should be undertaken within 3 years. In the meantime, the bioeconomic analysis should be fully documented, technically reviewed and published.

In relation to the explicit terms of reference for this review, I conclude that a new strategy along the lines I have suggested, involving an increase in nights fished and a corresponding downward revision of targets and limits, would be consistent with the objects of the Fisheries Management Act 2007, would maintain prawn biomass at ecologically sustainable levels, and would move the fishery in the direction of better economic performance. The overall form of the strategy would remain consistent with the South Australian Harvest Strategy Policy and Guidelines.

References cited

Punt, A.E., A.D.M. Smith, D.C. Smith, G. Tuck and N. Klaer (2014) Selecting relative abundance proxies for B_{MSY} and B_{MEY}. *ICES Journal of Marine Science* 71: 469-483

Attachment 1: Terms of Reference for the review

Independent scientific review of proposed harvest strategy options for Gulf St Vincent Prawn Fishery.

These Terms of Reference relate to a review of the proposed harvest strategy for the Gulf St Vincent Prawn Fishery (GSVPF). The purpose of the review is to provide advice to the Gulf St Vincent Prawn Fishery Management Advisory Committee (GSVPFMAC) and the Department of Primary Industries and Regions (PIRSA) on the harvest strategy's:

- ability to meet the objects of the *Fisheries Management Act 2007* (the Act)
- ability to maintain ecologically sustainable prawn biomass
- ability to optimize economic performance within biologically sustainable limits
- Consistency with the South Australian Harvest Strategy Policy and South Australian Harvest Strategy Guidelines

The review is to provide advice and recommendations on a range of components of the proposed harvest strategy, particularly with respect to the monitoring program; application and potential limitations of the bio-economic assessment model; limit and target reference points (and associated risk levels); and associated harvest decision rules.

Outcomes from the review are to be provided in a report format, and potentially in-person (remotely) to the GSVPFMAC and GSVPFMAC Research Subcommittee, if required.

The report is to be provided to PIRSA by 20 October 2021

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR. LACHLAN MCLEAY (SARDI AQUATIC SCIENCES)**

SUBJECT: **GULF ST VINCENT PRAWN FISHERY: STANDARDISED ANNUAL COMMERCIAL CATCH PER UNIT EFFORT (CPUE)**

DATE: **29 SEPTEMBER 2021**

KEY ISSUES

- Under the Management Plan for the South Australian Commercial Gulf St Vincent Prawn Fishery, three performance indicators are used to inform the harvest strategy for the fishery in the following season.
- Previous advice to PIRSA on 23 June 2021 reported: 1) a Standardised Fishery Independent Survey (FIS) Catch Per Unit Effort (CPUE) of **22.2 kg.trawl-shot^{-1};** and 2) a FIS Recruitment Index (FRI) of **800.6 recruits.hour^{-1}**.
- This advice note reports on the third indictor used to inform the harvest strategy - standardised annual commercial CPUE.
- In 2020/21, standardised annual commercial CPUE was **656.1 kg.block^{-1}.vessel-night^{-1}**.
- This estimate is within the trigger range for this reference point of ≥600 to <750 kg.block^{-1}.vessel-night^{-1} defined within the Management Plan.

BACKGROUND

The Gulf Saint Vincent Prawn Fishery (GSVPF) targets Western King Prawn (*Penaeus (Melicertus) latisulcatus*) in waters of Gulf St Vincent, South Australia. The performance of the fishery has varied since fishing commenced in 1967, with catches ranging annually between 6 and 630 tonnes (t) since 1968, and two periods of closure occurring between 1991/92 and 1992/1993, and 2012/13 and 2013/14. The fishery re-opened in 2014/15, and in 2019/20 the total harvest was 132 t (McLeay and Hooper 2020).

Under the Management Plan for the GSVPF (Management Plan) (PIRSA 2017), effective 1 July 2017, three performance indicators are used to inform the harvest strategy in the following season:

1) Standardised Fishery Independent Survey (FIS) Catch Per Unit Effort (CPUE) (kg.trawl-shot^{-1}) estimated from a survey in May.
2) FIS Recruitment Index (FRI) (recruits.hour^{-1}) estimated from the survey in May. This indicator informs decision rules that set total fishing nights (or catch) for the pre-Christmas period.
3) Standardised annual commercial CPUE (kg.block^{-1}.vessel-night^{-1}) obtained from commercial logbook data during the fishing season.

Previous advice to PIRSA dated 23 June 2021 reported:

1) Standardised FIS CPUE of **22.2 kg.trawl-shot^{-1};** and 2) FRI of **800.6 recruits.hour^{-1}**.

This advice note reports on the third indictor used to inform the harvest strategy for the 2021/22 fishing season, standardised annual commercial CPUE (kg.block^{-1}.vessel-night^{-1}). Along with standardised FIS CPUE, standardised annual commercial CPUE, which is estimated from commercial logbook data, is considered a proxy of relative prawn abundance.

RESULTS/DISCUSSION:

Standardised annual commercial CPUE (kg.block^{-1}.vessel-night^{-1}) for the 2020/21 fishing season was estimated from a total of 270 fished nights and total catch of 109.3 t. The total catch recorded in the 2020/21 season is the lowest catch on record since 1970/71 and 50.5% of the average seasonal catch recorded between 2000/01 and 2020/21 (Figure 1).

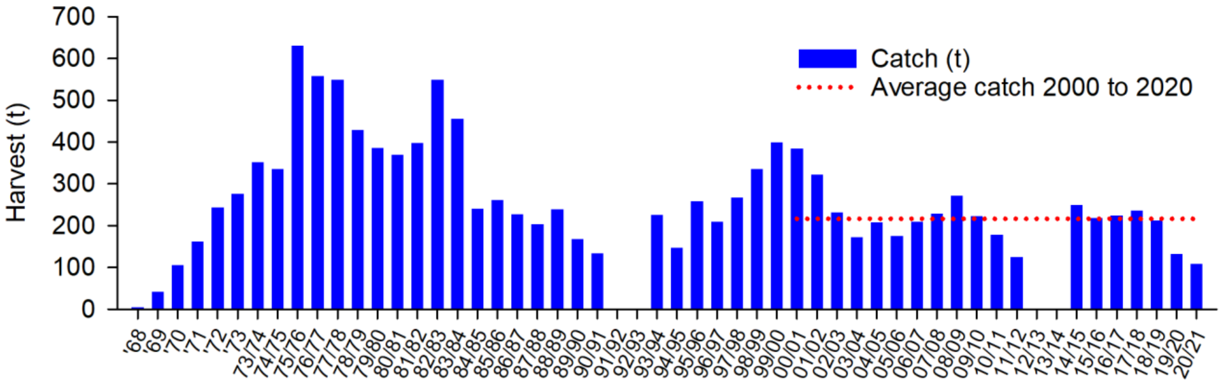


Figure 1. Commercial catch (tonnes, t) in the GSVPF between the 1968/69 and 2020/2021 fishing seasons. Note, the fishery was closed between 1991/92 and 1992/93 and 2012/13 and 2013/14.

Standardisation of data relating to annual commercial CPUE was undertaken using a Generalised Linear Model (GLM) to account for the effects of fishing year, month, region, lunar phase, effort, licence and cloud cover (Noell et al. 2015).

The estimate of standardised annual commercial CPUE for the 2020/21 season was **656.1 kg.block^{-1}.vessel-night^{-1}**, 95% CI [635.9, 676.9], which is a 16.3% decrease since 2019/20 (784.2 kg.block^{-1}.vessel-night^{-1}), and the lowest estimate recorded since the fishery reopened in 2014/15 (Figure 1). The 2020/21 estimate is within the trigger range defined for this reference point of ≥600 to <750 kg.block^{-1}.vessel-night^{-1} (Figure 1; PIRSA 2017).

Under the management plan for the GSVPF (PIRSA 2017), the 2020/21 estimate of standardised annual commercial CPUE, when combined with the data relating to standardised FIS CPUE and the FRI, will inform the harvest strategy for the 2021/22 season, noting that a review of the harvest strategy by members of the GSVPF Management Advisory Committee (GSVPFMAC) is underway.

An annual stock assessment report presenting information relating to the performance indicators, and other information relevant to the GSVPF, is due to be provided by SARDI to PIRSA Fisheries and Aquaculture by 31 October 2021.

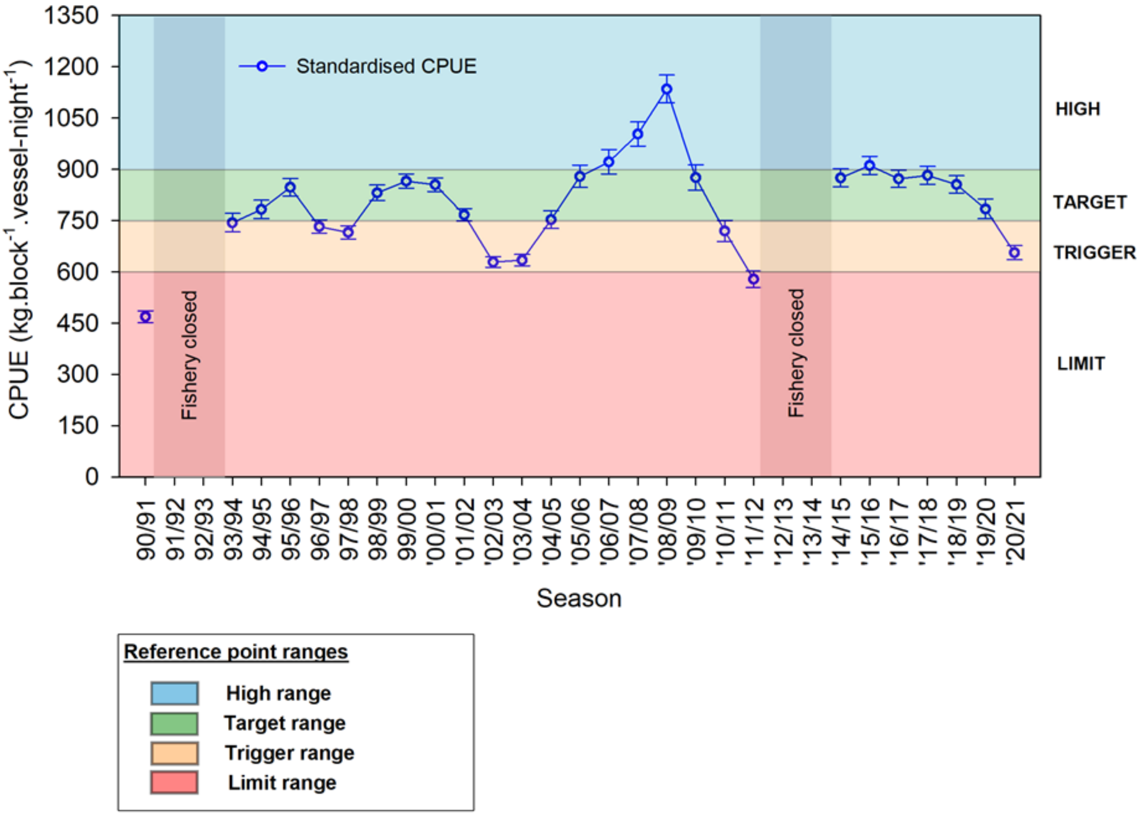


Figure 2. Standardised annual commercial CPUE between the 1990/91 and 2020/2021 fishing seasons. Note, the fishery was closed between 1991/92 and 1992/93 and 2012/13 and 2013/14. Error bars represent upper and lower (95%) confidence intervals.

Dr Michael Steer
Research Director, Aquatic Sciences

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REFERENCES

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DRS JASON EARL AND JONATHAN SMART (SARDI AQUATIC SCIENCES)**

SUBJECT: **IDENTIFICATION OF MARINE SCALEFIFSH FISHERY GEARS THAT PRIMARILY CAPTURE SPECIES THAT COULD TOLERATE INCREASED CATCHES**

DATE: **22 OCTOBER 2021**

KEY ISSUES

- On 27 September 2021, SARDI provided advice on:
  1. An evaluation of latent effort compared to active effort by Marine Scalefish Fishery (MSF) Fishing Zone (and the total effort at a state-wide scale); and
  2. The interaction of gear type by species to provide information on the capacity to take, with initial advice first produced for a few main gear types, before confirming approach with industry and providing advice on the rest.
- This advice was presented to MSF stakeholders on 1 October 2021. Following this presentation, additional advice was requested by PIRSA Fisheries and Aquaculture:
  1. Overlay the outputs produced by the SARDI Advice Note provided on 27 September 2021, with FRDC project 2017/023 'ESD risk assessment for "lesser known" species to facilitate structural reform of South Australia's commercial Marine Scalefish Fishery'
  2. Identify gear types in the MSF that primarily take species that have been attributed a low to medium risk associated with increased catch of up to 25%.

BACKGROUND

The MSF has recently undergone a historic reform that regionalised and rationalised the fishery and unitised specific stocks. One objective of the reform was to allow the fishery to operate with fewer input controls and allow fishers to modify their operations to maximise production and profitability. Accordingly, the Red Tape Reduction Working Group (RTRWG) has requested that rules pertaining to gear transferability be reviewed. This would allow fishers to activate latent effort in the fishery for specific gear endorsements that may be transferred from current licence holders who do not fully utilise them. This would assist fishers in adapting their operations, but the activation of latent effort could result in increased catches that may impact the sustainability of MSF fish stocks.

On 27 September 2021, SARDI provided the Advice Note 'Analysis of latent effort and catch composition for gear types in the MSF' to PIRSA Fisheries and Aquaculture. The evaluation provided percent estimates of mean annual retained catch of permitted species/taxa from 2011–2020 for 26 MSF gear types (Appendix Table A1) and identified significant latent effort for all gear types in the fishery except hauling nets and Octopus traps. This information was presented to MSF licence holders, including members of the RTRWG, on Friday 1 October 2021 at the ‘MSF Gear Transferability Workshop 2’.

As a result of discussions at the workshop, PIRSA Fisheries and Aquaculture have requested that (1) the Advice Note outputs relating to species composition of catches for each gear type (Appendix Table A1) be overlayed with results from FRDC project 2017/023 ‘ESD risk assessment for ‘lesser known’ species to facilitate structural reform of South Australia’s commercial MSF (Fowler et al. 2020) (Appendix Table A2); to enable (2) identification of MSF gear types that primarily take species that have been attributed a low to medium risk associated with increased catch of up to 25%.

The risk assessment process undertaken by Fowler et al. (2020) culminated in risk levels (negligible, low, medium, high, and severe) that were assigned to hypothetical increases in total catch (by 25%, 50%, 75% and 100%) for 27 candidate MSF taxa. The outcomes of the assessment are provided in Appendix Table A2. For half of the candidate taxa, high or severe risks were assigned to a 25% increase in catch. These are considered undesirable or unacceptable levels of risk, and so these taxa were assessed as not capable of supporting higher catches. Alternatively, there were 13 taxa for which there were negligible, low, or medium risk levels assigned to a 25% increase in catch. These were: Ocean Jackets (negligible risk assigned to a 25% increase in catch); Blue Mackerel, Sweep, Broadnose Shark, Sand Crab, *Octopus* spp., Western Striped Grunter, Yelloweye Mullet and Snook (low risk assigned to a 25% increase in catch); and Australian Herring, Whiskery Shark, Australian Salmon and Leatherjackets (medium risk assigned to a 25% increase in catch) (Appendix Table A2).

RESULTS/DISCUSSION

Of the 26 MSF gear types, seven primarily (>80%) captured species that were attributed a negligible, low, or medium risk associated with increased catch of up to 25% by Fowler et al. (2020) (Table 1). These are: Octopus trap, purse seine, crab pot, fish trap, Salmon net, troll line and bait net. For crab lift nets, 52.3% of the catch comprised species that were attributed a low risk associated with increased catch of up to 25%, with Blue Crabs (not assessed by Fowler et al. (2020)) comprising the remaining 47.6% of the catch. The remaining 18 MSF gear types primarily take: species that were attributed a high or severe risk associated with increased catch of up to 25%; Tier 1 species - Snapper, KGW or Garfish (Calamari were assessed by Fowler et al. (2020) as high risk); or species that were not assessed by Fowler et al. (2020).

Octopus traps

Octopus are the only reported catch with this method. There is a low risk for Octopus associated with an increase in catch of up to 25% (Appendix Table A2).

Purse seine

Australian Salmon are the only reported catch with this method. A medium risk was assigned to a 25% increase in catch of Australian Salmon (Appendix Table A2).

Crab pot

Sand Crab are the only reported catch with this method. A low risk was assigned to a 25% increase in catch of Sand Crab (Appendix Table A2).

Fish traps

Ocean Leather Jackets are the dominant (98.8%) species retained by this gear. A negligible risk was assigned to a 25% increase in catch of Ocean Leather Jackets (Appendix Table A2). Relatively small quantities of Western Striped Grunter (0.9% of the catch, low risk assigned) and Leather Jackets (0.2%, medium risk) are also taken using fish traps.

Salmon net

Australian Salmon, assigned a medium risk comprise almost the entire (99.8%) reported catch taken with this method, along with relatively negligible quantities (0.02%) of Mulloway. A high risk was assigned to a 25% increase in catch of Mulloway (Appendix Table A2).

Troll line
Catches taken using troll lines consisted of mostly Snook (68.6%), for which a medium risk was assigned to a 25% increase in catch, and Australian Salmon (25.8%; medium risk). A small proportion of the troll line catch comprised Bronze Whaler Shark (Appendix Table A1), for which a severe risk was assigned to an increase in catch up to 25%, while Gummy Shark and Trevally (both assigned high risk) were also landed.

Bait net (5 cm)
Around 84% of retained catches from bait nets comprised species for which low or medium risk was assigned to a 25% increase in catch. This included Australian Salmon (30.6%), Yelloweye Mullet (25.6%), Australian Herring (22.9%) and Western Striped Grunter (3.6%). Of the remaining catch, 9.5% consisted of taxa (Mulloway 7.5%, Trevally 1.7% and Black Bream (0.4%) for which a high risk was assigned to an increase in catch up to 25%.

Dr Michael Steer
Research Director, SARDI Aquatic Sciences

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Fowler, A.J., Rogers, P.J. and Smart, J. (2020). ESD risk assessment for 'lesser known' species to facilitate structural reform of South Australia's commercial Marine Scalefish Fishery. FRDC project 2017/023. SARDI Aquatic Sciences, Adelaide. Pp. 110.

Table 1. Percent of average annual catch reported for the 26 gear types of the MSF from 2011–2020 for species/taxa grouped by risk level (negligible, low, medium, high severe) assigned to a 25% increase in catch by Fowler et al. 2020. Tier 1 species (Snapper, King George Whiting and Garfish, excluding Calamari) and other species/taxa not assessed by Fowler et al. (2020) are also included.

	NEGLIGIBLE RISK	LOW RISK								MEDIUM RISK				HIGH RISK *includes SOUTHERN CALAMARI	SEVERE RISK	Tier 1 SPECIES SNAPPER KGW GARFISH	ALL OTHER SPECIES/TAXA
Gear Type	OCEAN LEATHER JACKET	BLUE MACKEREL	SWEEP	BROADNOSE SHARK	SAND CRAB	OCTOPUS	WESTERN STRIPED GRUNTER	YELLOW-EYE MULLET	SNOOK	AUSTRALIAN HERRING	WHISKERY SHARK	AUSTRALIAN SALMON	LEATHER JACKET				
OCTOPUS						100											
PURSE SEINE												100					
CRAB POT					100												
FISH TRAP (INCL. OCEANJACKET TRAP)	98.8						0.9						0.2	0.01			0.1
SALMON NET												99.8		0.2			
TROLL LINE		0.6	0.05						68.6	0.4		25.8	0.1	0.8	1.6		2
BAIT NET (5 CM)		0.5					3.6	25.6	0.3	22.9		30.6	0.2	9.5		2.7	4.2
CRAB LIFT NET (HOOP/DROP NETS)					52.2	0.1									0.1		47.6
HAUL NET (SINKING MESH NET)							0.9	1.3	7.5	10.3		26.2	2.4	30.8	0.1	19.4	1
HAUL NET (SINKING AND FLOATING NET)							3.5	5.8	2.8	16.5		8.9	5.1	30.3	0.1	25.9	1.1
HAUL NET (SINKING MIXED MESH)		0.02					1.5	2.3	7.3	13.1		12.1	2.5	42.5		17.1	1.7
SET GILL NET (5 CM)		0.05					0.3	5.8	13.1	6.9		6.1	0.1	38	0.2	23	6.4
HAUL NET (FLOATING GAR NET)			0.1				1.6	1.7	2	17.6		4.4	1.7	16.7	0.2	52.5	1.5
HAND					12.4												87.6
POLES/ROD AND LINE		1.7	0.5				0.3	0.6	1.3	1.2	0.2	2.5	1.7	14.4	10.8	61	3.8
DAB NET		0.1			1.7	0.03		0.1	0.1	0.3		0.9		2.3	1.5	80.4	12.6
HANDLINE		0.7	0.4	0.05			0.04			0.2	0.1	1.1	0.4	7.4	2.5	86.1	1
DROP LINE			0.03	0.4			0.2		0.1		1		0.1	46.6	31	10.1	10.5
LARGE MESH SET NET (> 15 CM)			0.1								1.7			33.3	61.9	0.2	2.7
LONG LINE		0.04	0.04	0.5							0.5			14	12.7	69.2	3.1
SQUID JIG														98.6			1.4
OTHER (INCL. DIVING)														6			94
COCKLE RAKE																	100
CRAB RAKE																	100
RAZOR FISH TONGS																	100
SPADE/FORK																	100

APPENDIX

Table A1. Percent of average annual catch reported for the gear types of the Marine Scalefish Fishery from 2011 – 2020 for primary, secondary and tertiary species. Colours represent the percentage of each species retained by specific gears, green = >50%, yellow = 49.9 – 25%, orange = 24.9 – 10%, red = 9.99 – 1.1%, pink = 1 – 0.01%. Values in the table are rounded, but across the three tables, each gear-type row sums to 100%.

	Primary				Secondary									Tertiary						
Gear Type	SNAPPER	SOUTHERN CALAMARI	KING GEORGE WHITING	GARFISH	AUSTRALIAN HERRING	AUSTRALIAN SALMON	BLUE CRAB	BRONZE WHALER SHARK	MULLOWAY	SAND CRAB	SNOOK	YELLOW-EYE MULLET	YELLOWFIN WHITING	BLACK BREAM	CUTTLEFISH	LEATHER JACKET	OCEAN LEATHER JACKET	PARROTFISH	RAYS AND SKATES	TREVALLY
BAIT NET (5 CM)			0.4	2.4	22.9	30.6			7.5		0.3	25.6		0.4		0.2				1.7
COCKLE RAKE																				
CRAB LIFT NET (HOOP/DROP NETS)							47.4			52.2										
CRAB POT										100.0										
CRAB RAKE							100.0													
DAB NET		1.4	0.2	80.1	0.3	0.9	5.4	0.6		1.7	0.1	0.1							1.0	0.2
DROP LINE	9.8		0.2					9.7	0.6		0.1					0.1		0.2	5.9	0.2
FISH TRAP (INCL. OCEANJACKET TRAP)																0.2	98.8			
HAND							21.9			12.4										
HANDLINE	25.6		60.4		0.2	1.1		0.5	0.1				0.1			0.4		2.4	0.1	1.9
HAUL NET (FLOATING GAR NET)		3.4	1.0	51.6	17.6	4.4		0.2	0.4		2.0	1.7	11.9			1.7		0.2	0.8	0.2
HAUL NET (SINKING AND FLOATING NET)		7.3	3.8	22.1	16.5	8.9		0.1	0.8		2.8	5.8	21.6			5.1			0.4	
HAUL NET (SINKING MESH NET)		15.3	3.2	16.3	10.3	26.2		0.1	1.3		7.5	1.3	11.5			2.4			0.7	
HAUL NET (SINKING MIXED MESH)		22.4	7.0	10.1	13.1	12.1			0.2		7.3	2.3	19.2			2.5			0.5	0.2
LARGE MESH SET NET (> 15 CM)	0.2							60.5	1.5				29.7	0.1					0.3	
LONG LINE	69.1		0.2					9.6										0.7	1.4	0.1
OCTOPUS TRAP																				
OTHER (INCL. DIVING)									0.1					5.9						
POLES/ROD AND LINE	15.2		45.3	0.6	1.2	2.5		1.9	1.9		1.3	0.6	1.1	0.3		1.7		3.0	0.5	2.4
PURSE SEINE						100.0														
RAZOR FISH TONGS																				
SALMON NET						99.8			0.2											
SET GILL NET (5 CM)		1.1	21.3	1.7	6.9	6.1		0.2	1.8		13.1	5.8	30.5	3.4		0.1			0.2	0.5
SPADE/FORK																				
SQUID JIG		98.6													1.4					
TROLL LINE					0.4	25.8		1.6			68.6					0.1		0.2		0.1

Table A1 continued: percent of average annual catch reported for the gear types of the Marine Scalefish Fishery from 2011–2020 that includes all other species reported in daily catch returns. Colours represent the percentage of each species caught by specific gears , green = >50%, yellow = 49.9 – 25%, orange = 24.9 – 10%, red = 9.99 – 1.1%, pink = 1 – 0.01%.

	All other species reported in MSF daily catch returns																															
Gear Type	GUMMY SHARK	SCHOOL SHARK	BIGHT REDFISH	WESTERN STRIPED GRUNTER	OCTOPUS	RAZOR FISH	KING SCALLOP	OTHER SHARK	RED MULLET	YELLOWTAIL KINGFISH	WHISKERY SHARK	BLUE MACKEREL	MUD COCKLE - OTHER	MUD COCKLE - YELLOW	MUD COCKLE - GREY	BROADNOSE SHARK	OTHER OR MIXED SPECIES	QUEEN SCALLOP	TUBEWORM	SEA URCHIN	SWEEP	FLATHEAD	BLOODWORM	SEA MULLET	JUMPER MULLET	MUSSEL	JACK MACKEREL	HAMMER HEAD SHARK	BLUE MORWONG	WOBBEGONG SHARK	DEEP SEA TREVALLA	SAMSONFISH
BAIT NET (5 CM)				3.6								0.5												3.7	0.4							
COCKLE RAKE													72.3	18.7	7.0											2.0						
CRAB LIFT NET (HOOP/DROP NETS)			0.1		0.1																											
CRAB POT																																
CRAB RAKE																																
DAB NET	0.6	0.8	0.1		0.0			0.0	0.0			0.1					0.2					0.1	5.7									
DROP LINE	45.4	9.9	11.4	0.2				1.2		0.1	1.0					0.4	0.0				0.0	0.1						0.3	0.2		1.0	1.0
FISH TRAP (INCL. OCEANJACKET TRAP)				0.9					0.0								0.0															
HAND						3.0													0.2	40.4						5.3						
HANDLINE	2.0	0.3	1.7	0.0				0.1	0.8	0.0	0.1	0.7				0.0	0.1				0.4	0.1					0.0	0.0	0.1	0.1		0.0
HAUL NET (FLOATING GAR NET)	0.0			1.6				0.0	0.2	0.4							0.2				0.1	0.1		0.2	0.0		0.0					
HAUL NET (SINKING AND FLOATING NET)	0.0			3.5				0.0	0.0	0.5							0.3					0.1					0.1					
HAUL NET (SINKING MESH NET)	0.0			0.9				0.1	0.0	2.5												0.1			0.2							
HAUL NET (SINKING MIXED MESH)	0.1			1.5				0.0	0.0	0.4		0.0					0.4					0.0		0.2	0.1		0.3					
LARGE MESH SET NET (> 15 CM)	1.9	0.5	0.9					0.2			1.7										0.1	0.0						0.5	1.0			
LONG LINE	12.9	2.3	0.8					0.6		0.0	0.5	0.0				0.5	0.1				0.0	0.2						0.1	0.1	0.1	0.1	0.0
OCTOPUS TRAP					100.0																											
OTHER (INCL. DIVING)							65.5											21.6		6.6		0.0										
POLES/ROD AND LINE	3.2	1.1	7.7	0.3				1.7	1.6	0.7	0.2	1.7					0.4				0.5	0.2					0.0	0.1	0.3			0.3
PURSE SEINE																																
RAZOR FISH TONGS						100.0																										
SALMON NET																																
SET GILL NET (5 CM)	0.0			0.3					0.3	0.1		0.0					0.2					0.4		2.5	3.5			0.0				
SPADE/FORK																			90.8				9.2									
SQUID JIG																																
TROLL LINE	0.5							1.1	0.0			0.6									0.0											

Table A1 continued: percent of average annual catch reported for the gear types of the Marine Scalefish Fishery from 2011–2020 that includes all other species reported in daily catch returns. Colours represent the percentage groups of average annual catch, green = >50%, yellow = 49.9 – 25%, orange = 24.9 – 10%, red = 9.99 – 1.1%, pink = 1 – 0.01%.

	All other species reported in MSF daily catch returns																																
Gear Type	LING	BEACHWORM	GUMMY And SCHOOL SHARK	MORWONG	WEEDY WHITING	SCHOOL WHITING	WESTERN BLUE GROPER	SWALLOWTAIL	RED GURNARD	WAREHOU	GURNARD PERCH	SAW SHARK	BARRACOUTA	MAKO SHARK	SOUTHERN ROCK COD	KNIFE JAW	THRESHER SHARK	FLOUNDER	ELEPHANT SHARK	HARLEQUIN FISH	DUSKY MORWONG	LUDERICK	BOARFISH	ROCK CRAB	GOULDS SQUID	CONGER EEL	SHARK FINS	DRUMMER	SPIDERCRAB	SOUTHERN BLUEFIN TUNA	BLUE GRENADIER	SERGEANT BAKER	TAILOR
BAIT NET (5 CM)					0.1																												
COCKLE RAKE																																	
CRAB LIFT NET (HOOP/DROP NETS)																								0.0									
CRAB POT																																	
CRAB RAKE																																	
DAB NET																					0.0												
DROP LINE	0.3		0.2	0.1				0.1							0.0																0.0		
FISH TRAP (INCL. OCEANJACKET TRAP)																0.0																	
HAND		16.7																															
HANDLINE			0.0	0.0	0.0	0.1		0.0		0.0			0.0		0.0																		
HAUL NET (FLOATING GAR NET)					0.0	0.0												0.0															
HAUL NET (SINKING AND FLOATING NET)					0.2													0.0															
HAUL NET (SINKING MESH NET)																																	
HAUL NET (SINKING MIXED MESH)					0.0					0.0																							
LARGE MESH SET NET (> 15 CM)							0.6																0.2										
LONG LINE	0.1		0.1	0.1			0.0		0.0		0.0	0.0		0.0	0.0	0.0	0.0																
OCTOPUS TRAP																																	
OTHER (INCL. DIVING)																					0.1												
POLES/ROD AND LINE	0.1			0.1	0.0	0.0		0.1					0.0			0.0														0.0			
PURSE SEINE																																	
RAZOR FISH TONGS																																	
SALMON NET																																	
SET GILL NET (5 CM)					0.1																	0.1											
SPADE/FORK																																	
SQUID JIG																																	
TROLL LINE													0.8																				

Table A2. Summary of risk levels assigned to the nominated percentages in total catch for the candidate taxa assessed in the risk assessment process undertaken by Fowler et al. 2020. Taxa are ranked according to assigned risk levels according to increases of 25 – 200% of 2013-2017 annual catches.

Broad taxonomic group	**Taxonomic Group**	**25%**	**50%**	**100%**	**200%**
Finfish	Ocean jackets	Negligible	Low	High	Severe
Finfish	Blue Mackerel	Low	Low	Low	Low
Finfish	Sea Sweep	Low	Low	Low	Low
Elasmobranch	Broadnose Shark	Low	Low	Low	Low
Crustacean	Sand Crab	Low	Low	Medium	High
Cephalopod	*Octopus* spp.	Low	Low	Medium	High
Finfish	Western Striped Grunter	Low	Low	Medium	High
Finfish	Yelloweye Mullet	Low	Medium	Medium	High
Finfish	Snook	Low	Medium	High	Severe
Finfish	Australian Herring	Medium	Medium	High	High
Elasmobranch	Whiskery Shark	Medium	Medium	High	High
Finfish	Western Australian Salmon	Medium	High	High	Severe
Finfish	Leatherjackets	Medium	High	Severe	Severe
Finfish	Yellowfin Whiting (GSV)	High	High	Severe	Severe
Finfish	Black Bream	High	High	Severe	Severe
Finfish	Yellowtail Kingfish	High	High	Severe	Severe
Elasmobranch	Gummy Shark	High	High	Severe	Severe
Finfish	Bluethroat Wrasse	High	Severe	Severe	Severe
Finfish	Mulloway	High	Severe	Severe	Severe
Finfish	Trevally	High	Severe	Severe	Severe
Finfish	Yellowfin Whiting (SG)	High	Severe	Severe	Severe
Finfish	Flathead spp.	High	Severe	Severe	Severe
Finfish	Red Mullet	High	Severe	Severe	Severe
Cephalopods	Southern Calamari	High	Severe	Severe	Severe
Finfish	Bight Redfish	Severe	Severe	Severe	Severe
Elasmobranch	Bronze Whaler & Dusky Shark	Severe	Severe	Severe	Severe
Elasmobranch	School Shark	Severe	Severe	Severe	Severe

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR MICHAEL DREW (SARDI AQUATIC SCIENCES)**

SUBJECT: **ANALYSIS OF LATENT EFFORT AND CATCH COMPOSITION FOR GEAR TYPES IN THE MSF**

DATE: **27 SEPTEMBER 2021**

KEY ISSUES

- The Marine Scalefish fishery (MSF) is a complex multi-species and multi-gear fishery. The multiple gear types endorsed on each fishers' licence has resulted in potentially large amounts of latent effort for many gear types across the fishery.
- The Red Tape Reduction Working Group (RTRWG) for the Marine Scalefish fishery have requested the transferability of gear endorsements between fishers throughout the fishery.
- Given the potential impacts of increased effort on both permitted species stocks and discards as a result of gear transferability, PIRSA Fisheries and Aquaculture have requested:
    1. An evaluation of latent effort compared to active effort by MSF Fishing Zone (and the total effort at a state-wide scale); and
    2. The interaction of gear type by species to provide information on the capacity to take, with initial advice first produced for a few main gear types, before confirming approach with industry and providing advice on the rest.

BACKGROUND

The MSF has recently undergone a historic reform that regionalised and rationalised the fishery, and unitised specific stocks. One of the objectives of the reform was to allow the fishery to operate with fewer input controls and allow fishers to tailor their operations to maximise production and profitability. Accordingly, the Red Tape Reduction Working Group (RTRWG) has requested that rules pertaining to gear transferability be reviewed. This would allow fishers to activate latent effort in the fishery for specific gear endorsements that may be transferred from current licence holders who do not fully utilise them. This would assist fishers in adapting their operations, but the activation of latent effort could result in increased catches (targeted or incidental) that may impact the sustainability of MSF fish stocks.

Estimates of actual and latent effort by gear type

The level of latent effort within the Marine Scalefish Fishery was first assessed in a Marine Scalefish fishery dynamic's report in 2009 (Steer 2009). This assessment used 'fisherday' as the unit of effort across all gear types. Due to the inconsistences of effort reported in catch records, fisherday is often the most appropriate parameter of effort available. However, the estimates of latent and actual units of effort in a fisherday would not adequately answer the proposed questions of the latent effort for each gear type, due to the number of devices that could be used on a given fishing day.

In this Advice Note, three estimates of effort are provided. These were ‘actual effort’, ‘maximum potential effort’ and ‘scaled potential effort’ (defined below) and were derived from the daily catch and effort data between January 2011 to December 2020 reported by remaining MSF fishers (i.e. those remaining following the MSF reform) and their licence-specific endorsements on PIRSA’s public register. Actual effort is presented at four spatial scales. Maximum and scaled potential efforts are presented at the state-wide scale as MSF licences are not restricted by regional zones for Tier 2 and Tier 3 species, meaning any gear transfers could be transferred state-wide

Actual effort is the sum of boat days for each gear type for each licence in each zone, multiplied by the maximum number of devices for that fishing method for each licence holder. For example, a fisher has 50 droplines endorsed on their licence and fishes ten days in Spencer Gulf (SG) and fifteen days in Gulf St Vincent (GSV) in one year. Their estimate of actual effort would be 500 droplines in SG and 750 droplines in GSV for that year. This method estimates the maximum amount of effort that the fisher could have used on that day of fishing using that specific method.

The estimates of actual effort for some gear types may over-estimate the true effort that could be applied for every day of fishing. This will vary among gear types as the method for fishing each gear type varies widely.

Maximum potential effort is the sum of all devices for each fishing method for all fishers with that endorsement multiplied by 365.25 days. These estimates show the maximum potential for each gear type to be used for each year but are likely over-estimates and misrepresentative of the potential number of days fished each year. This is because fishing does not occur on every day of the year by every licence holder.

Scaled potential effort is the sum of all devices for each fishing method for all fishers with that endorsement multiplied by the average number of days fished by remaining licences. The average number of days fished by remaining fishers varied marginally between years ranging from 84 days in 2020 to 107 days in 2015 and 2017. While this estimate accounts for the inability for fishers to operate every day of each year, scaled potential effort estimate may not be representative of all fishing methods, and it may not account for the higher levels of effort by a smaller number of dedicated fishers. However, it is considered the best current estimate of potential latent effort.

Estimates of mean annual retained catch by gear type

The average annual retained catch composition was quantified for each gear type for the period of January 2011 to December 2020 (Table 1). The data used in this assessment were from the daily catch and effort returns by each remaining licence holder in the MSF. All retained species recorded on the catch returns were included in this analysis (Table 1), which reflects the diverse breadth of species both targeted and captured as by-product within this fishery. By-catch information was available for hauling nets and longlines from a previous study (Fowler et. al 2009). This information is also presented for these gear types.

RESULTS/DISCUSSION

Summary of average annual retained catch composition by gear type

Of the 26 gear types or groups of similar gear types, 13 of them have catches dominated (>50% of the catch) by a single species (Table 1). The remaining gear types that catch a wider breadth of species are more generalist fishing methods, such as netting. These gear types are often used by a variety of fishers across regions and therefore catch a broader variety of species depending on the operations of these fishers (e.g., gill nets and pole and line; Table 1)

Effort and catch summary for individual gear types

Hauling nets

The dominant species retained from hauling net catches is Southern Garfish (Table 1; Table 3). Other species frequently caught in hauling nets include Southern Calamari, Yellowfin Whiting, Australian Herring and Australian Salmon. Bycatch information is available for hauling nets which indicates that a large variety of species are captured and discarded from hauling net catches (Appendix Table 3). A total of 43 hauling nets are active in the MSF, with no effort recorded for the South East region and limited effort recorded for the West Coast (Table 2; Appendix Fig. 1). The scaled potential effort for hauling nets is relatively low in comparison to the higher levels of actual effort, as fishers who currently have hauling net endorsements use this gear regularly. The number of days fished by hauling net fishers is relatively high compared to the average number of days fished by all method across the fishery, resulting in relatively lower levels of latent effort for haul nets (Appendix Fig. 1).

Gill nets

The dominant species retained from small mesh set gill nets are Yellowfin and King George Whiting (Table 1). A total of 142 gill nets are currently endorsed in the MSF, with no effort recorded in the South East and West Coast over the past ten years (Table 2;). Scaled potential effort is high relative to actual effort for gill nets as this gear type is used infrequently by licence holders with this endorsement (Table 2; Appendix Fig. 2).

Large mesh set nets

The dominant species retained varies by region for large mesh set nets and include Yellowfin Whiting in GSV/KI and whaler sharks in SG and WC (Table 1). A total of 107 large mesh set nets are currently endorsed in the MSF, with no effort recorded in the South East over the past ten years (Table 2 and Appendix Fig. 3). The scaled potential effort of large mesh set nets is high relative to actual effort due to their limited use (Table 2).

Longlines

Snapper has been the dominant species retained over the past ten years. However, a large variety of species is also captured and retained such as Gummy Shark, Whaler Sharks and School Shark (Table 1). A total of 1,750 longlines are currently endorsed in the MSF, with effort recorded in each region (Table 2; Appendix Fig. 4). Over the past ten years, actual effort has been less than 8% of the potential scaled effort (Table 2). Declines in longline effort and the closure of the Snapper fishery for most of SA in 2019 has resulted in scaled potential effort increasing over time (Appendix Fig. 4).

Droplines

Gummy Sharks are the dominant retained catch from droplines (Table 1). A total of 2,060 droplines are currently endorsed in the MSF, with effort recorded in all regions (Table 2; Appendix Fig. 5). The scaled potential effort is high due to the large number of devices that are endorsed on licences (Table 2). The WC region has recorded the most effort state-wide, which has been increasing over time (Appendix Fig. 5).

Fish traps

Ocean Leather Jackets are the dominant species retained by this gear with few other species caught (Table 1; Appendix Table 13). A total of 2,384 fish traps including Ocean Leather Jacket traps are currently endorsed in the MSF (Table 2; Appendix Figure 6). The scaled potential effort for fish traps is high relative to actual effort (Table 2) as a result of the large number of devices that are endorsed on licences. Most of the effort occurs in the post-reform SG region, which now includes MFA’s 26, 27, 28 (Appendix Table 13).

Dab nets

Dab net catches are dominated by Southern Garfish; few other species are retained (Table 1). Scaled latent effort for dab nets is high relative to actual effort (Table 2; Appendix Fig. 7).

Crab catching devices

The dominant species retained are Sand Crab and Blue Swimmer Crab, although there are regional differences between these two species as Blue Swimmer Crab catches are limited by management measures in SG and GSV/KI (Table 1). A total of 2,261 crab nets (combined crab nets, hoop nets and drop nets) are currently endorsed in the MSF (Table 1). Scaled potential effort is high relative to actual effort due to the large number of endorsed devices in the fishery (Table 1; Appendix Fig. 8).

Crab rakes

Catch information is very limited due to the low levels of effort for this gear type (Table 1). A total of 234 crab rakes are currently endorsed in the MSF, with effort recorded for <10 days in one year in the WC (Table 2; Appendix Fig. 9). Therefore, scaled potential effort is very high relative to actual effort (Table 2; Appendix Fig. 9).

Sand crab pots

A total of 400 Sand Crab pots are currently endorsed in the MSF, with effort primarily recorded in the post reform SG region (Table 2; Appendix Fig. 10). Given that negligible fishing with sand crab pots has occurred in recent years, the scaled potential effort is high relative to actual effort (Table 2; Appendix Fig. 10).

Octopus traps

Data on Octopus traps are confidential as fewer than 5 licence holders have this gear endorsement.

Bait nets

Retained catches from Bait nets include Australian Herring, Australian Salmon, Yellowfin Whiting (Table 1). A total of 27 bait nets are currently endorsed in the MSF, with low levels of effort recorded for the past ten years (Table 2; Appendix Fig. 13).

Bait fishing

This is a combination of bait harvesting gear types (bait spades, bait pumps and bait forks) which, over the past ten years, has tube worms and blood worms as the primary retained species A total of 83 bait spades, bait pumps and bait forks are currently endorsed in the MSF, with low levels of effort recorded across the state (Table 2; Appendix Fig. 14).

Razorfish tongs

Razorfish are the only reported species retained with this method (Appendix Table 1;2). A total of 395 razorfish tongs are currently endorsed in the MSF (Table 2), Scaled potential effort is high relative to actual effort due to the few fishers using this method (Table 2; Appendix Fig. 15).

Purse seine nets

Data on purse seine nets are confidential as fewer than 5 licence holders have this gear endorsement.

Cockle rakes

A total of 224 cockle rakes are currently endorsed in the MSF, with no effort recorded in the South East (Fig. 16). Marine Scalefish fishers without Vongole quota are permitted to harvest 10kg per day for bait. However, whether Vongole are harvested for bait or as Vongole quota is not differentiable in logbook records. Therefore, the latent effort that has been calculated includes effort attributed to the quota-managed Vongole fishery as well as the MSF fishers retaining Vongole for bait (Fig 16). Therefore, these estimated levels of actual and latent effort are overestimates for the MSF (Fig 16).

Mussel dredging

Twenty-three mussel dredges are endorsed in the MSF, with no reported catch or effort occurring in any region through the 2011–2020 period (Table 2; Appendix Fig. 17).

Cockle nets

Fifty-eight cockle nets are endorsed in the MSF, with no reported catch or effort occurring from this method in any region through the 2011–2020 period (Table 2; Appendix Fig. 18).

Fish spears

One-hundred fish spears are endorsed in the MSF, with no reported catch or effort occurring in any region through the 2011–2020 period (Table 2; Appendix Fig. 19). Fish spears are an endorsed gear type on MSF licenses but are not a recorded gear type on the daily catch returns.

Squid jigging machine

Data on squid jigging machines are confidential as fewer than 5 licence holders have this gear endorsement.

Estimates of by-catch in the Marine Scalefish Fishery

A preliminary fishery-dependant study of the by-catch of three key gear types in the MSF was conducted by in 2009 (Fowler et al. 2009). This work was conducted over a one-year field period, with SARDI observers present on MSF vessels for 122 fishing operations. The data from Fowler et al. (2009; the numbers of retained and discarded fish for all species captured during the observer work for two gear types, hauling nets and longlines) are provided in Appendix Tables 3 and 4). The catch composition for both gears types provides an indication of the numerous species which are captured and unretained. The survival rate of the discarded individuals is unknown and would vary dependant on the species and the gear type used. For the discarded species which are on the prescribed list of species for MSF fishery, it was assumed they were either not of legal-length or fishers were above the daily catch limit for that species.

