TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	**Meeting No. 20** **29-30 January 2020**
PRELIMINARIES **Chairs opening remarks, opening prayer and traditional owner welcome and apologies**	Agenda Item No. 1.1

RECOMMENDATIONS

1.1.1 That the TSPMAC **NOTE**:

a. an acknowledgement of Traditional Owners;
b. the Chair's welcome address;
c. apologies received from members unable to attend.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
PRELIMINARIES **Adoption of agenda**	Agenda Item No. 1.2

RECOMMENDATIONS

1.2.1 That the TSPMAC consider and **ADOPT** the agenda.

BACKGROUND

A basic draft agenda was discussed at the TSPMAC 19 teleconference on 17 September 2019. The full agenda was sent for comment on 5 December 2019. One additional agenda item was added, for Clive Turnbull to provide a preliminary overview of the management strategy evaluation process for comparing different fishing season dates, and their possible effect on the stock and catches.

TORRES STRAIT PRAWN

MANAGEMENT ADVISORY COMMITTEE MEETING No. 20

Date: Wednesday 29 January 2020: 9am-5pm, Thursday 30th 9am – 12pm (if required)

Venue: QDAF Northern Fisheries Centre, 38-40 Tingira St Cairns

AGENDA	DETAILS
1 Preliminaries	
1.1 Chairs opening remarks, opening prayer and traditional owner welcome and apologies	
1.2 Adoption of agenda	
1.3 Declarations of interest	Previous declaration of members will be reviewed and updated where required. New members will provide any possible declarations of interest, and committee to consider where declared interests have any clashes with specific agenda items.
2 Meeting Administration	
2.1 Actions and/or business arising from previous TSPMAC meetings (EO)	
3 Reports	
3.1 Native Title update.	**For Noting.** Verbal update.
3.2 a) Industry update. (Industry)	**For Noting.** Verbal update.
3.2 b) PNG update. (PNG verbal update)	**For Noting.** Verbal update.
3.3 Management update. **For Noting.** (AFMA)	**For Noting.** Updates will be provided on staffing changes, ERAs, Environment reporting, legislative amendments, observer coverage and any other relevant small management updates since the last meeting.
3.4 Compliance report - season update on activities. (AFMA)	**For Noting.** Discussion of compliance activities undertaken in the TSPF since the last meeting, including any breaches.
3.5 Data report. (Clive Turnbull)	**For Noting.** Clive Turnbull will present and explain results and trends in catch and effort data for the 2018 season and 2019 season.
3.6 Comparison of logbook and observer data for TEPS (AFMA)	**For Discussion.** An action from TSPMAC 18 was for AFMA to undertake a comparative analysis of TEPs reported in logbooks VS levels with observer trips to see

		if it seems that they have been underreporting.
4	**Management**	
4.1	TPC licenses and motherships in the Torres Strait (AFMA)	**For Discussion.**
4.2	BRD review (AFMA)	**For Discussion/ recommendation.** Discuss preliminary results of trial, and put forward recommendations (on how AFMA thinks we should introduce the new BRD). Talk about QLD fisheries concerns regarding seasnakes and logistics around mandating a BRD in the TSPF and need to consider it in the Queensland East Coast Otter Trawl Fishery where boats are dual endorsed. Info about second trail and where to from here following second trial.
4.3	Stock assessment. (AFMA)	**For Noting**. Discuss outcomes of the TSPF stock assessment update and implications for management and the HS.
4.4	Harvest Strategy trigger review. (AFMA)	**For Recommendation**. HS triggers haven been reviewed and the MAC is asked to consider trigger options to ensure we can effectively pursue the Harvest Strategy objectives (sustainability and economic).
4.5	Total Allowable Effort limit 2021-2022. (AFMA)	**For Recommendation**. TAE is currently set until December 2020. Noting HS and SA discussions, what TAE should apply going forward and for how long do we wish to set it.
4.6	Species of interest and logbooks. (AFMA)	**For Recommendation.** Should we ask license holders to collect information on discarded species of interest, particularly TRL. What's the best way of doing this without reprinting logbooks?
4.7	Preliminary results of management strategy evaluation of different season dates (Clive Turnbull)	**For Discussion.** Clive Turnbull will provide some preliminary results from initial MSE testing of a range of season dates for the TSPMAC to consider. Any advice provided can then be used in finalising this season date MSE testing project.
5	**Finance**	
5.1	TSPF draft budget for 2020 season levies (AFMA)	Update will be provided on progress of the draft budget.
6	**Other business**	
6.1	Dates and location for next meeting.	
6.2	Closing remarks and closing prayer.	

Individuals wishing to attend the meeting as an observer are required to contact the Chair (Mr. John Glaister: care of Lisa Cocking TSPMAC Executive Officer; lisa.cocking@afma.gov.au), notifying him of your desire to attend.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
PRELIMINARIES **Declarations of interest**	Agenda Item No. 1.3

RECOMMENDATION

1.4.1 That TSPMAC members and observers:

a. **NOTE** the previously declared real or potential conflicts of members and update this list with current real or potential conflicts of interest (**Table 1**);

b. **DETERMINE** whether the member may or may not be present during discussion of or decisions made on the matter which is the subject of the conflict;

c. **ABIDE** by decisions of the TSPMAC regarding the management of conflicts of interest; and

d. **NOTE** that the record of the meeting must record the fact of any disclosure, and the determination of the TSPMAC as to whether the member may or may not be present during discussion of, or decisions made, on the matter which is the subject of the conflict.

BACKGROUND

1. Consistent with the *Protected Zone Joint Authority (PZJA) Fisheries Management Paper No. 1* (FMP1), which guides the operation and administration of PZJA consultative forums, members are asked to declare any real or potential conflicts of interest.

2. Working Group members are asked to confirm the standing list of declared interests (**Table 1**) is accurate and provide an update to be tabled if it is not.

3. FMP1 recognises that members are appointed to provide input based on their knowledge and expertise and as a consequence, may face potential or direct conflicts of interest. Where a member has a material personal interest in a matter being considered, including a direct or indirect financial or economic interest; the interest could conflict with the proper performance of the member's duties. Of greater concern is the specific conflict created where a member is in a position to derive direct benefit from a recommendation if it is implemented.

4. When a member recognises that a real or potential conflict of interest exists, the conflict must be disclosed as soon as possible. Where this relates to an issue on the agenda of a meeting this can normally wait until that meeting, but where the conflict relates to decisions already made, members must be informed immediately. Conflicts of interest should be dealt with at the start of each meeting. If members become

aware of a potential conflict of interest during the meeting, they must immediately disclose the conflict of interest.

Where it is determined that a direct conflict of interest exists, the forum may allow the member to continue to participate in the discussions relating to the matter but not in any decision making process. They may also determine that, having made their contribution to the discussions, the member should retire from the meeting for the remainder of discussions on that issue. Declarations of interest, and subsequent decisions by the forum, must be recorded accurately in the meeting minutes.

DISCUSSION

Table 1. Declaration of interest formally declared by members. To be updated at TSPMAC 20.

Name	Disclosures of interest
Members	
John Glaister (Chair)	To be declared.
Lisa Cocking (EO)	Australian Fisheries Management Authority employee.
David Power	To be declared.
Darren Roy	Queensland fisheries Employee.
Edwin Morrison	TSPF Licence Holder and operator.
Marshall Betzel	President of QLD seafood marketers association and fleet manager for Torres Strait boats.
Clinton Farman	To be declared.
Glen Duggan	Licence holder in TSPF and QLD East Coast Otter Trawl Fishery.
Jim Newman	Holds 1 Torres Strait licence.
Clive Turnbull	Independent scientist employed to undertake TSPF annual data work.
Allison Runck	Torres Strait Regional Authority employee.
Gavin Mosby	Traditional inhabitant member for Masig. Traditional fisher for BDM, TRL and Finfish.
William Stephen	To be declared.
Mark David	To be declared.
Maluwap Nona	Chair of Malu lamar. No other interests declared.

Observers	

FINANCIAL IMPLICATIONS

Torres Strait Prawn Management Advisory Committee

Meeting 19 Record

17 September 2019

Teleconference

Note all meeting papers and record available on the PZJA webpage: www.pzja.gov.au

Australian Government
Australian Fisheries Management Authority

Box 7051, Canberra Business Centre, ACT 2610 / Ph (02) 6225 5555 / Fax (02) 6225 5500 / AFMA Direct 1300 723 621 afma.gov.au

Meeting participants

Members

Name	Position
William Stephens	Traditional Inhabitant Industry Member
Jim Newman	Industry member
Ed Morrison	Industry member
Clinton Farman	Industry member
Marshall Betzel	Industry member
Glen Duggan	Industry member
John Glaister	Chair
Lisa Cocking	Executive Officer and AFMA member
David Power	AFMA member
Allison Runck	TSRA member
Darren Roy	Queensland Fisheries member

Apologies

Name	Position
Mr Francis Pearson	Traditional Inhabitant Industry Member
Mr Gavin Mosby	Traditional Inhabitant Industry Member

TSPMAC meeting 19 decision record

1.1.1 TSPMAC **SUPPORTED** the proposal to develop catch rate based triggers for monitoring sustainability of catches within fishing seasons that would replace existing effort based triggers.

1.1.2 TSPMAC **SUPPORTED** the proposal for the Harvest Strategy working group to develop economic indicators to monitor fishery performance over time.

1.1.3 The TSPMAC **NOTED** that the total cost of engaging an independent scientist to assist with reviewing the harvest strategy triggers may exceed the $5000 originally budgeted but it is expected this can be covered with savings elsewhere.

1.1.4 The TSPMAC **AGREED** to convene the next face to face meeting in Cairns on Wednesday 29 January 2020.

Meeting Administration

The meeting opened at 10.35am.

The new members were welcomed to the meeting, including the new Chair, John Glaister, and the new industry member Mr Clinton Farman. The reappointed industry members were also thanked for their ongoing service. Apologies were acknowledged from Mr Gavin Mosby and Mr Francis Pearson.

The committee agreed to adopt the agenda as it stands.

1.1 Review of TSPF harvest strategy triggers

The TSPMAC discussed the harvest strategy review and considered the following main discussion points:

1. The MAC noted the developments around the review of harvest strategy triggers for the Torres Strait Prawn Fishery. The review came about because there was concern that some of the triggers in the current HS may not be working as intended, and may not take into account the fluctuations in the stock and changes to catch rates year to year.
2. A harvest strategy working group was established, which included an independent stock assessment scientist, Andrew Penney as well as AFMA, Clive Turnbull, the TSPMAC scientific member and a TSPMAC Industry member.
3. During the working group's first meeting on 30 July 2019, the working group noted that the current effort triggers used in the harvest strategy do not provide any indication on the state of the tiger prawn stocks and a catch rate based trigger would be more useful as an indicator of potential declines and the need for further review within season. A review paper on approaches for developing harvest strategy was prepared by Dr Penney and presented to the MAC for consideration. The MAC noted the review paper was very useful and supported the recommendation of the HSWG to progress with CPUE based triggers.
4. The triggers are intended to be a review point that doesn't prompt a specific management response, but instead triggers a review so management and the MAC can consider the possible reasons for lower catch rates and respond appropriately.
5. Any triggered review would also use economic data including prawn and fuel prices, to assess whether changes in the stock are more likely related to sustainability or economic pressures.
6. The TSPMAC noted that there is minimal additional cost beyond what has been budgeted, and that using CPUE based triggers in the harvest strategy is cost effective over the long term. TSPMAC supported the project being progressed and presented to a face to face meeting of the MAC in early 2020.

<u>Stock assessment update</u>

7. Clive Turnbull provided a brief report on the results of the 2019 stock assessment highlighting that tiger prawn stocks in the Torres Strait are in a healthy state with high CPUE and biomass levels ranging between 60-88% of virgin biomass. This was the first assessment update in more than five years and it is expected that the results will enable ABARES to update the status report for the Torres Strait prawn fishery tiger prawn stocks from ‘uncertain’ to ‘Not overfished and Not subject overfishing’. THE MAC noted the stock assessment results and approach for setting future TAEs will be considered further at the next meeting scheduled in early 2020/

1.2 TSPMAC workplan and meeting dates

The TSPMAC acknowledged that the trial of the new bycatch reduction device took place in July 2019, however, the trial was cut short due to bad weather. AFMA outlined a proposal to complete this trial on a different boat early in the 2020 fishing season. The trial could not be finalised this season as it takes time to get a new scientific permit, and AFMA considers it would be useful getting data from a second boat as well.

The committee supported further continuation of the BRD trial noting the importance of thoroughly testing the BRDs and ensuring the are effective and appropriate for use in the Torres Strait. The committee noted the full results were unlikely to be available at the next TSPMAC meeting and final results would likely be considered out of session during 2020.

Next Meeting

The committee discussed the proposed agenda and timing of the next face to face TSPMAC meeting. January 29 was proposed as a suitable date and key agenda items included; harvest strategy trigger review, initial BRD trial results and setting of the TAE for 2021. TSPMAC noted the updated stock assessment would also be discussed in greater detail, alongside the harvest strategy trigger review. Queensland fisheries also agreed to present a paper detailing the changes occurring in the Queensland East Coast Otter Trawl Fishery so the TSPMAC can consider potential future impacts for dual endorsed operators.

The meeting closed at 11.05am

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MEETING ADMINISTRATION Actions arising	**Agenda Item No. 2.1** For Discussion

RECOMMENDATION
2.1.1. That TSPMAC members **NOTE:**
a) the progress against actions items arising from previous TSPMAC meetings as detailed in the below table.

b) the final meeting record for TSPMAC 19 held via teleconference on 17 September 2019 (**Attachment 2.1a**). These minutes were sent for comment on 23 September 2019, and the final ratified version sent to TSPMAC out of session on 10 December 2019.

Actions arising from past TSPMAC meetings

Item number	Action	Responsibility	progress
ACTION 18.1	AFMA to seek clarification regarding master fisherman's licenses and requirements for TIB fishers and feedback to the TSPMAC.	AFMA	**Complete (not sent to TSPMAC OOS though).** No master fisherman's licence is required when working on a TIB licensed boat. If working on a TVH or TSF licensed primary boat, tender or dinghy, one person on board must hold a current TMF licence endorsed for the relevant fishery. For more information on TMJ licences, see the new TSF licensing guide available on the PZJA website.
ACTION 18.2	TSPMAC industry members to write to licence holders regarding pre-booking fuel and offloads for the mothership. Notification should occur to the Seaswift office and can also be to the boat drivers, however this is less reliable due to periodic driver changes.	TSPMAC industry members	**Incomplete**. The industry MAC report was not complete following TSPMAC 18, so this item was not included.
ACTION 18.3	AFMA and TSRA to work together to discuss the memberships and consultation with traditional inhabitants regarding Torres Strait management.	AFMA and TSRA	**Ongoing**. This action was in response to comments from traditional inhabitant members, who felt they needed more support from TSRA or AFMA with getting broader community views on decisions being considered by TSPMAC, so they can provide more grounded advice. The TSRA has recently supported all Kulkalgal, Kemer Kemer Meriam, Gudamalulgal, and Maluialgal members of all advisory

			committee meetings to undertake community consultations across all outer island Torres Strait communities throughout October and November 2019. Kaiwalagal consultations are scheduled for January 2020. All visits to date have been led by traditional inhabitant members and supported by a TSRA and AFMA staff member. The purpose of the visits have been two fold – to inform communities of key activities and discussions occurring in each PZJA advisory committee, and to seek community input for upcoming discussions. The visits follow-on from science and leadership training provided to members in May 2019.
ACTION 18.4	AFMA to send an email to licence holders and the TSPMAC once we know a start date and process for AFMA taking over the TSPF compliance functions.	AFMA	**Complete**. A letter was sent to licence holders providing an update on AFMA taking over compliance functions.
ACTION 18.5	AFMA to compare logbook data to observer data for TEPs to see if they match.	AFMA	This action will be reported against at agenda item 3.6.
ACTION 18.6	AFMA to monitor observer days and make sure we have enough budgeted as effort increases.	AFMA	**Ongoing**. AFMA continue to monitor, and increase/ decrease observer coverage to match actual effort in the fishery, to meet the 2.6% effort coverage.

ACTION 18.7	When information is obtained, AFMA to send an update on whether the TSPF will be joining the AFMA ERA process, to the TSPMAC.	AFMA	**Complete**. The TSPF will not be going through the standard ERA process at this time. See agenda item 3.3 for more details.
ACTION 18.8	Mr Betzel to contact the FRDC to see whether funding would be available to supplement fishers trialling BRDs.	Mr Betzel	**Remove as action item**. This was not progressed as an action, as the boat that undertook the trial did not require financing.
ACTION 18.9	AFMA to work with Maggie Jo (Clinton the Skipper) regarding trialling the KCF next year following NPF finishing trials.	AFMA	**Complete**. A BRD trial was undertaken in July / August 2019. See the outcomes in agenda item 4.2. An additional trial will be undertaken early in the 2020 season by a different boat.
ACTION 18.10	Circulate NPF trial data when it is released seeking TSPMAC recommendation about which BRD to trial in the TSPF.	AFMA	**Incomplete**. These reports are attached to agenda item 4.2 – BRD trial. The data was not sent following meeting 18, because the NPF were trailing a lot of BRDs, and AFMA were not yet in a position to recommend any specific ones for the TSPMAC to consider as options. Since then, AFMA has facilitated one trial of the Tom's Fisheye BRD, which is reported on in agenda item 4.2. NPF trial results are contained within the attachments.
ACTION 18.11	TSPF industry members to provide fuel and beach product price data to Clive Turnbull for use in the data summary.	Industry	
ACTION 18.12	AFMA to consider steps to remove the five boat rule policy for TSPF as industry are not generally concerned. Send a letter of question to industry.	AFMA	**Ongoing**. The five boat rule is a policy which is applied across all Commonwealth fisheries. Given the five

			boat rule applies broadly, AFMA is reticent to ceasing its application in just one fishery. It is more likely that AFMA would need to review the policy and consult with the industry in order to determine the status of its future value across all Commonwealth fisheries.
ACTION 18.13	Mr Turnbull to add gear composition to the gear survey.	Mr Turnbull	**Complete**. This was used for the gear survey and stock assessment update.
ACTION 18.15	AFMA to send fly river research from CSIRO TRL project to TSPMAC to consider.		**Complete.** This report was distributed to the TSPMAC on 9 December 2020.
ACTION 18.16	AFMA to review outcomes of Bodsworth project to see whether anything should be pursued relating to research or social licence in the future.	AFMA	**Ongoing**. An update against this item will be provided at agenda item 4.8.
ACTION 18.17	TSRA to put together a document for Traditional Inhabitant members of key outcomes from TSPMAC 18.	TSRA	**Complete**. The meeting summary community notice was sent to communities following the meeting.
ACTION 18.18	TSPMAC industry members to put together a TSPMAC 18 industry update, which can be sent to licence holders by AFMA.	TSPMAC industry members	**Incomplete**. This was not carried out following TSPMAC 18. We hope for industry to reinstate this practice following this meeting.
ACTION 18.19	AFMA to work to review the observer protocols to be sure the data being collected is still relevant.	AFMA	**Ongoing**. This action has not been progressed due to other higher priority work.
Actions from past meetings			
ACTION 17.3	TSRA to look into funding for training observers and funding co-observers, and AFMA to send skills information to TSRA.	TSRA and AFMA	**Ongoing**. There has been some initial correspondence between the TSRA and AFMA about the development of a

			Torres Strait based observer programme but it has not been progressed as a priority action in the fishery. TSRA are willing to provide future funding to progress as a capacity building exercise, as a collaboration with AFMA and CSIRO on the design of the programme as well as training. However, the issue has not been raised recently through other PZJA forums and is unlikely to be able to be actioned in the short term with available resourcing.
ACTION 17.4	PZJA agencies and executive officers to continue speaking with Ms Sansom about Seaswift services particularly if there are changes to opening and closing dates etc that would impact the demand for their services.	TSPMAC Executive Officer	**Complete**. Ongoing action.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
REPORTS **AFMA and TSRA management update**	Agenda Item No. 3.3

RECOMMENDATIONS

3.3.1 That the TSPMAC **NOTE** the updates provided by the AFMA member, in particular:

a. The update on Wildlife Trade Organisation (WTO) approval and conditions for the Torres Strait Prawn Fishery.
b. The update on observer coverage for the 2018 season for the TSPF.
c. The update on compliance operations for the 2018 /19 financial year.
d. The update the ecological risk assessment process.

3.3.2 That the TSPMAC NOTE the verbal update provided by the TSRA

KEY UPDATES

TSPF Wildlife Trade Operation (WTO)

In December 2017, the TSPF was granted a 10 year List of Exempt Native Specimens (LENS) export approval. In the past, the TSPF had been operating under a three year WTO. The LENS was issued based on the current low level risk, associated with low effort in the fishery. If effort is to increase substantially, or the fishery management arrangements change, AFMA will report these to the Department of Environment and the approvals may be changed (i.e. back to a WTO). The new 10 year LENS (to 9 October 2026) also still requires basic annual reporting, which details whether any changes have occurred in the management arrangements. AFMA plans to submit the annual report following this meeting, and agreement on new harvest strategy triggers, which also require reporting.

Ecological Risk Assessment (ERA)

In pursuing its ecologically sustainable development (ESD) objective AFMA takes an ecosystem approach to fisheries by managing the effects of commercial fisheries on the marine environment.

As part of this commitment, the Ecological Risk Management (ERM) framework is used to assist decision makers in developing fisheries management arrangements that are consistent with the ESD objective. The framework uses the Ecological Risk Assessment for the Effects of Fishing (ERAEF) as the primary means of assessing the risks that fisheries may pose to the marine environment. By AFMA undertaking the assessments in a group, it reduces cost and also ensures all fisheries are similarly assessed for sustainability and ecosystem based fisheries management.

At TSPMAC 18, the committee noted that AFMA is currently working towards updating, or undertaking ERAs for all AFMA managed fisheries (including Torres Strait) over the next several years. The AFMA policy is to update ERAs for each fishery every 5 years, however AFMA is currently reviewing whether this frequency is required for lower risk or smaller fisheries.

The TSPF uses a different, yet relatively high level ERA method (primary investigator, Dr Roland Pitcher). This method provides an analogous approach and equivalently, effective quantitative level 3 outputs and was more economically viable given the low level of effort in the TSPF and relatively high costs of the ERAEF methodology. This assessment was last updated in 2013, with 2011 fishing effort levels.

AFMA is currently assessing the cost efficiency of continuing to use the current TSPF methodology, including what would be required to update that assessment type, compared to moving to the standard AFMA ERA. AFMA will provide advice to the TSPMAC once is has undertaken this comparison.

Any ERAs undertaken in the TSPF would be 75 percent cost recovered.

Australian National Audit Office (ANAO) update

2. The ANAO recently tabled its report on the performance audit of the coordination arrangements of Australian Government agencies operating in the Torres Strait. The audit examined whether Australian Government agencies operating in the Torres Strait have appropriate governance arrangements to support the coordination of their activities; and the coordination arrangements are effective in supporting Australian Government activities in the Torres Strait.
3. Australian Government agencies subject to the audit included AFMA, the Department of Agriculture and Water Resources, the Department of Foreign Affairs and Trade, the Department of Home Affairs and the Torres Strait Regional Authority.
4. Overall, the report concludes that “the coordination arrangements of key Australian Government entities operating in the Torres Strait are largely effective in supporting Australian Government activities”.
5. Two AFMA recommendations were made, specifying that AFMA work with the TSRA and QDAF to;
    a. finalise the Protected Zone Join Authority annual reports for the 2015-16, 2016-17 and 2017-18 financial years and implement a process to ensure that future annual reports are published in a timely manner; and
    b. keep the PZJA website up to date.
6. The full audit report can be found at: https://www.anao.gov.au/sites/default/files/Auditor- General_Report_2018-2019_41a.pdf.

Australian Bureau of Agricultural and Resource Economics (ABARES) Fishery Status Reports

7. Each year, the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) compiles fishery status reports which provide an independent assessment of the biological status of fish stocks and the economic status of fisheries managed, or jointly managed, by the Australian Government (Commonwealth fisheries).

8. The most recent ABARES Fishery Status Reports (2019) were released on 27 September 2019 and summarise the performance of these fisheries in 2018 and over time, against the requirements of fisheries legislation and policy. The reports assess all key commercial species from Australian Government managed fisheries and examines the broader impact of fisheries on the environment, including on non-target species.

9. In summary, the most recent biological status for the Torres Strait Prawn Fishery has been assessed for the 2018 period are below. It should be noted that the “uncertain” rankings are related to the absence of a recent stock assessment, despite the stocks appearing at a healthy level when catch rates are considered. Now that the stock assessment has been updated, ABARES will be able to reassess these rankings for the 2020 report.

10. ABARES fishery status reports can be accessed on the ABARES website at: http://www.agriculture.gov.au/abares/publications/display?url=http://143.188.17.20/anrdl/D AFFService/display.php?fid=pb_fsr18d9abm_20180928.xml.