Table 1: Percent of average annual catch reported for the gear types of the Marine Scalefish Fishery from 2011 – 2020 for primary, secondary and tertiary species. Colours represent the percentage of each species retained by specific gears, green = >50%, yellow = 49.9 – 25%, orange = 24.9 – 10%, red = 9.99 – 1.1%, pink = 1 – 0.01%. Values in the table are rounded, but across the three tables, each gear-type row sums to 100%

	Primary				Secondary									Tertiary						
Gear Type	**SNAPPER**	**SOUTHERN CALAMARI**	**KING GEORGE WHITING**	**GARFISH**	**AUSTRALIAN HERRING**	**AUSTRALIAN SALMON**	**BLUE CRAB**	**BRONZE WHALER SHARK**	**MULLOWAY**	**SAND CRAB**	**SNOOK**	**YELLOW-EYE MULLET**	**YELLOWFIN WHITING**	**BLACK BREAM**	**CUTTLEFISH**	**LEATHER JACKET**	**OCEAN LEATHER JACKET**	**PARROTFISH**	**RAYS AND SKATES**	**TREVALLY**
BAIT NET (5 CM)			0.4	2.4	22.9	30.6			7.5		0.3	25.6		0.4		0.2				1.7
COCKLE RAKE																				
CRAB LIFT NET (HOOP/DROP NETS)							47.4			52.2										
CRAB POT										100.0										
CRAB RAKE							100.0													
DAB NET		1.4	0.2	80.1	0.3	0.9	5.4	0.6		1.7	0.1	0.1							1.0	0.2
DROP LINE	9.8		0.2					9.7	0.6		0.1					0.1		0.2	5.9	0.2
FISH TRAP (INCL. OCEANJACKET TRAP)																0.2	98.8			
HAND							21.9			12.4										
HANDLINE	25.6		60.4		0.2	1.1		0.5	0.1				0.1			0.4		2.4	0.1	1.9
HAUL NET (FLOATING GAR NET)		3.4	1.0	51.6	17.6	4.4		0.2	0.4		2.0	1.7	11.9			1.7		0.2	0.8	0.2
HAUL NET (SINKING AND FLOATING NET)		7.3	3.8	22.1	16.5	8.9		0.1	0.8		2.8	5.8	21.6			5.1			0.4	
HAUL NET (SINKING MESH NET)		15.3	3.2	16.3	10.3	26.2		0.1	1.3		7.5	1.3	11.5			2.4			0.7	
HAUL NET (SINKING MIXED MESH)		22.4	7.0	10.1	13.1	12.1			0.2		7.3	2.3	19.2			2.5			0.5	0.2
LARGE MESH SET NET (> 15 CM)	0.2							60.5	1.5				29.7	0.1					0.3	
LONG LINE	69.1		0.2					9.6										0.7	1.4	0.1
OCTOPUS TRAP																				
OTHER (INCL. DIVING)									0.1					5.9						
POLES/ROD AND LINE	15.2		45.3	0.6	1.2	2.5		1.9	1.9		1.3	0.6	1.1	0.3		1.7		3.0	0.5	2.4
PURSE SEINE						100.0														
RAZOR FISH TONGS																				
SALMON NET						99.8			0.2											
SET GILL NET (5 CM)		1.1	21.3	1.7	6.9	6.1		0.2	1.8		13.1	5.8	30.5	3.4		0.1			0.2	0.5
SPADE/FORK																				
SQUID JIG		98.6													1.4					
TROLL LINE					0.4	25.8		1.6			68.6					0.1		0.2		0.1

Table 1 continued: percent of average annual catch reported for the gear types of the Marine Scalefish Fishery from 2011–2020 that includes all other species reported in daily catch returns. Colours represent the percentage of each species caught by specific gears , green = >50%, yellow = 49.9 – 25%, orange = 24.9 – 10%, red = 9.99 – 1.1%, pink = 1 – 0.01%.

	All other species reported in MSF daily catch returns																														
Gear Type	GUMMY SHARK	SCHOOL SHARK	BIGHT REDFISH	WESTERN STRIPED GRUNTER	OCTOPUS	RAZOR FISH	KING SCALLOP	OTHER SHARK	RED MULLET	YELLOWTAIL KINGFISH	WHISKERY SHARK	BLUE MACKEREL	MUD COCKLE - OTHER	MUD COCKLE - YELLOW	MUD COCKLE - GREY	BROADNOSE SHARK	OTHER OR MIXED SPECIES	QUEEN SCALLOP	TUBEWORM	SEA URCHIN	SWEEP	FLATHEAD	BLOODWORM	SEA MULLET	JUMPER MULLET	MUSSEL	JACK MACKEREL	HAMMER HEAD SHARK	BLUE MORWONG	WOBBEGONG SHARK	DEEP SEA TREVALLA	SAMSONFISH
BAIT NET (5 CM)				3.6								0.5												3.7	0.4							
COCKLE RAKE													72.3	18.7	7.0											2.0						
CRAB LIFT NET (HOOP/DROP NETS)			0.1		0.1																											
CRAB POT																																
CRAB RAKE																																
DAB NET	0.6	0.8	0.1		0.0			0.0	0.0			0.1					0.2					0.1	5.7									
DROP LINE	45.4	9.9	11.4	0.2				1.2		0.1	1.0					0.4	0.0				0.0	0.1						0.3	0.2		1.0	1.0
FISH TRAP (INCL. OCEANJACKET TRAP)				0.9					0.0								0.0															
HAND						3.0													0.2	40.4						5.3						
HANDLINE	2.0	0.3	1.7	0.0				0.1	0.8	0.0	0.1	0.7				0.0	0.1				0.4	0.1					0.0	0.0	0.1	0.1		0.0
HAUL NET (FLOATING GAR NET)	0.0			1.6				0.0	0.2	0.4							0.2				0.1	0.1		0.2	0.0		0.0					
HAUL NET (SINKING AND FLOATING NET)	0.0			3.5				0.0	0.0	0.5							0.3					0.1					0.1					
HAUL NET (SINKING MESH NET)	0.0			0.9				0.1	0.0	2.5												0.1			0.2							
HAUL NET (SINKING MIXED MESH)	0.1			1.5				0.0	0.0	0.4		0.0					0.4					0.0		0.2	0.1		0.3					
LARGE MESH SET NET (> 15 CM)	1.9	0.5	0.9					0.2			1.7										0.1	0.0						0.5	1.0			
LONG LINE	12.9	2.3	0.8					0.6		0.0	0.5	0.0				0.5	0.1				0.0	0.2						0.1	0.1	0.1	0.1	0.0
OCTOPUS TRAP					100.0																											
OTHER (INCL. DIVING)							65.5											21.6		6.6		0.0										
POLES/ROD AND LINE	3.2	1.1	7.7	0.3				1.7	1.6	0.7	0.2	1.7					0.4				0.5	0.2					0.0	0.1	0.3			0.3
PURSE SEINE																																
RAZOR FISH TONGS						100.0																										
SALMON NET																																
SET GILL NET (5 CM)	0.0			0.3					0.3	0.1		0.0					0.2					0.4		2.5	3.5			0.0				
SPADE/FORK																			90.8				9.2									
SQUID JIG																																
TROLL LINE	0.5							1.1	0.0			0.6									0.0											

Table 1 continued: percent of average annual catch reported for the gear types of the Marine Scalefish Fishery from 2011–2020 that includes all other species reported in daily catch returns. Colours represent the percentage groups of average annual catch, green = >50%, yellow = 49.9 – 25%, orange = 24.9 – 10%, red = 9.99 – 1.1%, pink = 1 – 0.01%.

	All other species reported in MSF daily catch returns																																
Gear Type	**LING**	**BEACHWORM**	**GUMMY And SCHOOL SHARK**	**MORWONG**	**WEEDY WHITING**	**SCHOOL WHITING**	**WESTERN BLUE GROPER**	**SWALLOWTAIL**	**RED GURNARD**	**WAREHOU**	**GURNARD PERCH**	**SAW SHARK**	**BARRACOUTA**	**MAKO SHARK**	**SOUTHERN ROCK COD**	**KNIFE JAW**	**THRESHER SHARK**	**FLOUNDER**	**ELEPHANT SHARK**	**HARLEQUIN FISH**	**DUSKY MORWONG**	**LUDERICK**	**BOARFISH**	**ROCK CRAB**	**GOULDS SQUID**	**CONGER EEL**	**SHARK FINS**	**DRUMMER**	**SPIDERCRAB**	**SOUTHERN BLUEFIN TUNA**	**BLUE GRENADIER**	**SERGEANT BAKER**	**TAILOR**
BAIT NET (5 CM)					0.1																												
COCKLE RAKE																																	
CRAB LIFT NET (HOOP/DROP NETS)																								0.0									
CRAB POT																																	
CRAB RAKE																																	
DAB NET																					0.0												
DROP LINE	0.3		0.2	0.1				0.1							0.0																0.0		
FISH TRAP (INCL. OCEANJACKET TRAP)																0.0																	
HAND		16.7																															
HANDLINE			0.0	0.0	0.0	0.1		0.0		0.0			0.0		0.0																		
HAUL NET (FLOATING GAR NET)					0.0	0.0												0.0															
HAUL NET (SINKING AND FLOATING NET)					0.2													0.0															
HAUL NET (SINKING MESH NET)																																	
HAUL NET (SINKING MIXED MESH)					0.0					0.0																							
LARGE MESH SET NET (> 15 CM)							0.6																0.2										
LONG LINE	0.1		0.1	0.1			0.0		0.0		0.0	0.0		0.0	0.0	0.0	0.0																
OCTOPUS TRAP																																	
OTHER (INCL. DIVING)																					0.1												
POLES/ROD AND LINE	0.1			0.1	0.0	0.0		0.1					0.0			0.0														0.0			
PURSE SEINE																																	
RAZOR FISH TONGS																																	
SALMON NET																																	
SET GILL NET (5 CM)					0.1																	0.1											
SPADE/FORK																																	
SQUID JIG																																	
TROLL LINE													0.8																				

Table 2: Estimates of average actual effort and latent (scaled and maximum) effort for all gear types endorsed on MSF licenses for the period of 2011 – 2020 in the Marine Scalefish Fishery (MSF). % Scaled effort = the percentage of average actual effort compared to average scaled effort, % Max effort = the percentage of actual effort compared to average maximum potential effort.

Gear type	No. Devices in MSF	Actual Effort	% Scaled effort	Scaled effort	% Max effort	Max effort
Hauling nets	43	9540	222.6	4286	22.7	42004
Octopus traps	confidential	confidential	confidential	confidential	confidential	confidential
Longlines	1750	13215	7.6	174415	2.1	639188
Gill nets <15cm	142	1038	7.3	14153	2.0	51866
Sand crab pots	400	2890	7.2	39866	2.0	146100
Crab-hoop-drop-nets	2261	13397	5.9	225344	1.6	825830
Cockle rakes	224	738	3.3	22325	0.9	81816
Bait Spade-pump-fork	83	250	3.0	8272	0.8	30316
Droplines	2060	5540	2.7	205311	0.7	752415
Purse seine nets	confidential	confidential	confidential	confidential	confidential	confidential
Dab nets	658	1040	1.6	65580	0.4	240335
Fish traps	2384	3456	1.5	237603	0.4	870756
Bait net	27	25	0.9	2691	0.3	9862
Razorfish tongs	395	216	0.5	39368	0.1	144274
Large Mesh nets	107	26	0.2	10664	0.1	39082
Crab rakes	234	1	0.0	23322	0.0	85469
Mussel Dredges	23	0	0.0	2292	0.0	6940
Squid jig machines	confidential	confidential	confidential	confidential	confidential	confidential
Cockle nets	58	0	0.0	5781	0.0	21185
Fish spears	100	0	0.0	9967	0.0	36525

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Appendices

Hauling nets:

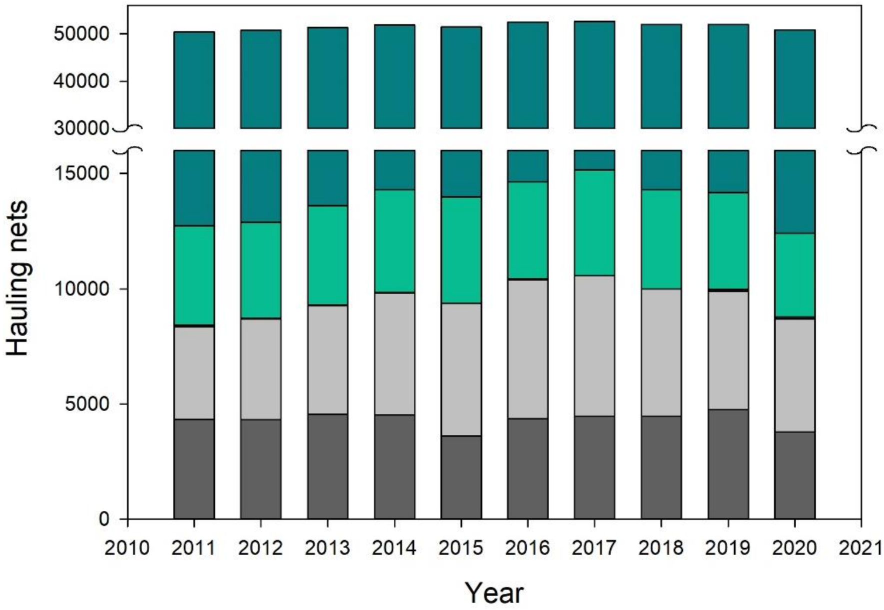


Figure 1. Estimates of latent and observed regional effort (fisher days * number of endorsed devices) for all types of hauling nets combined in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, dark green = maximum potential effort, light green = scaled potential effort.

Table 3: Catch species composition for 56 hauling net (floating and sinking) shots in Gulf St. Vincent and Spencer Gulf between September 2007 and August 2008 (Fowler et al. 2009).

	Gulf St. Vincent			**Spencer Gulf**			**Total**		
	No. captured	No. discarded	% discarded	No. captured	No. discarded	% discarded	No. captured	No. discarded	% discarded
Weeping toado	7601.9	7601.9	100.0	1617.5	1617.5	100.0	9219.4	9219.4	100.0
Spinytail leatherjacket	5560.7	5560.7	100.0	4430.8	3215.2	72.6	9991.5	8775.9	87.8
Southern garfish	12415.5	1832	14.8	11901.4	1703.9	14.3	24316.9	3535.9	14.5
Western striped grunter	701	701	100.0	3523.4	2680.9	76.1	4224.4	3381.9	80.1
King George whiting	643.6	232.1	36.1	1194	393	32.9	1837.6	625.1	34.0
Blue swimmer crab	121	118	97.5	491.5	490.5	99.8	612.5	608.5	99.3
Blue weed whiting	156	156	100.0	485.9	355.9	73.2	641.9	511.9	79.7
Snook	1139.7	288.8	25.3	247.1	117.1	47.4	1386.8	405.9	29.3
Prickly toadfish	2	2	100.0	351.1	351.1	100.0	353.1	353.1	100.0
Bridled leatherjacket	28.1	28.1	100.0	218.7	218.7	100.0	246.8	246.8	100.0
Australian herring	1368.5	54.4	4.0	1874.1	156.4	8.3	3242.6	210.8	6.5
Globefish	112.6	112.6	100.0	70.3	70.3	100.0	182.9	182.9	100.0
Soldier	142.3	142.3	100.0	3	3	100.0	145.3	145.3	100.0
Rough leatherjacket	43.1	43.1	100.0	67.6	67.6	100.0	110.7	110.7	100.0
Sixspine leatherjacket	7	3	42.9	218.5	105.6	48.3	225.5	108.6	48.2
Smooth toadfish	1	1	100.0	52.1	52.1	100.0	53.1	53.1	100.0
Southern fiddler ray				44.2	44.2	100.0	44.2	44.2	100.0
Western Australian salmon	458.4	7	1.5	112.3	33	29.4	570.7	40	7.0
Scarlet cardinalfish				30	30	100.0	30	30	100.0
Toothbrush leatherjacket	17.3	17.3	100.0	19.4	12.4	63.9	36.7	29.7	80.9
Yellowfin whiting	76.2	2	2.6	342.2	27	7.9	418.4	29	6.9
Old wife	1	1	100.0	22.5	22.5	100.0	23.5	23.5	100.0
Southern cardinalfish	8.3	8.3	100.0	13.4	13.4	100.0	21.7	21.7	100.0
Port Jackson shark	4.4	4.4	100.0	16.4	16.4	100.0	20.8	20.8	100.0
Estuary cobbler	13.1	13.1	100.0				13.1	13.1	100.0
Glover's anglerfish	13	13	100.0				13	13	100.0
Smooth stingray				6	6	100.0	6	6	100.0
Longray weed whiting	6	6	100.0				6	6	100.0
Greenback flounder				4	4	100.0	4	4	100.0
Western shovelnose ray				4	4	100.0	4	4	100.0
Red swimmer crab	3	3	100.0	1	1	100.0	4	4	100.0
Australian herring				6679.1	3	0.0	6679.1	3	0.0
Little weed whiting	2	2	100.0	1	1	100.0	3	3	100.0
Southern calamary	1532.9	2	0.1	1371.7	0	0.0	2904.6	2	0.1
Shaw's cowfish	1	1	100.0	1	1	100.0	2	2	100.0
Sandy sprat	1	1	100.0				1	1	100.0
Snapper				1	1	100.0	1	1	100.0
Tailor				1	1	100.0	1	1	100.0
Beaked salmon	1	1	100.0				1	1	100.0
Gummy shark				1	1	100.0	1	1	100.0
Southern crested weedfish				1	1	100.0	1	1	100.0
Southern banded wobbegong				1	1	100.0	1	1	100.0
Ornate cowfish				1	1	100.0	1	1	100.0
Red mullet	1	1	100.0	1	0	0.0	2	1	50.0
Black bream	2	0	0.0				2	0	0.0
Yelloweye mullet	104.6	0	0.0	4318.6	0	0.0	4423.2	0	0.0
Silver trevally	5.6	0	0.0				5.6	0	0.0
Bronze whaler				1	0	0.0	1	0	0.0
Southern bluespotted flathead				4.6	0	0.0	4.6	0	0.0
Southern sand flathead				1	0	0.0	1	0	0.0
Southern eagle ray	5.7	0	0.0	50.4	0	0.0	56.1	0	0.0

Gill nets:

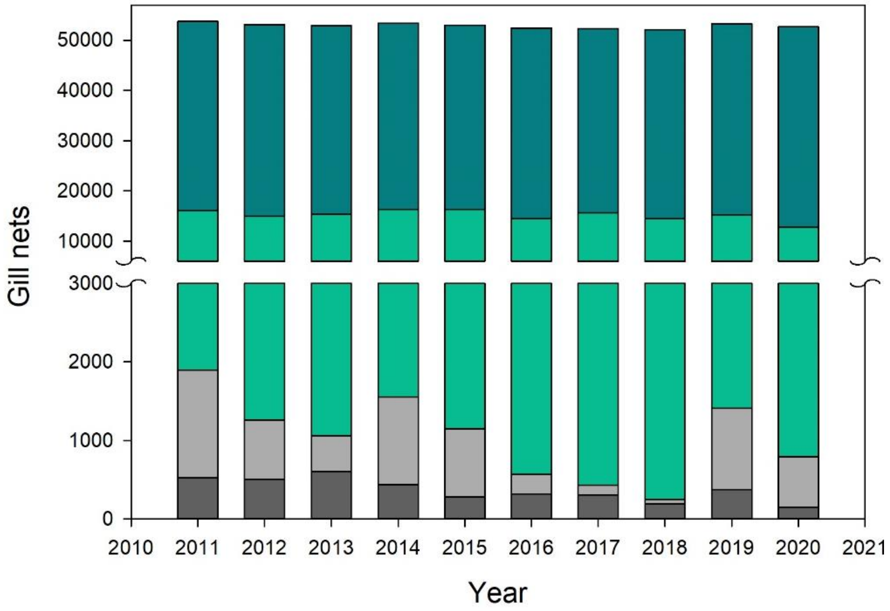


Figure 2. Estimates of latent and observed effort (fisher days * number of endorsed devices) for set gill nets in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, dark green = maximum potential effort, light green = scaled potential effort.

Large mesh set net:

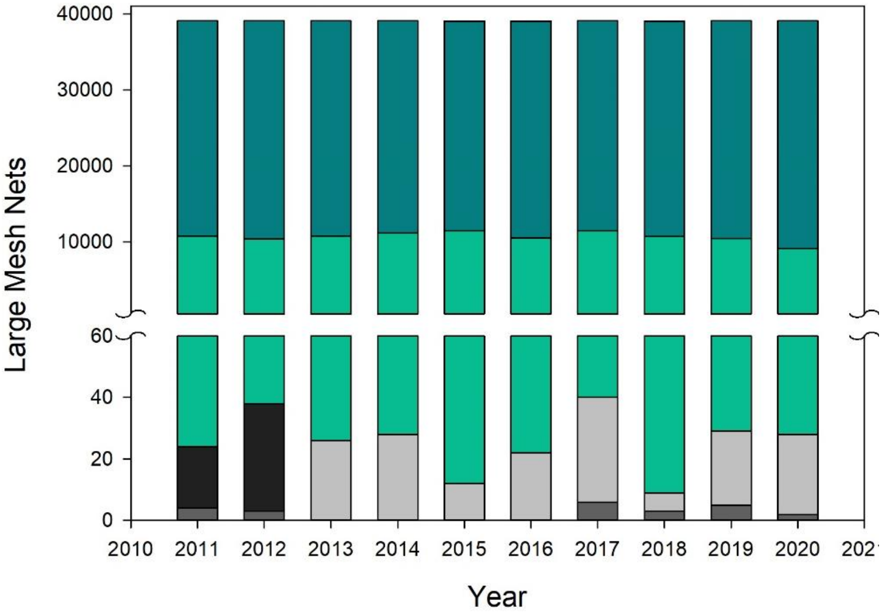


Figure 3. Estimates of latent and observed effort (fisher days * number of endorsed devices) for large mesh set nets in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, dark green = maximum potential effort, light green = scaled potential effort.

Longlines:

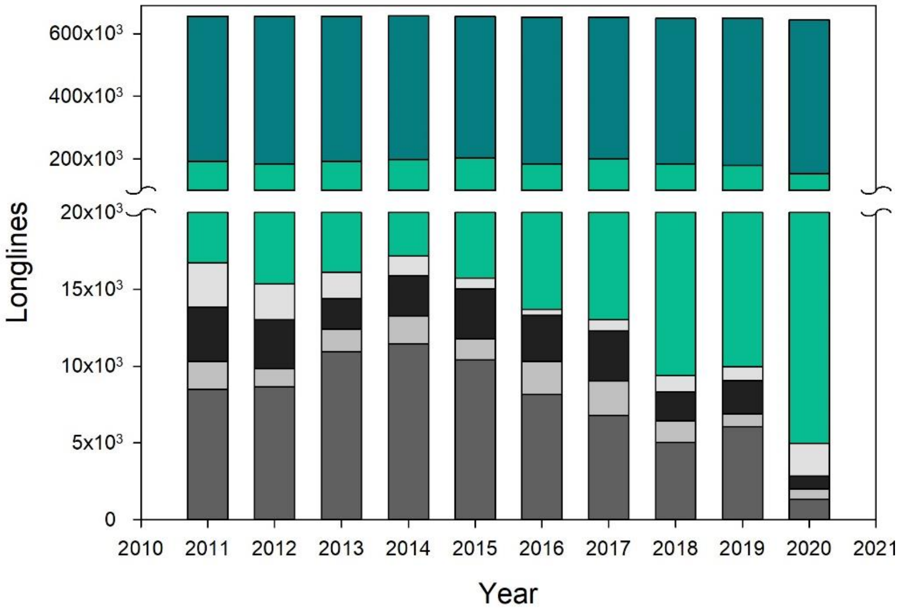
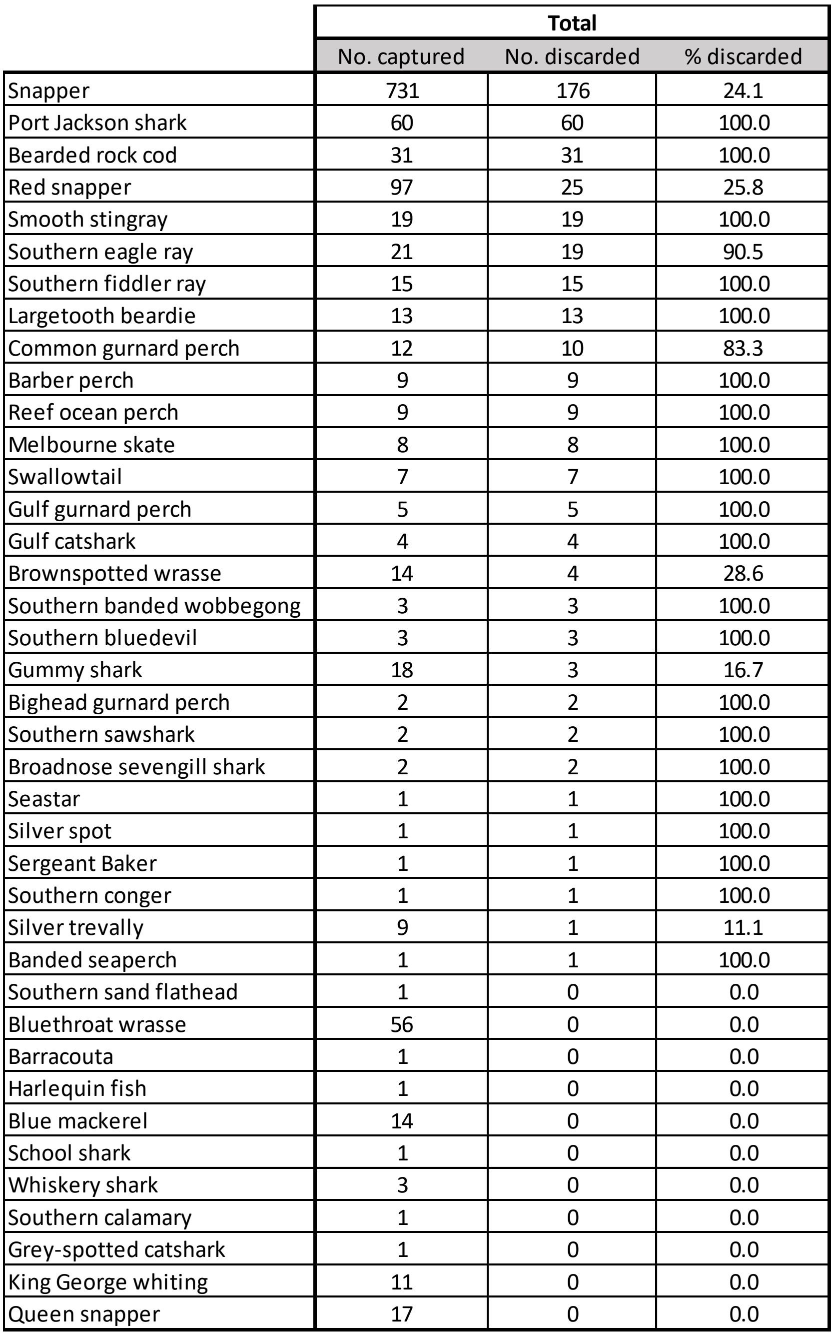


Figure 4. Estimates of latent and observed effort (fisher days * number of endorsed devices) for longlines in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, light grey = South East, dark green = maximum potential effort, light green = scaled potential effort.

Table 4: Catch species composition for 14 longline days (a total of 62 shots) (small and large hook) in Gulf St. Vincent and Spencer Gulf between September 2007 and August 2008 (Fowler et al. 2009).



	Total		
	No. captured	No. discarded	% discarded
Snapper	731	176	24.1
Port Jackson shark	60	60	100.0
Bearded rock cod	31	31	100.0
Red snapper	97	25	25.8
Smooth stingray	19	19	100.0
Southern eagle ray	21	19	90.5
Southern fiddler ray	15	15	100.0
Largetooth beardie	13	13	100.0
Common gurnard perch	12	10	83.3
Barber perch	9	9	100.0
Reef ocean perch	9	9	100.0
Melbourne skate	8	8	100.0
Swallowtail	7	7	100.0
Gulf gurnard perch	5	5	100.0
Gulf catshark	4	4	100.0
Brownspotted wrasse	14	4	28.6
Southern banded wobbegong	3	3	100.0
Southern bluedevil	3	3	100.0
Gummy shark	18	3	16.7
Bighead gurnard perch	2	2	100.0
Southern sawshark	2	2	100.0
Broadnose sevengill shark	2	2	100.0
Seastar	1	1	100.0
Silver spot	1	1	100.0
Sergeant Baker	1	1	100.0
Southern conger	1	1	100.0
Silver trevally	9	1	11.1
Banded seaperch	1	1	100.0
Southern sand flathead	1	0	0.0
Bluethroat wrasse	56	0	0.0
Barracouta	1	0	0.0
Harlequin fish	1	0	0.0
Blue mackerel	14	0	0.0
School shark	1	0	0.0
Whiskery shark	3	0	0.0
Southern calamary	1	0	0.0
Grey-spotted catshark	1	0	0.0
King George whiting	11	0	0.0
Queen snapper	17	0	0.0

Droplines:

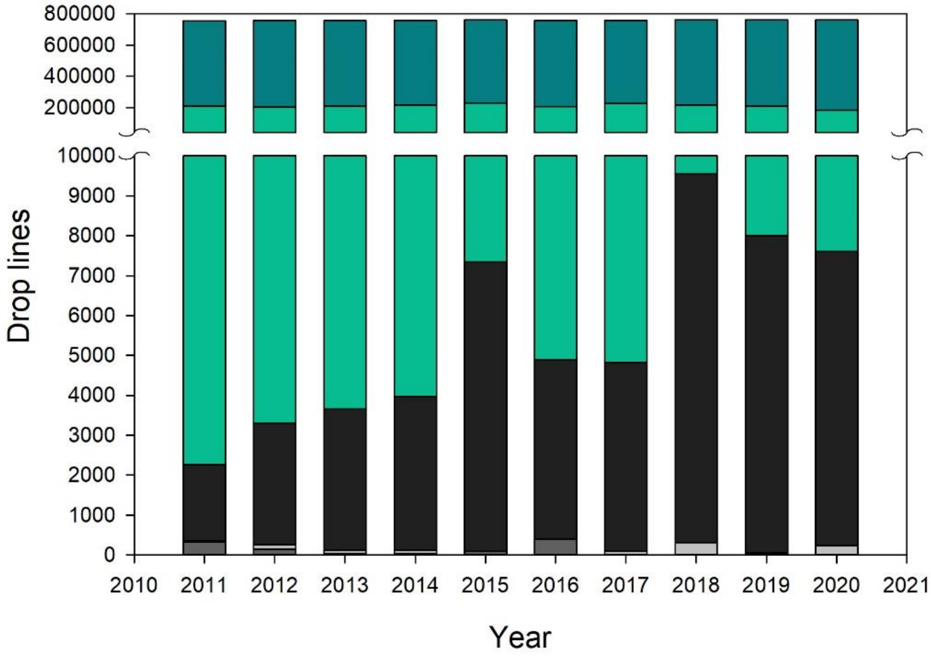


Figure 5. Estimates of latent and observed effort (fisher days * number of endorsed devices) for droplines in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, light grey = South East, dark green = maximum potential effort, light green = scaled potential effort.

Fish traps:

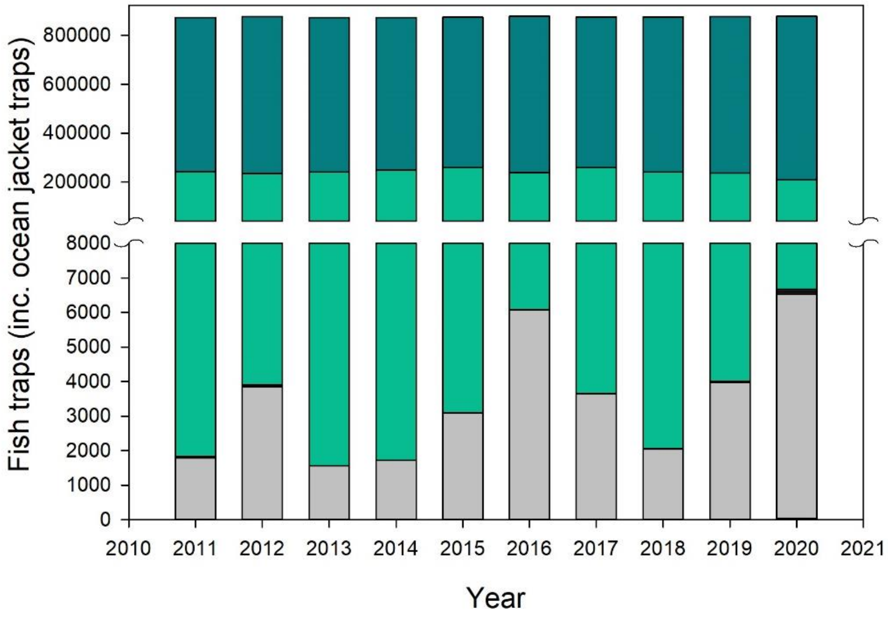


Figure 6. Estimates of latent and observed effort (fisher days * number of endorsed devices) for all fish traps, including ocean jacket traps in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, light grey = South East, dark green = maximum potential effort, light green = scaled potential effort.

Dab nets:

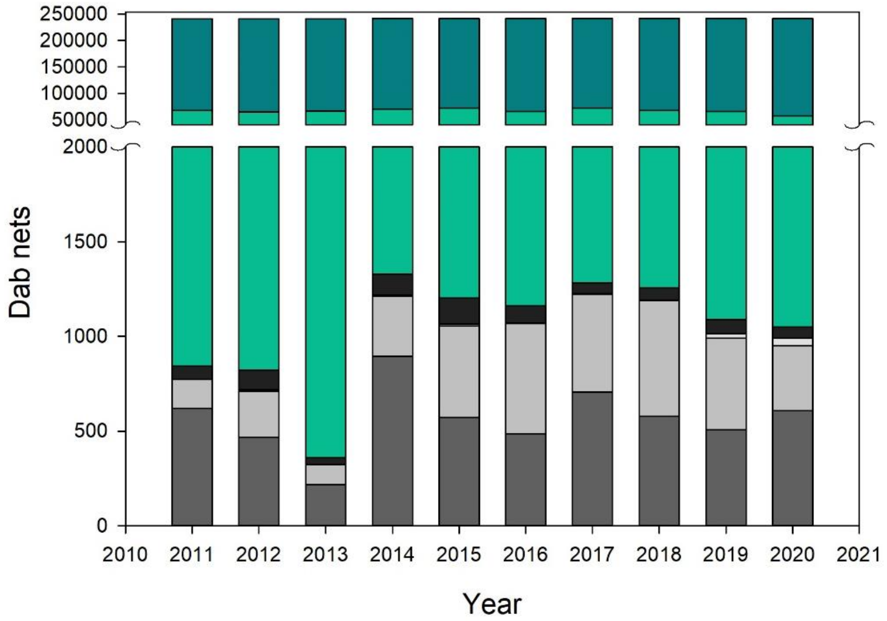


Figure 7. Estimates of latent and observed effort (fisher days * number of endorsed devices) for dab nets in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, light grey = South East, dark green = maximum potential effort, light green = scaled potential effort.

Crab catching devices:

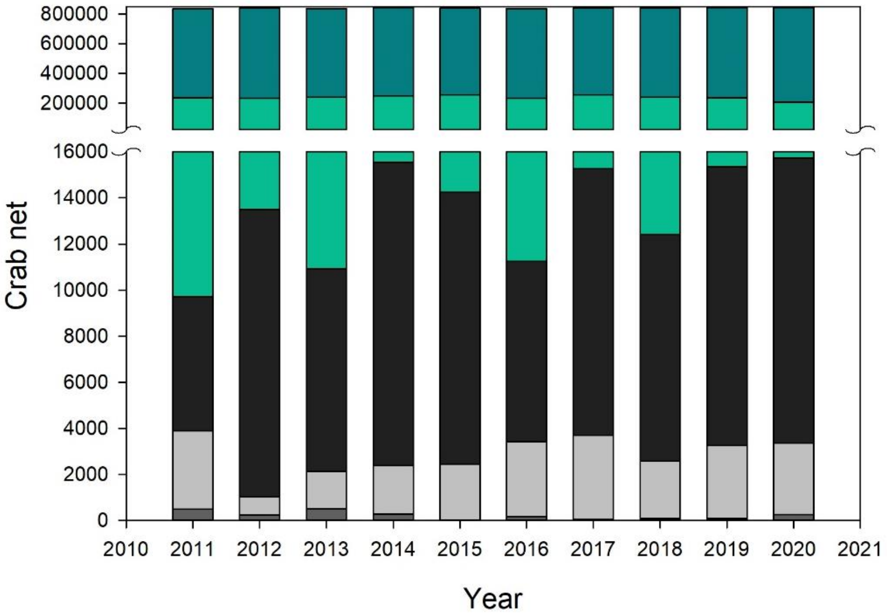


Figure 8. Estimates of latent and observed effort (fisher days * number of endorsed devices) for the combined crab fishing devices of crab nets, hoop nets and drop nets in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, dark green = maximum potential effort, light green = scaled potential effort.

Crab rakes:

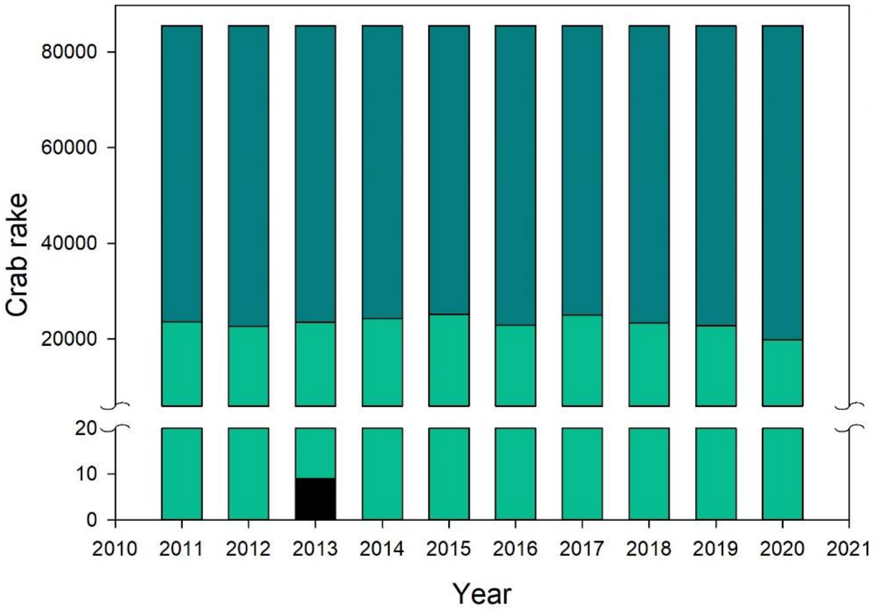


Figure 9. Estimates of latent and observed effort (fisher days * number of endorsed devices) for crab rakes in the MSF for the period of 2011–2020. Black = West coast, dark green = maximum potential effort, light green = scaled potential effort.

Sand crab pots:

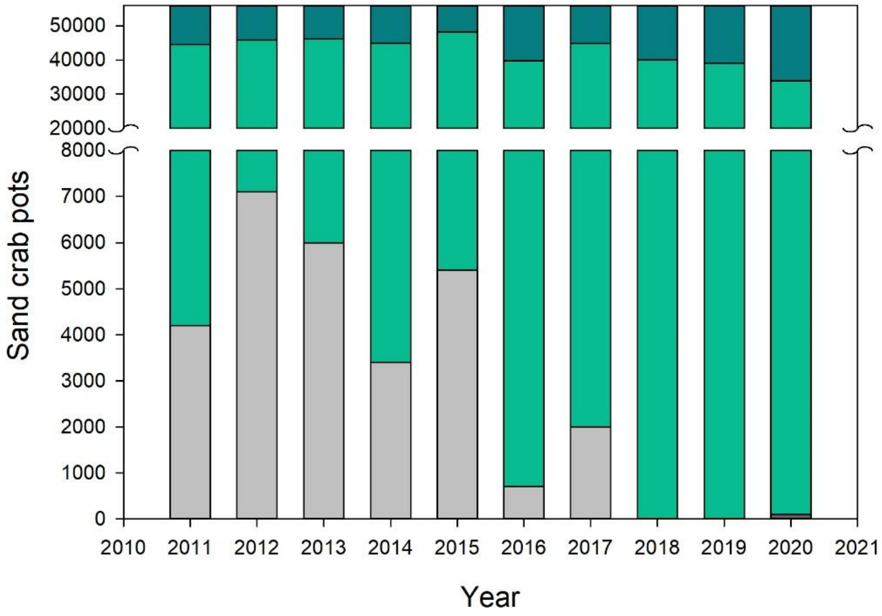


Figure 10. Estimates of latent and observed effort (fisher days * number of endorsed devices) for sand crab pots in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, dark green = maximum potential effort, light green = scaled potential effort.

Bait nets:

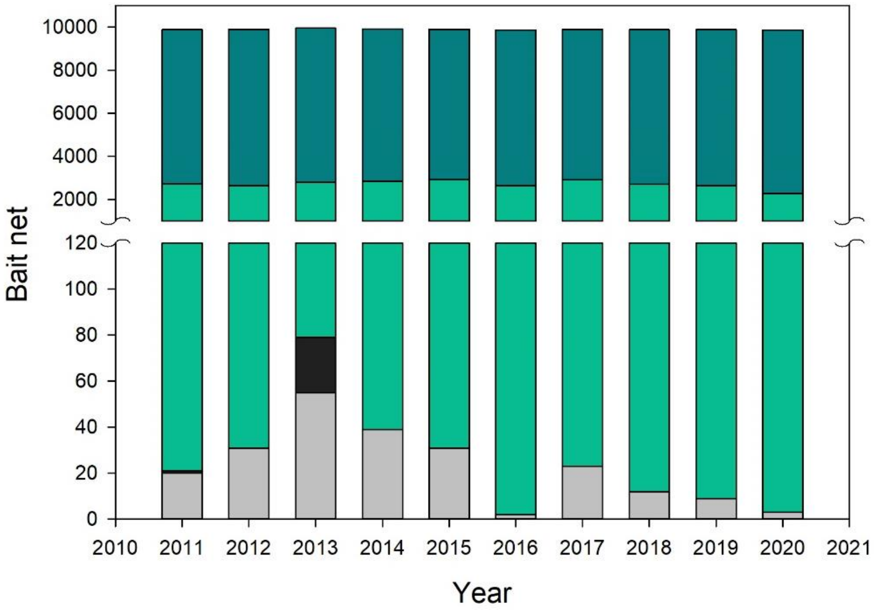


Figure 13. Estimates of latent and observed effort (fisher days * number of endorsed devices) for bait nets in the MSF for the period of 2011–2020. Mid grey = Spencer Gulf, black = West Coast, dark green = maximum potential effort, light green = scaled potential effort.

Bait fishing:

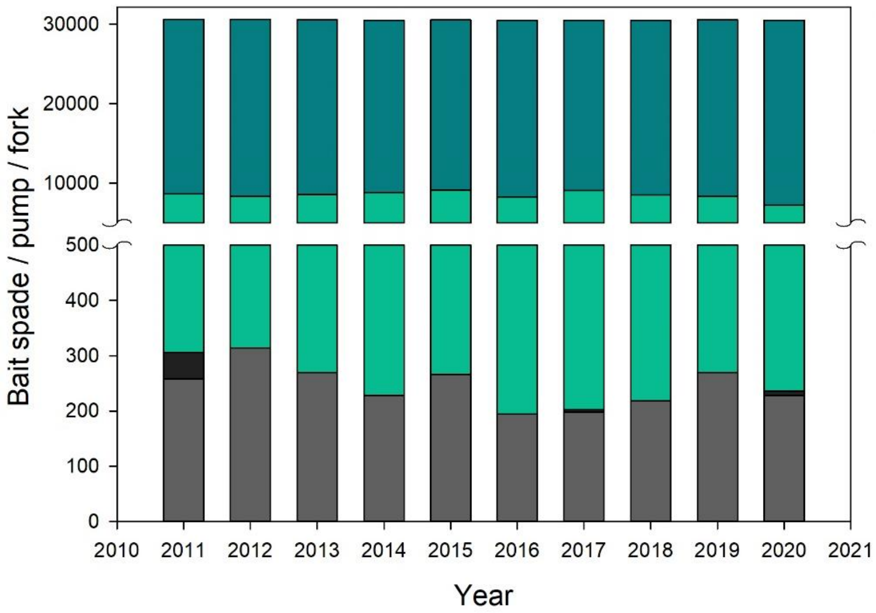


Figure 14. Estimates of latent and observed effort (fisher days * number of endorsed devices) for hand operated bait fishing methods of bait spade, bait pump and bait fork in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, black = West Coast, dark green = maximum potential effort, light green = scaled potential effort.