Status	2017		2018		Comments
Biological status	Fishing mortality	Biomass	Fishing mortality	Biomass	
Brown tiger prawn (*Penaeus esculentus*)	Uncertain	Uncertain	Uncertain	Uncertain	Uncertainty in estimates of biomass and fishing mortality because of the significant time since last stock assessment.
Blue endeavour prawn (*Metapenaeus endeavouri*)	Uncertain	Uncertain	Uncertain	Uncertain	Uncertainty in estimates of biomass and fishing mortality because of the significant time since last stock assessment.
Economic status	High levels of latency indicate low NER for this fishery. NER are likely to have declined in 2016–17 following a significant decline in production of brown tiger prawn and lower gross value of production per vessel.				

Legislative Amendments

11. AFMA is continuing to progress draft amendments to the Torres Strait Fisheries Act 1984 and Torres Strait Fisheries Regulations 1985 as resources and priorities permit. The purpose of the amendments is to provide improvements to the efficiency and effectiveness of fisheries administration in the Torres Strait. In the past 6 months, AFMA has experienced delays to the project due to the Federal Election, competing Australian Government legislative priorities and limited internal resources.

12. Details of the proposed amendments are provided at Attachment 3.3a.

New Assistant Minister

13. On 29 May 2019, Senator the Honorable Jonathon Dunium was sworn in as the Assistant Minister for Forestry and Fisheries. In his position, Senator Duniam will serve as the Chair of the Protected Zone Joint Authority.

Observer program update

14. The TSPF observer program aims to complete observer days which equate to 2.6% of the actual effort that occurs in the fishery each season. As observer days are budgeted based on financial year, not season (calendar year) AFMA monitors days to achieve the target as closely as possible.
15. During the 2018/19 financial year 35 sea-days were budgeted. However, this target was increased after discussion with the fishery manager to align with increased effort. As 2073 days were fished in 2018 and 62 observer days were undertaken, the TSPF achieved 2.99% coverage for the 2018 season.

Table 1. Boats that have participated in the TSPF observer program in 2007-2018.

BOAT	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Judy B	X											
Angelina S					X							X
Aquarius 6	X											
Avenger1										X		
Relentless		X		X		X	X					
Danny B										X	X	
Darden Star	X											
Samantha J	X	X										
Bounty Hunter	X		X									
Gulf Bounty						X						
Vandarlia		X	X									
Proteus							X		X			
Kamissa Lee							X					
Shell-Lee-N								X		X		
Bollanger								X				
Noalimba K											X	
CP Jane												X
Markina												X
Maggie Jo											X	

Species of interest to the traditional sector

In 2010, a list of 10 species of interest to the traditional sector was compiled (Table 2) by the TSRA and traditional inhabitant members on TSPMAC. Observations of these species are now recorded during observer trips. In addition to the nine species listed in Table 2 below, interactions with Threatened, Endangered and Protected (TEP) species such as turtles are also recorded (Table 3).

At TSPMAC 13 in December 2012, the TSPMAC agreed that a report should be provided on interactions with these species at each meeting. Tables 2 and 3 lists the interactions with these species of interest, and other protected species during the 2018 season.

Table 2. Species of interest to the traditional sector.

Scientific Name	Common Name	Number Caught	Alive	Dead
Panulirus ornatus	Ornate Crayfish	222	222	0
Mugil cephalus	Sea Mullet	0		
Siganus lineatus	Goldlined Rabbitfish	0		
Choerodon Schoenleinii	Black spot Tusk Fish / Parrot fish	0		
Epinephelus quoyanus	Gold Spot Rockcod / Long fin rockcod	0		
Plectorhinchus chrysotaenia	Painted Sweetlip / Goldlined Sweetlips	0		
Diagramma labiosum	Painted Sweetlip / Slatey Bream	0		
Cephalopholis sonnerati	Tomato Cod	0		
Acanthurus dussumieri	Pencil Surgeonfish	0		
Naso unicornis	Bluespine Unicornfish	0		

In the 2018 season all *Panulirus ornatus* observed were caught in September (n = 210) and October (n = 12). No other species of interest were caught on observed trips.

Table 3. Recorded interactions with protected species during 2018 season observer trips.

Scientific Name	Common Name	Number Caught	Alive	Dead
Natador depressus	Flatback Turtle	1	1	
Hydrophis elegans	Elegant Sea Snake	25	21	4
Hydrophis ornatus	Ornate Sea Snake	26	17	9
Disteira major	Olive Headed Sea Snake	5	3	2
Disteira kingii	Black Headed Sea Snake	1		1
Acalyptophis peronii	Horned Sea Snake	2	2	
Aipysurus eydouxii	Stagger Banded Sea Snake	6	4	2
Hydrophis mcdowelli	Small headed seasnake	1	1	

Trachyrhamphus bicoarctatus	Double ended Pipefish	2		2
Halicampus sp.	Pipefish	2		2

Observer coverage

AFMA would like to thank all of the licence holders who took observers this year. We have had a number of new boats take observers and everyone was very accommodating and assisted wherever possible to enable the observer to carry out their duties.

The ongoing cooperation of licence holders, and gaining a broad reach of observer coverage across vessels has the following purposes:

- Observer data is required to maintain approval to export product to the US (2.6% observer coverage is a requirement of this).
- To provide data for the fishery to assist in making management decisions, particularly around TEP species.
- Collect information on species of interest to the traditional sector to manage interactions with these species.

Proposed amendments to the *Torres Strait Fisheries Act 1984* and *Torres Strait Fisheries Regulations 1985*

<table>
<tr><th>Amendment</th><th>Status as at 25 November 2019</th></tr>
<tr><td colspan="2">Proposed amendments to the Torres Strait Fisheries Act 1984 (the Act)</td></tr>
<tr><td>Capacity to require catch reporting across all licence holders</td><td rowspan="8">Policy approval granted by PZJA, further policy approval to be sought before drafting can commence.</td></tr>
<tr><td>Capacity to provide electronic licensing and monitoring to licence holders</td></tr>
<tr><td>Capacity to delegate the powers to grant and vary scientific and development permits</td></tr>
<tr><td>Capacity to simplify the renewal of fishing licences</td></tr>
<tr><td>Capacity to delegate powers to contracted service providers</td></tr>
<tr><td>Provide for the grant of a licence without specifying a boat in the licence*</td></tr>
<tr><td>Provide for a class of licence that authorises the taking of fish as well as the processing and carrying of fish taken with the use of another boat*</td></tr>
<tr><td>Impose logbook requirements via the determination of a legislative instrument, exercisable by a delegate of the PZJA*</td></tr>
<tr><td colspan="2">Proposed amendments to the Torres Strait Fisheries Regulations 1985 (the Regulations)</td></tr>
<tr><td>Provide simplified legislative authority for the collection* and disclosure of information, to be exercised by a person exercising powers or performing functions under the Act</td><td rowspan="5">Drafting has commenced, further drafting required.</td></tr>
<tr><td>Implementation of Fisheries Infringement Notices</td></tr>
<tr><td>Allow licences (fish receivers, carrier and processing, fishing without boat) to be granted for up to five years duration*</td></tr>
<tr><td>Update provisions concerning the detention of illegal foreign fishers to be brought in line with analogous provisions of the Migration Regulations 1994*</td></tr>
<tr><td>Prescribe a condition that all licence holders must comply with any relevant plan of management*</td></tr>
</table>

*Additional proposed amendment approved by the PZJA at its meeting on 8 October 2019.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
REPORTS Compliance Report	Agenda Item No. 3.4

RECOMMENDATION

3.4.1 That the Torres Strait Prawn Management Advisory Committee (TSPMAC) **NOTES:**

a) the update on compliance activities for the Torres Strait Prawn fishery for 2018 and 2019.

b) that 6 at sea boards were undertaken in the TSPF and no breaches were reported.

BACKGROUND

AFMA took over the Torres Strait Fisheries Domestic Compliance Program on 1 July 2018 from the Queensland Fishing and Boating Patrol.

To increase capacity in this area, AFMA has since recruited a third member to assist with the increase in work load in delivering both domestic and foreign compliance activities. Darwin and Canberra based officers have also assisted with targeted operations as required.

AFMA staff continue to educate and raise awareness with industry about retention of by-product, in particular,

- Tropical Rock Lobster
- Moreton Bay Bug (75mm minimum carapace width)

DISCUSSION

Over the 2018-19 financial year AFMA have conducted 19 stakeholder / community meetings aimed at increasing education and awareness of compliance related issues and foster voluntary compliance with licence conditions and the fisheries management plans.

AFMA fisheries Officers have conducted twenty at sea patrols with 56 boats inspected, twenty four ports/freight hubs were visited and thirty six fish receiver premises were inspected within the Torres Strait Protected Zone and adjacent waters.

Supporting agencies involved in the assisting AFMA to deliver the compliance of the Torres Strait Protected Zone include Australian Border Force, Royal Australian Navy, Queensland Water Police and the Torres Strait Rangers.

Seven matters were referred to the Commonwealth Director of Public Prosecutions (CDPP) for consideration, two cases did not proceed, one case scheduled for hearing in November 2019 and four are currently under consideration by CDPP. AFMA have a further two matters under investigation. These matters were not relating to the TSPF.

Of particular relevance to the TSPMAC, AFMA have inspected ten prawn vessels with two gear related matters requiring further follow up investigation. Both these matters are pertaining to Turtle Exclusion Devices, one of which has been finalised through a warning and the second is being reviewed before a course of action is confirmed.

FINANCIAL IMPLICATIONS

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
REPORTS **Data report (Clive Turnbull)**	Agenda Item No. 3.5

RECOMMENDATION
That the Torres Strait Prawn Management Advisory Committee (TSPMAC):

3.5.1 NOTES and **DISCUSSES** the trends in catch and effort for the 2019 fishing season and the updated fishery analysis and figures for the 2019 Data Summary.

3.5.1 DISCUSSES the new grade and price data, and whether there are any concerns with the information being incorporated into the 2019 data summary.

BACKGROUND
The trends in catch and effort for the 2019 fishing season compared with earlier seasons is based on the complete logbook data for 2019. The tables and figures presented during this agenda item will be used to update the annual Data Summary for the TSPF. During the PowerPoint presentation MAC members will have the opportunity to discuss any comments or concerns they have with regard to the status of the fishery and the results that will be incorporated into the 2019 Data Summary.

There are two new sections for the data summary. The first is an annual analysis of prawn grade data since 2004. The second relates to action 18.11 from TSPMAC 18; "TSPF industry members to provide fuel and beach product price data to Clive Turnbull for use in the data summary."

DISCUSSION

Summary of the 2019 fishing season

1. Highest tiger prawn CPUE since 2013 and endeavour prawn CPUE since 2008 resulting in the highest prawn (tiger + endeavour + king + mixed) CPUE since the start of full logbook records in 1989.

2. Fishing effort was the highest since 2015 and is likely a result of the record prawn CPUE encouraging TSPF licenced vessels to spend more time in the fishery.

3. The tiger prawn (514t) and king prawn (11t) catches were the highest since 2015 (tiger 553t, king 17t) while the endeavour prawn catch (298t) was the highest since 2008 (420t).

4. The increase in catches for the 2019 season is a result of the increase in both fishing effort and CPUE.

Table 1. Annual catch and effort data for the years 2005-2019. Data includes total catch (tonnes) and catch rates (Catch Per Unit of Effort as average kilograms per day per boat) both annually as well as the average for the post 2008 years (2009-2018) and the period of highest fishing effort (1991-2003).

Year	Days fished (logbook)	VMS days fished	Catch (tonnes)					Catch rates CPUE (kg/day/ boat)		
			All prawn	Tiger	Endeavour	King	Mixed	All prawn	Tiger	Endeavour
2005	6012	6633	1318	655	598	51	14	225	112	103
2006	4405	4685	1331	602	672	45	12	308	139	156
2007	4829	5253	1139	582	503	49	5	242	127	107
2008	3477	4127	911	441	420	48	2	268	138	124
2009	2102	2599	528	338	173	16	1	258	166	84
2010	1879	2309	465	344	110	9	2	252	187	61
2011	1305	1663	281	203	73	4	1	221	160	58
2012	2080	2310	517	398	115	3	0	253	195	58
2013	1988	2240	526	419	103	4	0	270	215	57
2014	1954	2203	393	315	76	3	0	205	164	40
2015	2969	3263	737	553	165	17	2	252	189	57
2016	2313	2472	432	366	56	5	5	192	162	30
2017	934	1004	137	111	25	1	0	152	123	31
2018	2073	2135	419	329	81	6	3	206	162	41
2019	2624	2652	824	514	298	11	2	320	200	117
Average 2009-2018	1960	2220	444	338	98	7	1	226	172	52
Average 1991-2003	9699	NA	1785	668	1044	70	4	190	71	111

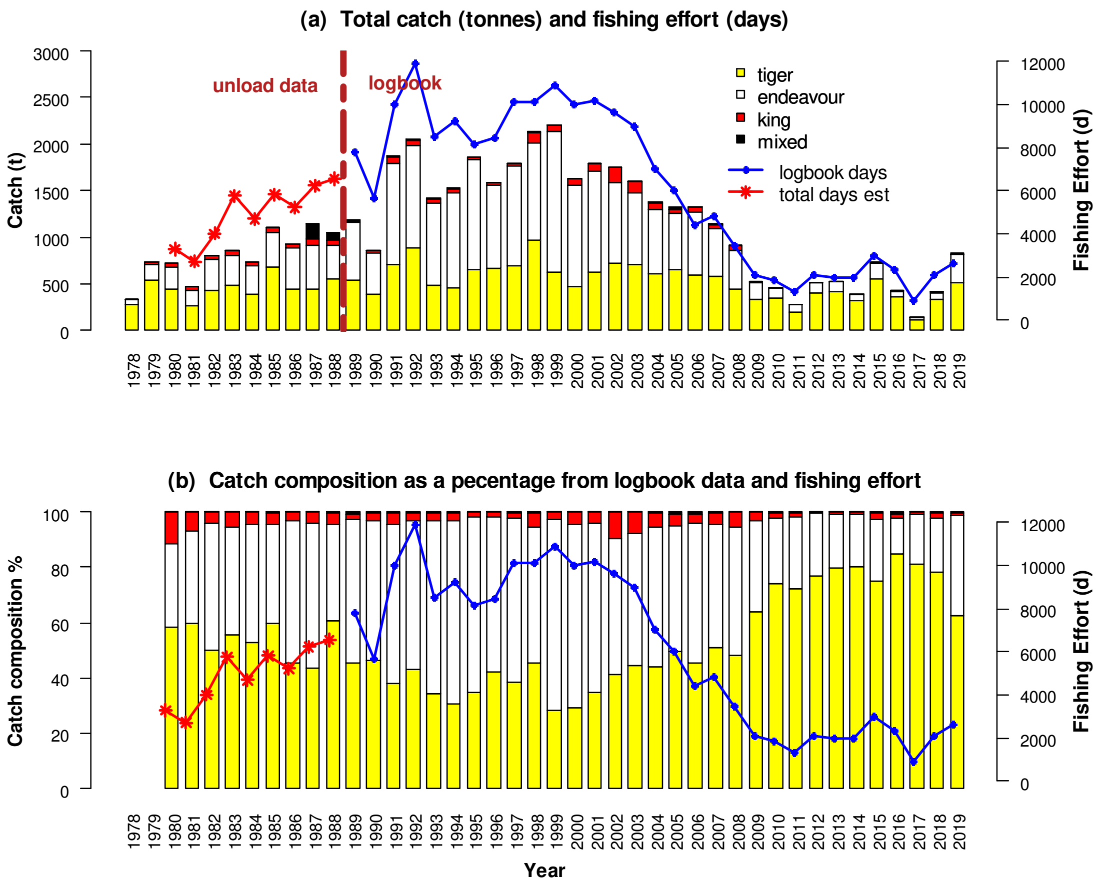

Figure 1 (a) Total catch in tonnes from unload data (1978-1988) and fishing effort (days) from logbook data. The "total days estimate" for 1980-88 is from logbook data adjusted by the logbook coverage. (b) Catch composition as a percentage from logbook data. Note that the 1980-1988 logbook data is from a subset of the fleet.

The decrease in the proportion of tiger prawn in the 2019 catch (Figure 1(b)) is a result of the increased endeavour prawn catch. Last year had the highest prawn catch since 2008 due to a higher tiger prawn catch and much higher endeavour prawn catch compared with recent years (Figure 1(a) and table 1).

The tiger prawn CPUE (Figure 2) since 2017 has increased indicating the stock has increased and that the 2017 season was the year of lowest tiger prawn recruitment for the years 2006-2019.

The higher CPUE for endeavour prawns in 2019 compared with the years 2009-18 (figure 3) is a result that requires input from the industry members of the MAC. Were there any changes in fishing gear or strategies (i.e. targeting of endeavour prawn) that could have effected endeavour prawn CPUE and if so why? For example an increase in the beach price of endeavour prawns in 2019.

Figure 4 shows that in 2019 fishing effort rapidly increased until May then gradually decreased this contrast with 2018 where most fishing occurred from June until end of the season.

Although the February tiger and endeavour CPUE values for 2017-19 (figure 5) need to be treated with caution due to the low fishing effort, these data points are useful in looking at trends during the seasons. The endeavour prawn CPUE for 2019 is interesting in that it up in the range observed during 1991-2003.

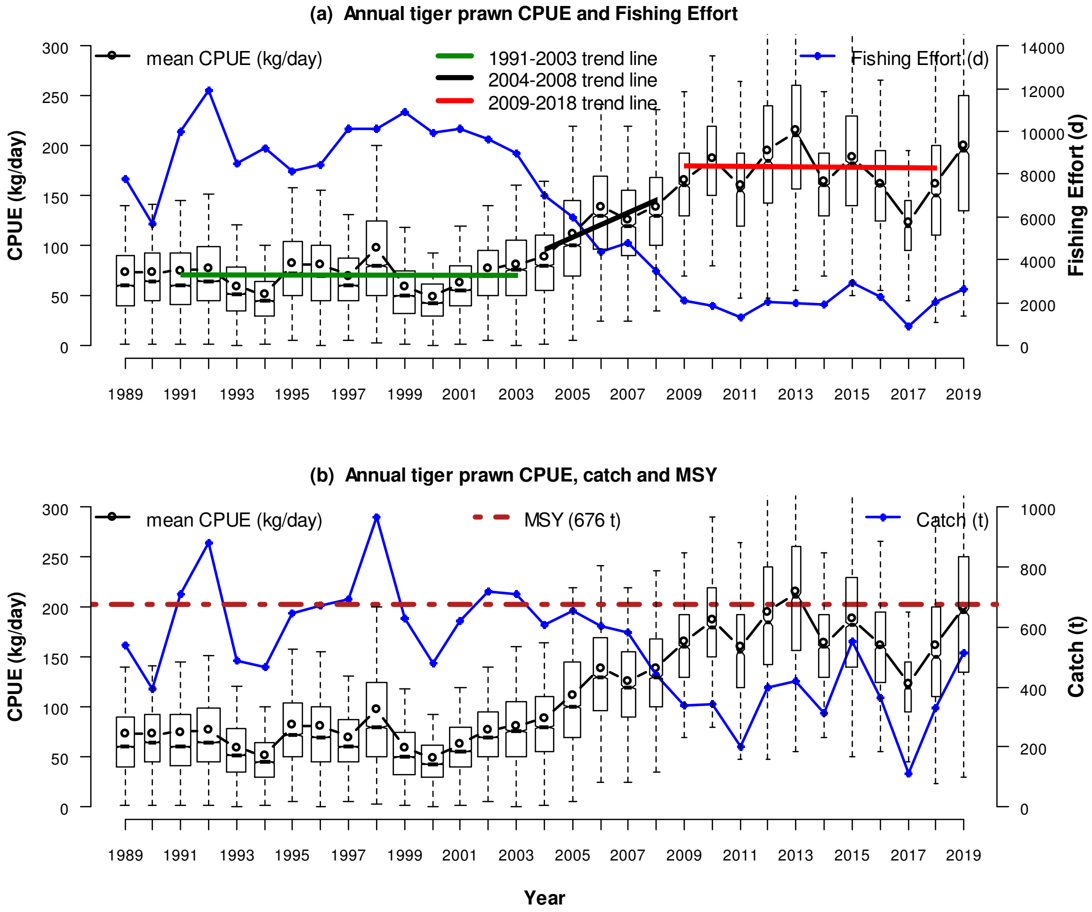

Figure 2 Tiger prawn catch rates (CPUE) as kilograms per vessel per day fished (kg/d) compared with (a) fishing effort in days and (b) catch in tonnes.

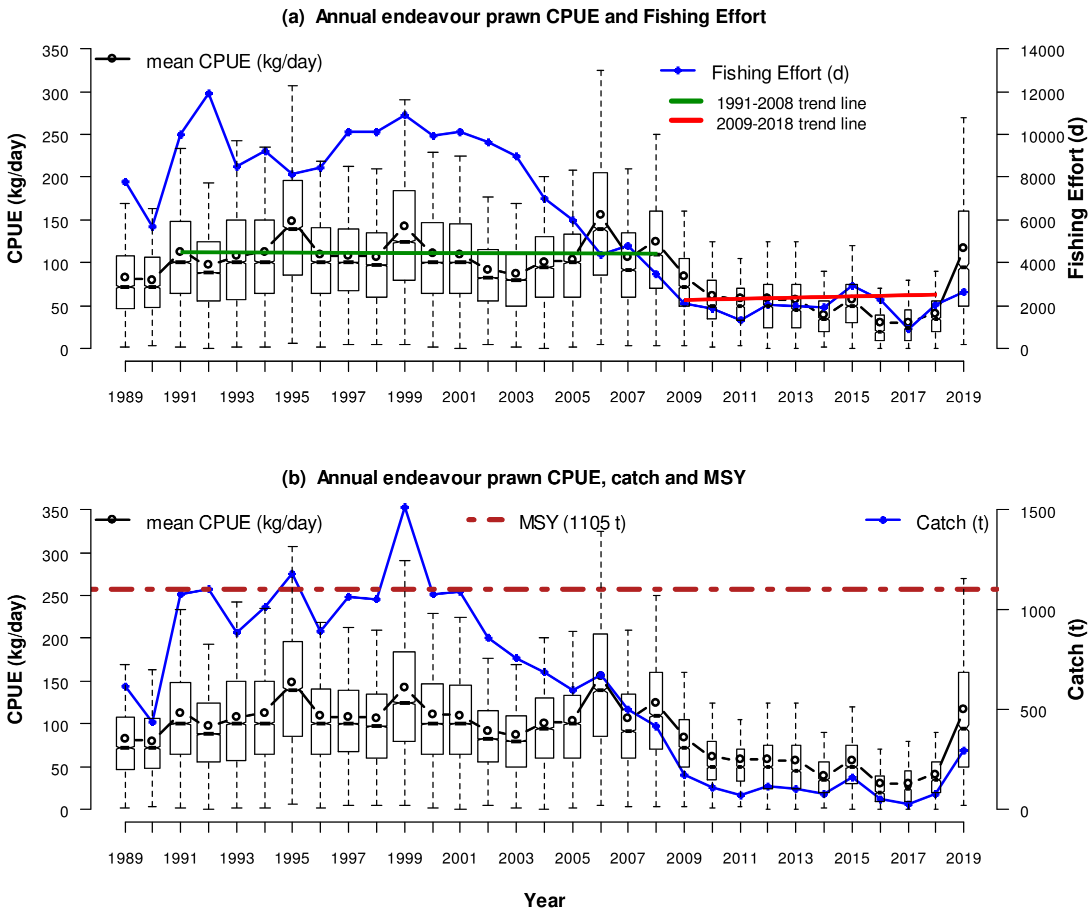

Figure 3 Endeavour prawn catch rates (CPUE) as kilograms per vessel per day fished (kg/d) compared with (a) fishing effort in days and (b) catch in tonnes.