Razorfish tongs:

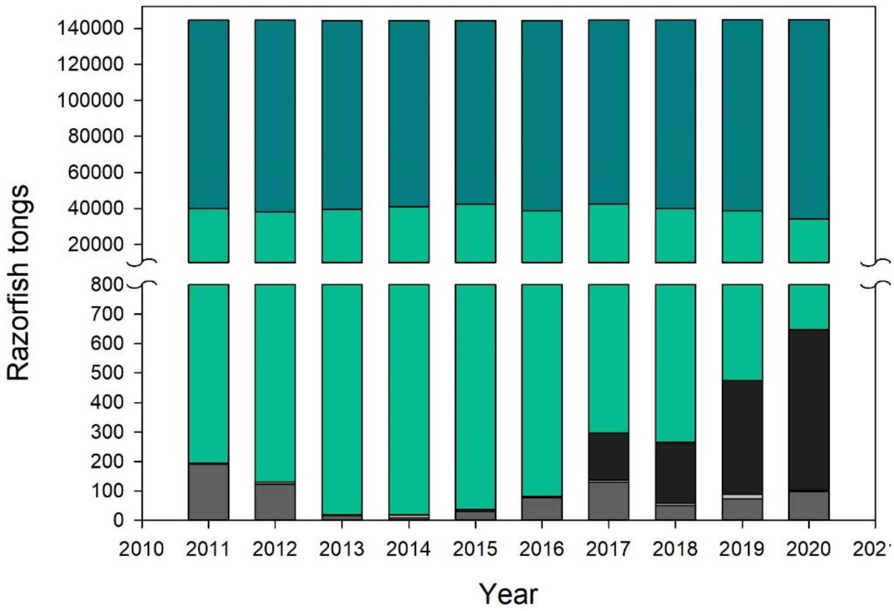


Figure 14 15. Estimates of latent and observed effort (fisher days * number of endorsed devices) for razorfish tongs in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West Coast, dark green = maximum potential effort, light green = scaled potential effort.

Cockle rake

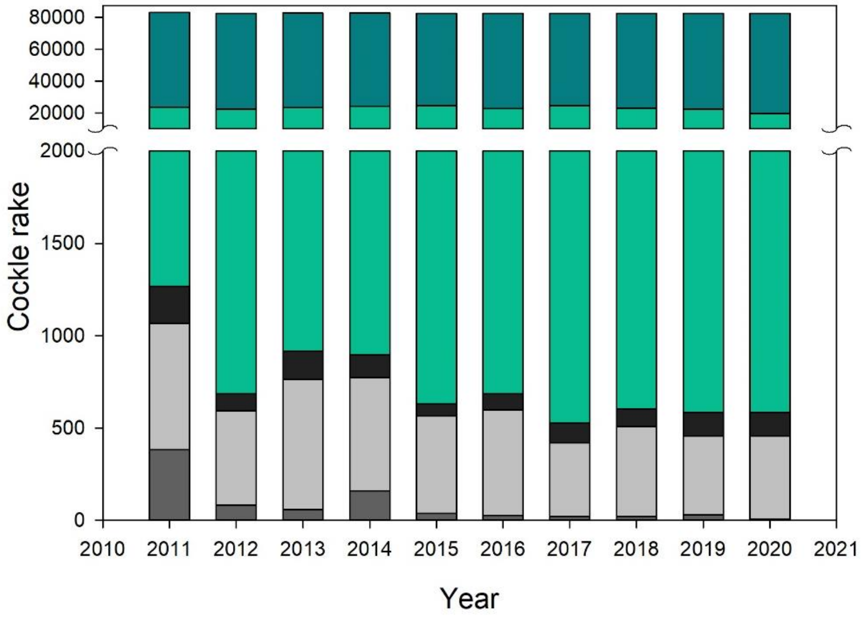


Figure 16. Estimates of latent and observed effort (fisher days * number of endorsed devices) for cockle rakes in the MSF for the period of 2011–2020. Dark grey = Gulf St. Vincent, mid grey = Spencer Gulf, black = West coast, light grey = South East, dark green = maximum potential effort, light green = scaled potential effort.

Mussel dredging:

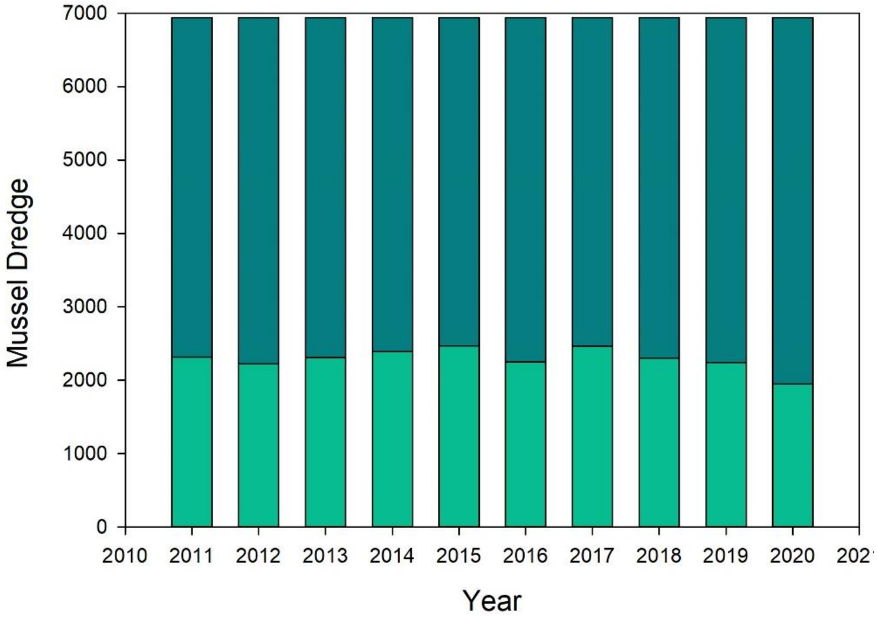


Figure 17. Estimates of latent effort (fisher days * number of endorsed devices) for mussel dredging in the MSF for the period of 2011–2020. Dark green = maximum potential effort, light green = scaled potential effort.

Cockle nets:

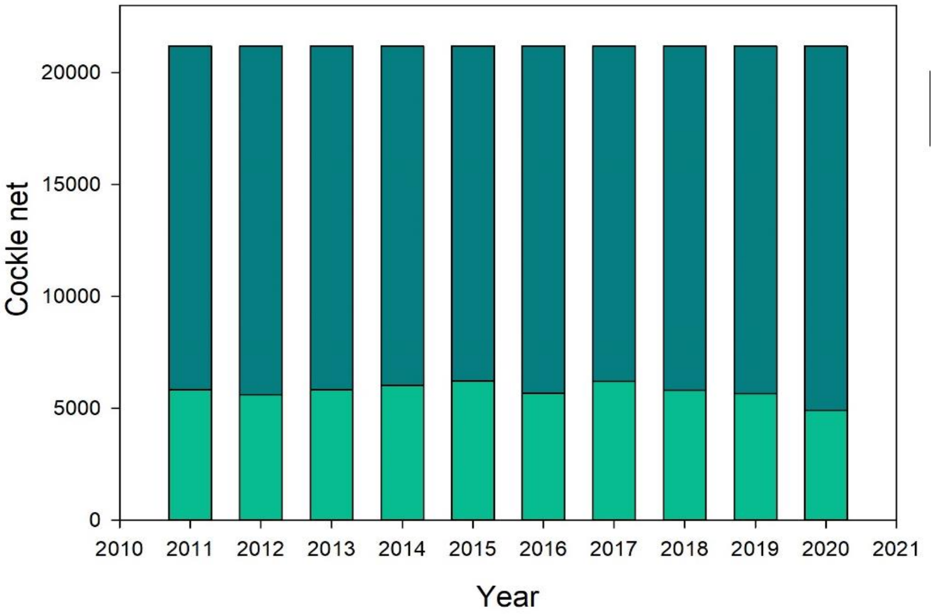


Figure 18. Estimates of latent effort (fisher days * number of endorsed devices) for cockle nets in the MSF for the period of 2011–2020. Dark green = maximum potential effort, light green = scaled potential effort.

Fish spears:

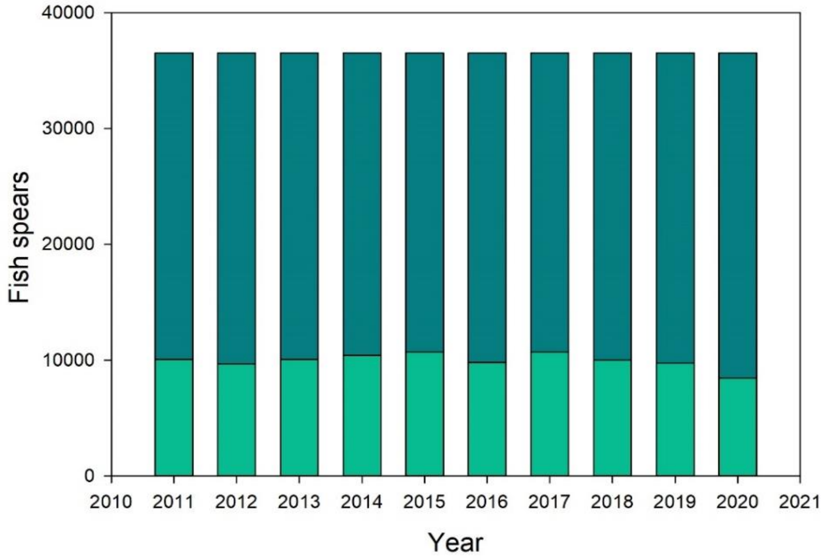


Figure 19. Estimates of latent effort (fisher days * number of endorsed devices) for fish spears in the MSF for the period of 2011–2020. Dark green = maximum potential effort, light green = scaled potential effort.

Doc 14

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **A/PROF. ADRIAN LINNANE AND A/PROF. RICHARD MCGARVEY (SARDI AQUATIC SCIENCES)**

SUBJECT: **NORTHERN ZONE ROCK LOBSTER FISHERY QUOTA CARRY-OVER**

DATE: **5 AUGUST 2021**

KEY ISSUES

- There has been a significant disruption in the market export of Southern Rock Lobster to China during the 2020/21 fishing season.
- PIRSA Fisheries and Aquaculture have requested advice on the biological sustainability of quota carry-over from 2020/21 in both the Inner and Outer Regions of the Northern Zone rock lobster fishery (NZRLF) into the 2021/22 fishing season.
- Southern Rock Lobster are a long-lived species with low levels of natural mortality (10% per annum in current fishery modelling estimates). In a carry-over event, stock biomass reduction due to natural mortality would likely be offset by an increase in biomass due to growth of uncaught lobsters, and greater egg production over winter by uncaught female lobsters.
- Negligible impact from carry-over was confirmed in projection modelling of carry-over scenarios within the NZRLF Inner Region presented in a previous Advice Note (5/2/21). Insufficient data are available to undertake projection modelling for the Outer Region. However, it is reasonable to assume that the same outcomes from the Inner Region of minimal impact can be applied.
- The NZRLF fishery is classified as ‘Sustainable’. In the Inner Region, as of 30 June 2021, 198 t had been harvested (75% of TACC), with 65 t of the TACC uncaught. The impact on the Inner Region stock of allowing the uncaught quota to be carried over to the 2021/22 season and the risk to a change in stock status classification from ‘sustainable’, are considered to be low under a 100% quota carry-over option. This reflects increasing catch rate trends within the region with the 2020/21 estimate the highest since spatial management was implemented in 2015.
- In the Outer Region, as of 30 June 2021, 22 t has been harvested (36% of TACC) with 39 t of the TACC uncaught. The total amount of potential carry-over to 2021/22 is 54 t (i.e. 39 t from 2020/21 and 50% of the 2019/20 uncaught quota equating to 15 t). The impact on the Outer Region of allowing the uncaught quota to be carried over to the 2021/22 season and the risk to a change in stock status classification from ‘sustainable’, are low under a 100% quota carry-over option. This reflects low exploitation rates over the last two seasons due to reduced catch levels which has resulted in an 18% increase in catch rate over this period.

BACKGROUND

There has been a significant disruption in the market export of Southern Rock Lobster to China during the 2020/21 fishing season. PIRSA Fisheries and Aquaculture have requested advice on the biological sustainability of quota carry-over from 2020/21 in both the Inner and Outer Regions of the Northern Zone (NZ) rock lobster fishery into the 2021/22 fishing season. Specifically, advice is requested on the potential impacts of:

(i) Inner Region – 100% carry-over (all uncaught quota for the NZRLF Inner Region from 2020/21 be carried over to relevant licence holders in the 2021/22 fishing season).

(ii) Outer Region – 100% carry-over (all uncaught quota for the NZRLF Outer Region from 2020/21 be carried over to relevant licence holders for the 2021/22 fishing season; including previously agreed 50% of the 2019/20 uncaught quota (i.e. 15 tonnes) be carried over to 2021/22).

(iii) Outer Region – proposed industry step-down approach to carry-over (2020/21 – maximum 100% uncaught quota; 2021/22 – maximum 50%; 2022/23 – maximum 10%).

Southern Rock Lobster are a long-lived species with low levels of natural mortality (10% per annum in current fishery modelling estimates). In a quota carry-over event, lobster stock left in the water and harvested at a later date experience three primary population processes: (1) stock biomass reduction due to natural mortality, is likely offset by (2) an increase in biomass due to growth of uncaught lobsters, and (3) greater egg production over winter by uncaught female lobsters.

RESULTS/DISCUSSION

Inner Region

The NZRLF Inner Region season extends from 1 November to 31 May (noting that it was extended to 31 October in both 2019/20 and 2020/21 seasons on a provisional basis). The Total Allowable Commercial Catch (TACC) in the Inner Region for the 2020/21 season is 263 t (this includes a 13 t carry-over from 2019/20). As of 30 June 2021, 198 t had been harvested (75% of TACC), with 65 t of the TACC uncaught (Table 1).

Under the National Fishery Status Reporting Framework (Stewardson et al. 2018), the NZRLF is currently classified as '**Sustainable**' (Linnane et al. 2021). This classification is supported by the following fishery information from the 2019/20 season: (i) the TACC is constraining catch; (ii) catch and effort are currently at, or among, historically low levels; (iii) biomass levels are increasing and exploitation rates have reduced substantially and (iv) catch per unit effort (CPUE: legal size kg/potlift) levels are increasing.

Spatial management has been in place in the NZRLF since 2015 with 84% of the allocated TACC in the Inner Region. While classifications are not assigned spatially, abundance trends over the last six seasons are positive (Figure 1). Specifically, CPUE (the primary fishery indicator of stock abundance) has continued to increase within the Inner Region with the 2020/21 estimate of 1.06 kg/potlift the highest since spatial management was implemented.

In addition, a previous Advice Note (5/2/21) detailed the outcomes from projection modelling of carry-over scenarios with the NZRLF Inner Region and concluded that the impact of carry-over on the biomass trajectory for subsequent years was negligible.

Based on this information, the impact on the Inner Region stock of allowing the uncaught quota to be carried over to the 2021/22 season and the risk to a change in stock status classification from 'sustainable', are considered to be low under a 100% quota carry-over option.

Outer Region

The NZRLF Outer Region season extends from 1 November to 31 October. The TACC in the NZRLF for the 2020/21 season is 61 t (this includes 15 t carry-over from 2019/20). As of 30 June 2021, 22 t has been harvested (36% of TACC) with 39 t of the TACC uncaught (Table 1).

The total amount of potential carry-over to 2021/22 is 54 t (i.e. 39 t from 2020/21 and 50% of the 2019/20 uncaught quota equating to 15 t). Catch rates in the region initially decreased from > 1 kg/potlift between 2015/16 and 2017/18 before stabilising at approximately 0.8 kg/potlift for three seasons (Figure 1). In 2020/21, CPUE increased by 18% to 0.92 kg/potlift which is likely to reflect low levels of exploitation in the Outer Region over the last two seasons (17 t in 2019/20 and 22 t in 2020/21) (Table 1).

Insufficient data are available to undertake projection modelling for the Outer Region. However, it is reasonable to assume that the same outcomes from the Inner Region could be applied in terms of negligible impact. In addition, the new Management Plan for the NZRLF (PIRSA 2021), details region-specific harvest strategy decision rules. If catch rates were to decrease as a result of carry-over, TACCs within the region would be adjusted accordingly.

Consequently, projection modelling outcomes from the Inner Region, combined with recent increases in CPUE and low levels of exploitation, indicates the impact on the Outer Region of allowing the uncaught quota to be carried over to the 2021/22 season and the risk to a change in stock status classification from ‘sustainable’, are considered to be low under a 100% quota carry-over option. This also applies to the industry step-down proposal of 50% carry-over from 2021/22 and 10% carry-over from 2022/23 for the Outer Region.

Dr. Mike Steer
Research Director, Aquatic Sciences

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Stewardson, C., Andrews, J., Ashby, C., Haddon, M., Hartmann, K., Hone, P., Horvat, P., Klemke, J., Mayfield, S., Roelofs, A., Sainsbury, K., Saunders, T., Stewart, J., Nicol, S. and Wise, B. (2018). Status of Australian Fish Stocks reports 2018. Fisheries Research and Development Corporation, Canberra.

Table 1. Commercial catch, effort and CPUE statistics for the NZRLF sub-regions. Catch and effort based on data from Nov-Oct. (2020 Nov-June). CPUE estimates for Inner and Outer Regions based on data from Nov-April and Nov-May respectively.

Inner sub-region					
Season	Catch (t)	Effort (potlifts)	CPUE (kg/potlift)	TACC (t)	TACC Uncaught (t)
2015	301	378,667	0.80	300	0
2016	284	382,007	0.74	300	16
2017	249	319,290	0.78	250	0.83
2018	249	277,843	0.90	250	0.35
2019	237	281,008	0.87	250	13
2020	198	192,276	1.06	263	65
Outer sub-region					
Season	Catch (t)	Effort (potlifts)	CPUE (kg/potlift)	TACC (t)	TACC Uncaught (t)
2015	47	59,148	1.04	60	13
2016	36	55,819	1.01	60	24
2017	52	70,481	0.79	60	8
2018	41	52,930	0.83	46	5
2019	17	23,045	0.78	46	29
2020	22	24,082	0.92	61	39

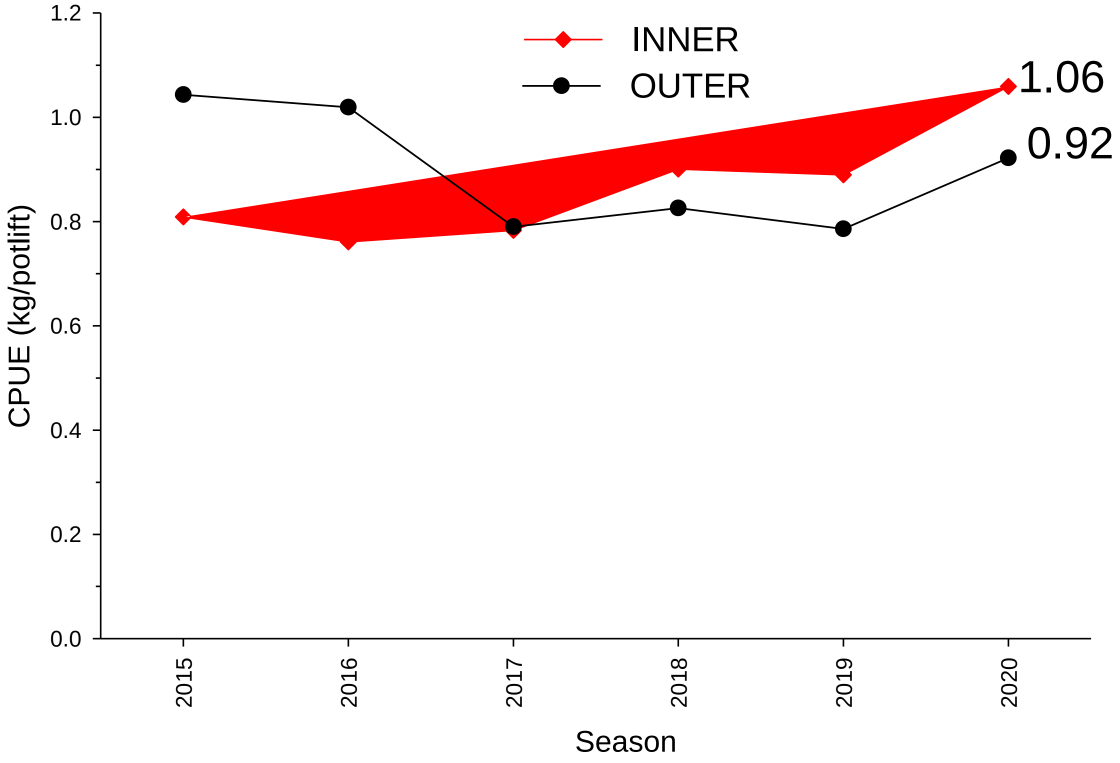

Figure 1. Catch Per Unit Effort (CPUE) trends for the Inner and Outer Regions of the NZRLF from 2015-2020.

Doc 15

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR GREG FERGUSON (RESEARCH SCIENTIST, SARDI AQUATIC SCIENCES)**

SUBJECT: **2020/21 ESTIMATES OF BIOLOGICAL PERFORMANCE INDICATORS FOR THE HARVEST STRATEGY OF THE LAKES AND COORONG FISHERY FOR PIPI *DONAX DELTOIDES***

DATE: **7 MAY 2021**

KEY ISSUES:

- This advice note provides estimates of two biological performance indicators (PIs) used in the harvest strategy to inform setting the annual total allowable commercial catch (TACC) for the Lakes and Coorong Fishery (LCF) for Pipi for the 2021/22 fishing season.
- In 2020/21, the estimate of the primary PI, fishery-independent mean annual relative biomass, was 8.9 kg/4.5 m^2. This was 1% below the trigger reference point of 9 kg/4.5 m^2, and 17% below the estimate of 10.8 kg/4.5 m^2 from the previous year.
- For the secondary PI, presence/absence of pre-recruits, pre-recruits were present in November 2021 (58%). Pre-recruits are considered to be present when they comprise >30% of the size frequency distribution.
- Interactions with non-target species were infrequent and limited to three species. The three species were Flathead pygmy stargazer, Ocean sand crab and Greenback flounder.

BACKGROUND:

The second harvest strategy for the LCF for Pipi was developed in 2015/16 and outlines the process for setting the annual TACC (PIRSA 2016; Appendix A). A third draft harvest strategy is currently under review and is due for completion in June 2021 (Appendix A).

The biological performance indicators (PIs) used in the harvest strategy are: (i) fishery-independent mean annual relative harvestable biomass (primary PI), and (ii) presence/absence of pre-recruits in size frequency distributions (secondary PI) with the detailed methods used to provide estimates of these PIs described in Ward et al. (2010), Ferguson and Ward (2014) and Ferguson et al. (2015, 2021).

Uncertainty around fishery-dependent catch per unit of effort (CPUE) as an index of abundance for Pipi led to development of mean relative harvestable biomass based on FIS from 2007/08 (Ward et al. 2010; Ferguson et al. 2015). Each annual estimate of mean harvestable relative biomass is based on the combined results of three sub-surveys (pre-, mid-, and post-season). In each sub-survey, fishers use rakes (44 mm mesh) to harvest Pipi from transects (4.5 m^2) located at 2 km intervals along the ocean beach on Younghusband Peninsula from the mouth of the Murray River to a point 60 km to the south-east. Each transect is sampled twice in each sub-survey. The annual estimate of relative biomass is the mean of the weights from all transects, across the entire fishing ground, from the three sub-surveys in that year (n=180).

Each annual estimate of the presence/absence of pre-recruits in size frequency distributions is based on sampling in November, with a subsequent estimate from sampling in February during those years when recruitment occurs later. Pipi are collected using a standardised research rake (10 mm mesh) from the same transect locations used to estimate mean annual relative biomass with data from all transects pooled (n~1,000). In the harvest strategy, pre-recruits (<35 mm) are considered to be present if their contribution is greater than 30% of the overall size frequency distribution during the November sub-survey (PIRSA 2016).

This advice note provides estimates of the biological PIs: (i) mean annual relative harvestable biomass; and (ii) presence/absence of pre-recruits. Estimates of these PIs from 2020/21 will inform setting the TACC for the 2021/22 Pipi fishing season. A summary of non-targeted species interactions is also provided.

DISCUSSION:

The overall objective of the Pipi harvest strategy is to ensure long-term sustainability of the fishery (PIRSA 2016). The harvest strategy aims to maintain mean annual relative biomass of Pipi above a target reference point of 11 kg/4.5 m^2 and not less than the trigger reference point of 9 kg/4.5 m^2 (PIRSA 2016; Appendix A).

In 2020/21, the estimate of the primary PI, fishery-independent mean annual relative harvestable biomass, was 8.9 kg/4.5 m^2 which was 1% below the trigger reference point of 9 kg/4.5 m^2 and 17% below the estimate of 10.8 kg/4.5 m^2 from the previous year (Table 1, Figure 1). Among three sub-surveys in 2020/21, the highest value of 10.5 kg/4.5 m^2 occurred in the pre-season survey with lower values of 7.9 kg/4.5 m^2 and 8.4 kg/4.5 m^2 observed in the mid- and post-season surveys, respectively (Figure 2).

For the secondary biological PI, presence/absence of pre-recruits, pre-recruits were present in 2020/21 and contributed 58% in numbers to the size frequency distribution from the November sub-survey (Figure 3). Pre-recruits in the north-western third (Section A, 0 to <20 km; 27%) of the fishing ground made a greater contribution to the overall size distribution, compared to the central (Section B, 20 to <40 km; 14.5%) and south-western (Section C, 40 to <60 km; 16.5%) sections.

Infrequent interactions between fishing rakes and three non-target species were observed during FIS: Flathead pygmy stargazer (*Lesueurina platycephala*), Ocean sand crab (*Ovalipes australiensis*) and Greenback flounder (*Rhomposolea tapirina*). Observed numbers were low (Appendix B) with individuals returned to the water along with undersized Pipi.

Dr Mike Steer

A/Research Director, Aquatic Sciences

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Table 1. Estimates of fishery-independent mean ±se annual relative biomass of Pipi from 2007/08 to 2020/21.

Year	Relative biomass (kg/4.5m^2)	se
2007/08	5.9	0.33
2008/09	4.0	0.34
2009/10	10.7	0.65
2010/11	9.7	0.51
2011/12	13.2	0.81
2012/13	12.4	0.82
2013/14	10.3	0.69
2014/15	12.3	0.61
2015/16	20.3	1.13
2016/17	21.5	1.43
2017/18	19.1	1.11
2018/19	12.6	1.08
2019/20	10.8	0.89
2020/21	8.9	0.61

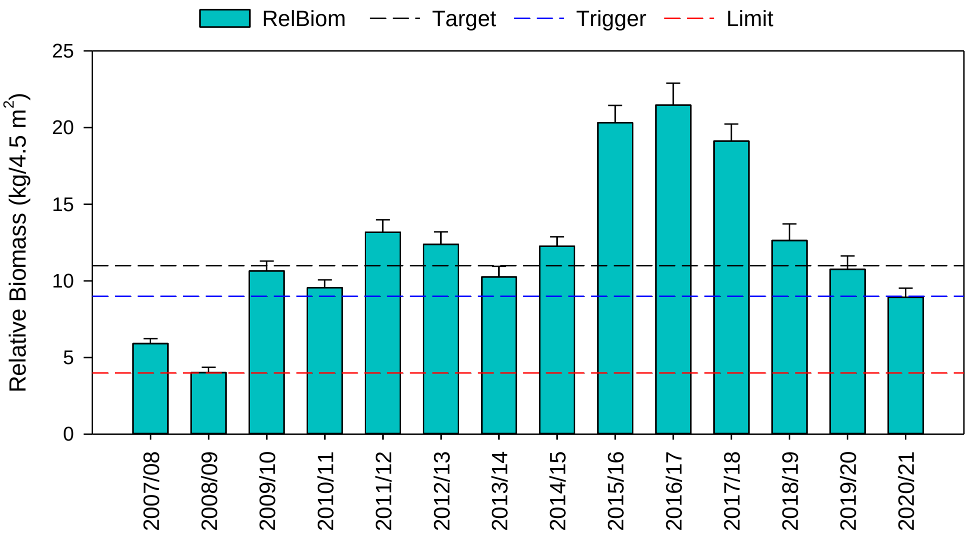

Figure 1. Estimates of fishery-independent mean annual relative biomass (± se) of Pipi from 2007/08 to 2020/21 showing target, trigger and limit reference points. The harvest strategy aims to maintain relative biomass above a target of 11 kg/4.5 m² (black dashes) and not less than the trigger reference point of 9 kg/4.5 m² (blue dashes). The lower limit reference point (red dashes) represents a historically low mean annual relative biomass of 4 kg/4.5 m² below which there may be risk of recruitment overfishing.

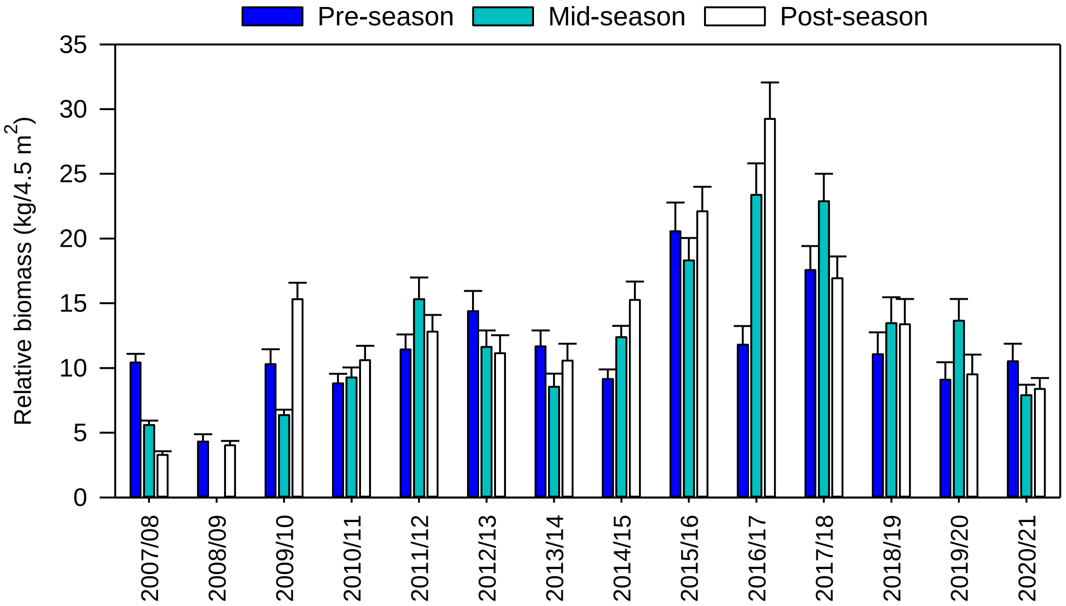

Figure 2. Intra-annual trends in estimates of mean annual relative biomass (±se) of Pipi on Younghusband Peninsula from fishery-independent surveys during 2007/08 to 2020/21.

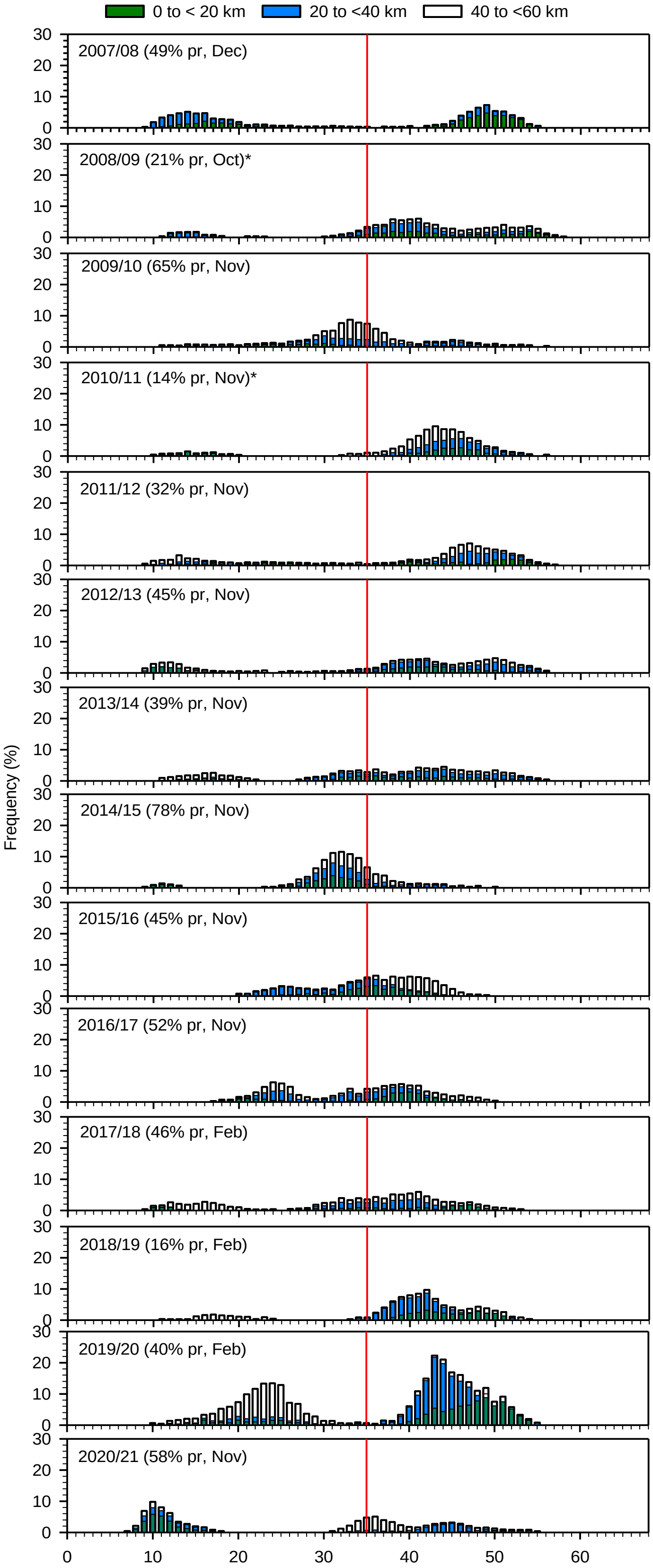

Figure 3. Estimates of the secondary biological performance indicator: presence/absence of pre-recruits (pr) during November from 2007/08 to 2020/21 and in February 2018, 2019, and 2020. Vertical red line represents legal minimum size of 35 mm.

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Ward, T. M., G. Ferguson, N. Payne and D. Gorman (2010) Effectiveness of fishery-independent surveys for monitoring the stock status of pipi (*Donax deltoides*) on the Younghusband Peninsula, South Australia. South Australian Research and Development Institute (Aquatic Sciences), SARDI Research Report Series 504, Report No. F2009/000824-1. Adelaide, 35 pp.

APPENDIX A - Summary of current and draft proposed harvest strategies for Pipi

Management Plan (2016)

Biological objectives:

- To maintain a target Pipi relative biomass above the target reference point of 11 kg/4.5 m² and not less than the trigger reference point of 9 kg/4.5 m².
- To ensure that the Pipi relative biomass does not drop below the limit reference point of 4 kg/4.5 m².

Table A1. Harvest strategy for Pipi in the current Management Plan (PIRSA 2016).

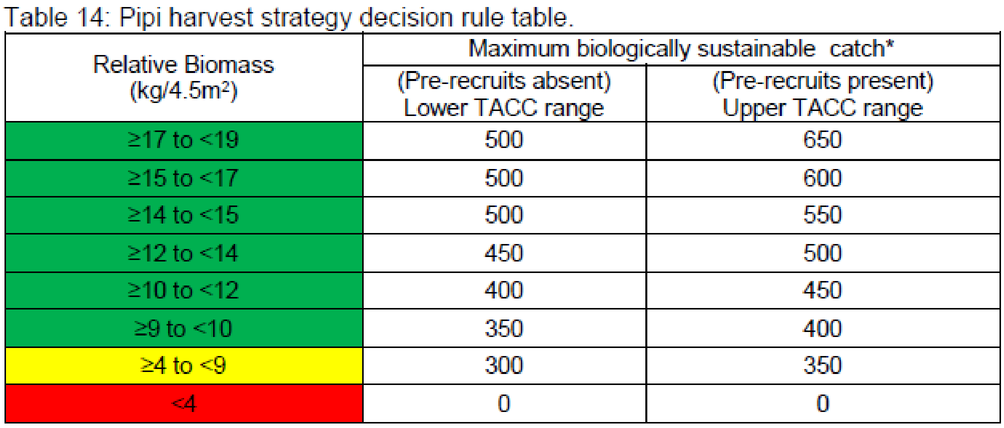


Table 14: Pipi harvest strategy decision rule table.

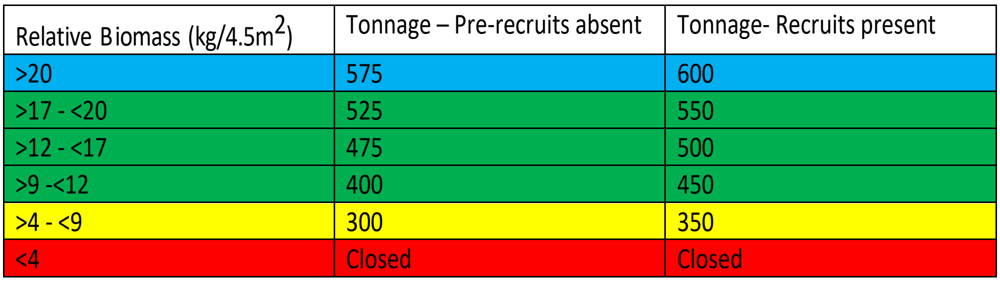
Relative Biomass (kg/4.5m²)	Maximum biologically sustainable catch*	
	(Pre-recruits absent) Lower TACC range	(Pre-recruits present) Upper TACC range
≥17 to <19	500	650
≥15 to <17	500	600
≥14 to <15	500	550
≥12 to <14	450	500
≥10 to <12	400	450
≥9 to <10	350	400
≥4 to <9	300	350
<4	0	0

Proposed Harvest Strategy in the draft Management Plan (2021)

Biological objectives:

- To maintain a target Pipi relative biomass above the target reference point of 12 kg/4.5 m² and not less than the trigger reference point of 9 kg/4.5 m².
- To ensure that the Pipi relative biomass does not drop below the limit reference point of 4 kg/4.5 m².

Table A2. Harvest strategy for Pipi in the Draft Management Plan (2021).



Relative Biomass (kg/4.5m^2)	Tonnage – Pre-recruits absent	Tonnage- Recruits present
>20	575	600
>17 - <20	525	550
>12 - <17	475	500
>9 -<12	400	450
>4 - <9	300	350
<4	Closed	Closed

APPENDIX B – Summary of non-targeted species interactions from Pipi FIS

A summary of non-targeted species collected from commercial fishing rakes during day 3 of the fishery-independent surveys (n = 30 transects) is provided to support the Marine Stewardship Council reassessment for the LCF fishery for Pipi (Table B1). Three species were observed in commercial fishing rakes during fishery-independent surveys from 2016/17 to 2020/21: Flathead pygmy stargazer (*Lesueurina platycephala*), Ocean sand crab (*Ovalipes australiensis*) and Greenback flounder (*Rhomposolea tapirina*). Observed numbers were low. Non-targeted individuals were returned to the water along with undersized Pipi.

Table B1. Summary of non-targeted species collected from commercial fishing rakes during fishery independent surveys.

Financial year	Sub-survey	Date	Flathead Pygmy stargazer	Ocean sand crab	Greenback flounder
2016-17	Post	8/05/2017		7	
2017-18	Pre	3/11/2017	1	2	
2018-19	Pre	27/11/2018		1	
2018-19	Mid	20/02/2019		13	
2018-19	Post	1/05/2019		10	1
2019-20	Pre	12/11/2019		1	
2019-20	Mid	11/02/2020	3	35	
2019-20	Post	7/05/2020		2	
2020-21	Pre	13/11/2020	1	17	
2020-21	Mid	25/02/2021		6	
2020-21	Post	29/04/2021		3	

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ADVICE TO: PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)

FROM: DR GREG FERGUSON (RESEARCH SCIENTIST, SARDI AQUATIC SCIENCES)

SUBJECT: BIOLOGICAL IMPLICATIONS OF TWO HARVESTING SCENARIOS FOR PIPI

DATE: 26 MAY 2021

KEY ISSUES:

- To inform setting the TACC for Pipi in the Lakes and Coorong Fishery (LCF) for the 2021/22 fishing season, advice has been requested on the biological implications of two scenarios: (1) a TACC in 2021/22 of 350 t plus 20 t carry-over quota (i.e. 370 t); and (2) a TACC in 2021/22 of 400 t plus 20 t carry-over quota (i.e. 420 t).
- Pipi, *Donax deltoides*, is a fast growing, short-lived (4.5 years) species, characterised by high temporal and spatial variability in abundance and variable recruitment. The fishery is based on one–two modes of 3–4 year-olds. The legal minimum length (LML) of 35 mm is conservative and allows all Pipi the opportunity to spawn at least once prior to harvest.
- The LCF for Pipi is currently classified as “sustainable” (Ferguson et al 2018; Ferguson and Hooper 2021).
- Estimates of two biological Performance Indicators (PIs) from 2020/21 inform the Harvest Strategy (HS) used to set the annual TACC in 2021/22. The primary PI, fishery-independent mean annual relative biomass, was 8.9 kg/4.5 m^2 which was 1% below the trigger reference point of 9 kg/4.5 m^2. The secondary PI, which is presence/absence of pre-recruits, was that pre-recruits were present (58%) in November 2021. The HS indicates a TACC in 2021/22 of 350 t.
- The relative biomass of 8.9 kg/4.5m^2 in 2020/21 was more than twice the limit reference point of 4 kg/4.5 m^2 from 2008/09. Pre-recruits were well represented in size structures in both 2019/20 (February 2019) and 2020/21 (November 2020). A previous period of three successive years of successful recruitment (2012/13 to 2014/15), when mean annual relative biomass was at moderate levels, was followed by an increase in biomass and spatial expansion.
- Based on the above information, 2021/22 TACCs of either 370 t or 420 t would be considered low risk to maintaining the current “sustainable” status of the Pipi fishery.

BACKGROUND:

The overall objective of the Pipi HS is to ensure long-term sustainability of the fishery (PIRSA 2016). The HS aims to maintain mean annual relative biomass of Pipi above a target reference point of 11 kg/4.5 m² and not less than the trigger reference point of 9 kg/4.5 m² (PIRSA 2016; Table1).

Estimates of two PIs from 2020/21 inform the HS used to set the annual TACC in 2021/22 (Ferguson and Ward 2014; Ferguson et al. 2015, 2021). The primary PI, fishery-independent mean annual relative biomass, was 8.9 kg/4.5 m^2, which was 1% below the trigger reference point of 9 kg/4.5 m^2 in the HS (Figure 1). The secondary PI, which is presence/absence of pre-recruits, was that pre-recruits were present (58%) in November 2021 (Figure 3). The HS this indicates a TACC in 2021/22 of 350 t.

At the Lakes and Coorong Fisheries Management Advisory Committee Meeting on 20 May 2021 at SARDI, West Beach, consideration was given to recommending a TACC of 400 t for the 2021/22 Pipi fishing season. Industry is also seeking to 'carry over' 20 t of TACC from 2020/21 to 2021/22.

PIRSA Fisheries and Aquaculture has requested advice on the biological implications of setting the TACC for 2021/22 under two scenarios: (A) a TACC of 350 t, as indicated by the HS, plus 20 t carry-over quota (i.e. 370 t); and (B) a TACC of 400 t, plus 20 t carry-over quota (i.e. 420 t).

The LCF for Pipi is currently classified as "sustainable" (Ferguson et al 2018; Ferguson and Hooper 2021).

RESULTS/DISCUSSION:

Pipi, *Donax deltoides*, is a fast growing, short-lived (4.5 years) species, characterised by high temporal and spatial variability in abundance and highly variable recruitment. The combination of rapid growth and short lifespan (of 4–5 years) suggest that natural mortality of Pipi is likely to be high. The fishery for Pipi is based on one or two modes of 3–4 year-olds. The legal minimum length of 35 mm is conservative and allows all Pipi the opportunity to spawn at least once prior to harvest.

The estimated relative biomass of 8.9 kg/4.5m^2 in 2020/21 was 1% below the trigger reference level in the HS of 9 kg/4.5m^2, and more than twice the limit reference point of 4 kg/4.5 m^2 (Figure 1).

Relative biomass in 2020/21 was highest in the central third of the fishing ground, with evidence that the resource has contracted spatially over recent years. In 2020/21, relative biomass increased in the south-eastern third of the fishing ground compared to previous years (Figure 2).

Pre-recruits comprised 40% of the size structure in February 2020 and 58% in November 2020 (Figure 3). In April 2021, pre-recruits were present across the entire fishing ground with two modal sizes (~10 mm, ~25 mm) across two thirds of the fishing ground. A previous period of three successive years of successful recruitment (2012/13 to 2014/15), when mean annual relative biomass was at moderate levels, was followed by an increase in biomass and spatial expansion.

Pre-recruits (~25 mm) observed in size structures in April 2021 are likely to enter the fishable biomass during late summer/early spring in 2021/22 at ~35 mm. This may result in more Pipi being harvested at a smaller size.

Based on the above information, 2021/22 TACCs of either 370 t or 420 t would be considered low risk to maintaining the current "sustainable" status of the Pipi fishery.