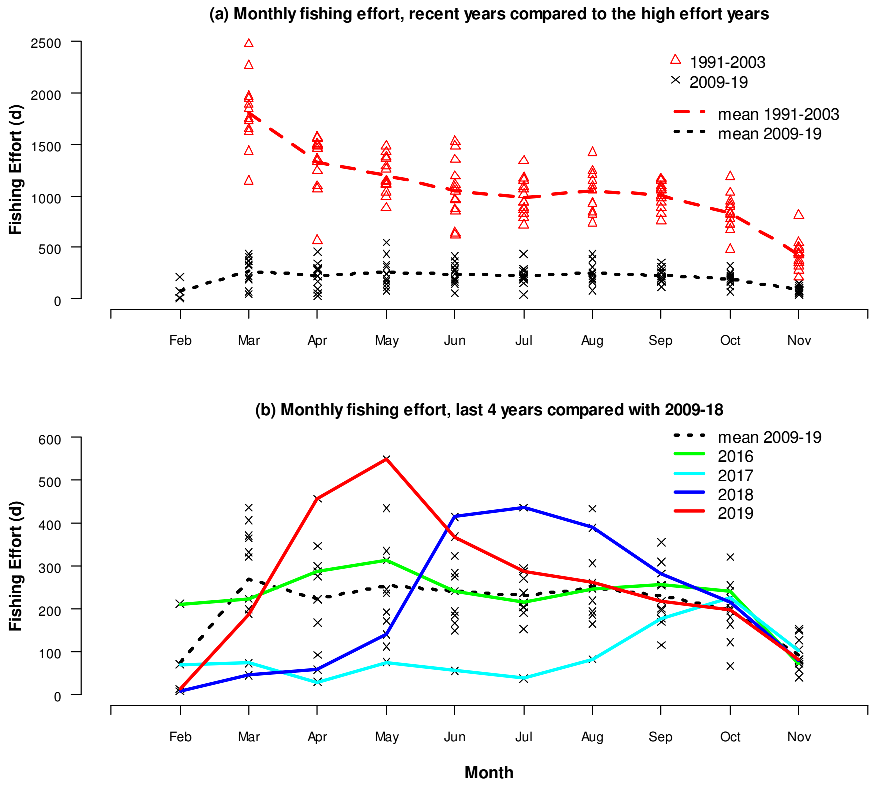

Figure 4 (a) Monthly fishing effort (days) for recent years (2009-18) compared to the years of high fishing effort (1991-2003). The point symbols (x and triangles) show the individual monthly fishing effort for the two time periods and the lines are the monthly means for the two time periods. (b) Monthly fishing effort for the last 4 years compared to all years since 2009. The point symbols (x) show the individual monthly fishing effort for the years 2009-19.

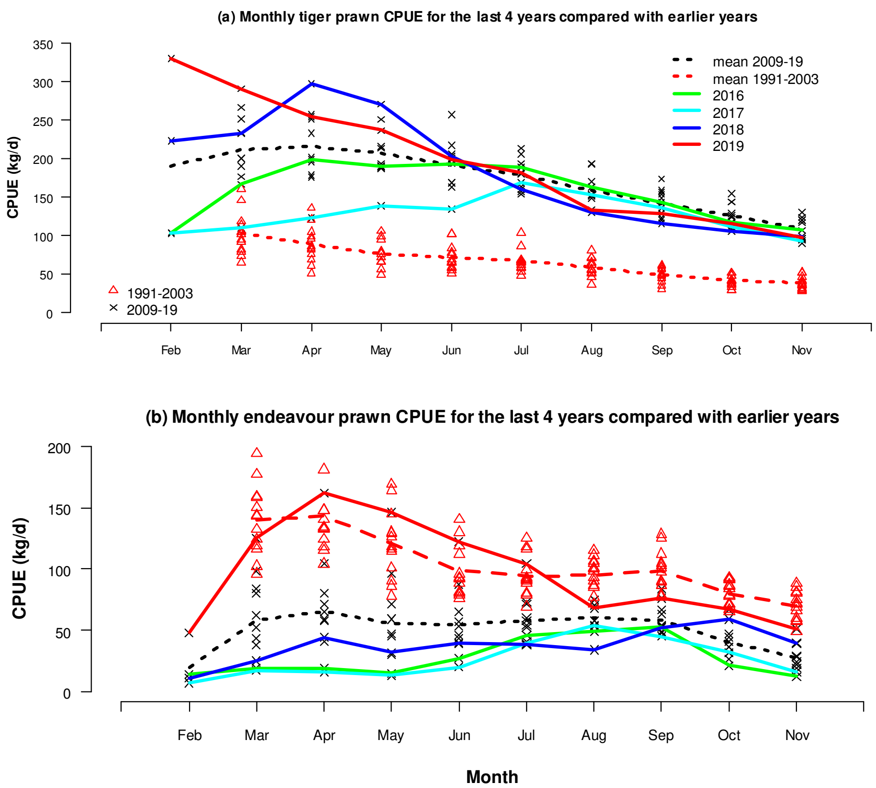

Figure 5 . Catch Per Unit of Effort (CPUE) as kilograms per day for (a) tiger prawn and (b) endeavour prawn. The CPUE for each month of the years 2016-18 is compared with the distribution and mean of the monthly CPUE for all years since 2009 and the years of highest fishing effort (1991-2003). The point symbols (x and triangles) show the individual monthly CPUE for the two time periods and the lines are the monthly means for the years 2016-19 and the two time periods.

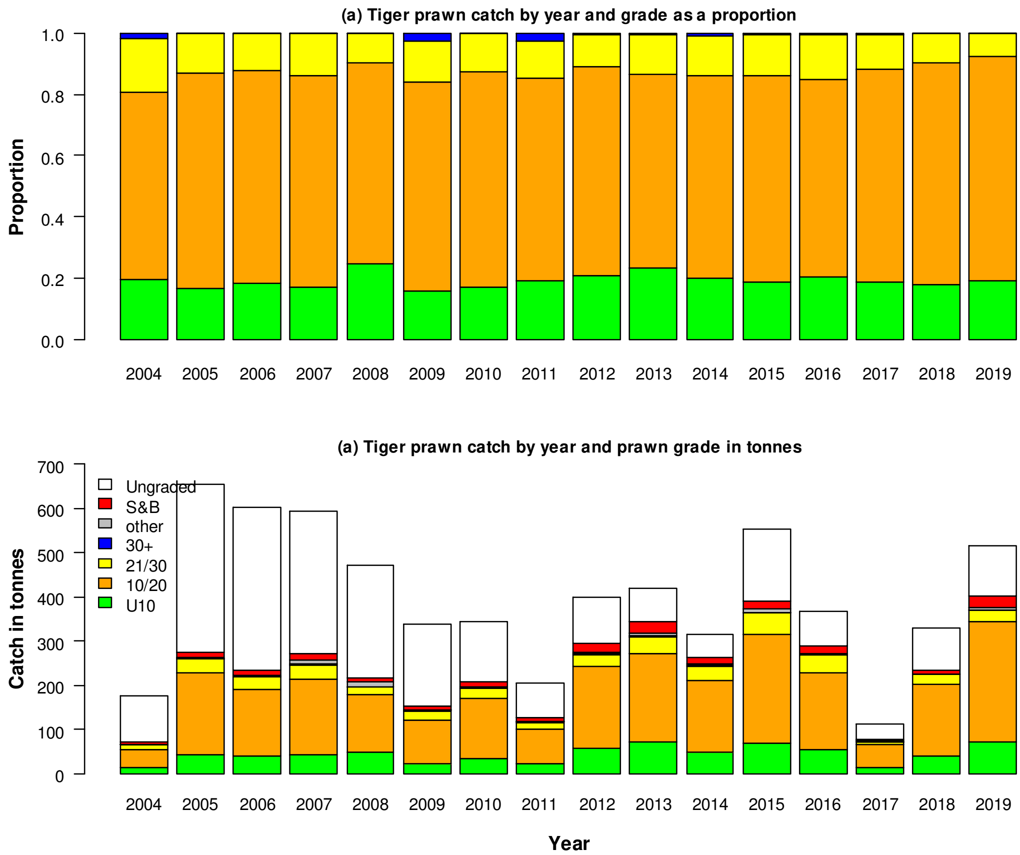

Figure 6 (a) Tiger prawn grades as a proportion for each year. (b) Tiger prawn catch in tonnes by grade. Note: that 2004 is only partial data due the phasing in of the new logbook format that included grade.

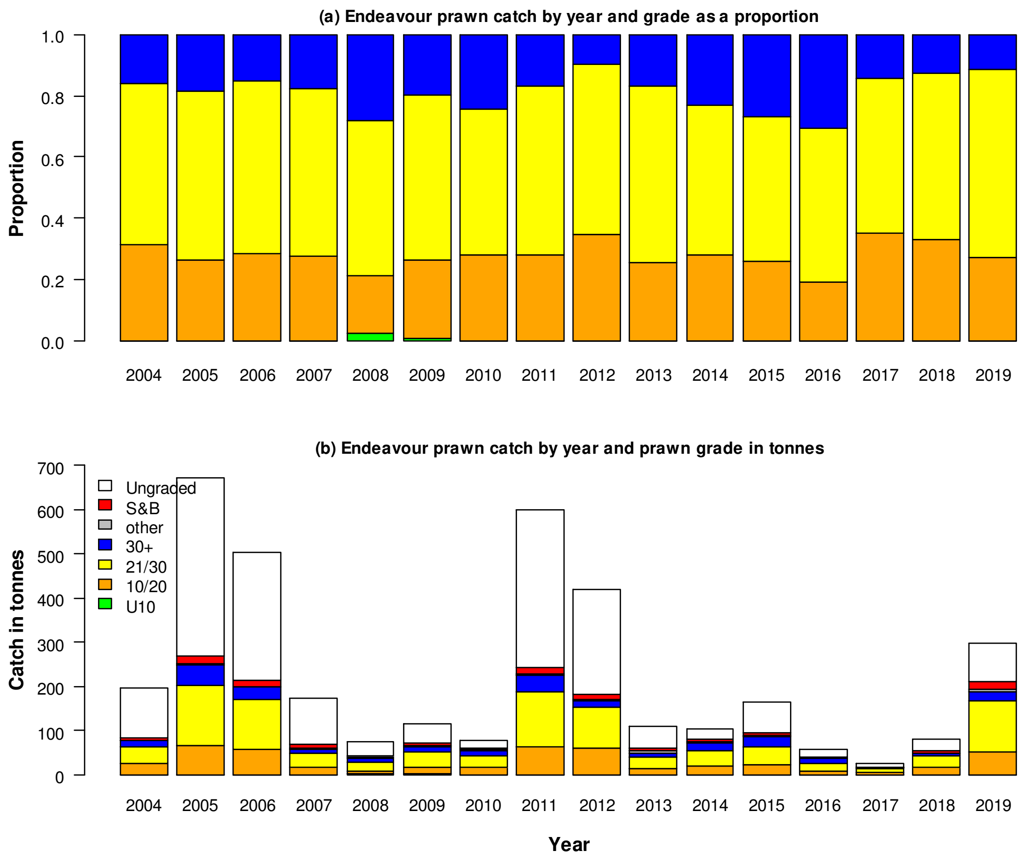

Figure 7 Endeavour prawn grades as a proportion for each year. (b) Endeavour prawn catch in tonnes by grade. Note: that 2004 is only partial data due the phasing in of the new logbook format that included grade.

Analysis of prawn grades

The breakup of each year's catch of tiger and endeavour prawns as a proportion by grade (U10, 10/20, 21/30 and 30+) is shown in Figures 6(a) & 7(a). There is no trend across the years in the tiger and endeavour prawn grades (sizes). Tiger prawn catch is dominated by the 10/20 grade whereas endeavour prawn catch is dominated by 21/30 grade. This reflects the grow characteristics of the two species. Tiger prawns, females in particular, grow to a large size and hence weight than endeavour prawns.

Figures 6(b) & 7(b) show the weight of each grade and include the "other" grades, soft and broken (S&B) and ungraded catch. Note that the recording of grades in the AFMA logbooks was phased in during 2004 during a change in the logbook type and database therefore the 2004 plots are based on partial data for that year.

The "MSE of season dates" project, has examined changes in prawn size using logbook grade data by month for the years 2016-2019. Those results will be presented under agenda item 4.7.

Diesel and product prices

Action 18.11 – TSPF industry members to provide fuel and beach product price data to Clive Turnbull for use in the data summary.

The data provided by an industry member for the 2019 season was combined with data for November 2008 (Turnbull et. al., 2009) in Tables 2 & 3. Additional price data for earlier years would make these tables more useful at TSPMAC meetings.

Table 3 Diesel prices

Month & year	$ / litre	location
Jun-2019	$ 1.60	Fishery
Jun-2019	$ 1.70	Fishery
Mar-2019	$ 1.32	Cairns
May-2019	$ 1.37	Cairns

Table 3 Beach product prices.

Species and grade	Nov-08	Jul-19	Aug-19
tiger U10	19.50	22.00	22.00
tiger 10/20	17.50	15.00	14.00
tiger 21/30	14.00	12.00	11.00
tiger 30+		8.00	8.00
tiger soft & broken		8.50	8.00
endeavour 10/20	9.50	8.00	8.00
endeavour 21/30	7.00	6.00	6.00
mixed endeavour prawn 30+	6.00	5.00	5.00
Endeavour soft & broken		5.00	5.00

References

Turnbull, C.T., Tanimoto, M., O'Neill, M.F., Campbell, A. and Fairweather, C.L. (2009) Torres Strait Spatial Management Research Project 2007-09. Final Report for DAFF Consultancy DAFF83/06. Department of Employment, Economic Development and Innovation, Brisbane, Australia

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MANAGEMENT Grant of carrier boat licenses in the Torres Strait	Agenda Item No. 4.1

RECOMMENDATIONS

4.1.1 That the TSPMAC **NOTES:**

a) the PZJA Standing Committee recommendation to consult with the PZJA forums alongside Native Title Notification on the grant of Carrier B licences to freight vessels, which may be owned by non-traditional inhabitants, in light of the ambiguity with PZJA licencing policy on the issue of new licenses to non-traditional inhabitants;

b) a pending application for a Carrier B licence from a non-traditional inhabitant looking to provide services to the TSPF and other fisheries, including mechanical, electrical and other services to these fisheries and communities.