Dr Mike Steer
A/Research Director, Aquatic Sciences

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APPENDIX

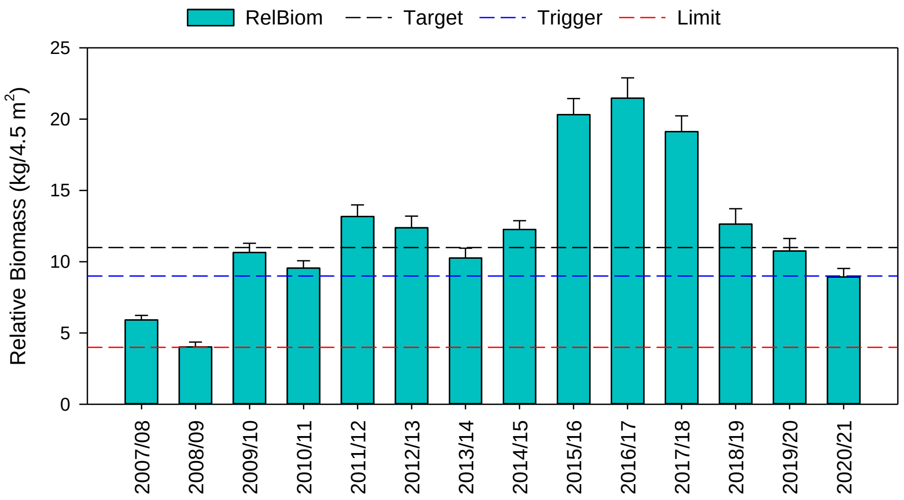

Figure 1. Estimates of fishery-independent mean annual relative biomass (± se) of Pipi from 2007/08 to 2020/21 showing target, trigger and limit reference points. The harvest strategy aims to maintain relative biomass above a target of 11 kg/4.5 m² (black dashes) and not less than the trigger reference point of 9 kg/4.5 m² (blue dashes). The lower limit reference point (red dashes) represents a historically low mean annual relative biomass of 4 kg/4.5 m² below which there may be risk of recruitment overfishing.

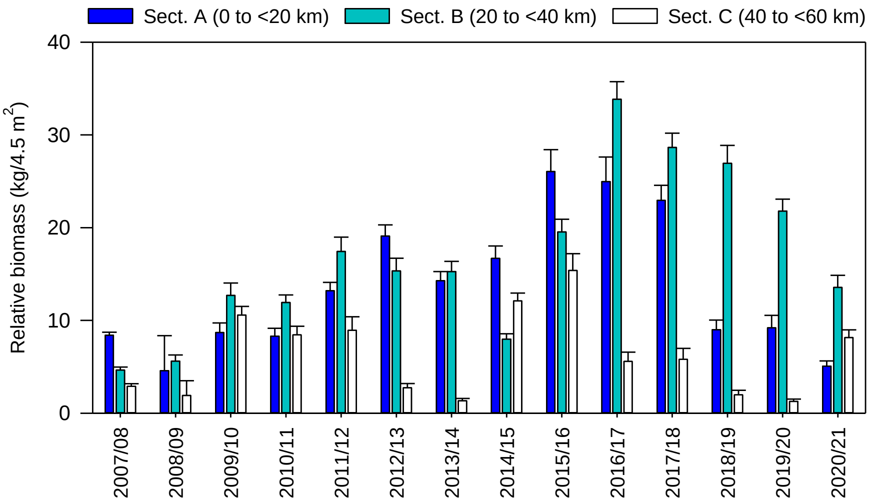

Figure 2. Spatial trends in mean (±se) annual relative biomass of Pipi on Younghusband Peninsula from fishery-independent surveys during 2007/08 to 2020/21.

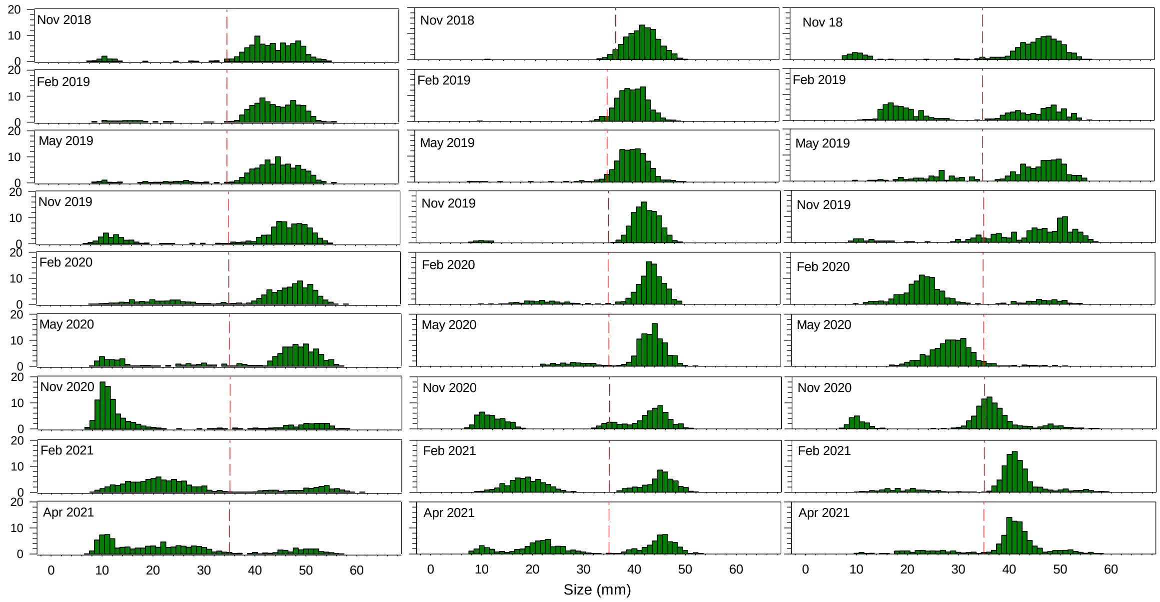

Figure 3. Size structures of Pipi on Younghusband Peninsula from November 2008 to April 2021. Left panels are size distributions for Section A (0 to <20 km from Murray Mouth); centre panels Section B (20 to < 40 km) and right panels (40 to <60 km). Vertical red line represents legal minimum size of 35 mm.

Table 1. Pipi harvest strategy decision rule table PIRSA (2016).

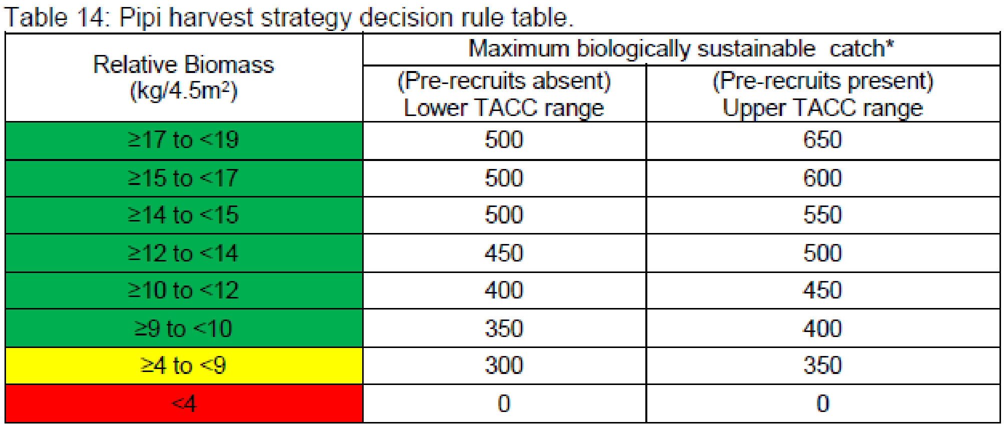

Table 14: Pipi harvest strategy decision rule table.

Relative Biomass (kg/4.5m²)	Maximum biologically sustainable catch*	
	(Pre-recruits absent) Lower TACC range	(Pre-recruits present) Upper TACC range
≥17 to <19	500	650
≥15 to <17	500	600
≥14 to <15	500	550
≥12 to <14	450	500
≥10 to <12	400	450
≥9 to <10	350	400
≥4 to <9	300	350
<4	0	0

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR GREG FERGUSON (RESEARCH SCIENTIST, SARDI AQUATIC SCIENCES)**

SUBJECT: **PROPOSED TRANSLOCATION OF UP TO 150 T OF SMALL GRADED PIPI**

DATE: **27 OCTOBER 2021**

KEY ISSUES:

- The LCF for Pipi (*Donax deltoides*) was classified as “**sustainable**” in 2020/21 (Ferguson and Hooper 2021).
- Pipi fishers use manual and mechanical graders to separate small (<35 mm) Pipi, from harvestable stock, with the small Pipi returned to the water at the fishing location.
- Industry stakeholders have expressed concern that the current high proportion of pre-recruits, and moderate levels of harvestable biomass, will result in individual small Pipi being exposed to repeated grading over successive days. PipiCo have proposed a project whereby small (30–39 mm) graded-off Pipi could be translocated to areas at either end of the main fishing area to mitigate possible damage/mortality due to repeated grading (PipiCo 2021).
- PIRSA Fisheries and Aquaculture have requested an assessment of the potential risks and benefits of the translocation.
- The proposed translocated amount (150 t) of small Pipi (30–39 mm) is equivalent to 37% of the TACC in 2021/22. Levels of increased mortality associated with translocation of small Pipi are unknown. If high levels of mortality were to occur, future biomass would likely be impacted.
- Because the primary PI was close to the trigger RP (-1%) in 2020/21, any increase in mortality could result in the primary biological PI being further below the trigger RP. Consequently, the overall risk of the proposed translocation of small Pipi resulting in a change from the current status of “sustainable” to “depleting” is considered “moderate”.
- The risk of mortality to small Pipi can likely be managed by mitigation strategies included in the PipiCo project application: (A) returning an estimated 50% (150 t) of graded Pipi to the water at the fishing location, (B) translocating the remaining 50% of small Pipi to locations with similar habitat at the northern (75 t) and southern (75 t) end of the fishing ground, (C) minimising the distance over which translocation occurs, (D)

spreading the translocated Pipi across sufficient area to avoid high densities, and (E) increased monitoring of relative biomass and size structures.

- The potential benefits of translocation of small Pipi (30–39 mm) are (A) reduced potential for mortality/damage from repeated grading over multiple, successive days, and (B) a reduction in possible impacts of multiple grading events on spawning of small Pipi, which are sexually mature from 28 mm (SAM_{50}).

BACKGROUND:

The LCF for Pipi is currently classified as "**sustainable**" (Figure 3). In 2020/21, fishery-independent mean annual relative biomass (primary biological performance indicator; PI) was 8.9 kg/4.5 m^2, which was 1% below the trigger reference point of 9 kg/4.5 m^2 in the current draft Harvest Strategy (HS; Ferguson and Hooper 2021; PIRSA 2021) and pre-recruits were present (58%; secondary biological PI) in size structures. A TACC of 400 t was recommended for 2021/22. An additional 20 t of uncaught quota from 2020/21 was also carried over in 2021/22.

In 2020/21, relative biomass was highest in the section of the fishing ground from 20–40 km from the Murray Mouth (Figure 2). Additionally, catch/effort data suggested that >80% of the annual catch was taken from the 20–40 km section in that year.

The high proportion of pre-recruits in size structures in 2020/21 (modal sizes ~10 mm; ~25 mm) will likely persist throughout the 2021/22 season (Figure 1). Industry stakeholders have expressed concern that repeated handling and grading of individual small Pipi (30–39 mm), then returning them to the water, over multiple, successive days from a spatially contracted fishing area may result in increased damage or mortality. For this reason, PipiCo have proposed a project to translocate small, graded Pipi from the beach section where most fishing occurs (20–40 km) to areas that are north (10–20 km) and south (40–50 km) of the main fishing ground (Figure 3). Industry have suggested that the total translocated stock may be approximately 150 t, i.e., 75 t translocated to each of the two areas located north and south of the current main fishing area. Industry have estimated that a further 150 t of small Pipi could be graded and returned to the water at the fishing location.

PIRSA Fisheries and Aquaculture have requested advice on the potential risks and benefits of the proposed translocation.

RESULTS/DISCUSSION:

Pipi *Donax deltoides*, are a fast growing, short-lived (4.5 years) species, characterised by high temporal and spatial variability in abundance, likely resulting from highly variable recruitment (Ferguson *et. al.* 2015; Ferguson *et. al.* 2021). The combination of rapid growth and short lifespan suggest that natural mortality of Pipi is likely to be high. The natural mortality of pre-recruits is currently unknown.

The LCF for Pipi is currently classified as "**sustainable**" (Ferguson and Hooper 2021). The estimate of mean relative harvestable biomass of 8.9 kg/4.5 m^2 in 2020/21 was slightly below (-1%) the trigger RP of 9 kg/4.5 m^2 but remained more than twice the limit RP of 4 kg/4.5 m^2, below which there is an unacceptably high risk of recruitment overfishing. There is evidence of spatial contraction of the stock with the highest estimates of relative harvestable biomass occurring in the central third (20–40 km) of the fishing ground, and 81% of catches also originating from that location. The high proportion of pre-recruits (<35 mm) present in size structures in November 2020 and subsequent presence of two modes of pre-recruits in size structures in April 2021 suggests that significant recruitment has occurred in 2020/21.

Fishers use mechanical graders to separate small (30–39 mm) Pipi from harvestable stock with the small Pipi returned to the water at the fishing location. Due to the combination of moderate levels of biomass, spatial contraction of the stock and the high proportion of pre-recruits in size structures, it is likely that the amount of mechanical grading of small Pipi will be higher in 2021/22 than in previous years. Consequently, repeated grading of Pipi that are below the Minimum Legal Length (LML) of 35 mm or too small for markets (30–39 mm), is likely to occur. The mode of pre-recruits (~25 mm) observed in size structures in April 2021 is likely to enter the harvestable biomass at ~35 mm during late summer/early spring in 2021/22.

The LML of 35 mm is conservative, consistent with all Pipi spawning at least once prior to harvest. For Pipi on Younghusband Peninsula, fifty percent of individuals attain sexual maturity at 28 mm (SAM_{50}) and ninety-five percent at 32 mm ($SAM_{95;}$ Ferguson and Ward 2014). Consequently, there is potential for small, sexually mature individuals (30–39 mm) to be impacted by repeated grading or by translocation. However, the possible impact of translocation of small, sexually mature Pipi on spawning is likely to be less than that of Pipi that have been repeatedly graded over multiple, successive days because translocated Pipi would be subject to less handling.

Levels of mortality/damage from grading small Pipi are unknown but likely to be low if Pipi are returned immediately to the water. For Pipi that are graded repeatedly over multiple, successive days mortality/damage is likely to be comparatively higher. Mortality/damage of small Pipi that are graded and translocated on one occasion is likely to be less that for Pipi graded repeatedly over multiple, successive days at the original fishing location.

In the unlikely event that mortality of large numbers of small Pipi were to occur from translocation, there could be considerable loss of potential biomass given known high growth rates (Ferguson *et. al.* 2021). The fishery was classified as “sustainable” in 2021/22. Because the primary PI was close to the trigger RP (-1%) in 2020/21, an increase in mortality could result in the primary biological PI moving further below the trigger RP. Consequently, the overall risk of the proposed translocation of small Pipi resulting in a change from the current status of “sustainable” to “depleting” is considered “moderate”.

The risks associated with the translocation of small Pipi, including levels of mortality, are poorly understood (Table 1). However, risks are likely to be mitigated by implementing the controls that are detailed in the PipiCo project proposal, namely (A) returning an estimated 50% (150 t) of graded Pipi to the water at the fishing location, (B) translocating the remaining 50% of small Pipi to locations at the northern (75 t) and southern (75 t) end of the fishing ground where the surf zone habitat is similar to that at the fishing ground, and Pipi are known to occur at relatively high levels of biomass, (C) ensuring that the translocation area is relatively large so that Pipi are not translocated into small areas of high density, and (D) increasing the monitoring of relative biomass and sizes in addition to the scheduled fishery-independent surveys (FIS).

Potential impacts on trophic interactions resulting from translocation of small Pipi are poorly understood. Pipi are a preferred food for Australian Pied (*Haematopus longirostris*) and Sooty (*H. fuliginosus*) Oystercatchers, although these birds have been shown to target larger Pipi (Owner and Rohweder 2003; Jones 2016).

The translocation project has the potential benefit of reducing handling of small, sexually mature Pipi. Translocated Pipi would experience a single handling event (grading and translocation) and likely lower rates of damage, mortality and disrupted spawning compared to those that remain at the fishing location and subject to repeated handling and grading over multiple, successive days.

The tag/recapture study suggested in the project proposal has the potential to provide a comparison of mortality of small Pipi that have been graded and returned to the water at the fishing location with that of Pipi that have been translocated.

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Research Director, Aquatic Sciences

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APPENDIX

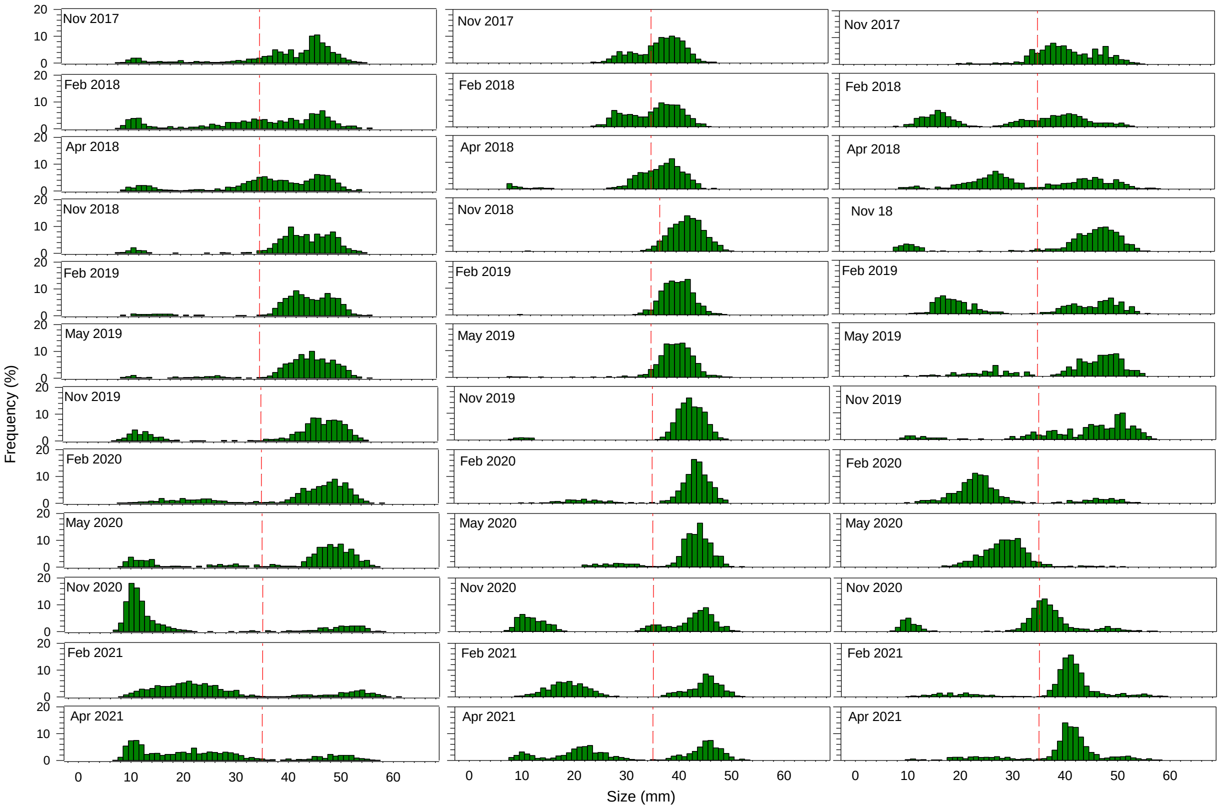

Figure 1. Size structures of Pipi on Younghusband Peninsula from November 2017 to April 2021. Left panels are size distributions for Section A (0 to <20 km from Murray Mouth); centre panels Section B (20 to < 40 km) and right panels Section C (40 to <60 km). Vertical red line represents legal minimum size of 35 mm.

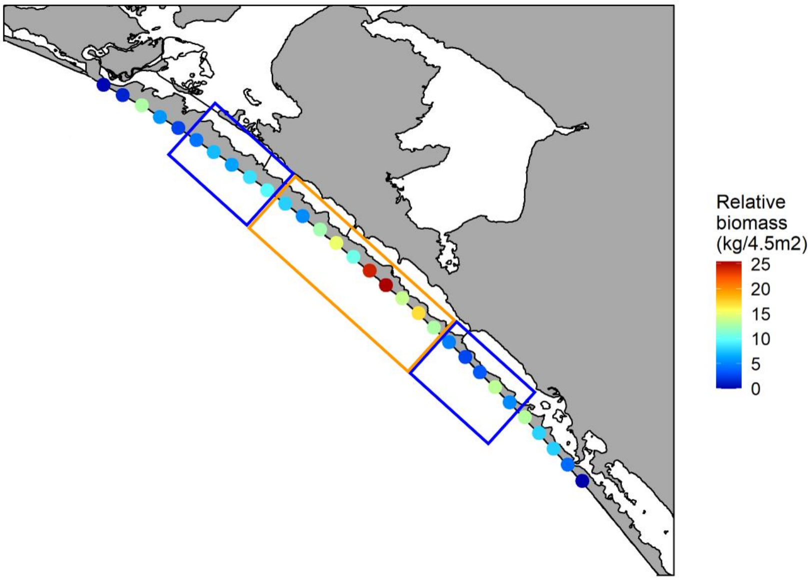

Figure 2. Spatial distribution of mean annual harvestable relative biomass from fishery-independent surveys of Pipi across 30 transects located 2 km apart on Younghusband Peninsula in 2020/21. Highest relative harvestable biomass and most fishery catches occur in the section from 20–40 km (orange box). Proposed translocation sites for small graded off Pipi are located at 10–20 km and 40–50 km (blue boxes; map by Fred Bailleu, SARDI).

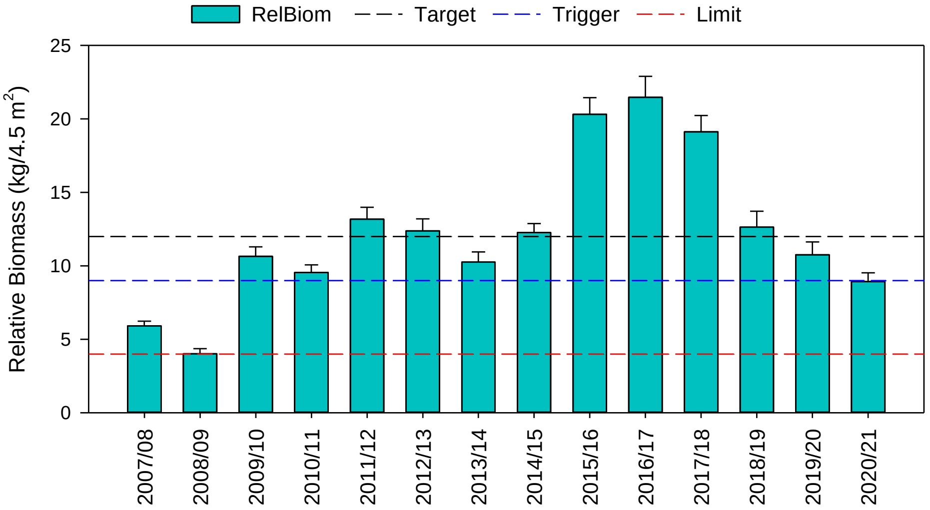

Figure 3. Fishery-independent estimates of mean annual relative harvestable biomass (± se) of Pipi from 2007/08 to 2020/21 showing target, trigger and limit reference points from the current draft harvest strategy. The harvest strategy aims to maintain relative biomass above a target of 12 kg/4.5 m² (black dashes) and not less than the trigger reference point of 9 kg/4.5 m² (blue dashes). The lower limit reference point (red dashes) represents a historically low mean annual relative biomass of 4 kg/4.5 m² below which there may be risk of recruitment overfishing.

Table 1. Relative risk to the maintenance of the "sustainable" status of Pipi in associated with translocating 75 t of small, graded Pipi to areas at either end of the main fishing ground. Risk mitigation measures outlined in the Project Application and an overall risk of increases mortality based on adherence to the mitigation measures is included.

Scenario	Potential consequence	Event	Mitigation/Monitoring	Risk of increased mortality/reduced reproductive potential
(A) Small Pipi (30–39 mm) graded and translocated	Increased mortality from unsuitable translocation habitat	• Translocation to unsuitable habitat	• 50% (150 t) of graded small Pipi returned to fishing location • Translocation within similar surf zone habitat on same beach • Translocation areas at northern and southern ends of main fishing ground • Translocation area has (i) low–moderate levels of relative biomass and (ii) similar beach slope to main fishing ground. • Minimise translocation distance – average distance ~10 km, maximum distance ~20 km • Translocation areas to be recorded in geospatial software so that small Pipi can be spread evenly • FIS and supplemental surveys of relative biomass and size structures • Mid-season review of stock status of Pipi	Low
	Interruption to spawning	• Handling/relocation	• Single handling event likely to have fewer negative effects compared to repeated grading over successive days • Affects small proportion of reproductively active size classes	Low
	Ecological impacts,	• . Trophic effects e.g, provisioning	• preferred food for Pied Oystercatcher • Oystercatchers thought to target large Pipi • Project conducted on small proportion of total habitat • Translocation within the same beach • Translocation over short distance ~ 10 km • Translocation will occur adjacent the area of highest relative biomass	Low
(B) Small Pipi graded and returned to fishing location	Increased Mortality of small Pipi from repeated grading	• Handling over multiple successive days	• Return small pipi immediately to the water. • Relocate daily fishing location - may be difficult because area of high relative biomass limited to 20-40 km from Murray Mouth.	Low–moderate
	Interruption to spawning	• Handling/relocation	• Affects small proportion of reproductively active size classes	Low-moderate
	Ecological impacts, e.g. trophic effects, provisioning	• Trophic effects e.g, provisioning	• Pipi returned to the water immediately after grading	Low

Doc 18

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR JONATHAN SMART (SARDI AQUATIC SCIENCES)**

SUBJECT: **RISK TO SUSTAINABILITY OF TIER 1 MSF STOCKS IF TACCS WERE INCREASED TO INCORPORATE ADDITIONAL QUOTA ALLOCATIONS**

DATE: **21 APRIL 2022**

KEY ISSUES

- Additional quota units may be added to the Marine Scalefish Fishery (MSF) for licence holders that were included in an exceptional circumstances process during the MSF reform.
- As these additional units could not have been fished during the 2021/22 season, an increase to the TACC in 2022/23 is being considered to allow these licence holders to catch this quota in a subsequent fishing season.
- PIRSA Fisheries and Aquaculture have requested advice on whether this poses a risk to sustainability for any Tier 1 stock, given the recently recommended TACCs for 2022/23 by the MSFMAC.
- Three pieces of information were considered for each stock:
    1. The current status of each stock
    2. The percentage of the TACC caught to date for the 2021/22 fishing season
    3. The increase in allocated quota units for each stock
- Snapper were not considered in this analysis as no additional allocations will occur for the South East fishing zone and the remaining fishing zones have not had a TACC recommended due to their ongoing closure.
- All King George Whiting and Southern Calamari stocks are classified as ‘sustainable’. Garfish are classified as ‘depleted’ and ‘recovering’ for GSV and SG, respectively.
- The 2021/22 TACCs for all stocks are not expected to be caught based on the percentage of the TACC caught to date and the remaining length of the 2021/22 fishing season.
- The percentage of uncaught TACC in 2021/22 is likely to be larger than any potential TACC increase for 2022/23. Therefore, a low risk to sustainability was assigned for all Tier 1 stocks.

BACKGROUND

Quota allocations for Tier 1 stocks were calculated and allocated to MSF licence holders on 1 July 2021. These allocations incorporated the results of an exceptional circumstances process that provided additional quota units to licence holders with successful applications.

The quotas allocations for these fishers may be reconsidered following applications to SACAT. This would increase the total number of units in the fishery from those allocated on 1 July 2021.

Currently, the TACCs for the 2021/22 fishing season for all Tier 1 stocks managed by ITQ were set using estimates of recent average annual catch. The only exception was Snapper in the South East (SE) fishing zone which had a TAC set using a model-based recommended biological catch. However, no additional quota will be allocated for Snapper in the SE fishing zone as no licence holders that were included in the exceptional circumstances process had catch history for this stock.

In April 2022, the MSF Management Advisory Committee (MSFMAC) recommended that all TACCs be maintained for the 2022/23 fishing season (see Appendices). Currently, Snapper fishing is prohibited until 1 February 2023 in the Gulf St Vincent (GSV), Spencer Gulf (SG) and West Coast (WC) fishing zones. Therefore, the MSFMAC did not recommend a TACC for these stocks. PIRSA Fisheries and Aquaculture have requested advice on the risk to sustainability of Tier 1 stocks if the TACCs recommended by the MSFMAC were increased for the 2022/23 season. This may be required in order to incorporate additional quota units for licence holders from the exceptional circumstances process that could not have been fished for during the 2021/22 fishing season.

RESULTS

The risk to sustainability was considered based on three pieces of information:

1. The current status of each stock
2. The percentage of the TACC caught to date for the 2021/22 fishing season
3. The increase in allocated quota units for each stock

Snapper

Snapper did not need to be considered in this analysis as no additional quota units will be allocated for the SE fishing zone and TACCs have not been set for Snapper in the GSV, SG and WC fishing zones for the 2022/23 fishing season.

King George Whiting

- Both GSV and SG stocks were classified as **sustainable** in the most recent stock assessment (Drew et al 2021).
- Less than 50% of the TACC has been caught for either stock with 75% of the fishing season complete (Table 1).
- The number of quota units in the fishery would increase by 0.2% and 8.5% for GSV and SG, respectively (Table 2).

Garfish

- In the most recent stock assessment for Garfish, the GSV stock was classified as **depleted,** and the SG stock was classified as **recovering** (Steer et al 2018). These classifications were maintained in the most recent stock status report (Drew et al 2021).
- Less than 60% of the TACC has been caught for either stock with 75% of the fishing season complete (Table 1).
- The number of units in the fishery would increase by 7.4% and 5.3% for GSV and SG, respectively (Table 2).

Southern Calamari

- Both GSV and SG stocks were classified as **sustainable** in the most recent stock status report (Drew et al 2021).
- In GSV 47.41% of the TACC has been caught while 54.68% of the TACC has been caught in SG with 75% of the fishing season complete (Table 1).
- The number of units in the fishery would increase by 3.7% and 5.2% for GSV and SG, respectively (Table 2).

Table 1. The 2021/22 TACCs for Tier 1 stocks and the percentage of each TACC caught by March 2022

SPECIES	Zone	TACC (T)	% TACC CAUGHT
GARFISH	GSV	71	55.15
GARFISH	SG	100	53.18
KING GEORGE WHITING	GSV	46	42.28
KING GEORGE WHITING	SG	111	46.93
SNAPPER	SE	36	48.63
SOUTHERN CALAMARI	GSV	162	47.41
SOUTHERN CALAMARI	SG	204	54.68

Table 2. The additional quota units for Tier 1 stocks that may be allocated to MSF licence holders.

SPECIES	Zone	Additional units	Total MSF sector units	Total fishery units	Updated total fishery units	% increase of total fishery units
GARFISH	GSV	147.19	2000	2000	2147.19	7.40%
GARFISH	SG	106.81	1998	2000	2106.81	5.30%
KING GEORGE WHITING	GSV	3.81	1944	2000	2003.81	0.20%
KING GEORGE WHITING	SG	170.56	1958	2000	2170.56	8.50%
SNAPPER	GSV	450.12	3972	4000	4450.12	11.30%
SNAPPER	SG	97.04	3984	4000	4097.04	2.40%
SNAPPER	WC	74.61	992	1000	1074.61	7.50%
SOUTHERN CALAMARI	GSV	149.19	4000	4000	4149.19	3.70%
SOUTHERN CALAMARI	SG	209.74	3928	4000	4209.74	5.20%

DISCUSSION

There is a low risk to sustainability for all Tier 1 stocks if TACCs were increased for the 2022/23 fishing season, in accordance with additional units allocated to licence holders from the exceptional circumstances process. This risk is lowest for King George Whiting and Southern Calamari in the GSV and SG fishing zones as both stocks are classified as sustainable. Garfish are classified as depleted and recovering in GSV and SG fishing zones, respectively. However, it is unlikely that the TACC will be caught for any Tier 1 stock during the 2021/22 fishing season (Table 1). Given that there would be an under catch in the current season, an increase to any TACC of less than 10% (see Table 2) would be offset. Therefore, even though Garfish have unfavourable stock status classifications, increases in TACCs of 7.4% and 5.3% for GSV and SG, respectively, would not put either population at risk of overfishing. For King George Whiting and Southern Calamari, their sustainable stock statuses reduce this risk further.

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Research Director, Aquatic & Livestock Sciences

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APPENDICES

Species summary templates considered by the MSFMAC when providing TACC recommendations in April 2022.

Southern Garfish *Hyporhamphus melanchir*

Gulf St Vincent/Kangaroo Island

Last revised: 25 March 2022

<table>
<tr><th colspan="6">Stock summary</th></tr>
<tr><td>Stock status</td><td colspan="5">Depleted (2019)</td></tr>
<tr><td>Stock assessment</td><td colspan="5">Tier 1 species – last assessment was 2017 (Steer et al 2018). Most recent stock status was assigned in 2019 (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td colspan="5">Southern Garfish in the Gulf St Vincent/Kangaroo Island (GSV/KI) fishing zone experienced exploitation rates of more than 80% during the 1990’s when the population was only sustained through high levels of recruitment. During this period, few fish survived past age two and the population age structure was severely truncated.
Management measures implemented since 2005 have reduced exploitation rates. However, biomass has not recovered, age structures have remained truncated, and recruitment is impaired. Therefore, this stock was classified as depleted in the last stock assessment (Steer et al 2018).</td></tr>
<tr><td rowspan="13">Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
<u>Sector allocations</u> Allocations in the current management plan are statewide.</td><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>75</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>81</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>81</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>62</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>67</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td>-</td><td>-</td><td>-</td><td>71</td></tr>
<tr><th colspan="5">Sector allocations (State-wide)</th></tr>
<tr><td colspan="2">Commercial</td><td>Recreational</td><td>Aboriginal traditional</td><td>Total</td></tr>
<tr><td>MSF</td><td>79.33%</td><td rowspan="3">19.5%</td><td rowspan="3">1%</td><td rowspan="3">100%</td></tr>
<tr><td>SZRL</td><td>0.13%</td></tr>
<tr><td>NZRL</td><td>0.04%</td></tr>
<tr><td>Current assessment program</td><td colspan="5">• Weekly length and age structures collected through market sampling in Adelaide.
• Annual fishery statistics provided through a stock status report
• Application of a length-and-age-structured population model every three years
• Recreational data collected every five years through statewide recreational survey
• No information is available for Aboriginal/Traditional fishing.</td></tr>
<tr><td>Assessment summary</td><td colspan="5">There are two biological stocks in the GSV/KI fishing zone which occur in the northern and southern regions. The northern Gulf St Vincent (NGSV) stock constitutes the majority of the biomass and is predominantly fished with haul nets. The southern Gulf St Vincent (SGSV) stock has a much smaller</td></tr>
</table>

biomass and is fished with dab nets due to haul netting restrictions in this region. Most of the catch and effort for the GSV/KI fishing zone occurs in NGSV via the haul net fishery.

The most recent stock assessment included data up until September 2017 using a weight-of-evidence approach (Steer et al 2018). The GarEst stock assessment model for the GSV/KI fishing zone combines both NGSV and SGSV stocks as some biological mixing occurs, despite demographic separation. The GarEst model includes data on commercial catch and effort, commercial age and length structures, and recreational and charter boat catch and effort. Numerous management measures have been implemented since 2005 which included licence reduction schemes, spatial and temporal closures, changes to gear restrictions and changes to legal minimum length. This assessment demonstrated that these management measures have not yet allowed the stock recovery to occur. As a result, the stock was classified as **depleted**.

The 2021/22 TACC of 100 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.

RBC / TACC options for 2022/23

Sector catch shares

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.

M = natural mortality

Sector	Commercial sector catch share (%)	Target H in management plan (0.3)	Target H = 2/3M (0.23)	2021/22 TACC	Five-year average commercial catch (2016/17 – 2020/21)
RBC	100	61 t	48 t	-	-
TACC	82	50 t	39 t	71 t	73 t

The RBC’s were determined from average five-year biomass estimates from the last assessment (2013-2017).

Research needs

- Development of harvest strategy with performance indicators, reference points and harvest control rules.
- Standardisation of commercial CPUE, using improved measures of fishing effort.
- Improved estimates of recreational catch and effort.

SSC recommendation

A new stock assessment was being finalised and the results still being considered. The previous assessment indicated signs of stock recovery and there are continuing trends of stock recovery in the new assessment.

The target harvest fraction of 30% as provided in the MSF Management Plan was considered appropriate for the species. Whilst the stock has a depleted status, the biomass has been stable and there was a significantly reducing harvest fraction. Catches in recent years were below average and this was likely due to a combination of changes to the legal minimum length in addition to MSF reform and covid-19 market related impacts.

Noting the above factors, the MSFMAC considered there was no basis to reduce catch limits and recommended a rollover of the current 2021/22 TACC of 71t.

References

Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

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Southern Garfish *Hyporhamphus melanchir*

Spencer Gulf

Last revised: 25 March 2022

<table>
<tr><th colspan="6">Stock summary</th></tr>
<tr><td>Stock status</td><td colspan="5">Recovering (2019)</td></tr>
<tr><td>Stock assessment</td><td colspan="5">Tier 1 species – last assessment was 2017 (Steer et al 2018). Most recent stock status was assigned in 2019 (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td colspan="5">Southern Garfish in the Spencer Gulf (SG) fishing zone experienced exploitation rates of more than 90% during the 1990’s when the population was only sustained through high levels of recruitment. During this period, few fish survived past age two and the population age structure was severely truncated.
Management measures implemented since 2005 have allowed stock recovery. Exploitation has been reduced, biomass has been stable and age structures have become less truncated. However, as of the last assessment, biomass has not yet begun to increase and recruitment remains impaired.</td></tr>
<tr><td rowspan="13">Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
Sector allocations
Allocations in the current management plan are statewide.</td><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>107</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>91</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>110</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>99</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>109</td><td>-</td><td>-</td><td>-</td></tr>
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Recreational data collected every five years through statewide recreational survey
No information is available for Aboriginal/Traditional fishing.</td></tr>
<tr><td>Assessment summary</td><td colspan="5">There are two biological stocks in the SG fishing zone which occur in the northern and southern regions. The northern Spencer Gulf (NSG) stock constitutes the majority of the biomass and is predominantly fished with haul nets. The southern Spencer Gulf (SSG) stock has a much smaller</td></tr>
</table>

biomass and is fished with dab nets due to haul netting restrictions in this region. Most of the catch and effort for the SG fishing zone occurs in NSG via the haul net fishery.

The most recent stock assessment included data up until September 2017 using a weight-of-evidence approach (Steer et al 2018). The GarEst stock assessment model for the SG fishing zone combines both NSG and SSG stocks as some biological mixing occurs, despite demographic separation. The GarEst model includes data on commercial catch and effort, commercial age and length structures, and recreational and charter boat catch and effort. Numerous management measures have been implemented since 2005 which included licence reduction schemes, spatial and temporal closures, changes to gear restrictions and changes to legal minimum length. This assessment demonstrated that these management measures have been effective and that the stock was **recovering.**

The 2021/22 TACC of 100 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.

RBC / TACC options for 2022/23

Sector catch shares

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.

M = natural mortality

Sector	Commercial sector catch share (%)	Target H in management plan (0.3)	Target H = 2/3M (0.23)	2021/22 TACC	Five-year average commercial catch (2016/17 – 2020/21)
RBC	100	79 t	62 t	-	-
TACC	78	62 t	48 t	100 t	102 t

The RBC's were determined from average five-year biomass estimates from the last assessment (2013-2017).

Research needs

- Development of harvest strategy with performance indicators, reference points and harvest control rules.
- Standardisation of commercial CPUE, using improved measures of fishing effort.
- Improved estimates of recreational catch and effort.

SSC recommendation

A new stock assessment was being finalised and the results still being considered.

The target harvest fraction of 30% as provided in the MSF Management Plan was considered appropriate for the species. Whilst the stock has a recovering status, the stable to increasing biomass and reducing harvest fraction indicate that recent catches have been at an appropriate level. It was noted that positive changes have been observed by SARDI in the age structure of the stock.

Noting the above factors, the MSFMAC considered there to be no basis to reduce catch limits, and recommended a rollover of the current 2021/22 TACC of 100t.

References

Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

Steer, M.A., Fowler, A.J., McGarvey, R., Feenstra, J., Smart, J., Rogers, P.J., Earl, J., Beckmann, C., Drew, M. and Matthews, J. (2018). Assessment of the South Australian Marine Scalefish Fishery in 2017. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000427-2. SARDI Research Report Series No. 1002. 230pp.

MSF Species / Stock summaries – 2022

King George Whiting *Sillaginodes punctatus*

Gulf St. Vincent / Kangaroo Island

Last revised: 23 March 2022

<table>
<tr><th colspan="2">Stock summary</th></tr>
<tr><td>Stock status</td><td>Sustainable (2019)</td></tr>
<tr><td>Stock assessment</td><td>Tier 1 species – last assessment was 2019 (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td>Fishable biomass has been stable for the past ten years at ~650 t. The harvest fraction has had a decreasing trend during this period and was estimated as 20% in 2019. Targeted hand line CPUE has had an increasing trend over this period which has been driven through consistent annual decreases of commercial catch and effort.</td></tr>
<tr><td>Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
<u>Sector allocations</u>
Allocations in the current management plan are statewide.</td><td>
<table>
<tr><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>52</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>37</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>40</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>42</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>31</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td></td><td>-</td><td>-</td><td>46</td></tr>
</table>
<table>
<tr><th colspan="6">Sector allocations (State-wide)</th></tr>
<tr><th colspan="2">Commercial</th><th colspan="2">Recreational</th><th>Aboriginal traditional</th><th>Total</th></tr>
<tr><td>MSF</td><td>49.5%</td><td>REC</td><td>45.5%</td><td rowspan="3">1%</td><td rowspan="3">100%</td></tr>
<tr><td>SZRL</td><td>0%</td><td rowspan="2">CHT</td><td rowspan="2">3%</td></tr>
<tr><td>NZRL</td><td>1%</td></tr>
</table>
</td></tr>
<tr><td>Current assessment program</td><td>• Weekly length and age structures collected through market sampling in Adelaide and regional areas.
• Annual fishery statistics provided through a stock status report
• Application of a length-and-age-structured population model every three years
• Recreational data collected every five years through statewide recreational survey
• Daily egg production methods (DEPM) have been established to estimate spawning biomass but are not undertaken as part of ongoing assessments.
• No information is available for Aboriginal/Traditional fishing.</td></tr>
<tr><td>Assessment summary</td><td>The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary fishery performance indicators were total catch, targeted handline catch, targeted handline CPUE, and fishery</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<p>age structure. All datasets pertaining to the fishery were integrated in a computer stock assessment model (WhitEst) that produced time-series of annual estimates of output parameters that included fishable biomass, recruitment, harvest fraction and egg production. This assessment demonstrated that this stock was sustainable.</p>
<p>The 2021/22 TACC of 46 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.</p>
</td>
</tr>
<tr>
<td>
<p>RBC / TACC options for 2022/23</p>
<p><u>Sector catch shares</u></p>
<p>Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.</p>
<p>M = natural mortality</p>
</td>
<td>
<table>
<tr><th>Sector</th><th>Commercial sector catch share (%)</th><th>Target H in management plan (0.28)</th><th>Target H = 2/3M (0.125)</th><th>2021/22 TACC</th><th>Five-year average commercial catch (2016/17 – 2020/21)</th></tr>
<tr><td>RBC</td><td>100</td><td>184 t</td><td>74 t</td><td>-</td><td>-</td></tr>
<tr><td>TACC</td><td>40</td><td>82 t</td><td>33 t</td><td>46 t</td><td>40 t</td></tr>
</table>
<p>The RBC’s were determined from average five-year biomass estimates from the last assessment (2015-2019).</p>
</td>
</tr>
<tr>
<td>Research needs</td>
<td>

Development of harvest strategy with performance indicators, reference points and harvest control rules.
Standardisation of commercial CPUE, using improved measures of fishing effort
Improved estimates of recreational catch and effort.

</td>
</tr>
<tr>
<td>SSC recommendation</td>
<td>
<p>The stock was classified as sustainable with a stable and increasing biomass, declining harvest fraction and increasing CPUE. There had been no change in status since the current catch limits had been set. The harvest fraction of 28% provided in the Management Plan was no longer considered appropriate for King George Whiting. The SSC noted the latest year’s catch was below the 5yr average and this was likely due to a combination of the reform, covid-19 and market-related impacts contributing to less targeting of the species.</p>
<p>Considering the above, the SSC considered there to be no basis to reduce the current catch limit and recommended to rollover the current 2021/22 TACC of 46t.</p>
</td>
</tr>
<tr>
<td>References</td>
<td>Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.</td>
</tr>
</table>

King George Whiting *Sillaginodes punctatus*

Spencer Gulf

Last revised: 23 March 2022

Stock summary	
Stock status	**Sustainable** (2019)
Stock assessment	Tier 1 species – last assessment was 2019 (Drew et al 2021)
Fishery/stock trend	Trends in fishable biomass have been cyclical since 1984, reflecting periods of increase and decline, but nevertheless have shown a long-term increase. Biomass has been stable for the past five years at ~1,500 t. The harvest fraction been stable since the early 2000s and was 20% in 2019. Recruitment, which has historically been heavily cyclical in nature, declined steeply from 2016 to 2019. However, the lower recruitment during that period was not reflected in lower fishable biomass, with low exploitation rates in recent years enabling the highest estimated biomass levels in recent years to be retained. Targeted handline CPUE has shown a long-term increasing trend, although with clear cyclical variation. It increased to a record-high level in 2016, and then marginally declined in the three subsequent years to a moderate–high level in 2019. Catch and targeted handline effort have been stable at low levels since 2010.