4.1.2 **DISCUSS** and **PROVIDE ADVICE** on granting new carrier-only boat licenses to non-traditional inhabitants only for vessels that are not licenced to fish.

KEY ISSUES

1. From time to time the PZJA receives applications from persons seeking authorisation to transport (carry) seafood by boat in the Torres Strait. Vessels must hold a carrier licence to carry seafood taken in Torres Strait Fisheries.

2. Recognising the reliance of Torres Strait commercial fishers on sea-freight services to transport products from and within the Torres Strait, the PZJA has granted new carrier licences and renewed others for freight vessels. This includes freight vessels owned by non-traditional inhabitant persons, for example, sea-freight companies such as *Seaswift Pty Ltd*. These decisions have been consistent with directions from the PZJA.

3. More recently there has been interest by non-traditional inhabitants in transporting seafood that are owned by, in the TRL, hand collectable and finfish fisheries.

4. There has also been interest from one party to introduce a carrier vessel to service the Torres Strait Prawn Fishery and other fisheries if there is demand. This vessel would be able to transport product, fuel, water and crew to and from the fishing grounds, as well as provide ship maintenance (mechanical, refrigeration, hydraulic, electrical repairs). It may also be able to provide some services to communities if required, and may have employment and training opportunities for Traditional Inhabitants.

5. The PZJA licensing policy* is described within the PZJA "*Guide to management arrangements for Torres Strait Fisheries, June 2004*" (the Guide). However this guide has some ambiguity around the issuing of new licences, including carrier boat licences.

6. Having regard for the objectives of the *Torres Strait Fisheries Act* 1984 (TSF Act), AFMA is seeking advice from PZJA forums on any concerns with the grant of new carrier-only licences

to non-traditional inhabitants, for the TSPF alone, and in other Torres Strait fisheries, subject to the conditions set out in paragraphs 9 and 10.

BACKGROUND

7. One of the objectives of the TSF Act is "*to have regard, in developing and implementing licensing policy, to the desirability of promoting economic development in the Torres Strait area and employment opportunities for traditional inhabitants*."

8. In addition to this, the Guide states '*carrier licences* ***may be granted*** *to boats which are legitimate cargo vessels*' (Carrier vessel licence, pp.19). Another section of the Guide states '*all new fishing licences and carrier licences are* ***only to be granted to Traditional Inhabitants***' (tropical rock lobster, Spanish mackerel, pearl shell, finfish, beche-de-mer, trochus and crab fisheries, pp.19).

9. Consistent with directions from the PZJA, the grant of a new carrier licence to a non-traditional inhabitant vessel to carry (transport) seafood, may be considered for vessels that are not also licenced to take fish in a Torres Strait Fishery (meaning the vessel can't be used to fish– it can only transport seafood) provided they are subject to the following minimum licence conditions:

   The carrier boat will not change the state of the product.

   a. The carrier boat will not purchase or take on board or carry product from a vessel which is not licenced.

   b. The boat shall not be used to take tender boats or dinghies to and from the fishing grounds or be used as accommodation for fishers.

   c. The licence is non-transferrable.

10. Consistent with the PZJA's recent decision, these licences would also be required to have an operating Vessel Monitoring System.

11. The PZJA ***Finfish Working Group*** (FWG) considered this matter (excluding the new consideration around a prawn service vessel) at its meeting on 16-17 March 2017 and minuted the following advice:

    The FWG noted advice that there is interest from small non-traditional inhabitant businesses to freight seafood in the Torres Strait and that these vessels require a carrier licence. The FWG noted advice that the PZJA licencing policy, as described in the 2004 licencing guide, is ambiguous for these types of applications. AFMA sought FWG advice on any concerns with the grant of new carrier licences to non-traditional inhabitant persons/businesses subject to specific conditions.

    In line with advice from industry members the FWG recommended that further industry and community consultation take place to gauge stakeholder opinions on the grant of new carrier licences to non-traditional inhabitant persons/businesses.

12. The ***Hand Collectable Working Group*** considered this matter (excluding the new consideration around a prawn service vessel) at its meeting on 27 June 2017. Noting that the meeting record for the HCWG remains in draft, advice from working group was:

    Recommendation: *noting the number of related issues (e.g. crewing, unemployment, c.f. agenda item 4.6) the HCWG and observers were not supportive of any additional carrier licenses being issued to non-traditional inhabitants.*

Note: the related issues referred to in the draft recommendation are those listed under the HCWG draft advice on the TSFA proposal to change current crewing restrictions on TIB licenses. See Agenda Item 5.8.

13. The TRLRAG was due to consider this matter (excluding the new consideration around a prawn service vessel) in 2017, however other priority work has overtaken it, and it is yet to be considered.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	**Meeting No. 20** **29-30 January 2020**
REPORTS **Trial of a new BRD in the TSPF**	Agenda Item No. 4.2

RECOMMENDATION

That the Torres Strait Prawn Management Advisory Committee (TSPMAC):

4.2.1 **NOTES** the preliminary results of the TSPF Toms Fisheye BRD trial in the 2019 fishing season, and intention to undertake another trial early in the 2020 season on a different boat.

4.2.2 **NOTES** AFMA will provide results of the second BRD trial out of session for discussion following the trial.

4.2.3 The **TSPMAC** should discuss the practicalities and need to mirror any future changes to BRDs in the QLD ECOTF and any risks of introducing a device in the TSPF before Queensland have trialled/ agreed to the device.

BACKGROUND

- The NPF implemented a new bycatch strategy in 2015, with an industry wide voluntary commitment to reduce small bycatch by 30% in 3 years.

- Since this time, a number of industry developed bycatch reduction devices have been tested in the NPF, with four successfully reducing bycatch by at least 30% (when compared to a square mesh panel), including the Kon's Covered Fisheye (KCF), FishX, Popeye Fishbox (installed at 70 meshes from the codend drawstrings) and the Tom's fisheye (attachment 3.4A and B).

- As of the 2020 fishing seasons, NPF boats will now be required to have one of these four devices in all fishing nets. The 2018 and 2019 seasons only required them in 50% of nets as a trial.

- The Tom's fisheye was found to be the most effective of the four devices in the NPF with a mean reduction of 44%. There was no significant different in prawn catch found between the new BRDs and square mesh panel (i.e. no notable decrease or increase in prawn catch).

- AFMA is also seeking to review the BRDs being used in the TSPF to continue to reduce bycatch in the TSPF. At TSPMAC 18, the TSPMAC noted AFMA's intention to adopt more effective BRDs.

- Although the TSPF is likely to see similar positive bycatch reductions with using the BRDs successfully trialled in the NPF, the fishery is different, and requires adequate testing to ensure any new device is effective in the TSPF.

- To facilitate this, the TSPMAC recommended *"that a trial be undertaken in 2019, using the most effective BRD identified through the NPF trial this year. The trial should be completed on one or two licence holders' boats".*

DISCUSSION

- Given the Tom's fisheye was the most effective BRD used in the NPF, a preliminary trial was undertaken in the TSPF on 1 boat in July/ August 2019.

- The TSPF trial found a reduction of 14% when compared to the most commonly used BRD in the TSPF – the *standard* Fisheye.

- The TSPF trial cannot be directly compared to the NPF trial, because the Tom's Fisheye was compared to square mesh panels in the NPF, which are not common in the TSPF. This may result in a lower comparative bycatch reduction in the TSPF than achieved in the NPF.

- A second trial will be undertaken in the TSPF early in the 2020 season on a different boat.

- AFMA will consider the results of the second trial and consult TSPMAC out of session regarding the next steps for improving bycatch reduction.

- AFMA will also consult with Queensland Fisheries regarding implications of potentially adopting a BRD in the TSPF that may not be a regulated device in the East Coast Otter Trawl Fishery, noting most boats are cross endorsed and fish in both fisheries during any season.

FINANCIAL IMPLICATIONS

Kon's Covered Fisheyes BRD Trial Report

Northern Prawn Fishery 2016

NPF Industry Pty Ltd
Producing the finest quality prawns from a sustainable marine ecosystem

raptis

Australian Government
Australian Fisheries Management Authority

TROPIC OCEAN PRAWNS

Adrianne Laird
NPF Industry Pty Ltd

Josh Cahill and Ben Liddell
Australian Fisheries Management Authority

Contents

1 Acknowledgements

NPF Industry Pty Ltd and AFMA would like to acknowledge the significant amount of work put into trialing the Kon's Covered Fisheyes BRD on board the *FV Xanadu*. In particular to Mike O'Brien (fleet manager, Tropic Ocean Prawns Pty Ltd), Jamie Ball (skipper *FV Xanadu*) and his crew members Jamie Charlier, Rhett Mckay, Jessie Hall, Bryce Wolfe, Kris Dixon and Krystal Moreton who all went above and beyond to assist with ensuring the trial was run successfully.

To CSIRO staff Gary Fry and Emma Lawrence for scientific advice on the experimental design of the trials and for the data modelling and analysis.

A special thanks goes to Phil Robson (fleet manager) and Kon Triantopoulos (net maker and designer of the Kon's Covered Fisheyes BRD) of A. Raptis and Sons Pty Ltd. Their continuous support of the industry Bycatch Strategy and Kon's innovation in the development of this device is a significant achievement for the industry initiative to reduce bycatch by 30% in 3 years.

NPFI would like to acknowledge the support of AFMA, particularly Josh Cahill and Ben Liddell who have worked closely with industry to help facilitate these trials.

2 List of Figures

3 List of Tables

4 Summary

In 2015, NPF Industry Pty Ltd launched the Northern Prawn Fishery's Bycatch Strategy 2015-2018 with the vision to reduce small bycatch by 30% in three years. A key component of the strategy was industry innovation and through this process the Kon's Covered Fisheyes Bycatch Reduction Device (BRD) was developed.

In 2016, at-sea testing of the Kon's Covered Fisheyes Bycatch Reduction Device (BRD) was conducted in the Gulf of Carpentaria to determine its effectiveness in reducing small bycatch in the tiger prawn fishery compared to a currently legislated device. The device was found to significantly reduce small bycatch by approximately 36.7%, with commercial prawn catch increasing by an average of 0.5%. The device proved to be easy and safe for crew to use and due to the significant reduction in bycatch, the time taken for crew to process the catch was reduced.

5 Aims

The aims of the trial were to:

1. Assess the performance in the reduction of small bycatch and retention of target species of the industry developed Kon's Covered Fisheyes BRD compared to the current legislated Square Mesh Panel BRD, in accordance the objectives of the NPF Bycatch Strategy 2015-18, during at-sea trials

2. Statistically measure (using a generalised linear mixed model) the effect of the Kon's Covered Fisheyes BRD compared to the legislated Square Mesh Panel BRD on reduction of small bycatch and retention of target species.

6 Introduction

The Northern Prawn Fishery (NPF) is located off Australia's northern coast, and extends from the low water mark to the outer edge of the Australian fishing zone in the area between Cape York in Queensland and Cape Londonderry in Western Australia. The NPF targets nine commercial species of prawns including White Banana (*Fenneropenaeus merguiensis*), Red-legged Banana (*F. indicus*), Brown Tiger (*Penaeus esculentus*), Grooved Tiger (*P. semisulcatus*), Blue Endeavour (*Metapenaeus endeavouri*), and Red Endeavour (*M. ensis*). Scampi, squid, scallops and bugs are also taken as by product. Since 2012 the fishery has been certified as sustainable under the Marine Stewardship Council (MSC).

The NPF is a tropical prawn trawl fishery where operators tow twin, triple or quad-rigged otter trawl nets. Being a tropical fishery, the volume and species diversity of bycatch caught in the NPF is relatively high. Over many years the NPF industry has been progressively working with the Australian Fisheries Management Authority (AFMA), researchers and gear technologists to develop and implement new ways to reduce bycatch in the fishery. Through the implementation of permanent and seasonal closures, gear reductions, fleet reductions and the introduction of TEDs and BRDs, the NPF has achieved significant reductions in bycatch over the past 20 years. To assist with the development and implementation of new devices, the NORMAC Bycatch

Subcommittee developed the TED and BRD Testing Protocol which requires a device to reduce bycatch by at least 10% with a prawn loss less than 2.5%.

BRDs were made mandatory in the NPF in 2001. There are currently seven BRDs approved for use in the NPF: the Square Mesh Codend, Square Mesh Panel, Radial Escape Section, Fisheye, Yarrow Fisheye, Popeye Fishbox, and Modified Turtle Excluder Device. By 2016, 90% of the fleet was using electronic logbooks. Of these, 83% of operators use Square Mesh Panel BRDs and the remaining use the Fisheye BRD (source: NPF logbook data).

In 2015, NPF Industry Pty Ltd launched its Bycatch Strategy 2015-2018 with a vision to voluntarily reduce small bycatch by 30% in three years in the Northern Prawn Fishery. The initial phase of the strategy was to encourage industry innovation to develop and test new or modified BRDs or gear to achieve this goal.

In order to compare and contrast changes in bycatch level and composition an experimental design that utilised controls (in this case a square mesh panel BRD) was adopted. This approach provided real time comparisons of the effectiveness of the Kon's Covered Fisheyes BRD against a currently approved BRD type across a number of variables including position, area, season and environmental conditions. This approach was taken after considerable discussion with the Northern Prawn Resource Assessment Group (NPRAG) in early 2015. It was determined that the complexity of the fishery (different species, areas, seasons, gear) made establishing a baseline very challenging.

The Kon's Covered Fisheyes BRD was developed by Kon Triantopoulos, net maker for A. Raptis & Sons Pty Ltd and was initially trialled by Raptis in November 2015, with encouraging results of 19% bycatch reduction and minimal prawn loss (<2.5%) compared to a Square Mesh Panel BRD located at 120 meshes from the codend drawstrings. As such, it was agreed by NPF Industry that the device should undergo a scientific trial to determine its effectiveness in reducing small bycatch without losing catch of target species.

The Kon's Covered Fisheyes BRD is modelled on the existing Fisheye BRD, but encompasses a cone shaped insert designed to create an area of reduced water flow for small teleost fishes to take shelter in and escape (Figure 1). The Kon's Covered Fisheyes BRD is comprised of two of these modified fisheyes in each net, positioned in line with each other.

Figure 1: A single Kon's Covered Fisheye stitched into the net including device specifications. The device was 45cm in total width, but the inside width of the mouth was 37cm.

The device was trialled on *FV Xanadu* from 2 to 10 June (Trial 1) and 31 October to 15 November (Trial 2) 2016 under normal commercial fishing conditions in the Gulf of Carpentaria. AFMA officers were deployed on the vessel to measure the performance of the Kon's Covered Fisheyes BRD (Treatment) compared to a standard Square Mesh Panel BRD (Control) and collect catch composition data. During the trials, data were obtained from 69 shots.

7 Gear Specifications

The *FV Xanadu* used quad-rigged tiger prawn nets with a headrope length of 14.21m, groundrope length of 16.0m, horizontal opening of 13.5m and vertical opening of 1.5m. Mesh was diamond orientation of 50mm in the wings and 42mm in the codends with the codend being 150 meshes around. Nets were fished using number 7 bison boards (300kg in weight, 183cm length, 20cm width and 112cm height), skids of 300kg (170cm length, 18cm width, 112cm height) were also used. Under normal fishing conditions each of the four nets would have a Square Mesh Panel BRD (650mm long x 450mm wide) positioned at 115 meshes from the codend drawstrings. For the duration of the trials, the vessel fished with one Square Mesh Panel BRD and one Kon's Covered Fisheyes BRD on each (port and starboard) side of the vessel.

Nets fitted with the Kon's Covered Fisheyes BRD had one of the modified fisheyes positioned at 78 meshes from the codend drawstrings and the other at 55 meshes (Figure 2). This spacing between the two devices was determined by the manufacturer of the Kon's Covered Fisheyes BRD. Both trial nets fitted with Kon's Covered Fisheyes BRD had the devices mounted identically, the same distances from the drawstrings.

A)

B)

Figure 2: A) The Kon's Covered Fisheyes BRD device stitched into a net prior to use and B) Spilling the codends separately onto the sorting tray (note the KCF mounted in the green net below the lifting ear).

8 Experimental Design

NPFI developed an industry trial guide in consultation with CSIRO to provide a standardised methodology for fishers to collect data when trialling new devices during preliminary industry trials in 2015. A rigorous experimental design for the formal scientific trials was also developed in consultation with CSIRO (Annexure 1). It was essential in the scientific trials that the BRDs, in this case a Square Mesh Panel BRD and Kon's Covered Fisheyes BRD, were swapped during the trial to ensure statistically robust data collection by accounting for possible differences in the fishing efficiency between the four nets (Table 1).

Table 1: Schedule of BRD placements for both trials of the Kon's Covered Fisheyes BRD.

Trial Number	Nights	Port Outside	Port Inside	Starboard Inside	Starboard Outside
1	1, 2, 3	SMP2	KCF2	SMP1	KCF1
1	4, 5, 6	KCF2	SMP1	KCF1	SMP2
1	7, 8, 9	SMP1	KCF1	SMP2	KCF2
2	10, 11, 12	KCF1	SMP2	KCF2	SMP1
2	13, 14, 15	KCF1	SMP2	KCF2	SMP1
2	16, 17, 18	SMP2	KCF2	SMP1	KCF1
2	19, 20, 21	KCF2	SMP1	KCF1	SMP2
2	22, 23, 24	SMP1	KCF1	SMP2	KCF2

8.1 Data Collection

Shots averaged four hours in duration, with three shots being undertaken each night between the hours of 18:00 and 07:30. The four codends were spilled into separated areas of the sorting tray to keep the catches split (Figure 3), so the performance of the Kon's Covered Fisheyes BRD could be analysed against the square mesh panel BRD control nets.

To obtain accurate bycatch weights for each codend, the bycatch was diverted via chute into 60L lug baskets and weighed. During processing, each lug basket of bycatch was weighed prior to the contents being discarded. The commercial prawn component of each of the four codends were also processed separately to measure any prawn loss or gain between the treatment and control BRDs. Although weights for each prawn group (Tiger, Banana, Endeavour and King) were recorded, only total commercial prawn weight for each codend was used for the BRD comparisons.

Catch composition analysis was undertaken for every shot, with a 10kg subsample of bycatch being collected from one Square Mesh Panel BRD net and one Kon's Covered Fisheyes BRD net. The bycatch in the subsamples were identified to species level, and weights for each species recorded. All Threatened, Endangered and Protected (TEP) species and 'at-risk' bycatch species (determined to be at-risk from trawling using the Environmental and SAFE risk assessments analyses) caught in the trawls were also identified, measured and recorded as per standard AFMA observer protocols. An analysis of catch composition between the treatment and control BRDs has not been undertaken for this report as the main objective of the trial was to assess the effectiveness of the Kon's Covered Fisheyes BRD in reducing small bycatch, rather than identifying exclusion of specific species.

Underwater video footage was also collected to provide insights into how the device functioned, fish behaviour and whether any potential improvements could be made to the BRD design. No lighting system was used in conjunction with the camera so footage was only able to be collected during the first shot of the evening. The decision was made not to pursue any form of independent lighting source for the camera as this may have impacted the efficacy of the Kon's Covered Fisheyes BRD and added another variable to the data.

Figure 3: Catch from the net with the Kon's Covered Fisheyes BRD (left) compared to a control net with a Square Mesh Panel BRD (right side), excluding the catch on the conveyer in the center. When compared, these two codends had the same quantity of prawns but significantly less bycatch in the net with the Kon's Covered Fisheyes BRD.

8.2 Bycatch Recapture

The recapture of bycatch from the previous trawl shot was an issue raised by CSIRO prior to the trials being undertaken. As vessels operating in the NPF use a technique referred to as 'line fishing' whereby a vessel will conduct multiple shots along the same trawl line over a relatively short period of time, there is a possibility that discards may be recaptured during the subsequent shots.

The likelihood of this occurring is anecdotally much higher in areas with little tidal or current movement and when trawls are carried out in shallower water depths. In order to ascertain whether bycatch recapture was occurring during this trip, 40kg of randomly selected bycatch was dyed using methylene blue on the first and second nights of fishing and discarded as per standard vessel operations.

The following shots of the night were monitored for stained bycatch recaptures. On the first night, one dyed crab was recaptured (alive) on the third shot and on the second night no dyed bycatch was recaptured. Fishing was carried out between 16 and 18m water depths on both night.

During the November trial, 40kg of randomly selected bycatch was stained and discarded on the second night of fishing in approximately 24-26m depths. None of the stained bycatch was recaptured during subsequent shots. Fishing was conducted at this depth range throughout the entire November trial.

Concentrations used for the dying of bycatch were: 10g of methylene blue concentrate powder to 10L of seawater. In addition, 500ml of 'Blue Planet Multi Cure' water treatment for aquarium fish, containing Malachite Green 0.40mg/ml and Methylene Blue 4.00mg/ml was added to another 10L of seawater. It should also be noted that once mixed, the solution was only effective for staining biological material for approximately 12 hours.

8.3 Data Analysis

Total bycatch and total commercial prawn weights were recorded separately for each of the four nets for each shot. This data was given to CSIRO for further analysis (for full report see Annexure 2). The bycatch volume and commercial prawn data from the two trials was combined for analysis. As there was always a control and treatment net on the port and starboard side, the differences in the bycatch volumes and prawn catch (kg per hour) between the two nets for each side for each shot was compared.

The bycatch data was assessed using a generalised linear mixed model (glmm). After trying various model forms the bycatch data was fitted to a glmm with a Gamma distribution to the data to determine the effectiveness of the treatment net after removing the effect of time trawled, position in the quad gear, Trial Number (1 or 2) and random effect of shot. Standard model diagnostics were checked and showed that the model fit was adequate. A similar model was then fitted to the commercial prawn catch data. Model diagnostics were checked and this model was shown to also be a good fit for the prawn data.

9 Results

Due to deteriorating weather conditions during the June trial, the trial was stopped after 9 nights of trawling. The BRD position in the second at-sea trial in November trial continued from where the first trial in June ceased to account for these lost sampling days, followed by another full rotation of the BRD types across the four net positions over 15 nights of trawling. The first trial was carried out within the Karumba and Mornington Island regions while the second trial started at Weipa for the first night then moved to north Vanderlins followed by the Groote Eylandt region (Figure 4).

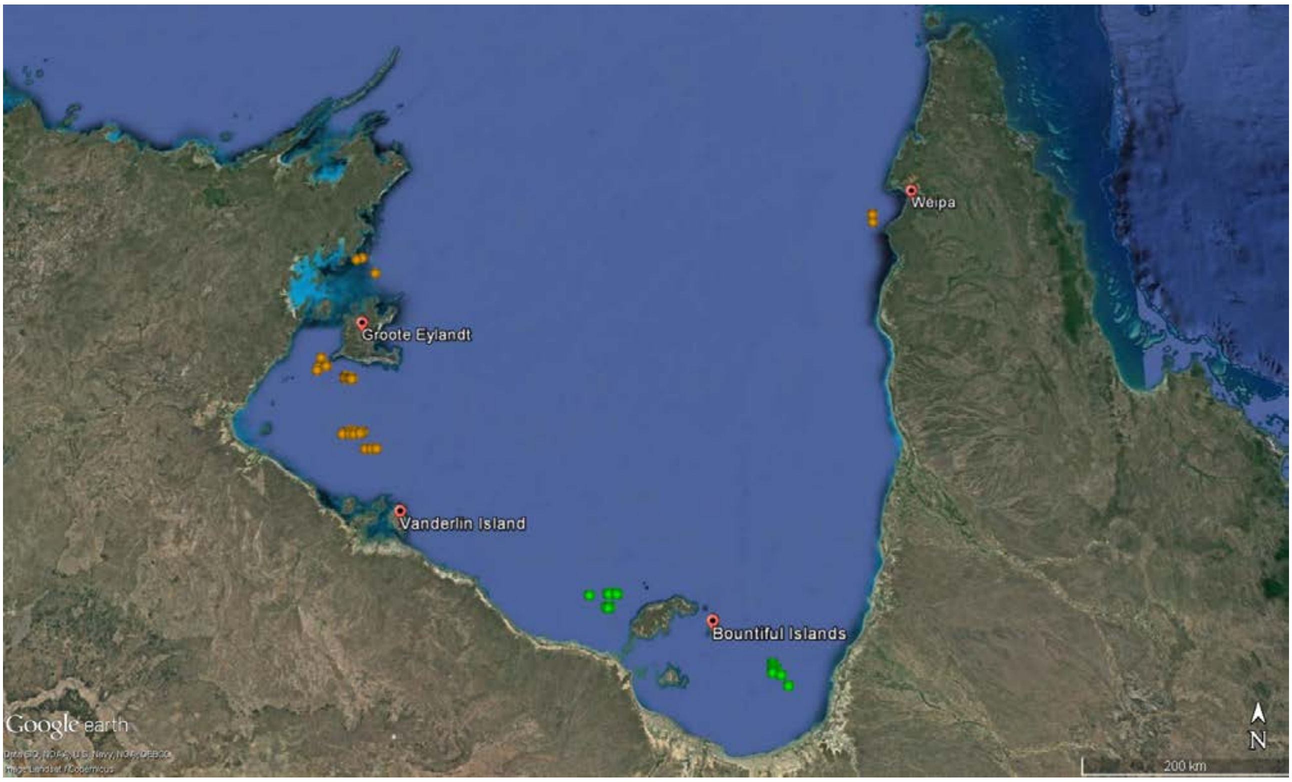

Figure 4: Area fished, showing show locations, during the 2016 scientific trials of the Kon's Covered Fisheyes BRD in June (green) and November (orange) in the Gulf of Carpentaria (source: Google Earth).