Current management measure and catch

RBC – recommended biological catch

RBCC - recommended biological commercial catch

TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)

Sector allocations
Allocations in the current management plan are statewide.

Commercial catch and TACC

Year	Total commercial catch (t)	RBC (t)	RBCC (t)	TACC (t)
2016/17	126	-	-	-
2017/18	108	-	-	-
2018/19	103	-	-	-
2019/20	96	-	-	-
2020/21	69	-	-	-
2021/22		-	-	111

Sector allocations (State-wide)

Commercial		Recreational		Aboriginal traditional	Total
MSF	49.5%	REC	45.5%	1%	100%
SZRL	0%	CHT	3%		
NZRL	1%				

Current assessment program	• Weekly length and age structures collected through market sampling in Adelaide and regional areas. • Annual fishery statistics provided through a stock status report • Application of a length-and-age-structured population model every three years • Recreational data collected every five years through statewide recreational survey

- Daily egg production methods (DEPM) have been established to estimate spawning biomass but are not undertaken as part of ongoing assessments.
- No information is available for Aboriginal/Traditional fishing.

Assessment summary

The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary fishery performance indicators were total catch, targeted handline catch, targeted handline CPUE, and fishery age structure. All datasets pertaining to the fishery were integrated in a computer stock assessment model (WhitEst) that produced time-series of annual estimates of output parameters that included fishable biomass, recruitment, harvest fraction and egg production. This assessment demonstrated that this stock was **sustainable.**

The 2021/22 TACC of 111 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.

RBC / TACC options for 2022/23

Sector catch shares

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.

M = natural mortality

Sector	Commercial sector catch share (%)	Target H in management plan (0.28)	Target H = 2/3M (0.125)	2021/22 TACC	Five-year average commercial catch (2016/17 – 2020/21)
RBC	100	418 t	187 t	-	-
TACC	44	184 t	82 t	111 t	100 t

- The RBC’s were determined from average five-year biomass estimates from the last assessment (2015-2019).

Research needs

- Development of harvest strategy with performance indicators, reference points and harvest control rules.
- Standardisation of commercial CPUE, using improved measures of fishing effort.
- Improved estimates of recreational catch and effort.

SSC recommendation

The stock was classified as sustainable with a stable and increasing biomass and declining harvest fraction. There had been no change in status since the 2021/22 TAC had been set. The harvest fraction of 28% was no longer considered appropriate for King George Whiting. The SSC noted the latest year’s catch was below the 5yr average MSF average and this was likely due to a combination of the MSF reform, Covid-19 and market-related impacts contributing to less targeting of the species.

Considering the above the factors the MSFMAC considered there was no basis to change the current catch limits and recommended a rollover of the current 2021/22 TACC of 111t.

References

Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

Southern Calamari *Sepioteuthis australis*

Gulf St Vincent/Kangaroo Island

Last revised: 23 March 2022

<table>
<tr><th colspan="2">Stock summary</th></tr>
<tr><td>Stock status</td><td>Sustainable (2019)</td></tr>
<tr><td>Stock assessment</td><td>Tier 1 species – no stock assessment has been undertaken. Most recent stock status was assigned in 2019 at the State-wide / biological stock level (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td>Annual catches have been relatively stable at moderate levels over the past ten years, consistent with stable targeted jig effort and targeted jig CPUE. In the past 5 years, catch has declined, consistent with a decline in targeted jig effort, while estimates of targeted jig CPUE for northern and southern GSV have been stable at moderate–high levels. This information indicates that biomass is unlikely to be depleted and that recruitment is unlikely to be impaired. The current level of fishing mortality is unlikely to reduce biomass to a recruitment impaired state.</td></tr>
<tr><td>Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
<u>Sector allocations</u>
Allocations in the current management plan are statewide.</td><td>
<table>
<tr><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>170</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>176</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>150</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>154</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>129</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td>-</td><td>-</td><td>-</td><td>162</td></tr>
</table>
<table>
<tr><th colspan="5">Sector allocations (State-wide)</th></tr>
<tr><td colspan="2">Commercial</td><td>Recreational</td><td>Aboriginal / Traditional</td><td>Total</td></tr>
<tr><td>MSF</td><td>56%</td><td rowspan="5">37.4%</td><td rowspan="5">1%</td><td rowspan="5">100%</td></tr>
<tr><td>NZRL</td><td>0.45%</td></tr>
<tr><td>GSVPF</td><td>0.45%</td></tr>
<tr><td>SGPF</td><td>4.6%</td></tr>
<tr><td>WCPF</td><td>0.1%</td></tr>
</table>
</td></tr>
<tr><td>Current assessment program</td><td>• No formal stock assessment.
• Annual fishery statistics provided through a stock status report.
• Recreational data collected every five years through statewide recreational survey.
• No information is available for Aboriginal/Traditional fishing.</td></tr>
</table>

Assessment summary

The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary measure for biomass and fishing mortality is targeted jig CPUE. This assessment demonstrated that South Australia's Southern Calamari stock was **sustainable.**

The 2021/22 TACC of 162 t was recommended by the SnapperMAC, and was calculated based on the average annual commercial catch from the from 2015–2019.

RBC / TACC options for 2022/23

Sector catch shares

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.

Hmsy = Harvest fraction corresponding to maximum sustainable yiefd (MSY)

Sector	Commercial sector catch share (%)	Target Hmsy (0.39)	Target H = 2/3Hmsy (0.26)	2021/22 TACC	Five-year average commercial catch (2016/17 – 2020/21)
RBC	100	358 t	238 t	-	-
TACC	62	216 t	143 t	162 t	156 t

Research needs

- Development of a stock assessment program that can be used to assign stock status, estimate RBCs and inform setting of TACCs.
- Development of harvest strategy with performance indicators, reference points and harvest control rules.
- Standardisation of commercial CPUE, using improved measures of fishing effort
- Improved estimates of recreational catch and effort.

SSC recommendation

There is no formal stock assessment for Southern Calamari and it was noted that only commercial catch statistics were available to evaluate. Hmsy figures provided in previous recommendations were based on catch-only models and there was less confidence in the appropriateness of these for Southern Calamari. It was recognised that CPUE had been stable.

Noting the above, the MSFMAC considered there was no basis to change the current catch limits and recommended a rollover of the current 2021/22 TACC of 162t.

References

Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

Southern Calamari *Sepioteuthis australis*

Spencer Gulf

Last revised: 23 March 2022

<table>
<tr><th colspan="6">Stock summary</th></tr>
<tr><td>**Stock status**</td><td colspan="5">**Sustainable** (2019)</td></tr>
<tr><td>**Stock assessment**</td><td colspan="5">Tier 1 species – no stock assessment has been undertaken. Most recent stock status was assigned in 2019 at the State-wide / biological stock level (Drew et al 2021).</td></tr>
<tr><td>**Fishery/stock trend**</td><td colspan="5">There has been evidence of regional depletion in the northern and southern Spencer Gulf over the past ten years. This was particularly evident in southern Spencer Gulf where targeted jig CPUE declined by 31% between 2012 and 2019. Similar declines in targeted jig CPUE had also been occurring over this period in northern Spencer Gulf but with less severity. A **sustainable** status was assigned at the State-wide/biological stock level.</td></tr>
<tr><td rowspan="15">**Current management measure and catch**
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
Sector allocations
Allocations in the current management plan are statewide.</td><td colspan="5">**Commercial catch and TACC**</td></tr>
<tr><td>Year</td><td>Total commercial catch (t)</td><td>RBC (t)</td><td>RBCC (t)</td><td>TACC (t)</td></tr>
<tr><td>2016/17</td><td>218</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>235</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>164</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>185</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>206</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td></td><td>-</td><td>-</td><td>204</td></tr>
<tr><td colspan="5">**Sector allocations (State-wide)**</td></tr>
<tr><td colspan="2">Commercial</td><td>Recreational</td><td>Aboriginal / Traditional</td><td>Total</td></tr>
<tr><td>MSF</td><td>56%</td><td rowspan="5">37.4%</td><td rowspan="5">1%</td><td rowspan="5">100%</td></tr>
<tr><td>NZRL</td><td>0.45%</td></tr>
<tr><td>GSVPF</td><td>0.45%</td></tr>
<tr><td>SGPF</td><td>4.6%</td></tr>
<tr><td>WCPF</td><td>0.1%</td></tr>
<tr><td>**Current assessment program**</td><td colspan="5">• No formal stock assessment.
• Annual fishery statistics provided through a stock status report.
• Recreational data collected every five years through statewide recreational survey.
• No information is available for Aboriginal/Traditional fishing.</td></tr>
<tr><td>**Assessment summary**</td><td colspan="5">The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary measure for biomass and fishing mortality is targeted jig CPUE. This assessment demonstrated that South Australia’s Southern Calamari stock was **sustainable.**</td></tr>
</table>

The 2021/22 TACC of 204 t was recommended by the SnapperMAC, and was calculated based on the average annual commercial catch from the from 2015–2019.

RBC / TACC options for 2022/23

Sector catch shares

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.

Hmsy = Harvest fraction corresponding to maximum sustainable yiefd (MSY)

Sector	Commercial sector catch share (%)	Target Hmsy (0.39)	Target H = 2/3Hmsy (0.26)	2021/22 TACC	Five-year average commercial catch (2016/17 – 2020/21)
RBC	100	400 t	267 t	-	-
TACC	62	247 t	165 t	204 t	202 t

Research needs

- Development of a stock assessment program that can be used to assign stock status, estimate RBCs and inform setting of TACCs.
- Development of harvest strategy with performance indicators, reference points and harvest control rules.
- Standardisation of commercial CPUE, using improved measures of fishing effort
- Improved estimates of recreational catch and effort.

SSC recommendation

There is no formal stock assessment for Southern Calamari and it was noted that only commercial catch statistics were available to evaluate. Hmsy figures provided in previous recommendations were based on catch-only models and there was less confidence in the appropriateness of these for Southern Calamari. It was recognised that CPUE had been increasing in recent years.

Noting the above, the MSFMAC considered there was no basis to change the current catch limits and recommended a rollover of the current 2021/22 TACC of 204t.

References

Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

Doc 19

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DRS JONATHAN SMART AND JASON EARL (SARDI AQUATIC SCIENCES)**

SUBJECT: **RISK TO SUSTAINABILITY OF TIER 1 MSF STOCKS IF TACCS WERE INCREASED TO (1) INCORPORATE ADDITIONAL QUOTA ALLOCATIONS, AND (2) ENABLE THE CARRY-OVER OF UP TO 10% OF THE UNCAUGHT QUOTA ON EACH LICENCE FROM THE 2021/22 SEASON TO THE 2022/23 SEASON.**

DATE: **27 APRIL 2022**

KEY ISSUES

- Additional quota units may be added to the Marine Scalefish Fishery (MSF) for licence holders that were included in an exceptional circumstances process during the MSF reform.
- As these additional units could not have been fished during the 2021/22 season, an increase to the Total Allowable Commercial Catch (TACC) in 2022/23 is being considered to allow these licence holders to catch this quota in a subsequent fishing season.
- In addition, the carry-over of uncaught quota entitlements for Tier 1 stocks on licences from the 2021/22 season to the 2022/23 season is being considered.
- PIRSA Fisheries and Aquaculture have requested advice on the risk these options pose to sustainability for any Tier 1 stock, given the recently recommended TACCs for 2022/23 by the MSF Management Advisory Committee (MSFMAC).
- Three pieces of information were considered for each stock:
  1. The status of each stock
  2. The percentage of the TACC caught to date for the 2021/22 fishing season
  3. The increase in allocated quota units for each stock relating to the exceptional circumstances process.
- Snapper were not considered in this analysis as no additional allocations will occur for the South East fishing zone and the remaining fishing zones have not had a TACC recommended due to their ongoing closure.
- All King George Whiting and Southern Calamari stocks are classified as ‘sustainable’. Garfish are classified as ‘depleted’ and ‘recovering’ for Gulf St Vincent (GSV) and Spencer Gulf (SG), respectively.
- The 2021/22 TACCs for all stocks are not expected to be caught based on the percentage of the TACC caught to date and the remaining length of the 2021/22 fishing season.
- The percentage of uncaught TACC in 2021/22 is likely to be larger than any potential TACC increase for 2022/23. Therefore, a low risk to sustainability was assigned for all Tier 1 stocks.

BACKGROUND

Quota allocations for the 2021/22 fishing season for Tier 1 stocks were calculated and allocated to MSF licence holders on 1 July 2021. These allocations incorporated the results of an exceptional circumstances process that provided additional quota units to licence holders with successful applications. The quota allocations for these fishers may be raised following applications to South Australian Civil and Administrative Tribunal (SACAT). This would increase the total number of units in the fishery from those allocated on 1 July 2021.

Currently, the TACCs for the 2021/22 fishing season for all Tier 1 stocks managed by Individual Transferable Quota (ITQ) were set using estimates of recent average annual catch. The only exception was Snapper in the South East (SE) fishing zone which had a TAC set using a model-based recommended biological catch. However, no additional quota will be allocated for Snapper in the SE fishing zone as no licence holders that were included in the exceptional circumstances process had catch history for this stock.

In April 2022, the MSFMAC recommended that all TACCs be maintained for the 2022/23 fishing season (see Appendices). Currently, Snapper fishing is prohibited until 1 February 2023 in the GSV, SG and West Coast (WC) fishing zones. Therefore, the MSFMAC did not recommend a TACC for these stocks.

PIRSA Fisheries and Aquaculture have requested advice on the risk to Tier 1 stocks if the TACCs recommended by the MSFMAC were increased for the 2022/23 season to enable carry-over of (i) uncaught quota entitlements on individual licences from the 2021/22 season to the 2022/23 season up to a maximum of 10% of total quota entitlements (unknown until the completion of the 2021/22 season; termed ‘existing entitlement carry-over’), and (ii) 100% of quota for EC applicants that could not have been fished during the 2021/22 fishing season (termed ‘new potential quota unit carry-over’).

RESULTS

The risk of both options was considered based on three pieces of information:

1. The status of each stock
2. The percentage of the TACC caught to date for the 2021/22 fishing season
3. The increase in allocated quota units for each stock

Snapper

Snapper did not need to be considered in this analysis as no additional quota units will be allocated for the SE fishing zone and TACCs have not been set for Snapper in the GSV, SG and WC fishing zones for the 2022/23 fishing season.

King George Whiting

- Both GSV and SG stocks were classified as **sustainable** in the most recent stock assessment (Drew et al. 2021).
- Less than 50% of the TACC has been caught for either stock with 75% of the fishing season complete (Table 1).
- The maximum existing entitlement carry-over for the GSV and SG stocks is 4.6 t and 11.1 t, respectively.
- The maximum new potential quota carry-over would increase the number of quota units in the fishery by 0.2% and 8.5% for GSV and SG, respectively (Table 2).

Garfish

- In the most recent stock assessment for Garfish, the GSV stock was classified as **depleted,** and the SG stock was classified as **recovering** (Steer et al 2018). These classifications were maintained in the most recent stock status report (Drew et al 2021).
- Less than 60% of the TACC has been caught for either stock with 75% of the fishing season complete (Table 1).
- The maximum existing entitlement carry-over of uncaught quota for the GSV and SG stocks is 7.1 t and 10 t, respectively.
- The maximum new potential quota carry-over would increase the number of quota units in the fishery by 7.4% and 5.3% for GSV and SG, respectively (Table 2).

Southern Calamari

- Both GSV and SG stocks were classified as **sustainable** in the most recent stock status report (Drew et al 2021).
- In GSV 47.41% of the TACC has been caught while 54.68% of the TACC has been caught in SG with 75% of the fishing season complete (Table 1).
- The maximum existing entitlement carry-over of uncaught quota for the GSV and SG stocks is 16.2 t and 20.4 t, respectively.
- The maximum new potential quota carry-over would increase the number of quota units in the fishery by 3.7% and 5.2% for GSV and SG, respectively (Table 2).

Table 1. The 2021/22 TACCs for Tier 1 stocks and the percentage of each TACC caught by March 2022

SPECIES	Zone	TACC (T)	% TACC CAUGHT
GARFISH	GSV	71	55.15
GARFISH	SG	100	53.18
KING GEORGE	GSV	46	42.28
KING GEORGE	SG	111	46.93
SNAPPER	SE	36	48.63
SOUTHERN	GSV	162	47.41
SOUTHERN	SG	204	54.68

DISCUSSION

There is a low risk to all stocks if the TACCs recommended by the MSFMAC were increased for the 2022/23 season to enable carry-over of uncaught quota entitlements on individual licences from the 2021/22 season to the 2022/23 season, up to a maximum of 10% of total quota entitlements. This is because the total catch would remain below the allocated TACC for 2021/22.

It is unlikely that the TACC will be caught for any Tier 1 stock during the 2021/22 fishing season (Table 1). Consequently, there is also a low risk to all stocks if the TACCs recommended by the MSFMAC were increased for the 2022/23 season to enable 100% carry-over of quota for EC applicants that could not have been fished during the 2021/22 fishing season. This is because the total catch is expected to remain below, or close to, the allocated TACC for 2021/22.

Table 2. The additional quota units for Tier 1 stocks that may be allocated to MSF licence holders.

Species	Zone	Additional units (EC)	Total MSF units	Total fishery units	Updated total fishery units	% increase of total fishery units
GARFISH	GSV	147.19	2000	2000	2147.19	7.4%
GARFISH	SG	106.81	1998	2000	2106.81	5.3%
KING GEORGE WHITING	GSV	3.81	1944	2000	2003.81	0.2%
KING GEORGE WHITING	SG	170.56	1958	2000	2170.56	8.5%
SNAPPER	GSV	450.12	3972	4000	4450.12	11.3%
SNAPPER	SG	97.04	3984	4000	4097.04	2.4%
SNAPPER	WC	74.61	992	1000	1074.61	7.5%
SOUTHERN CALAMARI	GSV	149.19	4000	4000	4149.19	3.7%
SOUTHERN CALAMARI	SG	209.74	3928	4000	4209.74	5.2%

Dr Mike Steer
Research Director, Aquatic & Livestock Sciences

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REFERENCES

Drew, M.J., Fowler, A.J., McGarvey, R., Feenstra, J., Bailleul, F., Matthews, D., Matthews, J.M., Earl, J., Rogers, T.A., Rogers, P.J., Tsolos, A. and Smart, J.J. (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019 Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254pp.

Steer, M.A., Fowler, A.J., McGarvey, R., Feenstra, J., Smart, J., Rogers, P.J., Earl, J., Beckmann, C., Drew, M. and Matthews, J. (2018). Assessment of the South Australian Marine Scalefish Fishery in 2017. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000427-2. SARDI Research Report Series No. 1002. 230pp.

APPENDICES

Species summary templates considered by the MSFMAC when providing TACC recommendations in April 2022.

Southern Garfish *Hyporhamphus melanchir*

Gulf St Vincent/Kangaroo Island

Last revised: 25 March 2022

Stock summary	
Stock status	**Depleted** (2019)
Stock assessment	Tier 1 species – last assessment was 2017 (Steer et al 2018). Most recent stock status was assigned in 2019 (Drew et al 2021).
Fishery/stock trend	Southern Garfish in the Gulf St Vincent/Kangaroo Island (GSV/KI) fishing zone experienced exploitation rates of more than 80% during the 1990's when the population was only sustained through high levels of recruitment. During this period, few fish survived past age two and the population age structure was severely truncated. Management measures implemented since 2005 have reduced exploitation rates. However, biomass has not recovered, age structures have remained truncated, and recruitment is impaired. Therefore, this stock was classified as **depleted** in the last stock assessment (Steer et al 2018).

Current management measure and catch

RBC – recommended biological catch

RBCC - recommended biological commercial catch

TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)

Commercial catch and TACC

Year	Total commercial catch (t)	RBC (t)	RBCC (t)	TACC (t)
2016/17	75	-	-	-
2017/18	81	-	-	-
2018/19	81	-	-	-
2019/20	62	-	-	-
2020/21	67	-	-	-
2021/22	-	-	-	71

Sector allocations (State-wide)

Commercial		Recreational	Aboriginal traditional	Total
MSF	79.33%	19.5%	1%	100%
SZRL	0.13%			
NZRL	0.04%			

Sector allocations Allocations in the current management plan are statewide.					

Current assessment program

- Weekly length and age structures collected through market sampling in Adelaide.
- Annual fishery statistics provided through a stock status report
- Application of a length-and-age-structured population model every three years
- Recreational data collected every five years through statewide recreational survey
- No information is available for Aboriginal/Traditional fishing.

Assessment summary

There are two biological stocks in the GSV/KI fishing zone which occur in the northern and southern regions. The northern Gulf St Vincent (NGSV) stock constitutes the majority of the biomass and is predominantly fished with haul nets. The southern Gulf St Vincent (SGSV) stock has a much smaller biomass and is fished with dab nets due to haul netting restrictions in this region. Most of the catch and effort for the GSV/KI fishing zone occurs in NGSV via the haul net fishery.

The most recent stock assessment included data up until September 2017 using a weight-of-evidence approach (Steer et al 2018). The GarEst stock assessment model for the GSV/KI fishing zone combines both NGSV and SGSV stocks as some biological mixing occurs, despite demographic separation. The GarEst model includes data on commercial catch and effort, commercial age and length structures, and recreational and charter boat catch and effort. Numerous management measures have been implemented since 2005 which included licence reduction schemes, spatial and temporal closures, changes to gear restrictions and changes to legal minimum length. This assessment demonstrated that these management measures have not yet allowed the stock recovery to occur. As a result, the stock was classified as **depleted**.

The 2021/22 TACC of 100 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.

RBC / TACC options for 2022/23

Sector catch shares

Regional catch shares were calculated according to the PIRSA allocation policy

Sector	Commercial sector catch share (%)	Target H in management plan (0.3)	Target H = 2/3M (0.23)	2021/22 TACC	Five-year average commercial catch (2016/17 – 2020/21)
RBC	100	61 t	48 t	-	-
TACC	82	50 t	39 t	71 t	73 t

The RBC’s were determined from average five-year biomass estimates from the last assessment (2013-2017).

using new MSF zones. M = natural mortality	
Research needs	- Development of harvest strategy with performance indicators, reference points and harvest control rules. - Standardisation of commercial CPUE, using improved measures of fishing effort. - Improved estimates of recreational catch and effort.
SSC recommendation	A new stock assessment was being finalised and the results still being considered. The previous assessment indicated signs of stock recovery and there are continuing trends of stock recovery in the new assessment. The target harvest fraction of 30% as provided in the MSF Management Plan was considered appropriate for the species. Whilst the stock has a depleted status, the biomass has been stable and there was a significantly reducing harvest fraction. Catches in recent years were below average and this was likely due to a combination of changes to the legal minimum length in addition to MSF reform and covid-19 market related impacts. Noting the above factors, the MSFMAC considered there was no basis to reduce catch limits and recommended a rollover of the current 2021/22 TACC of 71t.
References	Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp. Steer, M.A., Fowler, A.J., McGarvey, R., Feenstra, J., Smart, J., Rogers, P.J., Earl, J., Beckmann, C., Drew, M. and Matthews, J. (2018). Assessment of the South Australian Marine Scalefish Fishery in 2017. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000427-2. SARDI Research Report Series No. 1002. 230pp.

Southern Garfish *Hyporhamphus melanchir*

Spencer Gulf

Last revised: 25 March 2022

<table>
<tr><th colspan="6">Stock summary</th></tr>
<tr><td>Stock status</td><td colspan="5">Recovering (2019)</td></tr>
<tr><td>Stock assessment</td><td colspan="5">Tier 1 species – last assessment was 2017 (Steer et al 2018). Most recent stock status was assigned in 2019 (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td colspan="5">Southern Garfish in the Spencer Gulf (SG) fishing zone experienced exploitation rates of more than 90% during the 1990’s when the population was only sustained through high levels of recruitment. During this period, few fish survived past age two and the population age structure was severely truncated.
Management measures implemented since 2005 have allowed stock recovery. Exploitation has been reduced, biomass has been stable and age structures have become less truncated. However, as of the last assessment, biomass has not yet begun to increase and recruitment remains impaired.</td></tr>
<tr><td rowspan="14">Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
Sector allocations
Allocations in the current</td><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>107</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>91</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>110</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>99</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>109</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
<tr><th colspan="5">Sector allocations (State-wide)</th></tr>
<tr><td colspan="2">Commercial</td><td>Recreational</td><td>Aboriginal traditional</td><td>Total</td></tr>
<tr><td>MSF</td><td>79.33%</td><td rowspan="3">19.5%</td><td rowspan="3">1%</td><td rowspan="3">100%</td></tr>
<tr><td>SZRL</td><td>0.13%</td></tr>
<tr><td>NZRL</td><td>0.04%</td></tr>
</table>

<table>
<tr><td>management plan are statewide.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Current assessment program</td><td colspan="5">Weekly length and age structures collected through market sampling in Adelaide.
Annual fishery statistics provided through a stock status report
Application of a length-and-age-structured population model every three years
Recreational data collected every five years through statewide recreational survey
No information is available for Aboriginal/Traditional fishing.</td></tr>
<tr><td>Assessment summary</td><td colspan="5"><p>There are two biological stocks in the SG fishing zone which occur in the northern and southern regions. The northern Spencer Gulf (NSG) stock constitutes the majority of the biomass and is predominantly fished with haul nets. The southern Spencer Gulf (SSG) stock has a much smaller biomass and is fished with dab nets due to haul netting restrictions in this region. Most of the catch and effort for the SG fishing zone occurs in NSG via the haul net fishery.</p><p>The most recent stock assessment included data up until September 2017 using a weight-of-evidence approach (Steer et al 2018). The GarEst stock assessment model for the SG fishing zone combines both NSG and SSG stocks as some biological mixing occurs, despite demographic separation. The GarEst model includes data on commercial catch and effort, commercial age and length structures, and recreational and charter boat catch and effort. Numerous management measures have been implemented since 2005 which included licence reduction schemes, spatial and temporal closures, changes to gear restrictions and changes to legal minimum length. This assessment demonstrated that these management measures have been effective and that the stock was recovering.</p><p>The 2021/22 TACC of 100 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.</p></td></tr>
<tr><td><p>RBC / TACC options for 2022/23</p><p><u>Sector catch shares</u></p><p>Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.</p></td><td colspan="5">
<table>
<tr><th>Sector</th><th>Commercial sector catch share (%)</th><th>Target H in management plan (0.3)</th><th>Target H = 2/3M (0.23)</th><th>2021/22 TACC</th><th>Five-year average commercial catch (2016/17 – 2020/21)</th></tr>
<tr><td>RBC</td><td>100</td><td>79 t</td><td>62 t</td><td>-</td><td>-</td></tr>
<tr><td>TACC</td><td>78</td><td>62 t</td><td>48 t</td><td>100 t</td><td>102 t</td></tr>
</table>
<p>The RBC’s were determined from average five-year biomass estimates from the last assessment (2013-2017).</p></td></tr>
</table>

M = natural mortality	
Research needs	• Development of harvest strategy with performance indicators, reference points and harvest control rules. • Standardisation of commercial CPUE, using improved measures of fishing effort. • Improved estimates of recreational catch and effort.
SSC recommendation	A new stock assessment was being finalised and the results still being considered. The target harvest fraction of 30% as provided in the MSF Management Plan was considered appropriate for the species. Whilst the stock has a recovering status, the stable to increasing biomass and reducing harvest fraction indicate that recent catches have been at an appropriate level. It was noted that positive changes have been observed by SARDI in the age structure of the stock. Noting the above factors, the MSFMAC considered there to be no basis to reduce catch limits, and recommended a rollover of the current 2021/22 TACC of 100t.
References	Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp. Steer, M.A., Fowler, A.J., McGarvey, R., Feenstra, J., Smart, J., Rogers, P.J., Earl, J., Beckmann, C., Drew, M. and Matthews, J. (2018). Assessment of the South Australian Marine Scalefish Fishery in 2017. Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000427-2. SARDI Research Report Series No. 1002. 230pp.

King George Whiting *Sillaginodes punctatus*

Gulf St. Vincent / Kangaroo Island

Last revised: 23 March 2022

<table>
<tr><th colspan="2">Stock summary</th></tr>
<tr><td>Stock status</td><td>Sustainable (2019)</td></tr>
<tr><td>Stock assessment</td><td>Tier 1 species – last assessment was 2019 (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td>Fishable biomass has been stable for the past ten years at ~650 t. The harvest fraction has had a decreasing trend during this period and was estimated as 20% in 2019. Targeted hand line CPUE has had an increasing trend over this period which has been driven through consistent annual decreases of commercial catch and effort.</td></tr>
<tr><td>Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
Sector allocations
Allocations in the current</td><td>
<table>
<tr><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>52</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>37</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>40</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>42</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>31</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td></td><td>-</td><td>-</td><td>46</td></tr>
</table>
<table>
<tr><th colspan="6">Sector allocations (State-wide)</th></tr>
<tr><td colspan="2">Commercial</td><td colspan="2">Recreational</td><td>Aboriginal traditional</td><td>Total</td></tr>
<tr><td>MSF</td><td>49.5%</td><td>REC</td><td>45.5%</td><td rowspan="3">1%</td><td rowspan="3">100%</td></tr>
<tr><td>SZRL</td><td>0%</td><td rowspan="2">CHT</td><td rowspan="2">3%</td></tr>
<tr><td>NZRL</td><td>1%</td></tr>
</table>
</td></tr>
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Department of Primary Industries and Regions

<table>
<tr><td>management plan are statewide.</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Current assessment program</td><td colspan="6">
- Weekly length and age structures collected through market sampling in Adelaide and regional areas.
- Annual fishery statistics provided through a stock status report
- Application of a length-and-age-structured population model every three years
- Recreational data collected every five years through statewide recreational survey
- Daily egg production methods (DEPM) have been established to estimate spawning biomass but are not undertaken as part of ongoing assessments.
- No information is available for Aboriginal/Traditional fishing.
</td></tr>
<tr><td>Assessment summary</td><td colspan="6">The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary fishery performance indicators were total catch, targeted handline catch, targeted handline CPUE, and fishery age structure. All datasets pertaining to the fishery were integrated in a computer stock assessment model (WhitEst) that produced time-series of annual estimates of output parameters that included fishable biomass, recruitment, harvest fraction and egg production. This assessment demonstrated that this stock was sustainable.

The 2021/22 TACC of 46 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.</td></tr>
<tr><td>RBC / TACC options for 2022/23

<u>Sector catch shares</u>

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.

M = natural mortality</td><td colspan="6">
<table>
<tr><th>Sector</th><th>Commercial sector catch share (%)</th><th>Target H in management plan (0.28)</th><th>Target H = 2/3M (0.125)</th><th>2021/22 TACC</th><th>Five-year average commercial catch (2016/17 – 2020/21)</th></tr>
<tr><td>RBC</td><td>100</td><td>184 t</td><td>74 t</td><td>-</td><td>-</td></tr>
<tr><td>TACC</td><td>40</td><td>82 t</td><td>33 t</td><td>46 t</td><td>40 t</td></tr>
</table>

The RBC’s were determined from average five-year biomass estimates from the last assessment (2015-2019).
</td></tr>
</table>

Research needs	• Development of harvest strategy with performance indicators, reference points and harvest control rules. • Standardisation of commercial CPUE, using improved measures of fishing effort • Improved estimates of recreational catch and effort.
SSC recommendation	The stock was classified as sustainable with a stable and increasing biomass, declining harvest fraction and increasing CPUE. There had been no change in status since the current catch limits had been set. The harvest fraction of 28% provided in the Management Plan was no longer considered appropriate for King George Whiting. The SSC noted the latest year's catch was below the 5yr average and this was likely due to a combination of the reform, covid-19 and market-related impacts contributing to less targeting of the species. Considering the above, the SSC considered there to be no basis to reduce the current catch limit and recommended to rollover the current 2021/22 TACC of 46t.
References	Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

King George Whiting *Sillaginodes punctatus*

Spencer Gulf

Last revised: 23 March 2022

<table>
<tr><th colspan="6">Stock summary</th></tr>
<tr><td>Stock status</td><td colspan="5">Sustainable (2019)</td></tr>
<tr><td>Stock assessment</td><td colspan="5">Tier 1 species – last assessment was 2019 (Drew et al 2021)</td></tr>
<tr><td>Fishery/stock trend</td><td colspan="5">Trends in fishable biomass have been cyclical since 1984, reflecting periods of increase and decline, but nevertheless have shown a long-term increase. Biomass has been stable for the past five years at ~1,500 t. The harvest fraction been stable since the early 2000s and was 20% in 2019. Recruitment, which has historically been heavily cyclical in nature, declined steeply from 2016 to 2019. However, the lower recruitment during that period was not reflected in lower fishable biomass, with low exploitation rates in recent years enabling the highest estimated biomass levels in recent years to be retained.
Targeted handline CPUE has shown a long-term increasing trend, although with clear cyclical variation. It increased to a record-high level in 2016, and then marginally declined in the three subsequent years to a moderate–high level in 2019. Catch and targeted handline effort have been stable at low levels since 2010.</td></tr>
<tr><td rowspan="10">Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable</td><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>126</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>108</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>103</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>96</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>69</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td></td><td>-</td><td>-</td><td>111</td></tr>
<tr><th colspan="5">Sector allocations (State-wide)</th></tr>
<tr><td colspan="2">Commercial</td><td>Recreational</td><td>Aboriginal traditional</td><td>Total</td></tr>
</table>

<table>
<tr><td rowspan="3">commercial catch (based on 5-yr average catch from 2015–2019)

<u>Sector allocations</u>
Allocations in the current management plan are statewide.</td><td>MSF</td><td>49.5%</td><td>REC</td><td>45.5%</td><td rowspan="3">1%</td><td rowspan="3">100%</td></tr>
<tr><td>SZRL</td><td>0%</td><td rowspan="2">CHT</td><td rowspan="2">3%</td></tr>
<tr><td>NZRL</td><td>1%</td></tr>
<tr><td>Current assessment program</td><td colspan="6">Weekly length and age structures collected through market sampling in Adelaide and regional areas.
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Application of a length-and-age-structured population model every three years
Recreational data collected every five years through statewide recreational survey
Daily egg production methods (DEPM) have been established to estimate spawning biomass but are not undertaken as part of ongoing assessments.
No information is available for Aboriginal/Traditional fishing.</td></tr>
<tr><td>Assessment summary</td><td colspan="6">The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary fishery performance indicators were total catch, targeted handline catch, targeted handline CPUE, and fishery age structure. All datasets pertaining to the fishery were integrated in a computer stock assessment model (WhitEst) that produced time-series of annual estimates of output parameters that included fishable biomass, recruitment, harvest fraction and egg production. This assessment demonstrated that this stock was sustainable.

The 2021/22 TACC of 111 t was recommended by the SnapperMAC and was calculated based on the average 5-year annual commercial catch from 2015–2019.</td></tr>
<tr><td>RBC / TACC options for 2022/23

<u>Sector catch shares</u></td><td colspan="6"><table><tr><th>Sector</th><th>Commercial sector catch share (%)</th><th>Target H in management plan (0.28)</th><th>Target H = 2/3M (0.125)</th><th>2021/22 TACC</th><th>Five-year average commercial catch (2016/17 – 2020/21)</th></tr><tr><td>RBC</td><td>100</td><td>418 t</td><td>187 t</td><td>-</td><td>-</td></tr><tr><td>TACC</td><td>44</td><td>184 t</td><td>82 t</td><td>111 t</td><td>100 t</td></tr></table></td></tr>
</table>

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones. M = natural mortality	• The RBC’s were determined from average five-year biomass estimates from the last assessment (2015-2019).
Research needs	• Development of harvest strategy with performance indicators, reference points and harvest control rules. • Standardisation of commercial CPUE, using improved measures of fishing effort. • Improved estimates of recreational catch and effort.
SSC recommendation	The stock was classified as sustainable with a stable and increasing biomass and declining harvest fraction. There had been no change in status since the 2021/22 TAC had been set. The harvest fraction of 28% was no longer considered appropriate for King George Whiting. The SSC noted the latest year’s catch was below the 5yr average MSF average and this was likely due to a combination of the MSF reform, Covid-19 and market-related impacts contributing to less targeting of the species. Considering the above the factors the MSFMAC considered there was no basis to change the current catch limits and recommended a rollover of the current 2021/22 TACC of 111t.
References	Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

Southern Calamari *Sepioteuthis australis*

Gulf St Vincent/Kangaroo Island

Last revised: 23 March 2022

<table>
<tr><th colspan="6">Stock summary</th></tr>
<tr><td>Stock status</td><td colspan="5">Sustainable (2019)</td></tr>
<tr><td>Stock assessment</td><td colspan="5">Tier 1 species – no stock assessment has been undertaken. Most recent stock status was assigned in 2019 at the State-wide / biological stock level (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td colspan="5">Annual catches have been relatively stable at moderate levels over the past ten years, consistent with stable targeted jig effort and targeted jig CPUE. In the past 5 years, catch has declined, consistent with a decline in targeted jig effort, while estimates of targeted jig CPUE for northern and southern GSV have been stable at moderate–high levels. This information indicates that biomass is unlikely to be depleted and that recruitment is unlikely to be impaired. The current level of fishing mortality is unlikely to reduce biomass to a recruitment impaired state.</td></tr>
<tr><td rowspan="15">Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)</td><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>170</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>176</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>150</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>154</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>129</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td>-</td><td>-</td><td>-</td><td>162</td></tr>
<tr><th colspan="5">Sector allocations (State-wide)</th></tr>
<tr><td colspan="2">Commercial</td><td>Recreational</td><td>Aboriginal / Traditional</td><td>Total</td></tr>
<tr><td>MSF</td><td>56%</td><td rowspan="5">37.4%</td><td rowspan="5">1%</td><td rowspan="5">100%</td></tr>
<tr><td>NZRL</td><td>0.45%</td></tr>
<tr><td>GSVPF</td><td>0.45%</td></tr>
<tr><td>SGPF</td><td>4.6%</td></tr>
<tr><td>WCPF</td><td>0.1%</td></tr>
</table>

<u>Sector allocations</u> Allocations in the current management plan are statewide.					

Current assessment program

- No formal stock assessment.
- Annual fishery statistics provided through a stock status report.
- Recreational data collected every five years through statewide recreational survey.
- No information is available for Aboriginal/Traditional fishing.

Assessment summary

The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary measure for biomass and fishing mortality is targeted jig CPUE. This assessment demonstrated that South Australia's Southern Calamari stock was **sustainable.**

The 2021/22 TACC of 162 t was recommended by the SnapperMAC, and was calculated based on the average annual commercial catch from the from 2015–2019.

RBC / TACC options for 2022/23

<u>Sector catch shares</u>

Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.

Hmsy = Harvest fraction corresponding to maximum sustainable yiefd (MSY)

Sector	Commercial sector catch share (%)	Target Hmsy (0.39)	Target H = 2/3Hmsy (0.26)	2021/22 TACC	Five-year average commercial catch (2016/17 – 2020/21)
RBC	100	358 t	238 t	-	-
TACC	62	216 t	143 t	162 t	156 t

Research needs	• Development of a stock assessment program that can be used to assign stock status, estimate RBCs and inform setting of TACCs. • Development of harvest strategy with performance indicators, reference points and harvest control rules. • Standardisation of commercial CPUE, using improved measures of fishing effort • Improved estimates of recreational catch and effort.
SSC recommendation	There is no formal stock assessment for Southern Calamari and it was noted that only commercial catch statistics were available to evaluate. Hmsy figures provided in previous recommendations were based on catch-only models and there was less confidence in the appropriateness of these for Southern Calamari. It was recognised that CPUE had been stable. Noting the above, the MSFMAC considered there was no basis to change the current catch limits and recommended a rollover of the current 2021/22 TACC of 162t.
References	Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

Southern Calamari *Sepioteuthis australis*

Spencer Gulf

Last revised: 23 March 2022

<table>
<tr><th colspan="6">Stock summary</th></tr>
<tr><td>Stock status</td><td colspan="5">Sustainable (2019)</td></tr>
<tr><td>Stock assessment</td><td colspan="5">Tier 1 species – no stock assessment has been undertaken. Most recent stock status was assigned in 2019 at the State-wide / biological stock level (Drew et al 2021).</td></tr>
<tr><td>Fishery/stock trend</td><td colspan="5">There has been evidence of regional depletion in the northern and southern Spencer Gulf over the past ten years. This was particularly evident in southern Spencer Gulf where targeted jig CPUE declined by 31% between 2012 and 2019. Similar declines in targeted jig CPUE had also been occurring over this period in northern Spencer Gulf but with less severity. A sustainable status was assigned at the State-wide/biological stock level.</td></tr>
<tr><td rowspan="15">Current management measure and catch
RBC – recommended biological catch
RBCC - recommended biological commercial catch
TACC – total allowable commercial catch (based on 5-yr average catch from 2015–2019)
Sector allocations
Allocations in the current</td><th colspan="5">Commercial catch and TACC</th></tr>
<tr><th>Year</th><th>Total commercial catch (t)</th><th>RBC (t)</th><th>RBCC (t)</th><th>TACC (t)</th></tr>
<tr><td>2016/17</td><td>218</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2017/18</td><td>235</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2018/19</td><td>164</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2019/20</td><td>185</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2020/21</td><td>206</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2021/22</td><td></td><td>-</td><td>-</td><td>204</td></tr>
<tr><th colspan="5">Sector allocations (State-wide)</th></tr>
<tr><td colspan="2">Commercial</td><td>Recreational</td><td>Aboriginal / Traditional</td><td>Total</td></tr>
<tr><td>MSF</td><td>56%</td><td rowspan="5">37.4%</td><td rowspan="5">1%</td><td rowspan="5">100%</td></tr>
<tr><td>NZRL</td><td>0.45%</td></tr>
<tr><td>GSVPF</td><td>0.45%</td></tr>
<tr><td>SGPF</td><td>4.6%</td></tr>
<tr><td>WCPF</td><td>0.1%</td></tr>
</table>

<table>
<tr><td>management plan are statewide.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Current assessment program</td><td colspan="5">No formal stock assessment.
Annual fishery statistics provided through a stock status report.
Recreational data collected every five years through statewide recreational survey.
No information is available for Aboriginal/Traditional fishing.</td></tr>
<tr><td>Assessment summary</td><td colspan="5">The most recent stock assessment was completed for data up until 31 December 2019 using a weight-of-evidence approach (Drew et al. 2021). The primary measure for biomass and fishing mortality is targeted jig CPUE. This assessment demonstrated that South Australia’s Southern Calamari stock was sustainable.
The 2021/22 TACC of 204 t was recommended by the SnapperMAC, and was calculated based on the average annual commercial catch from the from 2015–2019.</td></tr>
<tr><td>RBC / TACC options for 2022/23
<u>Sector catch shares</u>
Regional catch shares were calculated according to the PIRSA allocation policy using new MSF zones.
Hmsy = Harvest fraction corresponding to maximum sustainable yiefd (MSY)</td><td colspan="5"><table>
<tr><th>Sector</th><th>Commercial sector catch share (%)</th><th>Target Hmsy (0.39)</th><th>Target H = 2/3Hmsy (0.26)</th><th>2021/22 TACC</th><th>Five-year average commercial catch (2016/17 – 2020/21)</th></tr>
<tr><td>RBC</td><td>100</td><td>400 t</td><td>267 t</td><td>-</td><td>-</td></tr>
<tr><td>TACC</td><td>62</td><td>247 t</td><td>165 t</td><td>204 t</td><td>202 t</td></tr>
</table></td></tr>
<tr><td>Research needs</td><td colspan="5">Development of a stock assessment program that can be used to assign stock status, estimate RBCs and inform setting of TACCs.
Development of harvest strategy with performance indicators, reference points and harvest control rules.</td></tr>
</table>

	- Standardisation of commercial CPUE, using improved measures of fishing effort - Improved estimates of recreational catch and effort.
SSC recommendation	There is no formal stock assessment for Southern Calamari and it was noted that only commercial catch statistics were available to evaluate. Hmsy figures provided in previous recommendations were based on catch-only models and there was less confidence in the appropriateness of these for Southern Calamari. It was recognised that CPUE had been increasing in recent years. Noting the above, the MSFMAC considered there was no basis to change the current catch limits and recommended a rollover of the current 2021/22 TACC of 204 t.
References	Drew, M., A. J. Fowler, R. McGarvey, J. E. Feenstra, F. Bailleul, D. Matthews, J. M. Matthews, J. Earl, T. A. Rogers, P. J. Rogers, A. Tsolos and J. Smart (2021). Assessment of the South Australian Marine Scalefish Fishery in 2019. Report for PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences). SARDI Publication No. F2017/000427-4. SARDI Research Report Series No. 1109. 254 pp.

Doc 20

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **A/PROF. ADRIAN LINNANE (SARDI AQUATIC SCIENCES)**

SUBJECT: **SIMULTANEOUS USE OF MAXIMUM ROCK LOBSTER AND GIANT CRAB POT ENTITLEMENTS**

DATE: **12 NOVEMBER 2021**

KEY ISSUES

- There has been a request from NZRLF licence holders who are endorsed with giant crab and rock lobster to allow the following: (i) Use their Northern Zone Rock Lobster License with 100 pots to carry out rock lobster fishing operations; and (ii) at the same time be able to use their Northern Zone Rock Lobster License with 100 pots to carry out Northern Zone Giant Crab fishing operations.
- PIRSA Fisheries and Aquaculture have requested an Advice Note on the impacts associated with increasing the pot numbers individual licence holders are able to use in the NZRLF. Specifically, advice is requested on any sustainability issues and impacts on CPUE and the TACC decision rule in the rock lobster harvest strategy for the fishery.
- If both rock lobster and giant crab fishing was conducted simultaneously, it is reasonable to assume that some rock lobsters would be caught in giant crab pots. The catch per unit effort (CPUE) used to set the annual rock lobster TACC is based on lobsters caught in nominated rock lobster pots only.
- If the maximum number of pots allowed for both giant crab and rock lobster were set on one day, it could be assumed that the soak time, for at least some pots, will be longer than 24 hours for operational reasons.
- Over 98% of within-pot mortality is attributable to predation by Maori octopus in South Australia, with approximately 4% of the total annual catch lost to predation. Within-pot mortalities increase with soak time.
- If CPUE is underestimated due to large numbers of rock lobster pots being fished with longer soak times, this could result in lower levels of TACC being recommended than are warranted.

BACKGROUND

There has been a request from NZRLF licence holders who are endorsed with giant crab and rock lobster to allow the following: (i) Use their Northern Zone Rock Lobster License with 100 pots to carry out rock lobster fishing operations; and (ii) at the same time be able to use their Northern Zone Rock Lobster License with 100 pots to carry out Northern Zone Giant Crab fishing operations.

PIRSA Fisheries and Aquaculture have requested an Advice Note on the impacts associated with increasing the pot numbers individual licence holders are able to use in the NZRLF. Specifically, advice is requested on any sustainability issues and impacts on CPUE and the TACC decision rule in the rock lobster harvest strategy for the fishery.

RESULTS/DISCUSSION

The maximum number of pots that can be used to fish in each of the rock lobster and giant crab fisheries in the NZRLF is 100 (PIRSA 2014). However, rock lobster fishers rarely use this amount as it exceeds the number of pots that can be set and retrieved effectively in a 24-hour period. If both rock lobster and giant crab fishing was conducted simultaneously, it is reasonable to assume that some rock lobsters would be caught in giant crab pots.

The key performance indicator for the NZRLF is annual catch per unit effort (CPUE) of legal sized lobster. It is calculated as total weight divided by total potlifts from nominated rock lobster pots only, based on data from November to April inclusive. In the harvest strategy decision rule, the annual CPUE from the previous season is used to set a TACC for the upcoming season.

Therefore, to maintain the integrity of the harvest control rule, any rock lobsters caught in giant crab pots would need to be removed from any rock lobster CPUE calculation.

If the maximum number of pots allowed for both giant crab and rock lobster were set on one day, it could be assumed that the soak time, for at least some pots, will be longer than 24 hours for operational reasons.

Over 98% of within-pot mortality is attributable to attacks by Maori octopus in South Australia, with approximately 4% of the total annual catch lost to predation. Within-pot mortalities increase with soak time (Brock and Ward 2004). Any increase in within-pot mortality is negative from both sustainability and economic perspectives.

If large numbers of rock lobster pots were fished with increased soak times, this has the potential to reduce daily catch rates which, in turn, could result in the annual CPUE underestimating lobster abundance. Consequently, as CPUE is the primary indicator driving TACCs in the harvest strategy decision rule, this could result in lower levels of TACC being recommended than are warranted.

Dr. Michael Steer
Research Director, Aquatic Sciences

Disclaimer

REFERENCES

Brock, D. J. and Ward, T. M. (2004). Maori octopus (*Octopus maorum*) bycatch and southern rock lobster (*Jasus edwardsii*) mortality in the South Australian lobster fishery. Fishery Bulletin, 102: 430-440.

PIRSA (2021). The South Australian Fisheries Management Series. Paper number 81: Management Plan for the South Australian Commercial Northern Zone Rock Lobster Fishery. ISBN 978-0-64822-04-6-6. ISSN 1322-8072.

Doc 21

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR JONATHAN SMART (SARDI AQUATIC SCIENCES)**

SUBJECT: **REMOVAL OF SEASONAL CLOSURES FOR SNAPPER IN THE SOUTH EAST REGION**

DATE: **10 JULY 2021**

KEY ISSUES

- PIRSA Fisheries and Aquaculture have requested advice in relation to Snapper in the South East of South Australia (SE) regarding sustainability implications for the spawning biomass if the seasonal closures were removed from this region.
- The SE Snapper population is part of the Western Victorian Snapper stock (WVS). This population has recruitment occurring in Port Philip Bay in Victoria (PPB) and density dependent movement from PPB into the SE. The WVS has recently had several large recruitment events, with the largest occurring in 2018. The stock is classified as **Sustainable** (Fowler et al. 2020)**.**
- Based on the limited contribution that spawning in the SE region makes to replenishing the WVS, removing the seasonal spawning closures while a TACC and TARC are in place has a low risk of impacting the stock status classification of 'sustainable'.

BACKGROUND

South Australia has three Snapper stocks: The Spencer Gulf/West Coast stock (SG/WCS), Gulf St Vincent stock (GSVS) and the South East region (SE), with the latter being part of the Western Victorian stock (WVS). Snapper fishing is currently closed in all state-waters until 2023 with the exception of the SE, which is managed using a Total Allowable Catch (TAC) divided between the commercial, charter and recreational sectors according to the allocations listed in the Management Plan (PIRSA 2013).

The Snapper fishing season in the SE extends from 1 February to 31 October each year. A fishing closure is in place during the spawning season from 1 November to 31 January. PIRSA Fisheries and Aquaculture have requested advice about the sustainability implications for Snapper stock sustainability in the SE of removing the seasonal closures from this region.

RESULTS/DISCUSSION

State-wide seasonal closures for Snapper have been implemented since 2000. They serve two purposes: 1) to facilitate more successful spawning by protecting spawning aggregations from disturbance; and 2) to increase stock sustainability by reducing fishing effort when they are most vulnerable to fishing, i.e. aggregated for spawning.

The SE region is part of the WVS which has a 'source and sink' dynamic where recruitment occurs into PPB, after which some fish subsequently migrate to the SE (Figure 1; Fowler 2016). Therefore, spawning events in the SE are unlikely to contribute significantly to local recruitment. Furthermore, it is considered unlikely that large numbers of Snapper migrate from the SE to supplement the spawning population in PPB. Consequently, the stock dynamics of the SE mean that the seasonal closures do not have the same efficacy as they do for the other SA Snapper stocks. In addition, based on the monthly trends in recreational fishing activity from the 2007/08 survey, catch and effort for Snapper in the SE is highest in the summer months when most of the Snapper TARC is likely to be caught (Figure 2).

Based on the limited contribution that spawning Snapper in the SE region likely make to replenishing the WVS, the risk of impact to the stock status classification ‘sustainable’ of removing the seasonal spawning closures while a TACC and TARC are in place is low.

Dr Mike Steer
Research Director, Aquatic Sciences

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REFERENCES

Fowler AJ (2016) The influence of fish movement on regional fishery production and stock structure for South Australia’s Snapper (Chrysophrys auratus) fishery. FRDC Project 2012/020. Final Report.

Fowler, A.J., Smart, J., McGarvey, R., Feenstra, J., Bailleul, F., Buss, J.J., Drew, M., Matthews, D., Matthews, J. and Rogers, T. (2020). Snapper (Chrysophrys auratus) Fishery. Fishery Assessment Report to PIRSA Fisheries and Aquaculture. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. F2007/000523-6. SARDI Research Report Series No. 1072.111pp.

PIRSA (2013). Management Plan for the South Australian Commercial Marine Scalefish Fishery. PIRSA Fisheries and Aquaculture, Adelaide, 143pp. The South Australian Fishery Management Series, Paper No. 59.

APPENDIX

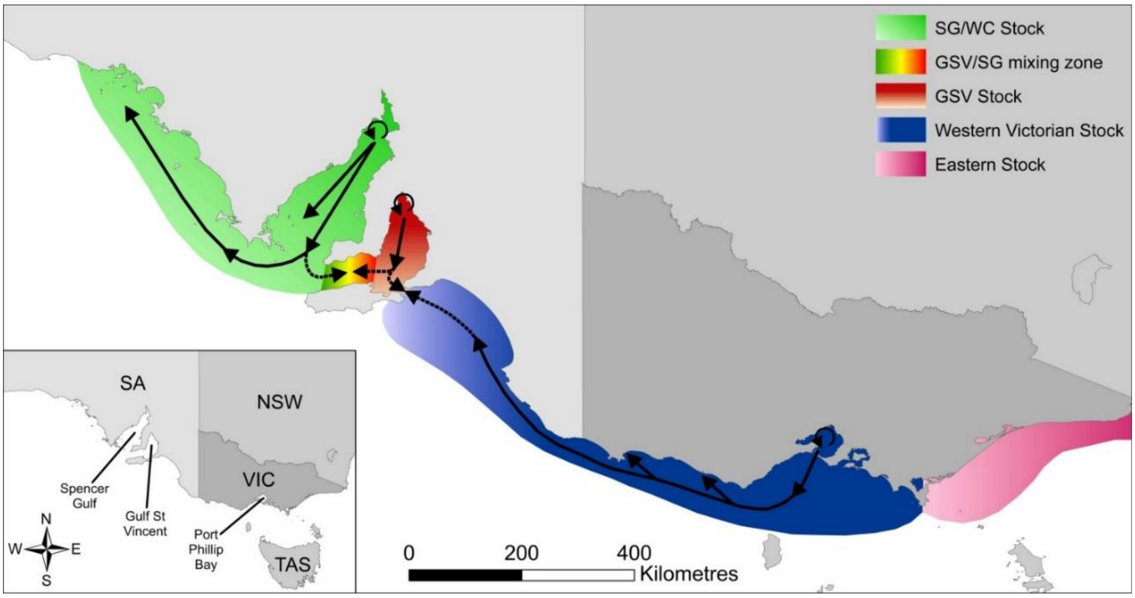

Figure 1: Map of the coast of south eastern Australia, showing the stock structure for Snapper based on fish movement (Fowler 2016). The arrows indicate directions and extent of emigration of fish from three primary nursery areas in Northern Spencer Gulf, Northern Gulf St. Vincent and Port Phillip Bay, Victoria. Inset shows the broader geographic region. SG – Spencer Gulf, GSV – Gulf St. Vincent, WC – west coast of Eyre Peninsula.

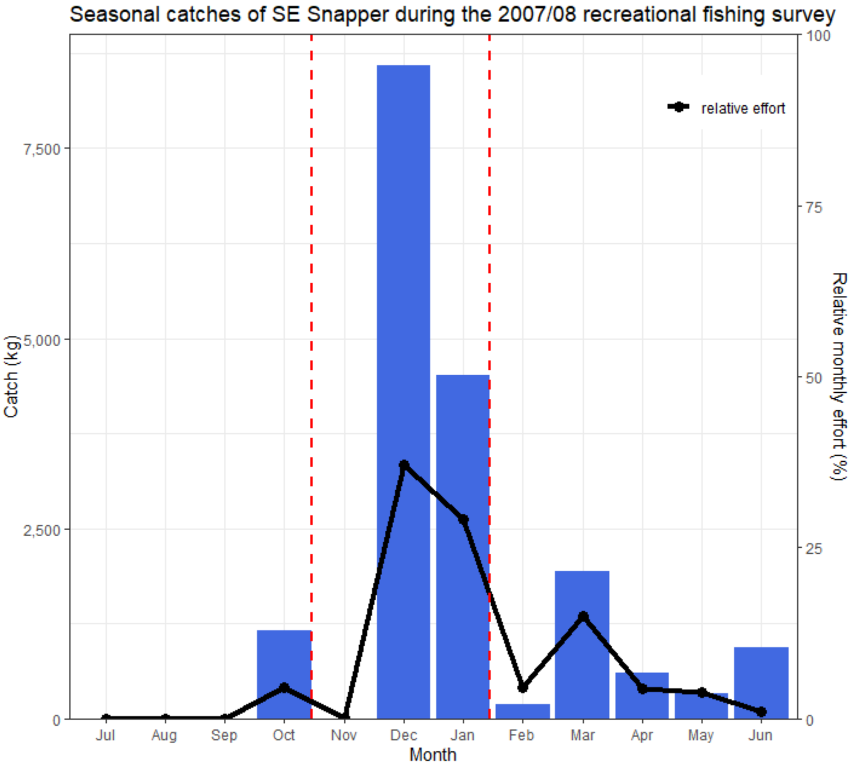

Figure 2: Monthly catch in weight (blue bars) and effort (% of yearly effort) of Snapper in the SE region during the 2007/08 recreational fishing survey. Red vertical lines indicate the current (2021) seasonal closure. In 2007, the seasonal closure only included November accounting for why catch and effort are zero for this month.

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR JONATHAN SMART (SARDI AQUATIC SCIENCES)**

SUBJECT: **SCIENCE USED IN ESTIMATING THE TAC/TACC FOR SNAPPER IN THE SOUTH EAST**

DATE: **28 MAY 2021**

KEY ISSUES

- The SE Snapper fishery is managed using a Total Allowable Catch (TAC) which consists of a Total Allowable Commercial Catch (TACC) and Total Allowable Recreational Catch (TARC).
- For setting the 2020 TAC, the key input to the Snapper Management Advisory Committee (SMAC) was a recent time series of commercial catches. The SMAC recommended a 75 t TAC, and the basis for the recommendation has been made publicly available through the Chairs' report for SMAC Meeting #2 (see PIRSA website).
- In 2019-20, funding was received from the Regional Growth Fund to undertake a Snapper stock assessment program. This program included development of a stock assessment model that produces estimates of stock biomass, and other biological performance indicators, for the SE. The model integrates data on age and length structures, estimates of commercial, charter boat and recreational catches, and commercial handline CPUE. The robustness of the model's outputs is demonstrated by the strong relationship between model-estimated recruitment and an independent recruitment index from Port Philip Bay (PPB) where the SE Snapper are spawned. The model outputs are now the science used to support the TAC setting process.
- Since 2011-12, the SE Snapper fishery has had daily trip limits that have ranged from 350-800 kg. As CPUE is calculated as catch-per-fisher-day, these trip limits have the potential to prevent high CPUE values, particularly for long line CPUE. The impact of trip limits on handline CPUE is negligible. Thus, the stock assessment model for the SE only used commercial handline CPUE.
- For setting the 2021 and 2021-22 TACs, the key scientific input to the SMAC was the estimates of stock biomass from the model and a target harvest fraction range of 20-30%. This level of exploitation was determined based on the stock's historical responses to relative levels of exploitation and recruitment.
- The SMAC recommended 48 t TACs (1 Feb 2021 – 30 June 2021, and 1 July 2021 – 30 June 2022), and the basis for the recommendation has been made publicly available through the Chairs' report for SMAC Meeting #3.

BACKGROUND

South Australia has three Snapper Stocks: the Spencer Gulf/West Coast stock (SG/WCS), the Gulf St Vincent stock (GSVS) and the south east (SE) region of South Australia which forms part of the Western Victorian Stock (WVS). Significant management measures for Snapper were implemented in November 2019, resulting in a state-wide fishery closure for all waters other than the SE. Since 2020, the SE Snapper fishery has been managed using a Total Allowable Catch (TAC) that consisted of a Total Allowable Commercial Catch (TACC) and Total Allowable Recreational Catch (TARC).

RESULTS/DISCUSSION

Science to support SE Snapper TAC setting process

SE Snapper TAC for 2020

The 2020 TAC for SE Snapper was set at 75,000 kg following recommendation by the Snapper Management Advisory Committee (SMAC). This recommendation was based on a recent time series of commercial catches, as no stock assessment model for the SE Snapper fishery was available. These recommendations were documented in the Chairs report from the SMAC Meeting #2.

SE Snapper TAC for 2021 and 2021/22

Following publication of the 2020 Snapper stock assessment report (Fowler et al. 2020), outputs from the recently developed stock assessment model provided the science to support the SE Snapper TAC decision by the SMAC for 2021 and 2021/22.

The model integrates numerous datasets including:

- Age and length structures of SE Snapper collected through catch sampling.
- Commercial and charter boat catches from logbook returns.
- Recreational catches estimated from surveys conducted in 2000/01, 2007/08 and 2014/15 (Jones and Doonan 2005; Jones 2009; Giri and Hall 2015).
- Commercial handline CPUE, calculated as catch-per-fisher-day.

The model provides estimates of stock biomass, harvest fraction, annual recruitment, and egg production for the SE component of the WVS. The model treats movement of juvenile fish from Port Philip Bay (PPB) in Victoria as annual recruitment but does not model the total stock biomass or fishery dynamics of the Victorian component of the WVS. The robustness of the model's outputs is demonstrated by the strong relationship between model-estimated recruitment and an independent recruitment index from Port Philip Bay (PPB) where the SE Snapper are spawned. Fisheries Victoria conducts annual Snapper pre-recruitment surveys in PPB (Hamer and Conron 2016). This confirms that the model is sufficiently modelling the population structure of SE Snapper and captures the recruitment of fish migrating from western Victoria to SA.

The TAC, TACC and TARC for SE Snapper from 1 Feb 2021 – 30 June 2021 and for the 2021/22 fishing season were recommended based on the modelled stock biomass in March 2020 (160 t) and a recommended harvest fraction of 20-30%. This level of exploitation was determined based on the stock's historical responses to relative levels of exploitation and recruitment. As the WVS is anticipated to receive strong recruitment from PPB in the next 4-6 years, the SMAC determined that a 30% harvest fraction was suitable for setting annual TACs until the end of the 2021/22 season. This equated to a

TAC of 48,000 kg for both seasons. These recommendations were documented in the Chairs report from SMAC Meeting #3.

Influence of trip limit regulations on CPUE and the TAC setting process

The 2020 Snapper stock assessment model uses handline CPUE as an index of abundance for all three Snapper stocks (SG/WCS, GSVS and WVS) (Fowler et al 2020). In the SE, handline CPUE was used because it (1) provided a plausible index of relative abundance that matched the understanding of stock dynamics (i.e. an increase and subsequent reduction of stock size between 2008 and 2012 resulting from a strong recruitment pulse) and (2) long line CPUE is known to a less reliable index of relative abundance elsewhere (e.g. SG/WCS and GSVS models).

A third advantage of using handline CPUE as an index of abundance was that it was also robust to daily trip limits as 95% of daily catches were well below the corresponding trip limits (Table 1). Thus, handline CPUE was the most appropriate time series to include in the stock assessment model. Trip limit regulations had no influence on the model outputs and, subsequently, the TAC setting process to date.

In contrast, long line CPUE for SE Snapper is influenced by changes in daily trip limits as ‘fisher days’ is used as the unit of effort in the CPUE series. This is demonstrated by the 95th percentiles of catches being constrained to the corresponding trip limit for a given year (Table 1). Therefore, raw CPUE calculated based on ‘fisher days’ in those years cannot currently be used as an index of abundance in the stock assessment model.

The SE Snapper assessment model will be reassessed following the implementation of the MSF reform in July 2021 because there are early indications that minimal Snapper will be taken using handlines. Therefore, alternative indices of stock abundance will need to be evaluated.

One option is to evaluate if long line CPUE could be used as an input for the SE Snapper assessment. For this approach to be suitable, longline CPUE would need to be adapted to make it robust to changes in trip limits and be assessed as a credible index of relative abundance. Two potential approaches are: 1) updating the unit of effort from fisher days to number of hooks from 2003 onwards, and 2) Standardising CPUE using generalised linear models (GLMs).

Table 1: A comparison of annual trip limit regulations and daily catch statistics for handlines and long lines of SE Snapper. The 95th percentile is used to determine whether daily trip limits constrained daily catches as maximum annual daily catch often provides records that had potentially spurious catch reports.

Season	**Daily trip limit (kg)**	**Daily handline catches (kg)**		**Daily long line catches (kg)**	
		Average	95th percentile	Average	95th percentile
2011/12	800	28	122	173	536
2012/13	800	40	123	129	449
2013/14	500	30	84	155	470
2014/15	500	81	243	122	407
2015/16	500	45	122	73	237
2016/17	350	46	111	78	214
2017/18	350	30	95	131	329
2018/19	350	70	287	138	350
2019/20	350	50	107	195	350

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DRS ADRIAN LINNANE AND RICHARD MCGARVEY (SARDI AQUATIC SCIENCES)**

SUBJECT: **SZRLF: FISHERY-INDEPENDENT MONITORING SURVEY SEPTEMBER 2021 RESULTS**

DATE: **09 NOVEMBER 2021**

KEY ISSUES:

- The latest fishery-independent monitoring survey (FIMS) for the Southern Zone Rock Lobster Fishery (SZRLF) was conducted from 7-15 September, 2021.
- This Advice Note reports on the results of the September 2021 survey and provides the location and catch number of legal-sized and undersized rock lobsters from each of the 286 pots surveyed. Results are compared with previous September surveys only.
- Results indicate that in 2021, the abundance of legal-sized increased, while those of undersized lobsters decreased, compared to 2020 estimates. The CPUE of legal-sized lobsters in 2021 is now the highest estimate since 2007. The CPUE of undersized lobsters in 2021 remains below the long-term average.
- The 2021 September survey results will be combined with further surveys to be undertaken in January 2022 which will form part of the next SZRLF stock assessment report (due by 30 June 2022).

BACKGROUND:

A fishery-independent monitoring survey has been undertaken in the SZRLF since 2006/07. The survey design consists of 29 transects, that run from inshore (~10 m depth) to offshore (~120 m depth) grounds. Each transect line consists of 10 pots set at predetermined locations that are independent of known fishing effort. Sampling is undertaken during September and January of each season. All lobsters are sexed, measured, staged (females only) and tagged.

Surveys provide spatially-explicit fishery-independent catch rate estimates of both legal and undersized (pre-recruit) rock lobsters.

RESULTS/DISCUSSION:

The 2021 SZRLF fishery independent monitoring survey took place from 7-15 September based on the transect survey design shown in Figure A-1. Data were entered and validated according to established protocols. The abundance of legal-sized and undersized (pre-recruit) rock lobsters from all survey pots combined, based on data from September surveys only, are provided in Figure A-2.

Results indicate that in 2021, the abundance of legal-sized increased, while those of undersized lobsters decreased, compared to 2020 estimates. The CPUE of legal-sized lobsters in 2021 was 0.83 lobsters/potlift, a 43% increase from 2020 (0.58 lobsters/potlift) and the highest estimate since 2007. The CPUE of undersized lobsters in 2021 was 0.26 lobsters/potlift, a 31% decrease from 2020 (0.34 lobsters/potlift) and below the long-term average (0.43 lobsters/potlift).

The location and catch (by number) of legal-sized and undersized rock lobsters from each of the 286 pots sampled in September 2021 are provided in Table A-1.

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APPENDIX

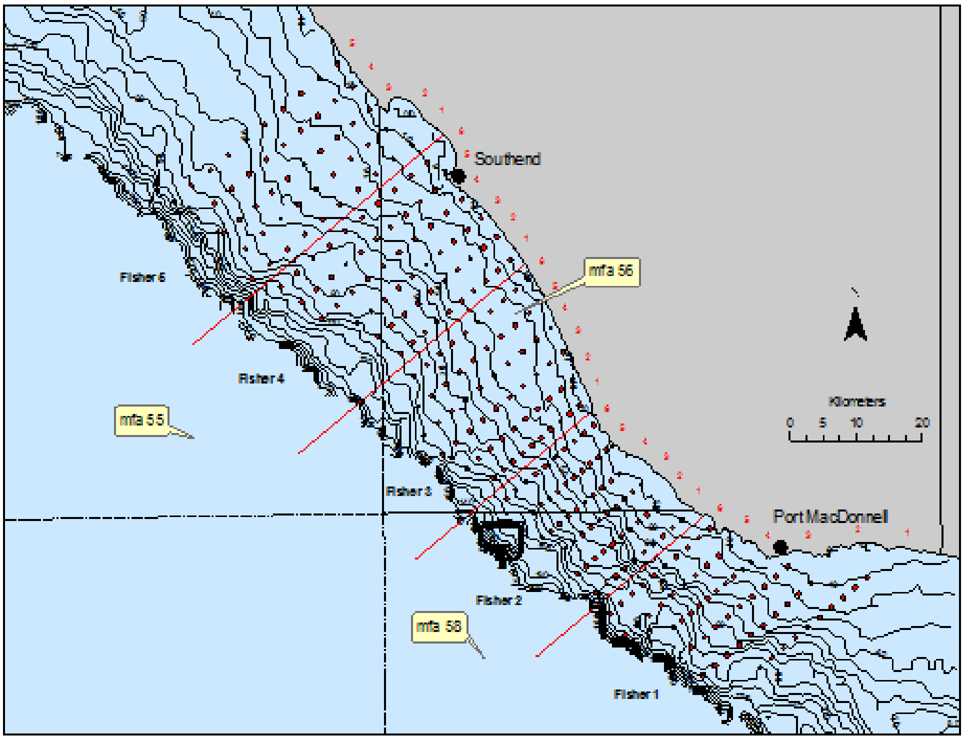

Figure A-1. Location of Fishery Independent Monitoring Survey (FIMS) transects in the SZRLF.

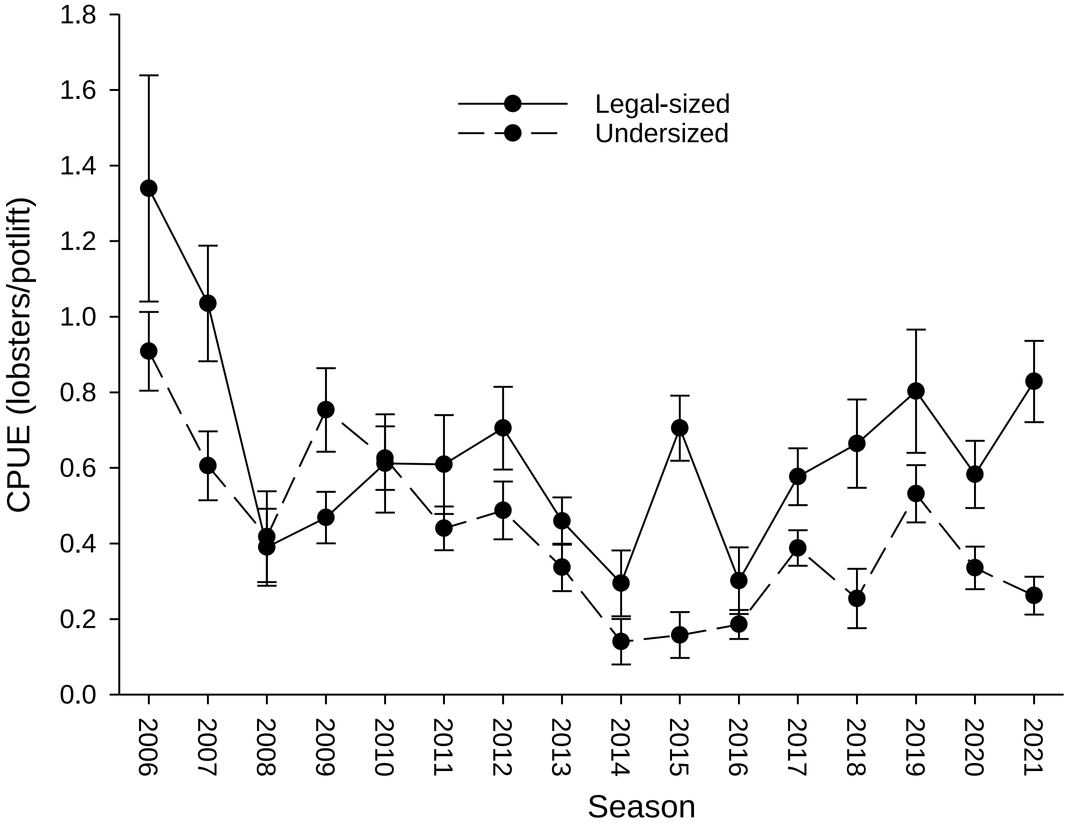

Figure A-2. Catch rate of legal sized lobsters (nr/potlift) as estimated from fishery independent monitoring surveys (FIMS) from 2006 to 2021. Note: above data are presented as <u>numbers</u> of lobsters/potlift and only compare <u>start of season</u> (Sept/Oct) surveys.

Table A-1. Location and catch number of legal and undersized lobsters from each of the 286 pots sampled in the SZRLF September 2021 fishery independent monitoring survey (FIMS).

Date	Pot Number	Lat	Long	Legal Number	Undersize Number
7/09/2021	1	-38.0708000	140.6966333	0	2
7/09/2021	2	-38.0835833	140.6786667	0	0
7/09/2021	3	-38.0659333	140.6356000	1	1
7/09/2021	4	-38.0446500	140.6020000	0	0
7/09/2021	5	-38.0241833	140.5620833	0	0
7/09/2021	6	-38.0354000	140.5451667	0	0
7/09/2021	7	-38.0466500	140.5262333	2	0
7/09/2021	8	-38.0583833	140.5069667	1	0
7/09/2021	9	-38.0702667	140.4881667	4	3
7/09/2021	10	-38.0818333	140.4686667	0	0
7/09/2021	11	-38.0937833	140.4499000	0	0
7/09/2021	12	-38.1058667	140.4303333	0	0
7/09/2021	13	-38.1179000	140.4113667	0	0
7/09/2021	14	-38.1289667	140.3920667	0	0
7/09/2021	15	-38.1567333	140.4190333	0	0
7/09/2021	16	-38.1449333	140.4384500	0	0
7/09/2021	17	-38.1324167	140.4588167	0	0
7/09/2021	18	-38.1198833	140.4795833	0	0
7/09/2021	19	-38.1074333	140.4992000	1	0
7/09/2021	20	-38.0944167	140.5193000	2	0
7/09/2021	21	-38.0818333	140.5396167	2	1
7/09/2021	22	-38.0698000	140.5602833	4	3
7/09/2021	23	-38.0592833	140.5803833	3	1
7/09/2021	24	-38.0741500	140.6216667	3	2
7/09/2021	25	-38.0834500	140.6060500	1	0
7/09/2021	26	-38.0927167	140.5911000	2	1
7/09/2021	27	-38.1020000	140.5760333	1	0
7/09/2021	28	-38.1111167	140.5563667	1	0
7/09/2021	29	-38.1205167	140.5463167	1	0
7/09/2021	30	-38.1296833	140.5313000	0	0
7/09/2021	31	-38.1387000	140.5163833	0	0
7/09/2021	32	-38.1482667	140.5013333	0	0
7/09/2021	33	-38.1864000	140.5122167	0	0
7/09/2021	34	-38.1740833	140.5332000	3	0
7/09/2021	35	-38.1609833	140.5539333	0	0
7/09/2021	36	-38.1480167	140.5751500	0	0
7/09/2021	37	-38.1348500	140.5957167	2	1
7/09/2021	38	-38.1178167	140.6167833	1	0
7/09/2021	39	-38.1093667	140.6372500	1	1
7/09/2021	40	-38.0968500	140.6581167	0	1
7/09/2021	41	-38.0929000	140.7408667	1	1
7/09/2021	42	-38.1074333	140.7202333	0	0
7/09/2021	43	-38.1196167	140.6980000	4	1
7/09/2021	44	-38.1317167	140.6780667	0	2
7/09/2021	45	-38.1446333	140.6569833	1	0

7/09/2021	46	-38.1571500	140.6361833	0	0
7/09/2021	47	-38.1700500	140.6155667	0	0
7/09/2021	48	-38.1830333	140.5946000	3	0
7/09/2021	49	-38.1958333	140.5733333	1	0
7/09/2021	50	-38.2088667	140.5523167	0	0
7/09/2021	51	-38.2001333	140.6501000	0	0
7/09/2021	52	-38.1870833	140.6720500	0	0
7/09/2021	53	-38.1741500	140.6920667	5	2
7/09/2021	54	-38.1616000	140.7127667	0	0
7/09/2021	55	-38.1485167	140.7335667	0	0
7/09/2021	56	-38.1359000	140.7539333	3	0
7/09/2021	57	-38.1233000	140.7750167	0	0
7/09/2021	58	-38.1105167	140.7957833	0	0
7/09/2021	59	-38.0979500	140.8166833	0	0
7/09/2021	60	-38.0848333	140.8318167	0	0
8/09/2021	61	-37.6466000	139.8695500	0	0
8/09/2021	62	-37.6644500	139.8393333	0	0
8/09/2021	63	-37.6836833	139.8077167	0	0
8/09/2021	64	-37.6994167	139.7832833	0	0
8/09/2021	65	-37.6817667	139.7374667	1	0
8/09/2021	66	-37.6633333	139.7681667	0	0
8/09/2021	67	-37.6496833	139.7895333	0	0
8/09/2021	68	-37.6269000	139.7568833	0	0
8/09/2021	69	-37.6175667	139.7724500	2	0
8/09/2021	70	-37.5859000	139.7481167	0	0
8/09/2021	71	-37.5933833	139.7354667	0	0
8/09/2021	72	-37.5990333	139.6507167	0	0
8/09/2021	73	-37.5840000	139.6749833	0	0
8/09/2021	74	-37.5695333	139.6983333	0	0
8/09/2021	75	-37.5608333	139.7144333	0	0
8/09/2021	76	-37.5266500	139.7698833	0	0
8/09/2021	77	-37.5067833	139.8027333	7	0
8/09/2021	78	-37.4872500	139.8340333	0	0
8/09/2021	79	-37.4664167	139.8683500	0	0
8/09/2021	80	-37.4491333	139.8969333	0	0
8/09/2021	81	-37.4382167	139.9131500	0	0
8/09/2021	82	-37.4604500	139.9531333	0	0
8/09/2021	83	-37.4781333	139.9236167	0	0
8/09/2021	84	-37.4968833	139.8939500	0	0
8/09/2021	85	-37.5146167	139.8640167	0	0
8/09/2021	86	-37.5330500	139.8342833	0	0
8/09/2021	87	-37.5510500	139.8039667	1	0
8/09/2021	88	-37.5691667	139.7746667	0	0
8/09/2021	89	-37.5924000	139.8132833	1	0
8/09/2021	90	-37.5762167	139.8400500	0	0
8/09/2021	91	-37.5581000	139.8700500	1	0
8/09/2021	92	-37.5408500	139.8982333	0	0
8/09/2021	93	-37.5241000	139.9262000	0	0
8/09/2021	94	-37.5055000	139.9553000	0	0

8/09/2021	95	-37.4895667	139.9823667	0	0
8/09/2021	96	-37.5145833	140.0118333	0	0
8/09/2021	97	-37.5337000	139.9811167	0	0
8/09/2021	98	-37.5519167	139.9505833	0	0
8/09/2021	99	-37.5708167	139.9200000	1	0
8/09/2021	100	-37.5893167	139.8895333	0	0
8/09/2021	101	-37.6078167	139.8582333	0	0
8/09/2021	102	-37.6260667	139.8287500	0	0
8/09/2021	103	-37.6273833	139.9005000	0	0
8/09/2021	104	-37.6089000	139.9310333	0	0
8/09/2021	105	-37.5903000	139.9618000	0	0
8/09/2021	106	-37.5715333	139.9926333	0	0
8/09/2021	107	-37.5527833	140.0231667	0	0
8/09/2021	108	-37.5284000	140.0573500	0	0
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10/09/2021	113	-37.9528000	140.4081167	2	0
10/09/2021	114	-37.9320000	140.3723833	2	0
10/09/2021	115	-37.9230000	140.3865667	3	4
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10/09/2021	129	-37.9748333	140.3013500	0	0
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10/09/2021	136	-37.9798333	140.3642500	0	0
10/09/2021	137	-37.9886167	140.3493500	0	0
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10/09/2021	139	-38.0066667	140.3198500	0	0
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10/09/2021	144	-38.0387500	140.3300333	1	1
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10/09/2021	192	-37.6711667	140.0314167	0	0

10/09/2021	193	-37.6877333	140.0037333	0	0
10/09/2021	194	-37.7036667	139.9773833	4	0
10/09/2021	195	-37.7197833	139.9481500	0	0
10/09/2021	196	-37.7364167	139.9228833	0	0
10/09/2021	197	-37.7485667	139.9731167	0	0
10/09/2021	198	-37.7444167	139.9822500	0	0
10/09/2021	199	-37.7298667	140.0062333	0	0
10/09/2021	200	-37.7142500	140.0320833	0	0
10/09/2021	201	-37.7012500	140.0544667	2	0
10/09/2021	202	-37.6864000	140.0778667	2	0
10/09/2021	203	-37.6716833	140.1017667	0	0
10/09/2021	204	-37.6573667	140.1259500	0	0
10/09/2021	205	-37.6803833	140.1517333	0	0
10/09/2021	206	-37.6932500	140.1313667	0	0
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10/09/2021	208	-37.7212333	140.0862333	1	0
10/09/2021	209	-37.7345333	140.0639500	0	0
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10/09/2021	211	-37.7626167	140.0173333	0	0
10/09/2021	212	-37.7965833	140.0337000	0	0
10/09/2021	213	-37.7813167	140.0598000	0	0
10/09/2021	214	-37.7720833	140.0748000	0	0
10/09/2021	215	-37.7592500	140.0962333	0	0
10/09/2021	216	-37.7462000	140.1172667	0	0
10/09/2021	217	-37.7332167	140.1385833	0	0
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10/09/2021	220	-37.6941667	140.2025167	0	0
10/09/2021	221	-37.6809833	140.2231000	0	0
10/09/2021	222	-37.6555167	140.1930667	2	5
10/09/2021	223	-37.6655500	140.1771667	1	0
10/09/2021	224	-37.6428167	140.1499167	0	0
10/09/2021	225	-37.6317333	140.1668000	2	0
10/09/2021	226	-37.6056667	140.1375000	1	0
15/09/2021	227	-37.8754500	140.3247500	0	0
15/09/2021	228	-37.8859000	140.3073500	2	0
15/09/2021	229	-37.8957500	140.2907000	3	0
15/09/2021	230	-37.9055333	140.2736333	0	0
15/09/2021	231	-37.9159167	140.2578167	0	0
15/09/2021	232	-37.9267167	140.2412833	1	0
15/09/2021	233	-37.9373333	140.2252000	0	0
15/09/2021	234	-37.9473333	140.2092500	0	0
15/09/2021	235	-37.9579167	140.1924833	0	0
15/09/2021	236	-37.9452333	140.1461833	8	0
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15/09/2021	239	-37.8675000	140.0618667	0	0
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15/09/2021	243	-37.7861000	140.1203000	0	0
15/09/2021	244	-37.7726667	140.1420333	0	0
15/09/2021	245	-37.7590500	140.1650333	3	4
15/09/2021	246	-37.7462500	140.1866167	0	0
15/09/2021	247	-37.7324833	140.2087500	0	0
15/09/2021	248	-37.7187833	140.2314667	4	3
15/09/2021	249	-37.7086500	140.2485000	8	1
15/09/2021	250	-37.7404000	140.2723500	2	2
15/09/2021	251	-37.7486167	140.2538000	5	5
15/09/2021	252	-37.7630500	140.2296333	2	0
15/09/2021	253	-37.7778667	140.2054000	0	0
15/09/2021	254	-37.7923167	140.1817167	0	0
15/09/2021	255	-37.8069500	140.1576333	0	0
15/09/2021	256	-37.8225667	140.1332000	0	0
15/09/2021	257	-37.8383833	140.1091333	0	0
15/09/2021	258	-37.8521000	140.0859000	0	0
15/09/2021	259	-37.8882667	140.0957667	0	0
15/09/2021	260	-37.8731000	140.1194833	0	0
15/09/2021	261	-37.8580333	140.1437000	0	0
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15/09/2021	264	-37.8125167	140.2166333	0	0
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15/09/2021	266	-37.7823667	140.2663500	2	2
15/09/2021	267	-37.7687833	140.2891000	0	0
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15/09/2021	269	-37.8122667	140.2898500	8	1
15/09/2021	270	-37.8264833	140.2665000	6	0
15/09/2021	271	-37.8405333	140.2428500	0	1
15/09/2021	272	-37.8550000	140.2193500	2	0
15/09/2021	273	-37.8694333	140.1964500	7	0
15/09/2021	274	-37.8842000	140.1733000	0	0
15/09/2021	275	-37.8974500	140.1499500	0	0
15/09/2021	276	-37.9127500	140.1275000	0	0
15/09/2021	277	-37.9322500	140.1657167	0	0
15/09/2021	278	-37.9200833	140.1856000	0	0
15/09/2021	279	-37.9077333	140.2056333	0	0
15/09/2021	280	-37.8947833	140.2261667	0	0
15/09/2021	281	-37.8818500	140.2461500	1	0
15/09/2021	282	-37.8695667	140.2670167	3	2
15/09/2021	283	-37.8587333	140.2851167	8	1
15/09/2021	284	-37.8451167	140.3081333	2	1
15/09/2021	285	-37.8321500	140.3284333	1	0
15/09/2021	286	-37.8652333	140.3404667	6	0

Doc 24

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **A/PROF. ADRIAN LINNANE AND A/PROF RICHARD MCGARVEY (SARDI AQUATIC SCIENCES)**

SUBJECT: **SZRLF: FISHERY-INDEPENDENT MONITORING SURVEY 2021/22 RESULTS**

DATE: **20 APRIL 2022**

KEY ISSUES:

- The latest fishery-independent monitoring survey (FIMS) for the Southern Zone Rock Lobster Fishery (SZRLF) was conducted between 14-24 January 2022.
- This Advice Note reports on the results of the 2021/22 season (September 2021 and January 2022 combined) by providing the catch rate (number/potlift) of legal and undersize rock lobsters from the 572 pots surveyed.
- In 2021/22, the catch rate of both legal and undersized lobsters increased compared to 2020/21 levels. Legal-size catch rates are now the highest on record while undersized abundances are the highest since 2010/11.
- Outputs from the FIMS will form part of the stock status analysis of the SZRLF in the next stock assessment report (due by 30 June 2022).

BACKGROUND:

A fishery-independent monitoring survey has been undertaken in the SZRLF since 2006/07. The survey design consists of 29 transects, that run from inshore (~10 m depth) to offshore (~120 m depth) grounds. Each transect line consists of 10 pots set at predetermined locations that are independent of known fishing effort. Sampling is undertaken during September and January of each season. All lobsters are sexed, measured, staged (females only) and tagged.

Surveys provide spatially-explicit fishery-independent catch rate estimates of both legal and undersized (pre-recruit) rock lobsters.

RESULTS/DISCUSSION:

The 2021/22 SZRLF FIMS occurred from 7-15 September 2021 and 14-24 January 2022, based on the transect survey design shown in Figure A-1. Data were entered and validated according to established protocols. The location and catch (by number) of legal and undersize rock lobsters from each of the 572 pots sampled in September 2021 and January 2022 are provided in Table A-1.

Results show that in 2021/22, the abundance of both legal and undersized sized lobsters increased compared to 2020/21 estimates (Figure A-2).

In 2021/22, the catch rate of legal-size lobsters was 1.26 lobsters/potlift, a 6% increase from 2020/21 (1.19 lobsters/potlift) and the highest estimate on record.

The catch rate of undersized lobsters in 2021/22 was 0.50 undersized/potlift, a 4% increase from 2020/21 (0.48 undersized/potlift) and the highest estimate since 2010/11.

In summary, the current FIMS legal-size catch rates are among the highest on record. However, while the FIMS undersized catch rates have generally increased from 2015/16, they remain below those observed at the commencement of the surveys (2006/07 to 2010/11).

Dr. Mike Steer
Research Director, Aquatic and Livestock Sciences

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APPENDIX

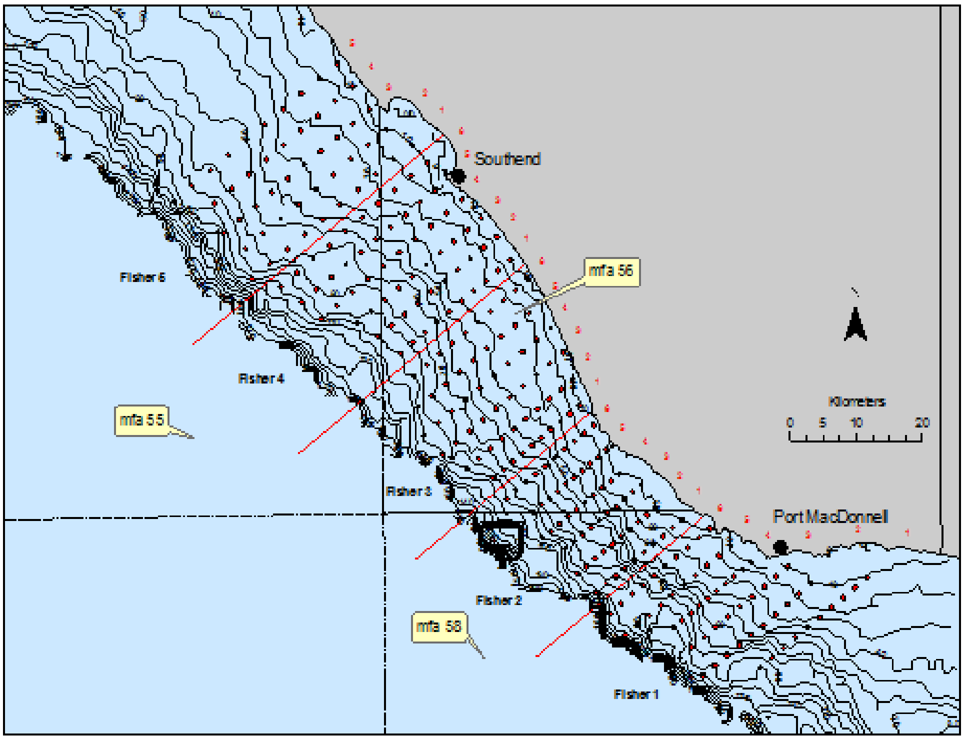

Figure A-1. Location of Fishery Independent Monitoring Survey (FIMS) transects in the SZRLF.

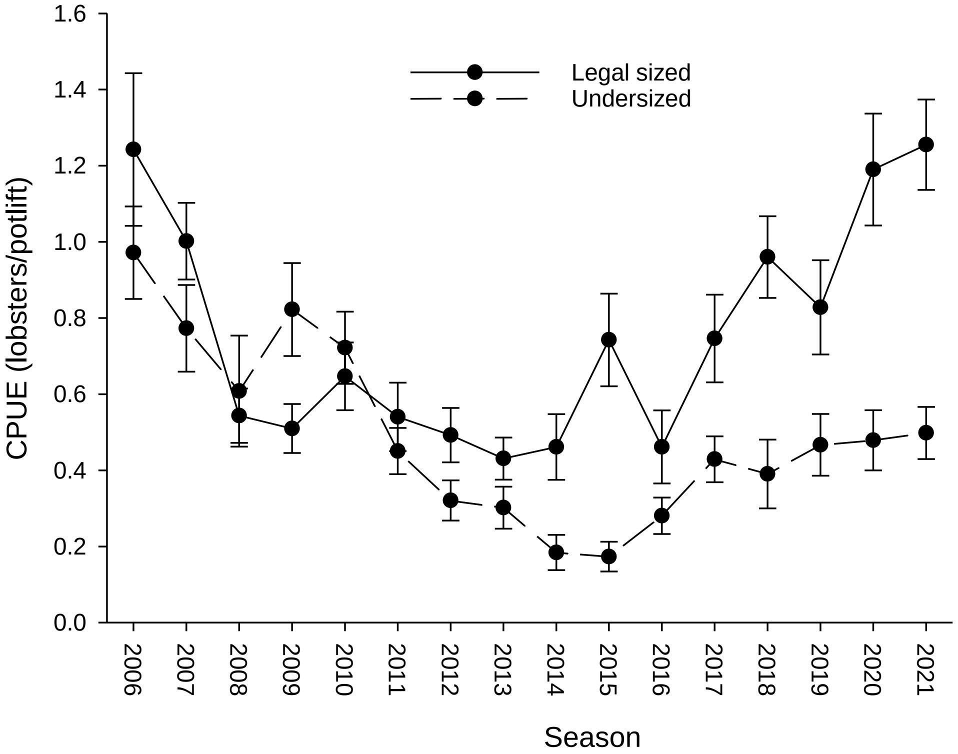

Figure A-2. Catch rate of legal and undersized sized lobsters (with confidence intervals) as estimated from fishery independent monitoring surveys (FIMS) from 2006 to 2021. Note: above data are presented as <u>numbers</u> of lobsters/potlift from <u>September and January/February surveys combined</u>. Year represents start-of-season year (e.g. 2021 = 2021/22). Error bars show 95% confidence intervals using the v8 systematic survey sampling error variance estimator.

Table A-1. Location, catch number of legal-sized and undersized lobsters from each of the 572 pots sampled in the SZRLF September 2021 and January 2022 fishery independent monitoring survey.

Date	Pot Number	Lat	Long	Legal Number	Undersize Number
7/09/2021	1	-38.0708000	140.6966333	0	2
7/09/2021	2	-38.0835833	140.6786667	0	0
7/09/2021	3	-38.0659333	140.6356000	1	1
7/09/2021	4	-38.0446500	140.6020000	0	0
7/09/2021	5	-38.0241833	140.5620833	0	0
7/09/2021	6	-38.0354000	140.5451667	0	0
7/09/2021	7	-38.0466500	140.5262333	2	0
7/09/2021	8	-38.0583833	140.5069667	1	0
7/09/2021	9	-38.0702667	140.4881667	4	3
7/09/2021	10	-38.0818333	140.4686667	0	0
7/09/2021	11	-38.0937833	140.4499000	0	0
7/09/2021	12	-38.1058667	140.4303333	0	0
7/09/2021	13	-38.1179000	140.4113667	0	0
7/09/2021	14	-38.1289667	140.3920667	0	0
7/09/2021	15	-38.1567333	140.4190333	0	0
7/09/2021	16	-38.1449333	140.4384500	0	0
7/09/2021	17	-38.1324167	140.4588167	0	0
7/09/2021	18	-38.1198833	140.4795833	0	0
7/09/2021	19	-38.1074333	140.4992000	1	0
7/09/2021	20	-38.0944167	140.5193000	2	0
7/09/2021	21	-38.0818333	140.5396167	2	1
7/09/2021	22	-38.0698000	140.5602833	4	3
7/09/2021	23	-38.0592833	140.5803833	3	1
7/09/2021	24	-38.0741500	140.6216667	3	2
7/09/2021	25	-38.0834500	140.6060500	1	0
7/09/2021	26	-38.0927167	140.5911000	2	1
7/09/2021	27	-38.1020000	140.5760333	1	0
7/09/2021	28	-38.1111167	140.5563667	1	0
7/09/2021	29	-38.1205167	140.5463167	1	0
7/09/2021	30	-38.1296833	140.5313000	0	0
7/09/2021	31	-38.1387000	140.5163833	0	0
7/09/2021	32	-38.1482667	140.5013333	0	0
7/09/2021	33	-38.1864000	140.5122167	0	0
7/09/2021	34	-38.1740833	140.5332000	3	0
7/09/2021	35	-38.1609833	140.5539333	0	0
7/09/2021	36	-38.1480167	140.5751500	0	0
7/09/2021	37	-38.1348500	140.5957167	2	1
7/09/2021	38	-38.1178167	140.6167833	1	0
7/09/2021	39	-38.1093667	140.6372500	1	1
7/09/2021	40	-38.0968500	140.6581167	0	1
7/09/2021	41	-38.0929000	140.7408667	1	1
7/09/2021	42	-38.1074333	140.7202333	0	0
7/09/2021	43	-38.1196167	140.6980000	4	1
7/09/2021	44	-38.1317167	140.6780667	0	2

7/09/2021	45	-38.1446333	140.6569833	1	0
7/09/2021	46	-38.1571500	140.6361833	0	0
7/09/2021	47	-38.1700500	140.6155667	0	0
7/09/2021	48	-38.1830333	140.5946000	3	0
7/09/2021	49	-38.1958333	140.5733333	1	0
7/09/2021	50	-38.2088667	140.5523167	0	0
7/09/2021	51	-38.2001333	140.6501000	0	0
7/09/2021	52	-38.1870833	140.6720500	0	0
7/09/2021	53	-38.1741500	140.6920667	5	2
7/09/2021	54	-38.1616000	140.7127667	0	0
7/09/2021	55	-38.1485167	140.7335667	0	0
7/09/2021	56	-38.1359000	140.7539333	3	0
7/09/2021	57	-38.1233000	140.7750167	0	0
7/09/2021	58	-38.1105167	140.7957833	0	0
7/09/2021	59	-38.0979500	140.8166833	0	0
7/09/2021	60	-38.0848333	140.8318167	0	0
8/09/2021	61	-37.6466000	139.8695500	0	0
8/09/2021	62	-37.6644500	139.8393333	0	0
8/09/2021	63	-37.6836833	139.8077167	0	0
8/09/2021	64	-37.6994167	139.7832833	0	0
8/09/2021	65	-37.6817667	139.7374667	1	0
8/09/2021	66	-37.6633333	139.7681667	0	0
8/09/2021	67	-37.6496833	139.7895333	0	0
8/09/2021	68	-37.6269000	139.7568833	0	0
8/09/2021	69	-37.6175667	139.7724500	2	0
8/09/2021	70	-37.5859000	139.7481167	0	0
8/09/2021	71	-37.5933833	139.7354667	0	0
8/09/2021	72	-37.5990333	139.6507167	0	0
8/09/2021	73	-37.5840000	139.6749833	0	0
8/09/2021	74	-37.5695333	139.6983333	0	0
8/09/2021	75	-37.5608333	139.7144333	0	0
8/09/2021	76	-37.5266500	139.7698833	0	0
8/09/2021	77	-37.5067833	139.8027333	7	0
8/09/2021	78	-37.4872500	139.8340333	0	0
8/09/2021	79	-37.4664167	139.8683500	0	0
8/09/2021	80	-37.4491333	139.8969333	0	0
8/09/2021	81	-37.4382167	139.9131500	0	0
8/09/2021	82	-37.4604500	139.9531333	0	0
8/09/2021	83	-37.4781333	139.9236167	0	0
8/09/2021	84	-37.4968833	139.8939500	0	0
8/09/2021	85	-37.5146167	139.8640167	0	0
8/09/2021	86	-37.5330500	139.8342833	0	0
8/09/2021	87	-37.5510500	139.8039667	1	0
8/09/2021	88	-37.5691667	139.7746667	0	0
8/09/2021	89	-37.5924000	139.8132833	1	0
8/09/2021	90	-37.5762167	139.8400500	0	0
8/09/2021	91	-37.5581000	139.8700500	1	0
8/09/2021	92	-37.5408500	139.8982333	0	0
8/09/2021	93	-37.5241000	139.9262000	0	0

8/09/2021	94	-37.5055000	139.9553000	0	0
8/09/2021	95	-37.4895667	139.9823667	0	0
8/09/2021	96	-37.5145833	140.0118333	0	0
8/09/2021	97	-37.5337000	139.9811167	0	0
8/09/2021	98	-37.5519167	139.9505833	0	0
8/09/2021	99	-37.5708167	139.9200000	1	0
8/09/2021	100	-37.5893167	139.8895333	0	0
8/09/2021	101	-37.6078167	139.8582333	0	0
8/09/2021	102	-37.6260667	139.8287500	0	0
8/09/2021	103	-37.6273833	139.9005000	0	0
8/09/2021	104	-37.6089000	139.9310333	0	0
8/09/2021	105	-37.5903000	139.9618000	0	0
8/09/2021	106	-37.5715333	139.9926333	0	0
8/09/2021	107	-37.5527833	140.0231667	0	0
8/09/2021	108	-37.5284000	140.0573500	0	0
10/09/2021	109	-38.0120667	140.5167833	0	1
10/09/2021	110	-37.9955833	140.4709333	0	6
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10/09/2021	112	-37.9674167	140.4459667	3	0
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10/09/2021	114	-37.9320000	140.3723833	2	0
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10/09/2021	122	-37.9525333	140.2635667	0	0
10/09/2021	123	-37.9626000	140.2465000	0	0
10/09/2021	124	-37.9732667	140.2300333	0	0
10/09/2021	125	-37.9834833	140.2129167	0	0
10/09/2021	126	-38.0010500	140.2586333	0	0
10/09/2021	127	-37.9925167	140.2733167	0	0
10/09/2021	128	-37.9836500	140.2873333	0	0
10/09/2021	129	-37.9748333	140.3013500	0	0
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10/09/2021	131	-37.9580333	140.3301667	0	0
10/09/2021	132	-37.9491000	140.3441667	0	0
10/09/2021	133	-37.9405167	140.3533667	1	1
10/09/2021	134	-37.9616667	140.3939500	0	0
10/09/2021	135	-37.9709000	140.3789333	4	0
10/09/2021	136	-37.9798333	140.3642500	0	0
10/09/2021	137	-37.9886167	140.3493500	0	0
10/09/2021	138	-37.9978167	140.3348167	2	0
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10/09/2021	157	-38.0602500	140.3654667	0	0
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10/09/2021	161	-38.0932333	140.3853500	0	0
10/09/2021	162	-38.0826333	140.4007333	0	0
10/09/2021	163	-38.0726167	140.4176833	0	0
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10/09/2021	189	-37.6207333	140.1129833	0	1
10/09/2021	190	-37.6373000	140.0861500	1	0
10/09/2021	191	-37.6538000	140.0587833	0	0

10/09/2021	192	-37.6711667	140.0314167	0	0
10/09/2021	193	-37.6877333	140.0037333	0	0
10/09/2021	194	-37.7036667	139.9773833	4	0
10/09/2021	195	-37.7197833	139.9481500	0	0
10/09/2021	196	-37.7364167	139.9228833	0	0
10/09/2021	197	-37.7485667	139.9731167	0	0
10/09/2021	198	-37.7444167	139.9822500	0	0
10/09/2021	199	-37.7298667	140.0062333	0	0
10/09/2021	200	-37.7142500	140.0320833	0	0
10/09/2021	201	-37.7012500	140.0544667	2	0
10/09/2021	202	-37.6864000	140.0778667	2	0
10/09/2021	203	-37.6716833	140.1017667	0	0
10/09/2021	204	-37.6573667	140.1259500	0	0
10/09/2021	205	-37.6803833	140.1517333	0	0
10/09/2021	206	-37.6932500	140.1313667	0	0
10/09/2021	207	-37.7071667	140.1086333	0	0
10/09/2021	208	-37.7212333	140.0862333	1	0
10/09/2021	209	-37.7345333	140.0639500	0	0
10/09/2021	210	-37.7488167	140.0405833	0	0
10/09/2021	211	-37.7626167	140.0173333	0	0
10/09/2021	212	-37.7965833	140.0337000	0	0
10/09/2021	213	-37.7813167	140.0598000	0	0
10/09/2021	214	-37.7720833	140.0748000	0	0
10/09/2021	215	-37.7592500	140.0962333	0	0
10/09/2021	216	-37.7462000	140.1172667	0	0
10/09/2021	217	-37.7332167	140.1385833	0	0
10/09/2021	218	-37.7205000	140.1598167	0	0
10/09/2021	219	-37.7075833	140.1809667	0	0
10/09/2021	220	-37.6941667	140.2025167	0	0
10/09/2021	221	-37.6809833	140.2231000	0	0
10/09/2021	222	-37.6555167	140.1930667	2	5
10/09/2021	223	-37.6655500	140.1771667	1	0
10/09/2021	224	-37.6428167	140.1499167	0	0
10/09/2021	225	-37.6317333	140.1668000	2	0
10/09/2021	226	-37.6056667	140.1375000	1	0
15/09/2021	227	-37.8754500	140.3247500	0	0
15/09/2021	228	-37.8859000	140.3073500	2	0
15/09/2021	229	-37.8957500	140.2907000	3	0
15/09/2021	230	-37.9055333	140.2736333	0	0
15/09/2021	231	-37.9159167	140.2578167	0	0
15/09/2021	232	-37.9267167	140.2412833	1	0
15/09/2021	233	-37.9373333	140.2252000	0	0
15/09/2021	234	-37.9473333	140.2092500	0	0
15/09/2021	235	-37.9579167	140.1924833	0	0
15/09/2021	236	-37.9452333	140.1461833	8	0
15/09/2021	237	-37.9272000	140.1048667	0	0
15/09/2021	238	-37.9031000	140.0715500	0	0
15/09/2021	239	-37.8675000	140.0618667	0	0
15/09/2021	240	-37.8280000	140.0558000	0	0

15/09/2021	241	-37.8145333	140.0772833	0	0
15/09/2021	242	-37.8003500	140.0987000	0	0
15/09/2021	243	-37.7861000	140.1203000	0	0
15/09/2021	244	-37.7726667	140.1420333	0	0
15/09/2021	245	-37.7590500	140.1650333	3	4
15/09/2021	246	-37.7462500	140.1866167	0	0
15/09/2021	247	-37.7324833	140.2087500	0	0
15/09/2021	248	-37.7187833	140.2314667	4	3
15/09/2021	249	-37.7086500	140.2485000	8	1
15/09/2021	250	-37.7404000	140.2723500	2	2
15/09/2021	251	-37.7486167	140.2538000	5	5
15/09/2021	252	-37.7630500	140.2296333	2	0
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15/09/2021	254	-37.7923167	140.1817167	0	0
15/09/2021	255	-37.8069500	140.1576333	0	0
15/09/2021	256	-37.8225667	140.1332000	0	0
15/09/2021	257	-37.8383833	140.1091333	0	0
15/09/2021	258	-37.8521000	140.0859000	0	0
15/09/2021	259	-37.8882667	140.0957667	0	0
15/09/2021	260	-37.8731000	140.1194833	0	0
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15/09/2021	262	-37.8424500	140.1677333	0	0
15/09/2021	263	-37.8271500	140.1921000	2	0
15/09/2021	264	-37.8125167	140.2166333	0	0
15/09/2021	265	-37.7971500	140.2415833	3	1
15/09/2021	266	-37.7823667	140.2663500	2	2
15/09/2021	267	-37.7687833	140.2891000	0	0
15/09/2021	268	-37.8003667	140.3093500	2	0
15/09/2021	269	-37.8122667	140.2898500	8	1
15/09/2021	270	-37.8264833	140.2665000	6	0
15/09/2021	271	-37.8405333	140.2428500	0	1
15/09/2021	272	-37.8550000	140.2193500	2	0
15/09/2021	273	-37.8694333	140.1964500	7	0
15/09/2021	274	-37.8842000	140.1733000	0	0
15/09/2021	275	-37.8974500	140.1499500	0	0
15/09/2021	276	-37.9127500	140.1275000	0	0
15/09/2021	277	-37.9322500	140.1657167	0	0
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15/09/2021	279	-37.9077333	140.2056333	0	0
15/09/2021	280	-37.8947833	140.2261667	0	0
15/09/2021	281	-37.8818500	140.2461500	1	0
15/09/2021	282	-37.8695667	140.2670167	3	2
15/09/2021	283	-37.8587333	140.2851167	8	1
15/09/2021	284	-37.8451167	140.3081333	2	1
15/09/2021	285	-37.8321500	140.3284333	1	0
15/09/2021	286	-37.8652333	140.3404667	6	0
14/01/2022	1	-37.9526500	140.4080500	7	4
14/01/2022	2	-37.9230833	140.3866000	1	7
14/01/2022	3	-37.8953500	140.3579333	0	1

14/01/2022	4	-37.9011167	140.3478500	2	4
14/01/2022	5	-37.9114000	140.3308833	2	0
14/01/2022	6	-37.9216833	140.3141167	4	1
14/01/2022	7	-37.9321833	140.2971833	0	0
14/01/2022	8	-37.9425000	140.2803167	0	0
14/01/2022	9	-37.9524833	140.2633833	0	0
14/01/2022	10	-37.9628000	140.2464833	0	0
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14/01/2022	12	-37.9833167	140.2127667	6	1
14/01/2022	13	-38.0009167	140.2589000	0	0
14/01/2022	14	-37.9919500	140.2728333	0	0
14/01/2022	15	-37.9832833	140.2870167	0	0
14/01/2022	16	-37.9748333	140.3007667	0	0
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14/01/2022	18	-37.9576833	140.3299500	1	1
14/01/2022	19	-37.9487667	140.3436833	1	7
14/01/2022	20	-37.9402333	140.3582167	4	4
14/01/2022	21	-37.9313500	140.3723167	1	1
14/01/2022	22	-37.9615667	140.3930000	4	2
14/01/2022	23	-37.9707833	140.3782000	0	0
14/01/2022	24	-37.9799667	140.3638667	0	0
14/01/2022	25	-37.9888500	140.3488667	3	0
14/01/2022	26	-37.9977833	140.3344333	0	0
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14/01/2022	29	-38.0248500	140.2897167	6	0
14/01/2022	30	-38.0340167	140.2757833	2	0
14/01/2022	31	-38.0473167	140.3151500	0	0
14/01/2022	32	-38.0380667	140.3297500	0	1
14/01/2022	33	-38.0291667	140.3445167	9	0
14/01/2022	34	-38.0205333	140.3588833	0	0
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14/01/2022	36	-38.0027667	140.3880500	1	1
14/01/2022	37	-37.9938167	140.4025000	1	0
14/01/2022	38	-37.9849000	140.4169667	6	4
14/01/2022	39	-37.9758833	140.4316167	0	0
14/01/2022	40	-37.9670500	140.4457833	4	0
14/01/2022	41	-37.9954500	140.4705500	6	4
14/01/2022	42	-38.0115667	140.5165500	2	4
14/01/2022	43	-38.0218833	140.5001500	4	7
14/01/2022	44	-38.0319667	140.4848333	0	0
14/01/2022	45	-38.0419333	140.4673500	2	3
14/01/2022	46	-38.0520000	140.4508333	1	2
14/01/2022	47	-38.0626333	140.4337000	3	4
14/01/2022	48	-38.0723667	140.4175667	0	0
14/01/2022	49	-38.0827667	140.4012000	0	0
14/01/2022	50	-38.0925167	140.3840500	0	0
14/01/2022	51	-38.1021500	140.3677500	4	2
14/01/2022	52	-38.0786333	140.3345833	0	0

14/01/2022	53	-38.0696333	140.3494833	1	0
14/01/2022	54	-38.0604500	140.3652333	0	0
14/01/2022	55	-38.0511667	140.3802000	2	0
14/01/2022	56	-38.0420500	140.3953333	0	0
14/01/2022	57	-38.0327667	140.4102667	1	3
14/01/2022	58	-38.0232500	140.4253667	1	3
14/01/2022	59	-38.0140833	140.4405667	4	1
14/01/2022	60	-38.0047167	140.4560000	2	3
15/01/2022	61	-37.5568833	140.0726667	2	0
15/01/2022	62	-37.5740667	140.0527500	0	0
15/01/2022	63	-37.5912000	140.0245167	0	0
15/01/2022	64	-37.6083500	139.9963833	0	2
15/01/2022	65	-37.6257667	139.9680000	0	0
15/01/2022	66	-37.6429667	139.9395000	0	0
15/01/2022	67	-37.6599000	139.9113167	0	0
15/01/2022	68	-37.6772833	139.8829833	0	0
15/01/2022	69	-37.6928000	139.8572833	4	0
15/01/2022	70	-37.7116333	139.8263667	6	0
15/01/2022	71	-37.7248500	139.8736333	2	0
15/01/2022	72	-37.7161500	139.8880000	2	0
15/01/2022	73	-37.7003833	139.9141333	0	0
15/01/2022	74	-37.6848333	139.9399667	0	0
15/01/2022	75	-37.6646833	139.9732333	0	0
15/01/2022	76	-37.6534833	139.9913000	5	0
15/01/2022	77	-37.6381000	140.0167667	0	0
15/01/2022	78	-37.6222833	140.0423333	1	4
15/01/2022	79	-37.6066000	140.0681167	0	0
15/01/2022	80	-37.5909500	140.0938000	0	0
15/01/2022	81	-37.6207833	140.1127333	0	0
15/01/2022	82	-37.6372000	140.0857833	0	0
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15/01/2022	84	-37.6711500	140.0313667	0	0
15/01/2022	85	-37.6872667	140.0032500	0	0
15/01/2022	86	-37.7033000	139.9771667	3	0
15/01/2022	87	-37.7195500	139.9476000	9	4
15/01/2022	88	-37.7364000	139.9221833	4	0
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15/01/2022	90	-37.7441833	139.9820667	0	0
15/01/2022	91	-37.7297500	140.0062667	0	0
15/01/2022	92	-37.7140167	140.0317667	0	0
15/01/2022	93	-37.7008000	140.0539500	10	2
15/01/2022	94	-37.6861167	140.0776833	1	0
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15/01/2022	99	-37.7068500	140.1084000	1	0
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15/01/2022	104	-37.7962333	140.0335667	4	0
15/01/2022	105	-37.7810500	140.0595833	0	0
15/01/2022	106	-37.7719500	140.0747333	2	0
15/01/2022	107	-37.7590000	140.0960833	0	0
15/01/2022	108	-37.7460667	140.1171167	0	0
15/01/2022	109	-37.7331667	140.1383667	0	0
15/01/2022	110	-37.7202500	140.1596167	1	0
15/01/2022	111	-37.7072500	140.1807167	0	1
15/01/2022	112	-37.6937833	140.2026500	4	0
15/01/2022	113	-37.6807667	140.2231500	1	0
15/01/2022	114	-37.6554167	140.1930167	0	0
15/01/2022	115	-37.6652500	140.1769167	0	0
15/01/2022	116	-37.6424000	140.1662000	0	0
15/01/2022	117	-37.6316333	140.1668167	5	2
15/01/2022	118	-37.6054500	140.1375000	1	2
16/01/2022	119	-38.0238833	140.5617833	0	1
16/01/2022	120	-38.0446167	140.5996167	2	0
16/01/2022	121	-38.0656500	140.6350000	0	3
16/01/2022	122	-38.0710667	140.6963833	2	7
16/01/2022	123	-38.0837833	140.6782500	2	3
16/01/2022	124	-38.0935500	140.7406167	4	0
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16/01/2022	126	-38.0982167	140.8164000	0	0
16/01/2022	127	-38.1104500	140.7954833	2	0
16/01/2022	128	-38.1232500	140.7748167	1	0
16/01/2022	129	-38.1360500	140.7539167	0	0
16/01/2022	130	-38.1489000	140.7318500	1	1
16/01/2022	131	-38.1616167	140.7125167	0	0
16/01/2022	132	-38.1740667	140.6912167	1	6
16/01/2022	133	-38.1872500	140.6712000	0	0
16/01/2022	134	-38.1995333	140.6507000	0	0
16/01/2022	135	-38.2079167	140.5516167	0	0
16/01/2022	136	-38.1959833	140.5728000	7	2
16/01/2022	137	-38.1829167	140.5940667	7	2
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16/01/2022	139	-38.1571000	140.6352167	4	1
16/01/2022	140	-38.1444000	140.6560333	1	0
16/01/2022	141	-38.1314167	140.6774000	0	3
16/01/2022	142	-38.1194000	140.6973167	1	1
16/01/2022	143	-38.1071667	140.7194333	1	1
16/01/2022	144	-38.0967833	140.6578333	0	0
16/01/2022	145	-38.1092167	140.6370500	3	2
16/01/2022	146	-38.1178333	140.6159667	4	0
16/01/2022	147	-38.1348500	140.5955167	0	0
16/01/2022	148	-38.1478833	140.5743000	5	1
16/01/2022	149	-38.1604167	140.5534333	0	0
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16/01/2022	155	-38.1201333	140.5455000	0	0
16/01/2022	156	-38.1110167	140.5552500	2	1
16/01/2022	157	-38.1018000	140.5755167	6	8
16/01/2022	158	-38.0925167	140.5907500	2	0
16/01/2022	159	-38.0833667	140.6059667	4	0
16/01/2022	160	-38.0741000	140.6210167	4	2
16/01/2022	161	-38.0592167	140.5798667	4	0
16/01/2022	162	-38.0695833	140.5596667	4	0
16/01/2022	163	-38.0820167	140.5393167	3	5
16/01/2022	164	-38.0945333	140.5188833	10	3
16/01/2022	165	-38.1068833	140.4972167	3	3
16/01/2022	166	-38.1195500	140.4779667	1	0
16/01/2022	167	-38.1316333	140.4572000	0	0
16/01/2022	168	-38.1437667	140.4370833	0	0
16/01/2022	169	-38.1561167	140.4152500	0	0
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16/01/2022	172	-38.1047833	140.4290500	0	0
16/01/2022	173	-38.0934333	140.4485667	0	0
16/01/2022	174	-38.0815833	140.4678833	2	1
16/01/2022	175	-38.0701500	140.4870500	1	3
16/01/2022	176	-38.0578500	140.5064167	2	1
16/01/2022	177	-38.0467000	140.5260167	1	3
16/01/2022	178	-38.0353667	140.5448167	4	4
17/01/2022	179	-37.5337000	140.0532667	1	0
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17/01/2022	181	-37.5712833	139.9921000	0	0
17/01/2022	182	-37.5899667	139.9613667	0	0
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17/01/2022	184	-37.6272333	139.8999167	0	0
17/01/2022	185	-37.6458167	139.8693833	0	0
17/01/2022	186	-37.6638333	139.8394500	7	0
17/01/2022	187	-37.6830667	139.8078333	12	0
17/01/2022	188	-37.6980000	139.7829167	5	0
17/01/2022	189	-37.6811833	139.7367167	8	0
17/01/2022	190	-37.6624500	139.7672500	7	0
17/01/2022	191	-37.6490833	139.7888167	7	1
17/01/2022	192	-37.6263833	139.7562333	4	0
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17/01/2022	195	-37.5930833	139.7345667	6	0
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17/01/2022	197	-37.5838000	139.6739833	1	0
17/01/2022	198	-37.5695833	139.6977500	0	0
17/01/2022	199	-37.5607667	139.7136833	0	0

17/01/2022	200	-37.5259667	139.7692333	0	0
17/01/2022	201	-37.5063333	139.8024000	0	0
17/01/2022	202	-37.4873167	139.8340500	7	1
17/01/2022	203	-37.4664833	139.8682333	0	0
17/01/2022	204	-37.4489667	139.8966667	3	0
17/01/2022	205	-37.4388333	139.9125500	0	3
17/01/2022	206	-37.4600500	139.9531167	1	1
17/01/2022	207	-37.4781000	139.9231667	0	0
17/01/2022	208	-37.4963167	139.8932833	4	0
17/01/2022	209	-37.5145000	139.8633333	0	0
17/01/2022	210	-37.5326667	139.8337833	0	0
17/01/2022	211	-37.5507500	139.8037000	5	0
17/01/2022	212	-37.5691500	139.7740000	7	0
17/01/2022	213	-37.5921667	139.8129000	2	0
17/01/2022	214	-37.5760833	139.8395000	0	1
17/01/2022	215	-37.5579667	139.8693667	0	0
17/01/2022	216	-37.5408000	139.8975667	0	0
17/01/2022	217	-37.5236833	139.9257333	0	0
17/01/2022	218	-37.5065500	139.9538333	0	0
17/01/2022	219	-37.4894167	139.9822500	4	1
17/01/2022	220	-37.5147333	140.0113500	1	0
17/01/2022	221	-37.5334333	139.9806333	0	0
17/01/2022	222	-37.5517167	139.9499000	1	0
17/01/2022	223	-37.5703667	139.9194167	0	0
17/01/2022	224	-37.5890000	139.8888333	1	1
17/01/2022	225	-37.6078333	139.8579333	0	0
17/01/2022	226	-37.6261333	139.8277500	0	0
24/01/2022	227	-37.8753500	140.3249167	1	4
24/01/2022	228	-37.8862500	140.3075500	3	4
24/01/2022	229	-37.8965000	140.2916000	1	0
24/01/2022	230	-37.9059000	140.2739000	2	0
24/01/2022	231	-37.9162833	140.2579500	5	1
24/01/2022	232	-37.9264000	140.2415167	9	0
24/01/2022	233	-37.9364500	140.2247833	0	0
24/01/2022	234	-37.9464500	140.2083667	0	0
24/01/2022	235	-37.9567667	140.1917500	0	0
24/01/2022	236	-37.9441500	140.1451167	8	1
24/01/2022	237	-37.9265333	140.1029833	3	0
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24/01/2022	239	-37.8661500	140.0612833	0	0
24/01/2022	240	-37.8268000	140.0553833	0	0
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24/01/2022	242	-37.7999500	140.0993167	6	0
24/01/2022	243	-37.7865167	140.1211167	0	0
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24/01/2022	246	-37.7462333	140.1873333	1	0
24/01/2022	247	-37.7327333	140.2093833	0	0
24/01/2022	248	-37.7189500	140.2315833	4	3

24/01/2022	249	-37.7091000	140.2489500	4	0
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24/01/2022	282	-37.8702500	140.2675833	3	3
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24/01/2022	285	-37.8327500	140.3280833	4	3
24/01/2022	286	-37.8653833	140.3405833	5	1

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **A/PROF. ADRIAN LINNANE (SARDI AQUATIC SCIENCES)**

SUBJECT: **SZRLF: SEPTEMBER 2021 FISHING DATA**

DATE: **28 OCTOBER 2021**

KEY ISSUES

- The Southern Zone Rock Lobster Fishery (SZRLF) extends from 1 October to 31 May of the following year. In response to market disruptions during 2019/20 and 2020/21, a season extension was introduced with the fishery opening early on 15 September in both 2020 and 2021.
- PIRSA Fisheries and Aquaculture have requested an Advice Note on September 2021 fishing compared to monthly data from the previous three seasons (2018/19 to 2020/21).
- Legal-size catch in September 2021 was 139.66 t based on an effort of 78,182 potlifts. Monthly legal-sized catch rate in September 2021 was one of the highest estimates recorded over the last three seasons. The September 2021 undersized catch rate was within the range observed during both September and October of the last three seasons.
- The September 2021 catch rate of spawning females, dead lobsters and octopus were all within the range observed during September and October of the last three seasons.
- September fishing was slightly more male dominated (by 10%) when compared to October sex ratios. Of all lobsters landed in September 2021, 19% were spawning (egg bearing) females, which is within the range observed in September and October over the past three seasons (10% to 19%).

BACKGROUND

The Southern Zone Rock Lobster Fishery (SZRLF) extends from 1 October to 31 May of the following year. In response to market disruptions during 2019/20 and 2020/21, a season extension was introduced with the fishery opening early on 15 September in both 2020 and 2021.

PIRSA Fisheries and Aquaculture have requested an Advice Note on September 2021 fishing compared to monthly data from the previous three seasons (2018/19 to 2020/21). Specific information included (i) catch, effort and catch per unit effort (CPUE) of legal sized lobsters; (ii) CPUE of undersized (pre-recruit index; PRI) lobsters; (iii) CPUE of spawning females and (iv) CPUE of octopus and dead lobsters (predation mortality). Additional information also provided includes monthly; (i) mean weight; (ii) sex ratios and (iii) reproductive condition of females.

RESULTS/DISCUSSION

Legal-size Catch, Effort, CPUE, PRI and Mean Wt

Legal-size catch in September 2021 was 139.66 t based on an effort of 78,182 potlifts (Fig. 1a). The CPUE was 1.79 kg/potlift (Fig. 1b). Compared to the previous three seasons, this was one of the highest monthly catch rates recorded (the highest being 1.85 kg/potlift in January 2019/20).

The September 2021 PRI was 1.54 undersized/potlift (Fig. 1c). Compared to the previous three seasons, this within the range observed during both September and October (range: 1.42 undersized/potlift in October 2018 to 1.95 undersized/potlift in October 2019). The mean weight of legal-sized lobsters in September 2021 was 0.97 kg which the same estimate recorded in September of 2020 (Fig. 1d).

Spawning females and predation mortality

Spawning females are most prevalent during the start of the season (particularly October) before declining thereafter (Linnane et al. 2017). The catch rate of spawning females in September 2021 was 0.83 spawners/potlift (Fig. 2a). This estimate is within the range observed during September and October over the last three seasons (0.80 to 0.93 spawners/potlift).

Predation mortality was analysed through the catch rate of dead lobsters and octopus, both of which are highly correlated (Brock and Ward, 2004). The September 2021 catch rates of dead lobsters (0.20 lobsters/potlift) (Fig.2b) and octopus (0.02 octopus/potlft) (Fig. 2c) were within the range observed for mortalities (0.15 to 0.25 lobsters/potlift) and octopus (0.01 to 0.03 octopus/potlift) during September and October over the last three seasons.

Sex ratios and reproductive condition of females

The sex ratio in September 2021 was 57:43 male/female (Fig. 3). This compares to a consistent 45:55 male/female ratio observed in October over the last three seasons, thereby indicating that September fishing is more male dominated by approximately 10%.

Of all lobsters landed in September 2020, 19% were spawning (egg bearing) females while 2% and 22% were non egg bearing and sexually immature females respectively (Fig. 3). In relation to spawning females, the September 2021 estimate is within the range observed in September and October over the past three seasons (10 to 19%).

Dr. Mike Steer
Research Director, Aquatic Sciences

Disclaimer

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Linnane, A., McLeay, L., McGarvey, R., and Jones, A. (2017). Industry-Supported Sampling Underpins Temporal Management Policy Change in a Commercial Rock Lobster (*Jasus edwardsii*) Fishery. Journal of Shellfish Research, 36: 511-517.

APPENDIX

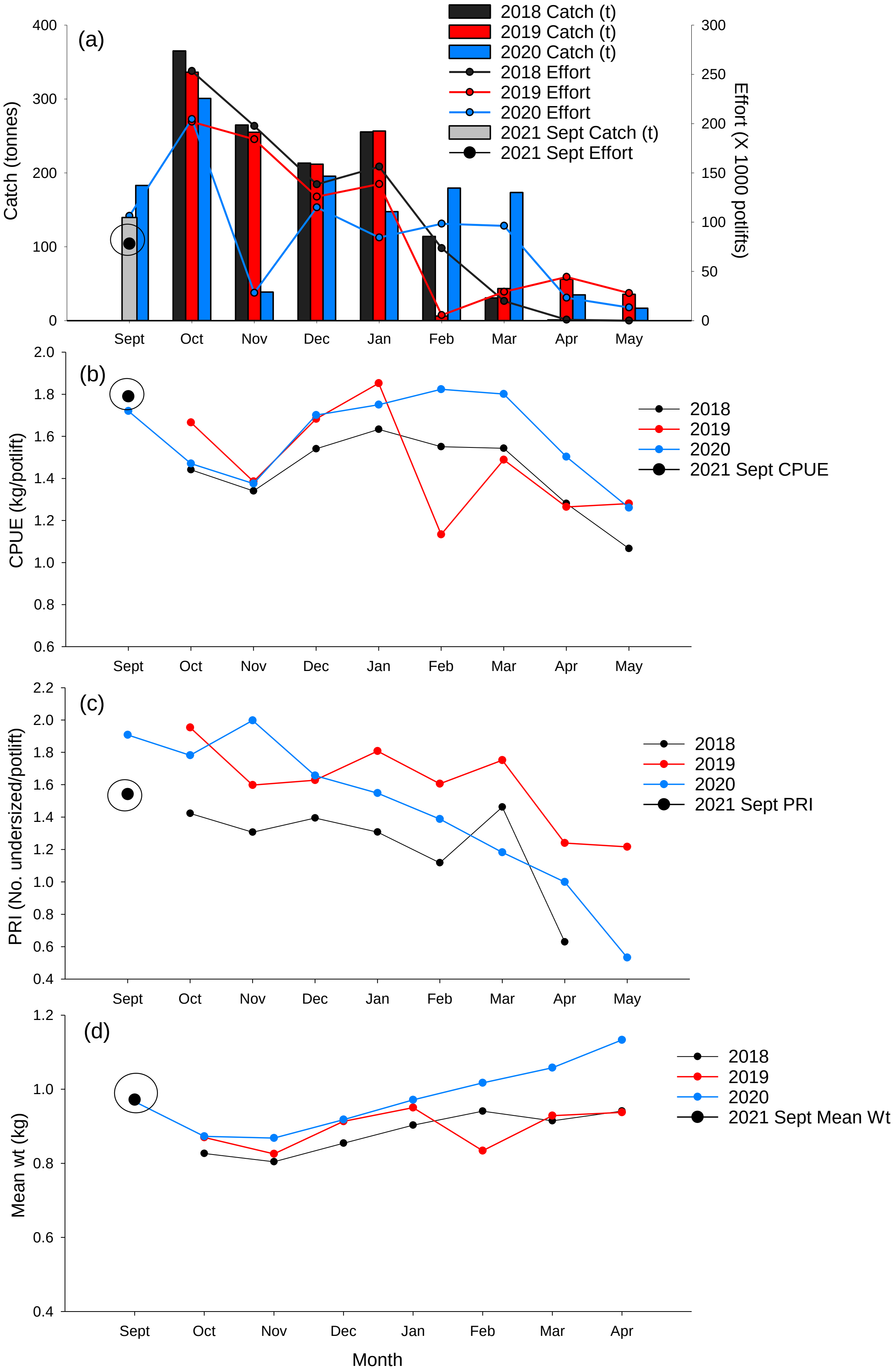

Figure 1. Within-season fishery dependent trends in the SZRLF. (a) Catch and effort; (b) catch per unit effort (CPUE); (c) pre-recruit index (PRI); and (d) mean weight.

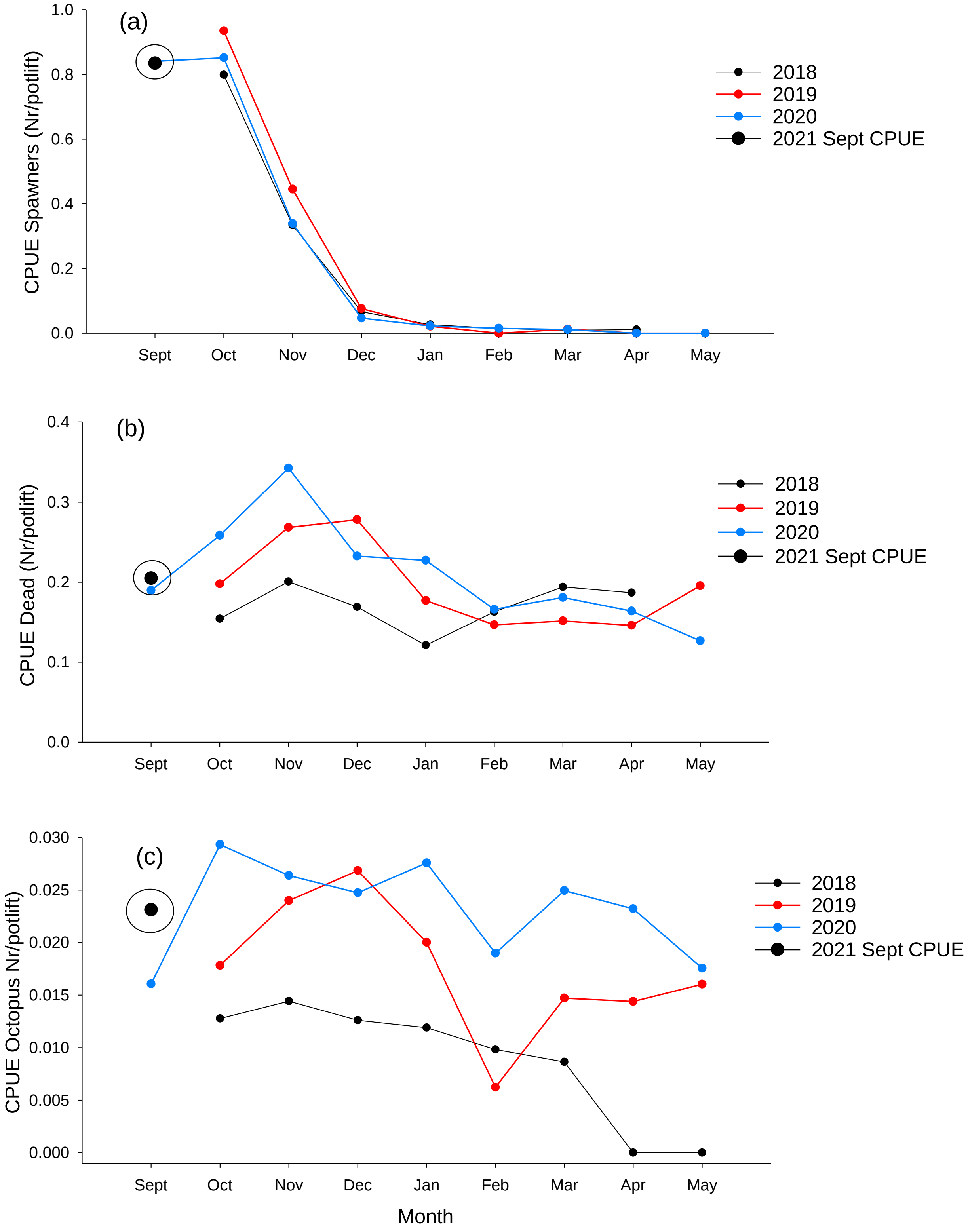

Figure 2. Within-season fishery dependent trends in the SZRLF. Catch per unit effort (CPUE) trends of (a) spawning lobsters; (b) dead lobsters and; (c) octopus.

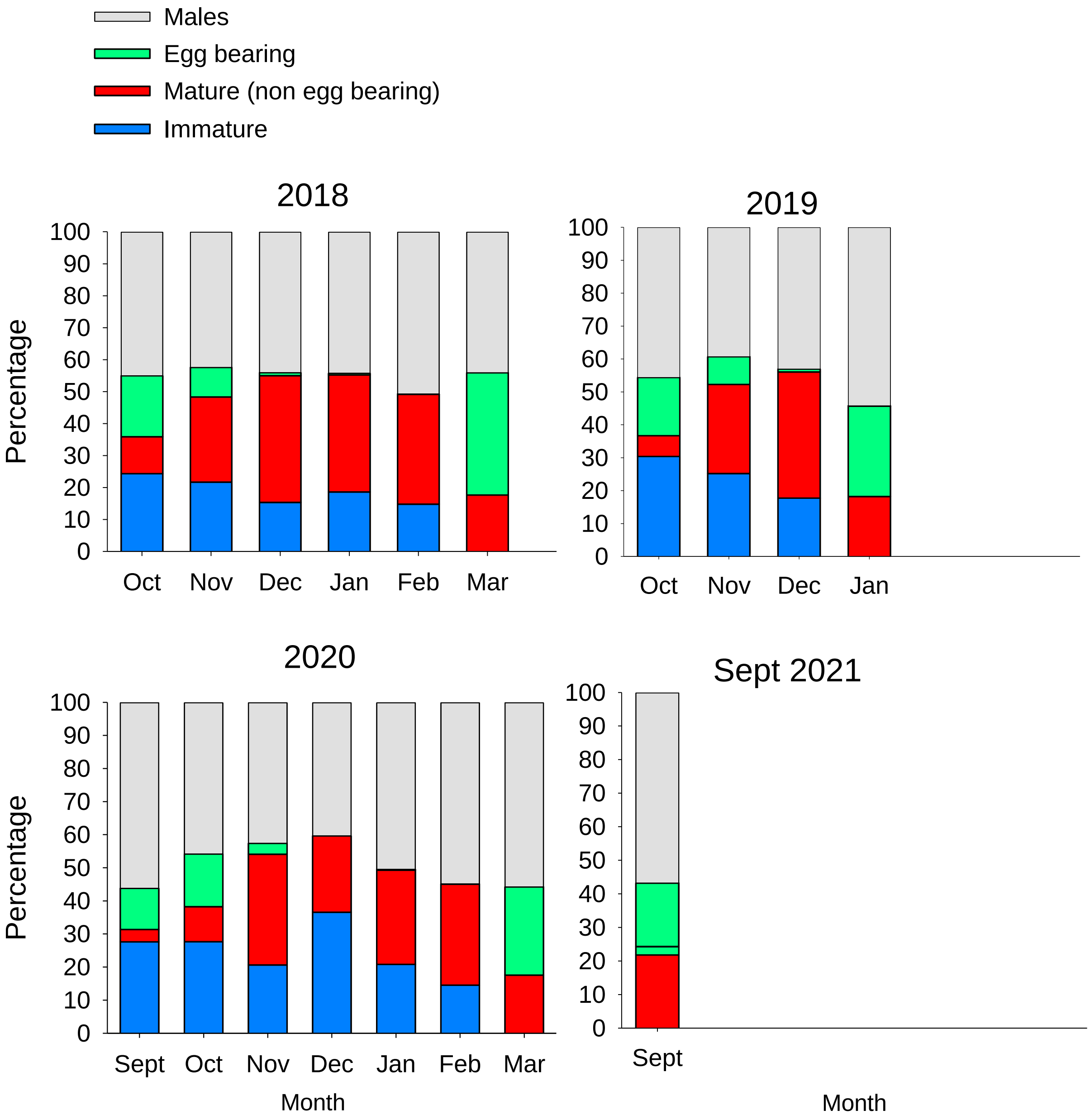

Figure 3. Within-season trends in the proportion of male and female lobsters (in various stages of reproductive condition) in the SZRLF.

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF. GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR CRAIG NOELL (SARDI AQUATIC SCIENCES)**

SUBJECT: **WEST COAST PRAWN FISHERY – 2021 FISHERY ASSESSMENT**

DATE: **26 NOVEMBER 2021**

KEY ISSUES:

- This Advice Note reports on the Performance Indicators used to guide stock status classification for the West Coast Prawn Fishery (WCPF).
- The average catch rate of **49.1 kg.h^{-1}** in 2021 was below the Trigger Reference Point of 54 kg.h^{-1}.
- The status of the WCPF stock is classified as '**Transitional-depleting**' (equates to **Depleting** in the 2018 NFSRF; Stewardson *et al*. 2018).

BACKGROUND:

The West Coast Prawn Fishery (WCPF) targets Western King Prawn (*Penaeus* (*Melicertus*) *latisulcatus*) in coastal waters off western Eyre Peninsula, South Australia.

The Harvest Strategy (PIRSA 2019) for the West Coast Prawn Fishery (WCPF) uses the following Performance Indicators (PIs) to guide stock status classification:

- <u>Average Catch Rate</u>: estimated from nominal commercial catch per unit effort (CPUE) data from at least three months of fishing between March and September, combined with Venus Bay fishery-independent survey CPUE (VBCPUE) data collected from March and June surveys.
- <u>El Niño - Southern Oscillation (ENSO) Outlook status</u>: as determined from the monthly ENSO outlook status published by the Bureau of Meteorology for the 24-month period prior to 30 September 2021 (the 'assessment period').

Under the Harvest Strategy for the WCPF (PIRSA 2019), stock status classification for the fishery is consistent with the 2014 National Fishery Status Reporting Framework (NFSRF) (Flood *et al.* 2014) and is guided by Target, Trigger and Limit Reference Points (RPs) linked to average catch rate (Table 1, Figure 1).

However, the WCPF stock can be considered 'Environmentally Limited' when average catch rate is below the Trigger Reference Point of 54 kg.h^{-1} and three or more consecutive months during the assessment period are declared as El Niño by the Bureau of Meteorology.

Table 1: Reference Points (RPs) relating to average catch rate in the West Coast Prawn Fishery (PIRSA 2019).

	Average Catch Rate (kg/hr)
Target RP	72.00 (2.64 lb/min)
Trigger RP	54.00 (1.95 lb/min)
Limit RP	36.00 (1.32 lb/min)

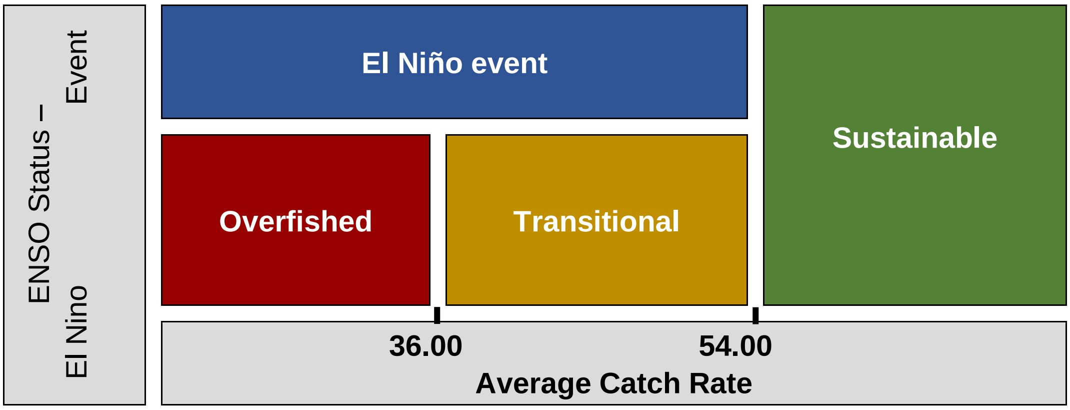


Figure 1: Decision rules for guiding stock status classification for the West Coast Prawn Fishery.

PIRSA Fisheries and Aquaculture has requested an Advice Note to report on the status of the WCPF stock in 2021 based on the PIs defined above. Specifically, this Advice Note reports on the following:

1. Average VBCPUE from the March and June surveys in Venus Bay.
2. Commercial CPUE from March-September.
3. Average catch rate (average of the results of dot points 1 and 2 above).
4. ENSO outlook status.
5. Stock status of the fishery using the decision matrix in the Harvest Strategy (Figure 1).

RESULTS/DISCUSSION:

Fishery-independent surveys

The March and June fishery-independent surveys were undertaken in Venus Bay on 11 March (10 shots) and 2 June (12 shots) 2021, respectively.

The average VBCPUE in **March** was 25.1 ± 18.6 kg.h^{-1} in 2021. This was 16% lower than the 2020 estimate of 29.9 ± 9.7 kg.h^{-1} and was the third lowest VBCPUE observed in March since the historic low in 2006 (9.4 ± 4.4 kg.h^{-1}).

The average VBCPUE in **June** was 55.8 ± 7.6 kg.h^{-1} in 2021. This was 67% higher than the 2020 estimate of 33.3 ± 4.5 kg.h^{-1}.

Average VBCPUE (March and June combined) was 41.8 ± 9.8 kg.h^{-1} in 2021. This represents a 32% increase from 2020 (31.6 ± 5.2 kg.h^{-1}), which is below the long-term mean since 2003 (48 kg.h^{-1}) (Figure 2).

Commercial catch and effort (March-September)

Commercial catch and effort data were available for 6 months between March and September 2021. The total catch during this period was 56.2 t, which is 14% higher than the 2020 catch of 49.2 t. The total effort in the WCPF between March and September 2021 was 996 trawl hours, which was 31% greater than that recorded in 2020 (762 trawl hours).

In 2021, the estimate of commercial CPUE was 56.4 kg.h^{-1}, a decrease of 13% from 2020 (64.6 kg.h^{-1}) (Figure 2).

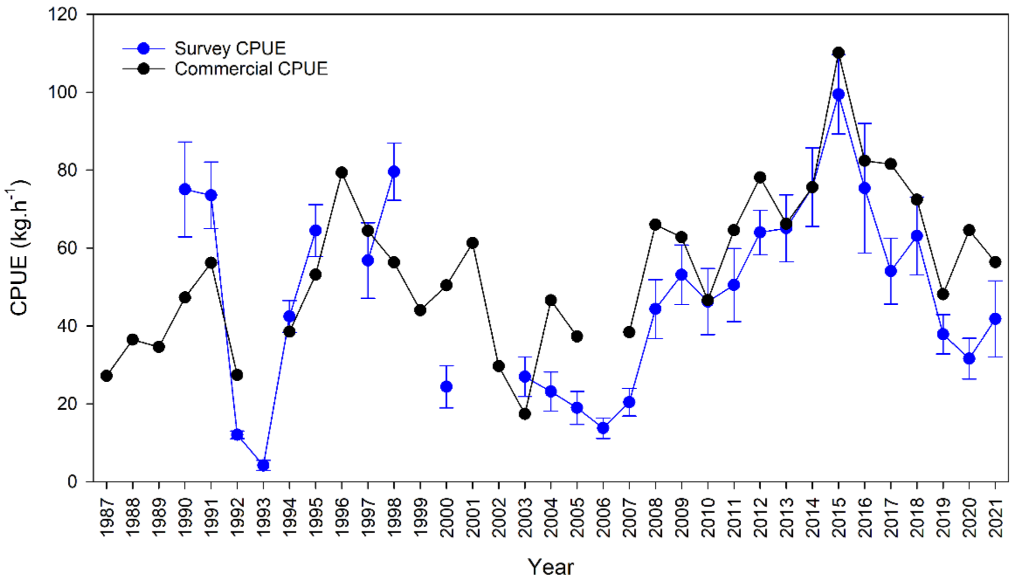


Figure 2. Average fishery-independent survey VBCPUE (March and June) and commercial CPUE (March-September). Error bars: Standard Error.

Average catch rate

In 2021, the average catch rate, estimated from nominal commercial CPUE recorded between March and September, and VBCPUE from the March and June surveys, was **49.1 kg.h^{-1}** (Figure 3). This estimate represents a 2% increase in average catch rate from 2020 (48.1 kg.h^{-1}) but remains below the Trigger Reference Point of 54 kg.h^{-1} (Table 1, Figure 3).

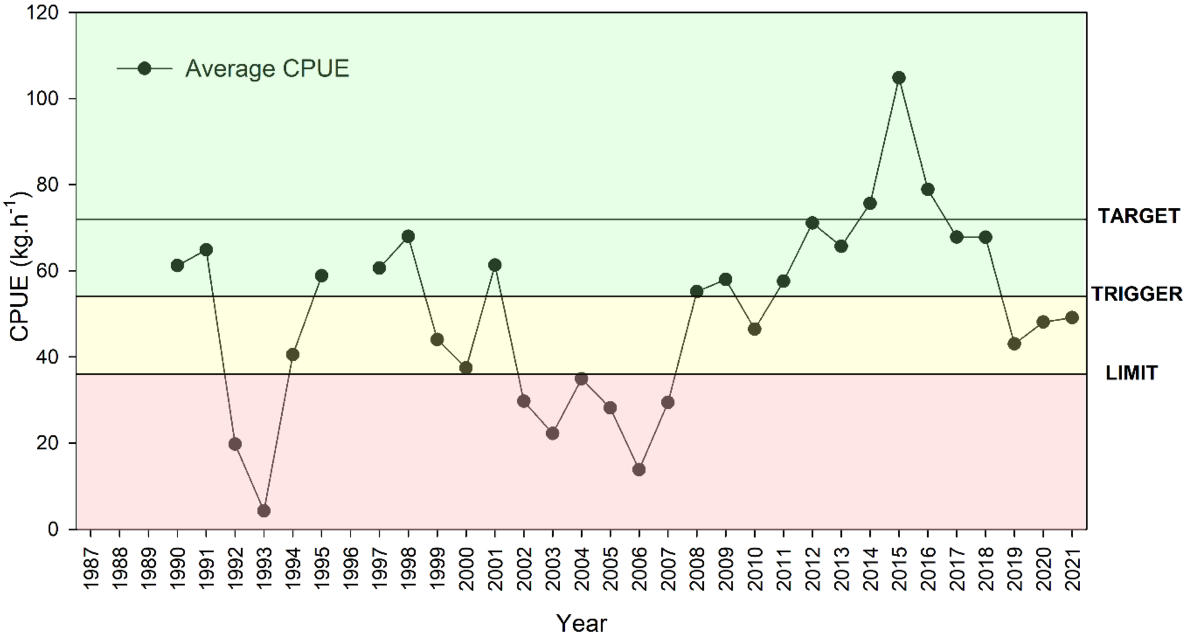
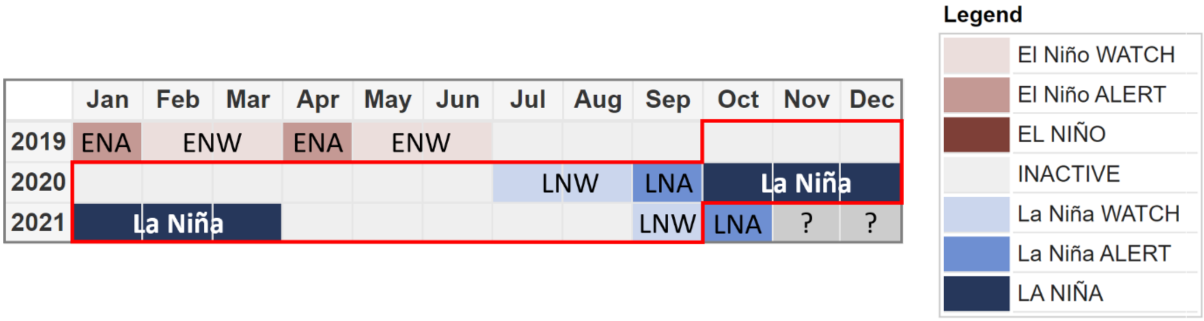


Figure 3. Average catch rate for the West Coast Prawn Fishery. Target, Trigger and Limit Reference Points are defined as per the Harvest Strategy (PIRSA 2019).

El Niño - Southern Oscillation (ENSO) Outlook status

During the assessment period (October 2019–September 2021) there were no months classified as having El Niño conditions (Table 2). The most recent El Niño event occurred from May 2015 to March 2016, which was outside of the assessment period.

Table 2. ENSO outlook summary from the Bureau of Meteorology (BOM 2021).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	ENA	ENW		ENA	ENW							
2020							LNW		LNA	La Niña		
2021	La Niña								LNW	LNA	?	?

Legend

	El Niño WATCH
	El Niño ALERT
	EL NIÑO
	INACTIVE
	La Niña WATCH
	La Niña ALERT
	LA NIÑA

Stock status determination

In 2021, the average catch rate was **49.1 kg.h^{-1}**, which is below the Trigger Reference Point of 54 kg.h^{-1} defined in the Harvest Strategy for the WCPF (PIRSA 2019). Given that this represents only a marginal increase from 2020 (48.1 kg.h^{-1}, when the stock was classified as Transitional-depleting), the WCPF stock classification is retained as being '**Transitional-depleting'** according to the 2014 NFSRF (Flood *et al.* 2014), which equates to **Depleting** under the 2018 NFSRF (Stewardson *et al*. 2018).

There were no months classified as having El Niño conditions (Table 2) during the assessment period (October 2019–September 2021). Consequently, under the Harvest Strategy for the WCPF, the WCPF stock cannot be considered 'Environmentally Limited'.

Dr Mike Steer
Research Director, Aquatic Sciences

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ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROF GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR BEN STOBART (SARDI AQUATIC SCIENCES)**

SUBJECT: **UPDATED WESTERN ZONE ABALONE FISHERY HARVEST STRATEGY OUTCOMES AND REVIEW OF RECORDS INCLUDED IN HARVEST STRATEGY ANALYSIS**

DATE: **26 NOV 2021**

KEY ISSUES

- To assist with determining TACC's for Blacklip and Greenlip Abalone for the Western Zone Abalone Fishery for 2022 PIRSA Fisheries & Aquaculture have requested:
    - Updated harvest strategy outcomes including updated fishing record and fishery-independent survey data, and Spatial Assessment Unit (SAU) adjustments
    - Confirmation of daily catch records used in catch rate estimation
- For Blacklip Abalone, the catch weighted zonal score for the 2020/21 financial year was 3.00 and, when combined with the zone trend score of 5.78, defines the stock status as **'sustainable'**. The recommended zonal catch for the 2022 calendar year is 42.35 t. In combination with the adjustments from the TACC meeting of 21 October 2021, the adjusted zonal catch was 43.54 t.
- For Greenlip Abalone, the catch weighted zonal score for the 2020/21 financial year was 3.04 and, when combined with the zone trend score of 5.00, defines the stock status as **'sustainable'**. The recommended zonal catch for the 2022 calendar year is 43.65 t. In combination with the adjustments from the TACC meeting of 21 October 2021, the adjusted zonal catch was 44.12 t.

BACKGROUND

The harvest strategy outputs presented to PIRSA and Industry during the Western Zone Abalone Fishery workshop held on 16 September and the TACC setting meeting held on the 21 October 2021 were based on catch and effort data received on 21 July 2021 and fishery-independent survey data to 16 September 2021. Hence, the data underpinning the Harvest Strategy outputs presented on 16 September and 21 October 2021 did not include all fishing records to the end of the 2020/2021 financial year (the time step for the Harvest Strategy) or fishery independent survey (FIS) density estimates for Sheringa and Anxious Bay for 2021. The absence of these data was conveyed to the meetings.

PIRSA Fisheries and Aquaculture have requested updated Harvest Strategy outcomes for both abalone species including the SAU adjustments discussed at the TACC meeting on 21 October 2021. Also requested is investigation and confirmation that the daily catch records for all SAUs included in the catch-per-unit-effort calculations determining the CPUE score for each SAU meet the criteria for inclusion/exclusion as described in section 2 (Methods) of the latest fishery stock status report (Stobart et al 2020). Briefly, this involves calculating CPUE estimates from daily records where (1) the species, for which CPUE is being estimated, constituted >=30% of the catch, (2) effort was >3 and <8 hours and the ratio of total catch over total hours was <66.7 kg.hr^{-1} meat weight.

RESULTS/DISCUSSION

Comparison of catch and effort data provided on 12 November 2021, confirmed to be the complete dataset, with those from 21 July 2021, demonstrated that eight fishing records from a single licence were added to the database. The eight new records constituted an additional 0.52 t and 0.58 t meat weight blacklip and greenlip catch, respectively.

Updated harvest strategy outcomes using the updated dataset and FIS density estimates for Sheringa and Anxious Bay (see Appendix Figure 1) are:

Blacklip - The catch weighted zonal score for the 2020/21 financial year was 3.00. In combination with the zone trend score of 5.78, these define the stock status for Blacklip Abalone in the WZ in the 2020/21 financial year as 'sustainable'. The zone score of 3.00 for 2020 translates to a recommended zonal catch of 42.35 t for the 2022 calendar year. In combination with the adjustments from the TACC meeting of 21 October 2021, the adjusted zonal catch for Blacklip Abalone in 2022 was 43.54 t (see Appendix Table 1).

Greenlip - The catch weighted zonal score for the 2020/21 financial year was 3.04. In combination with the zone trend score of 5.00, these define the zonal stock status for Greenlip Abalone in the WZ in the 2020/21 financial year as 'sustainable'. The zone score of 3.04 for 2020 translates to a recommended zonal catch of 43.65 t for the 2022 calendar year. In combination with the adjustments from the TACC meeting of 21 October 2021, the adjusted zonal catch for Greenlip Abalone in 2022 is 44.12 t (see Appendix Table 2).

The parameters used to define inclusion/exclusion of daily catch records from the estimation of CPUE described above are coded ('hard-wired') into the R code that runs the harvest strategy. Recalculation of CPUE using the original SAab R code confirmed that the values used in the harvest strategy were identical for greenlip in the Lincoln and Streaky Low SAUs and for the blacklip Lincoln Low SAUs, all of which had more than ten records in the 2020/21 financial year. Remaining Low SAUs had fewer than ten records for 2020, and thus CPUE was not estimated using SAab. Manual calculation of the number of records that met the criteria to be used in estimating CPUE matched those from SAab. The data used in the harvest strategy therefore do meet the criteria for inclusion/exclusion of daily catch records for CPUE estimation.

Dr Mike Steer

Research Director, Aquatic Sciences

Disclaimer

REFERENCES

Stobart, B., K. Heldt and S. Mayfield (2020). Western Zone Greenlip Abalone (*Haliotis laevigata*) and Blacklip Abalone (*H. rubra*) fisheries in 2019/20. Adelaide, Report to PIRSA Fisheries and Aquaculture. South Australian research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2017/000331-4. SARDI Research Report Series No. 1079. 73pp.**:** 73.

APPENDIX

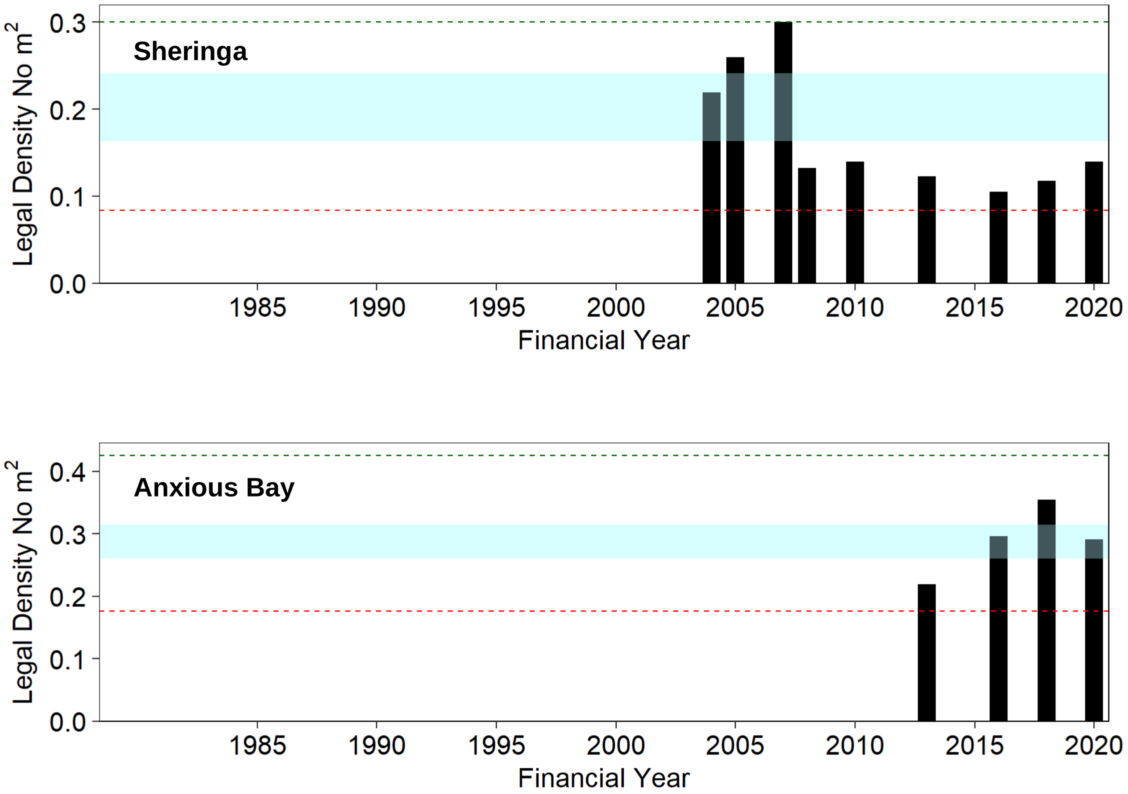
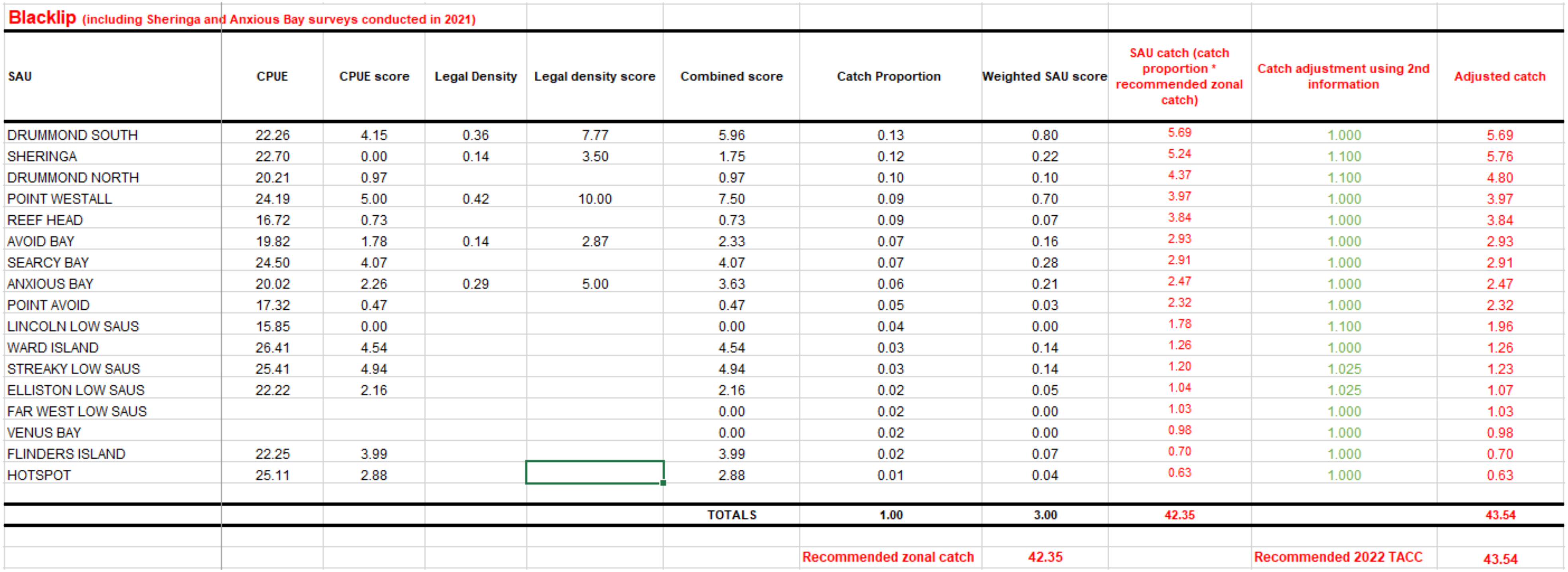


Figure 1. performance indicator legal-sized mean density (abalone.m^{-2}, bottom plot black bars) from Sheringa and Anxious Bay by financial year. For the harvest strategy, the horizontal green and red dashed lines show the upper and limit reference points, respectively, and the target reference band is shaded light blue.

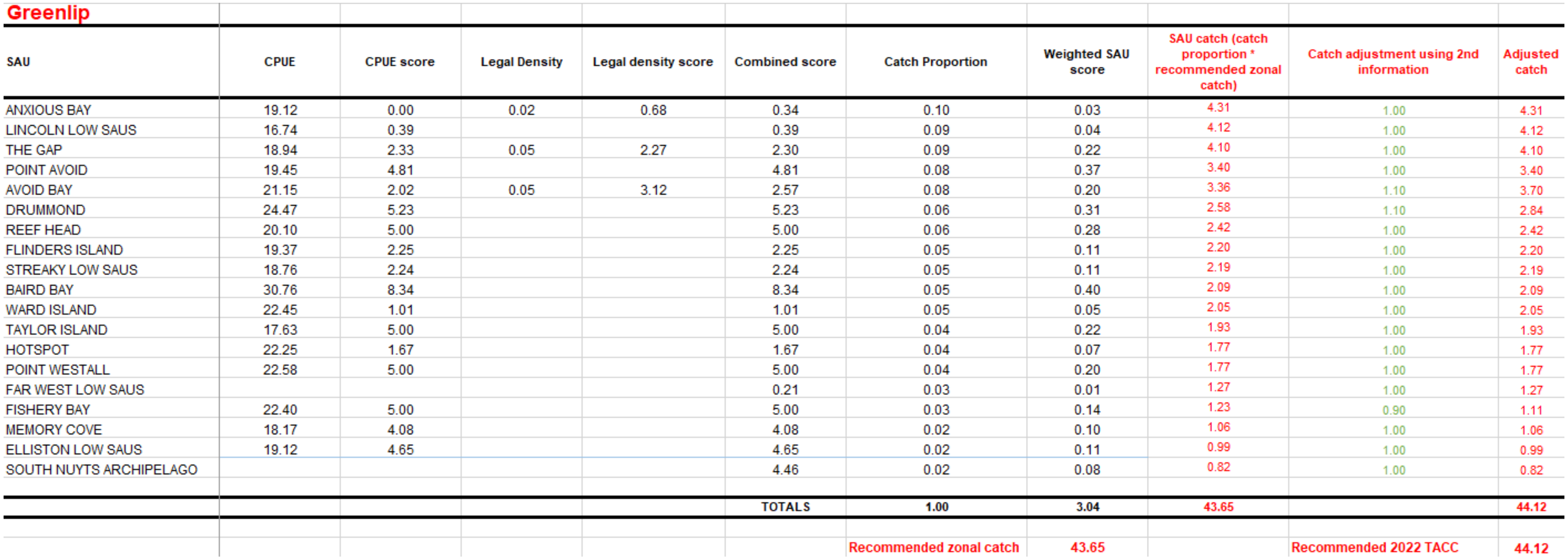
Table 1. Harvest strategy outputs and recommended zone catch adjustment table for Blacklip Abalone for 2022.



Blacklip (including Sheringa and Anxious Bay surveys conducted in 2021)

SAU	CPUE	CPUE score	Legal Density	Legal density score	Combined score	Catch Proportion	Weighted SAU score	SAU catch (catch proportion * recommended zonal catch)	Catch adjustment using 2nd information	Adjusted catch
DRUMMOND SOUTH	22.26	4.15	0.36	7.77	5.96	0.13	0.80	5.69	1.000	5.69
SHERINGA	22.70	0.00	0.14	3.50	1.75	0.12	0.22	5.24	1.100	5.76
DRUMMOND NORTH	20.21	0.97			0.97	0.10	0.10	4.37	1.100	4.80
POINT WESTALL	24.19	5.00	0.42	10.00	7.50	0.09	0.70	3.97	1.000	3.97
REEF HEAD	16.72	0.73			0.73	0.09	0.07	3.84	1.000	3.84
AVOID BAY	19.82	1.78	0.14	2.87	2.33	0.07	0.16	2.93	1.000	2.93
SEARCY BAY	24.50	4.07			4.07	0.07	0.28	2.91	1.000	2.91
ANXIOUS BAY	20.02	2.26	0.29	5.00	3.63	0.06	0.21	2.47	1.000	2.47
POINT AVOID	17.32	0.47			0.47	0.05	0.03	2.32	1.000	2.32
LINCOLN LOW SAUS	15.85	0.00			0.00	0.04	0.00	1.78	1.100	1.96
WARD ISLAND	26.41	4.54			4.54	0.03	0.14	1.26	1.000	1.26
STREAKY LOW SAUS	25.41	4.94			4.94	0.03	0.14	1.20	1.025	1.23
ELLISTON LOW SAUS	22.22	2.16			2.16	0.02	0.05	1.04	1.025	1.07
FAR WEST LOW SAUS					0.00	0.02	0.00	1.03	1.000	1.03
VENUS BAY					0.00	0.02	0.00	0.98	1.000	0.98
FLINDERS ISLAND	22.25	3.99			3.99	0.02	0.07	0.70	1.000	0.70
HOTSPOT	25.11	2.88			2.88	0.01	0.04	0.63	1.000	0.63
					TOTALS	1.00	3.00	42.35		43.54
						Recommended zonal catch	42.35		Recommended 2022 TACC	43.54

Table 2. Harvest strategy outputs and recommended zone catch adjustment table for Greenlip Abalone for 2022.



Greenlip

SAU	CPUE	CPUE score	Legal Density	Legal density score	Combined score	Catch Proportion	Weighted SAU score	SAU catch (catch proportion * recommended zonal catch)	Catch adjustment using 2nd information	Adjusted catch
ANXIOUS BAY	19.12	0.00	0.02	0.68	0.34	0.10	0.03	4.31	1.00	4.31
LINCOLN LOW SAUS	16.74	0.39			0.39	0.09	0.04	4.12	1.00	4.12
THE GAP	18.94	2.33	0.05	2.27	2.30	0.09	0.22	4.10	1.00	4.10
POINT AVOID	19.45	4.81			4.81	0.08	0.37	3.40	1.00	3.40
AVOID BAY	21.15	2.02	0.05	3.12	2.57	0.08	0.20	3.36	1.10	3.70
DRUMMOND	24.47	5.23			5.23	0.06	0.31	2.58	1.10	2.84
REEF HEAD	20.10	5.00			5.00	0.06	0.28	2.42	1.00	2.42
FLINDERS ISLAND	19.37	2.25			2.25	0.05	0.11	2.20	1.00	2.20
STREAKY LOW SAUS	18.76	2.24			2.24	0.05	0.11	2.19	1.00	2.19
BAIRD BAY	30.76	8.34			8.34	0.05	0.40	2.09	1.00	2.09
WARD ISLAND	22.45	1.01			1.01	0.05	0.05	2.05	1.00	2.05
TAYLOR ISLAND	17.63	5.00			5.00	0.04	0.22	1.93	1.00	1.93
HOTSPOT	22.25	1.67			1.67	0.04	0.07	1.77	1.00	1.77
POINT WESTALL	22.58	5.00			5.00	0.04	0.20	1.77	1.00	1.77
FAR WEST LOW SAUS					0.21	0.03	0.01	1.27	1.00	1.27
FISHERY BAY	22.40	5.00			5.00	0.03	0.14	1.23	0.90	1.11
MEMORY COVE	18.17	4.08			4.08	0.02	0.10	1.06	1.00	1.06
ELLISTON LOW SAUS	19.12	4.65			4.65	0.02	0.11	0.99	1.00	0.99
SOUTH NUYTS ARCHIPELAGO					4.46	0.02	0.08	0.82	1.00	0.82
					TOTALS	**1.00**	**3.04**	**43.65**		**44.12**
						Recommended zonal catch	43.65		Recommended 2022 TACC	**44.12**

ADVICE TO: **PIRSA FISHERIES AND AQUACULTURE (PROFESSOR GAVIN BEGG – EXECUTIVE DIRECTOR)**

FROM: **DR JONATHAN SMART, DR ANTHONY FOWLER (SARDI AQUATIC SCIENCES)**

SUBJECT: **YELLOWTAIL KINGFISH**

DATE: **02 FEBRUARY 2022**

KEY ISSUES

This Advice Note, requested by PIRSA Fisheries and Aquaculture, provides a qualitative assessment of the possible origins of a small Yellowtail kingfish that was located on a beach north of Fitzgerald Bay, Spencer Gulf.

BACKGROUND

The Yellowtail Kingfish (*Seriola lalandi)* is a large pelagic, predatory finfish species of the Family Carangidae that has a broad distribution throughout the temperate waters of the Atlantic, Pacific and Indian Oceans. In Australian waters, it occurs along the entire southern seaboard of the continent from southern Queensland to the mid-coast of Western Australia (WA) (Kailola et al. 1993), throughout which they inhabit rocky reefs and adjacent areas in coastal waters to depths of more than 300 m (SAFS 2020). Throughout the Australasian distribution, the Yellowtail Kingfish (YTK) populations are divisible into two stocks: the Western Stock involves the populations of WA; the Eastern Stock includes the populations that occur in the waters of South Australia (SA), New South Wales (NSW), Victoria, and New Zealand (NZ). The geographic extent of the latter stock reflects the highly mobile nature of the species, as demonstrated by tagging studies that have shown cross-jurisdictional and bi-directional movement between NSW and SA as well as NSW and NZ (SAFS 2020). Across the Australasian jurisdictions, the YTK is a fishery resource for the commercial and recreational sectors. In SA, the reported commercial catches of YTK have been characteristically low, ranging from several hundred kg up to several tonnes per year. The recreational catches have generally been considerably higher, increasing from 62 t.yr^{-1} in 2000/01 to 199 t.yr^{-1} in 2013/14 (SAFS 2020).

In SA throughout the 2000s, an important aquaculture industry for YTK was developed. This involved the establishment of a number of sea farms that rear fish in sea cages in several places in Spencer Gulf. Using sea cages can result in escapement events. Through the early years of development of the YTK sea farming operations in Spencer Gulf, there were a number of escapement events (PIRSA Website). In 2003, this led to a study for which the aim was to determine whether it was possible to differentiate between cultured YTK and wild fish (Fowler et al. 2003). Fowler et al. (2003) concluded there were considerable differences between wild and cultured YTK fish in terms of: morphology; otolith microstructure; gut contents; and behaviour. Compared with the wild fish, cultured fish could display differences in head shape, alignment of the head and body and shape of the operculum as well as deformities in the alignment of the upper and lower jaws and curvature of the spine (Fowler et al. 2003). Furthermore, in a comparison between wild YTK and some fish of unknown origin captured in Northern Spencer Gulf (NSG), there were differences in gut contents and behaviour of the latter that were consistent with them having originated from a 'cultured' background (Fowler et al. 2003).

In early January 2022, there were reports from the public of large numbers of YTK located in Fitzgerald Bay in NSG. No information was provided on numbers, size of the fish or specific location as to where they were sighted. Also, at this time, one small YTK was located washed up on a beach 10 km north of Fitzgerald Bay. This fish was frozen and then sent to the South Australian Aquatic Sciences Centre (SAASC) for consideration of its likely origin, with respect to whether it was a wild or cultured fish. This assessment was qualitative in nature. The fish was weighed and measured, and examined for any head, facial and body deformities that would be consistent with a cultured origin (Fowler et al. 2003). It was then dissected, and the stomach contents were examined. The observations were considered in a weight-of-evidence approach addressing the issue about its likely origin.

RESULTS/DISCUSSION

Three factors were considered in evaluating the likely origin of this fish:

1. The size of the specimen, relative to known sizes of cultured fish in the Fitzgerald Bay lease corresponding to date of capture and to the size range of wild fish in NSG.
2. The presence/absence of deformities associated with cultured YTK (Fowler et al 2003).
3. The stomach contents of the specimen.

Specimen size range

The retrieved specimen of YTK that had been sent to SAASC for consideration was relatively small, i.e., was 29.0 cm TL, 26.6 cm CFL and weighed 246 g. This was within the size range of cultured YTK that were located at the Fitzgerald Bay lease at that time, whose length range was 15 – 35 cm CFL and weight range was from 50 to 450 g.

The life history of YTK in the open coastal and gulf waters of SA is very poorly understood and spatial information about where reproduction occurs and where the various life history stages are found is currently lacking. However, small YTK do not appear to be a natural component of the biota of NSG, with the occurrence of YTK in Spencer Gulf usually reflecting seasonal visits by the highly mobile adults of 10 kg or more in size (McGlennon 1997, Fowler et al. 2003).

Presence/absence of deformities

The morphology of the fish was examined. It showed no obvious deformities that were previously considered to be characteristic of cultured fish (compare Figs. 1 and 2 and more photographs of deformities in Fowler et al. 2003). If this was a cultured fish, the lack of deformities might relate to it being relatively small, young and having been in a sea cage for only a short time.

Stomach content

The stomach was very full of semi-digested flesh. Based on the presence of scales, vertebrae, and other bones (Fig. 1), this was recognisable as a relatively large fish that had been recently eaten. The stomach contents did not include artificial pellets, odd plant material or surface-based litter that had been found previously in escaped YTK (Fowler et al. 2003).

Conclusion

There is insufficient information from this single fish to confidently determine whether it was a wild or cultured YTK.

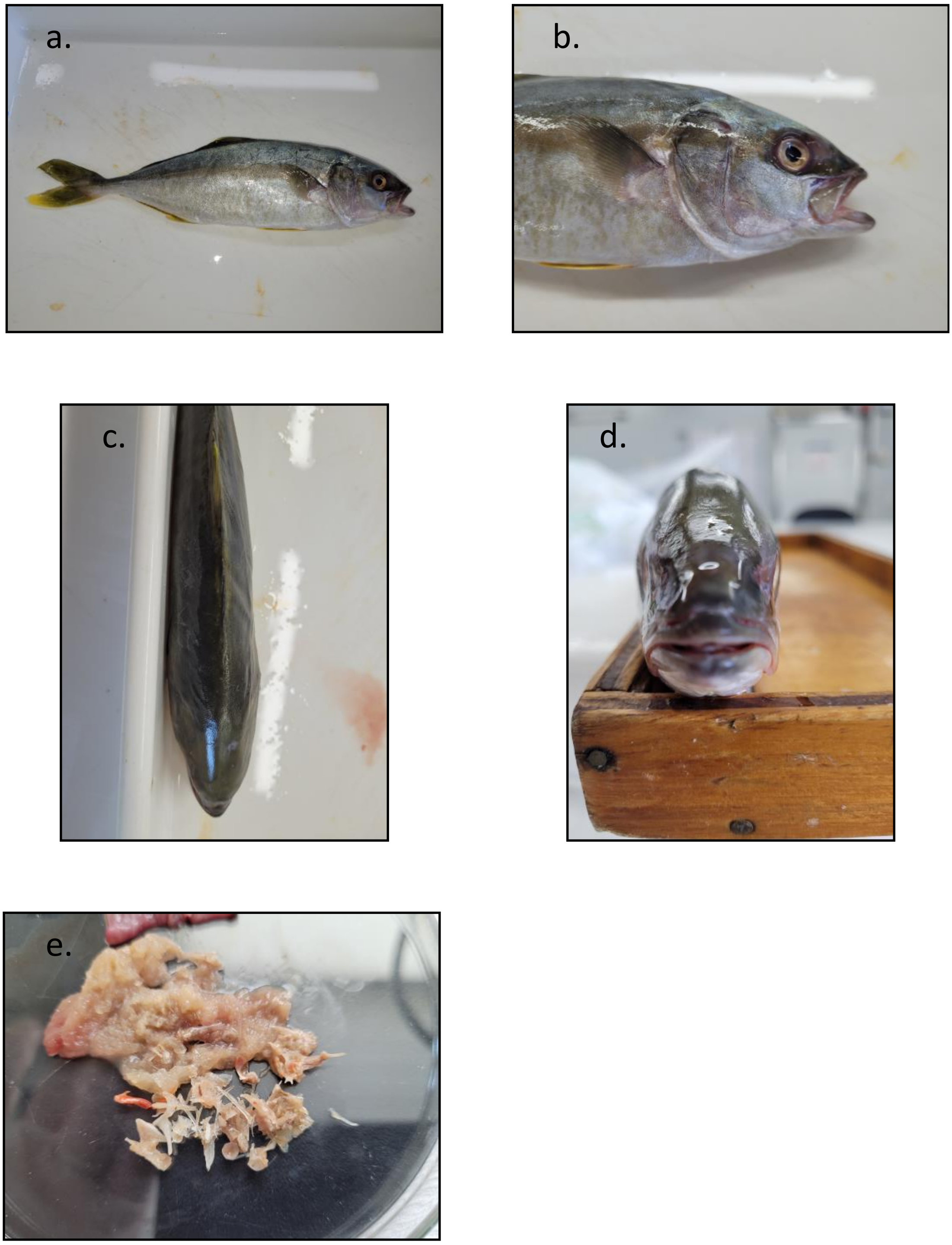


Figure 1. Photographs of specimen of Yellowtail Kingfish that washed up on a beach in NSG north of Fitzgerald Bay. When compared with photos in Fowler et al. (2003) they demonstrate little evidence of deformities. a. whole body. b. head and jaw morphology. c. alignment of the spine. d. frontal view of facial morphology. e. stomach contents showing soft flesh as well as bones and vertebrae of a fish being digested.

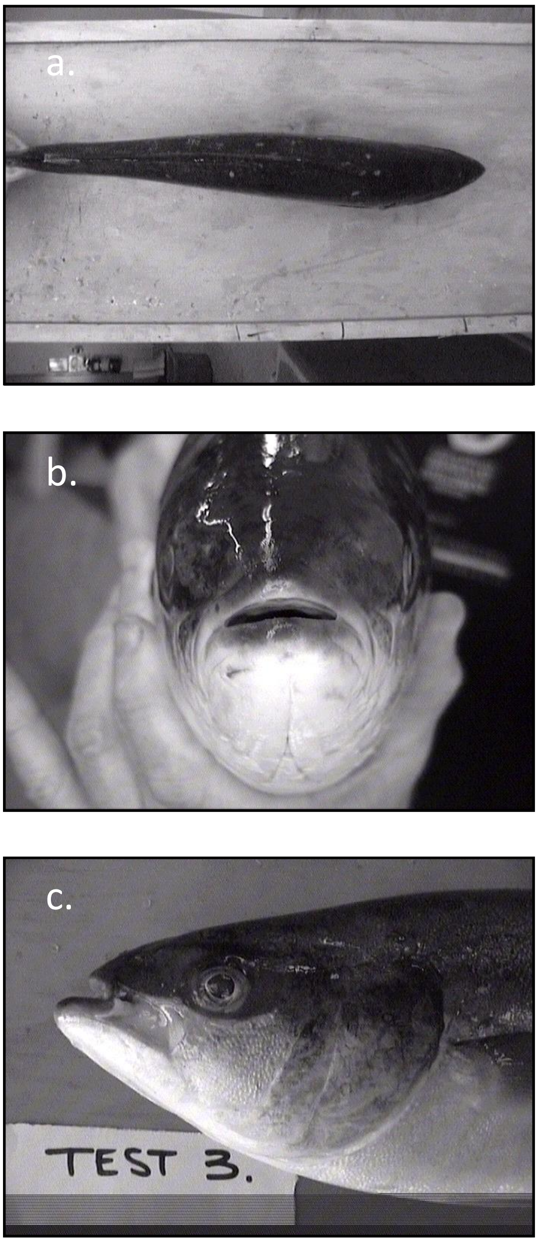


Figure 2. Photographs of some cultured Yellowtail Kingfish showing some of the types of deformities that were observed in 2003 (Fowler et al. 2003). a. whole body showing deviation of the spine. b. frontal view of facial morphology showing off-set between the upper and lower jaws. c. head and jaw morphology showing a protruding lower jaw.

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