Analysis of the data shows significantly less bycatch is caught ($p<0.0001$) in the nets with the Kon's Covered Fisheyes BRDs installed compared to the nets with the standard Square Mesh Panel BRD installed. Mean bycatch reduction by weight achieved by the Kon's Covered Fisheyes BRDs was 36.7% (95% Confidence Interval: 33.6 – 39.6%), when compared to the Square Mesh Panel nets across the 69 shots. The difference in prawn catch rates, between the two gear configurations, was not significantly different ($p=0.815$).

There were large variations in both the total bycatch caught and the commercial prawns retained between each of the four quad gear nets for most shots during the two trials (Table 2). While the prawn catch was similar across the two trials, approximately 6.5kg per hour of trawling for one main quad gear net, the bycatch caught during the second trial (34.51kg) was about half that of the first trial (71.39kg). This may be due to either differences in bycatch communities across the Gulf of Carpentaria and/or the different time of year the trials were undertaken.

Table 2: Comparison of the average bycatch caught and commercial prawns retained (kgs/hr) during the two at-sea trials (Annexure 2).

	Trial 1 (June)	Trial 2 (November)
Bycatch Weight	71.39kg	34.51kg
Commercial Prawns	6.53kg	6.76kg

9.1 Bycatch reduction

There was almost always more bycatch caught in the codends with the Square Mesh Panel (Control) compared to the nets with the Kon's Covered Fisheyes (Treatment) (Figure 5). There were only 10 trawls where one of the Kon's Covered Fisheye BRD nets caught more bycatch than the adjacent Square Mesh Panel BRD net and eight of these occurred during one rotation (for three nights; Trawls 52 to 59) on only one side.

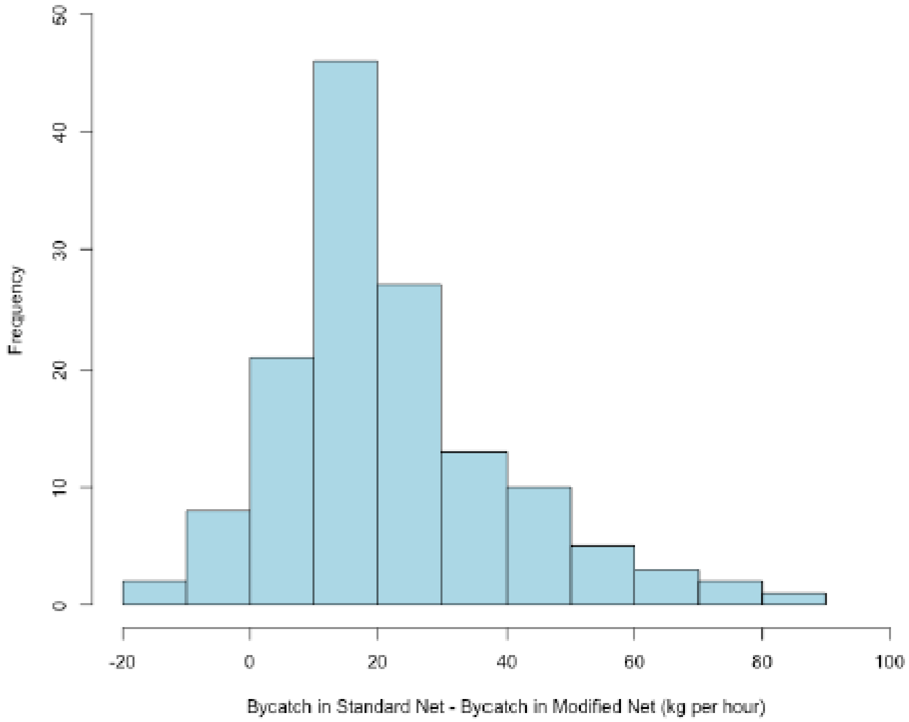

Figure 5: The frequency of the differences in total bycatch (kgs caught per hour of trawling) caught between the Kon's Covered Fisheye BRD net and Square Mesh Panel BRD net on each side during the two at-sea trials (Annexure 2).

The results indicate that a large amount of the variability in the catches of bycatch is accounted for by the random effect. For example, the correlation between nets within a shot is very high (see Annexure 2) whereas the fixed effects (net, position, trial number) show significantly less bycatch was caught in the Kon's Covered Fisheyes BRD nets compared to the Square Mesh Panel BRD nets. The transformed model coefficients indicate a reduction of approximately 36.7% in bycatch weights in the Kon's Covered Fisheyes BRD nets (95% Confidence Interval: 33.6 – 39.6%) compared to the Square Mesh Panel BRD nets. The catch rates in the different main quad gear positions were compared against the Port Inside and some significant differences were detected. The highest catch rates of bycatch were in the Port outside and the lowest was in the Port Inside nets.

9.2 Prawn catch

For the commercial prawn catches, there was a more even distribution around 0 than the bycatch weights between the Kon's Covered Fisheyes BRD and Square Mesh Panel BRD nets (i.e no difference between the treatment and control) during the two at-sea trials (Figure 6).

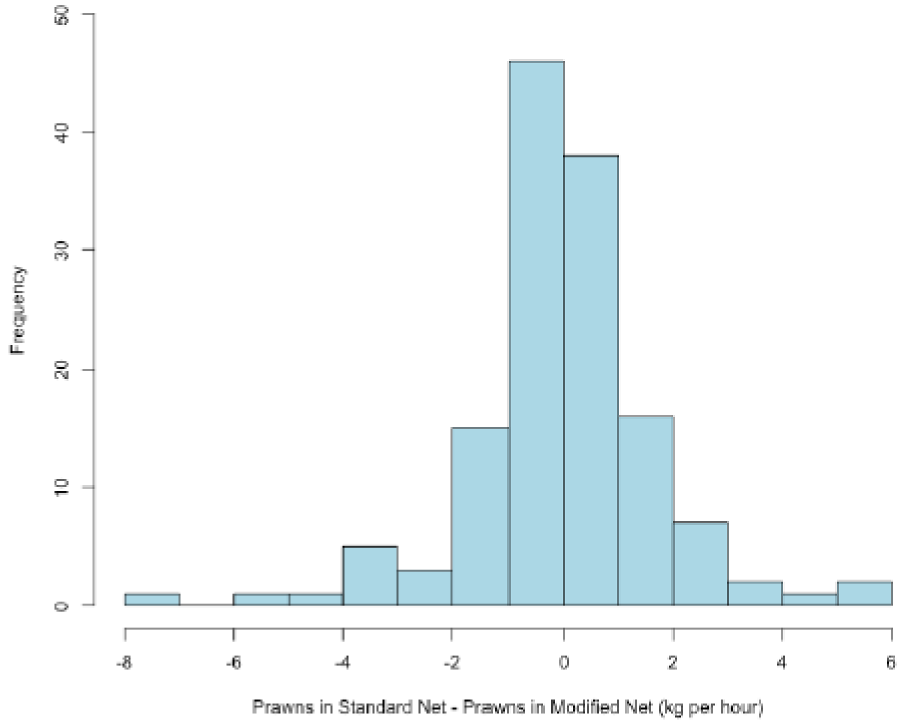

Figure 6: The frequency of the differences in commercial prawn catch (kgs caught per hour of trawling) between the Kon's Covered Fisheyes BRD net and Square Mesh Panel BRD net on each side during the two at-sea trials (Annexure 2).

As seen with the bycatch, most of the variability in commercial prawn catches is described by shot to shot variability (see Annexure 2). There were significantly more commercial prawns caught on the Port Outside net compared to the other main quad gear net positions. The fixed effects show negligible difference between the commercial prawns caught in the Kon's Covered Fisheye BRD nets (Treatment) compared to the Square Mesh Panel BRD nets (Control) with 0.5% more commercial prawns caught using the Kon's Covered Fisheye BRD nets (Confidence Interval: -3.8 – 5.1%).

10 Discussion

There is sufficient data from the two scientific trials to demonstrate that the Kon's Covered Fisheyes BRD, located at 55 and 78 meshes from the codend drawstrings, reduces bycatch by 36.7% with no significant difference in the commercial prawn catch compared to a Square Mesh Panel BRD at 115 meshes from the codend drawstrings.

Based on analysis of underwater video footage, slightly extending the front bar of the device could further assist fish in utilising the escape opening. Some fish were observed struggling to use the escape opening due to their size and swimming speed. The design tested in this trial demonstrated the specifications required to achieve the 36.7% reduction in bycatch compared to a Square Mesh Panel BRD when they are positioned at 55 and 78 meshes from the codend drawstrings. With further refinement of this device, greater escapement rates of the larger sized bycatch species may be achieved.

In addition to reducing bycatch in the NPF, there may be a number of other significant benefits of using the KCF. The reduction in volume of bycatch demonstrated by the use of Kon's Covered Fisheyes BRD may reduce net drag thereby having a fuel saving effect. This reduced catch volume in the codends and reduced net drag also has the potential to increase the swept area of the trawls due to trawl doors being maintained at the optimal distance apart. Furthermore, with significantly less bycatch to sort through for the crew, processing times (from hopper to freezer) and potential prawn damage from larger volumes of bycatch in the codend would be reduced.

This device is most suited to tiger prawn fishing where there is generally lower volumes of total catch caught in each shot and a greater proportion of small bycatch caught compared to banana prawn fishing. As the two covered fisheyes of Kon's Covered Fisheyes BRD that were assessed are located at 55 and 78 meshes from the codend drawstrings, it is possible that during very large shots (i.e banana prawn fishing), product could be lost through the escape opening, however trials of the device in this fishery have not been undertaken.

Due to the shape of the device and the need for small animals to swim through an escape opening, it is highly unlikely that the Kon's Covered Fisheyes BRD would be an effective mitigation device for larger bycatch species such as sea snakes, sawfish and other elasmobranchs or benthic species such as crabs and other invertebrates.

11 Adoption

The skipper of the *FV Xanadu* commented that the significant visual difference between nets with the Kon's Covered Fisheyes compared to the nets with a Square Mesh Panel was very disconcerting when the trials began. So much so he considered ceasing the first trial after the first night believing there was significant prawn loss when in actual fact the catch was the same (J. Ball pers. comm).

To assist industry with the transition from the Square Mesh Panels or standard Fisheye BRDs to the Kon's Covered Fisheyes BRD a combination of both could be used initially i.e Kon's Covered Fisheyes in two nets and Square Mesh Panels or standard Fisheyes in the other nets for the first few nights of fishing. As there will be significantly lower net volumes while using the Kon's Covered Fisheyes BRDs compared to what skippers are used to, comparing their catches between the new device and what they previously used could alleviate concerns and show commercial prawn catch is not being compromised. This will assist with the long-term adoption of the new device and the NPFs initiative to reduce bycatch by 30% by mid-2018.

12 Further Research

During initial trials of the Kon's Covered Fisheyes BRD by Raptis in 2015 the skipper noted that the frame of the BRD would at times catch on the gunwale of the vessel when hauling the nets (M. Robson pers. comm). This is unlikely to occur on most other NPF vessels due to the specific design of the Raptis vessels. However, further research could investigate the effectiveness of the Kon's Covered Fisheyes BRD without the fisheye frame and utilising just the cone insert. Such a design may also make the device easier to install or replace (P. Robson pers. comm). Initial trials of such a design were undertaken by Raptis in November 2016 with varying results. Further fine-tuning of the design of the device should also improve its operational performance and the likelihood of its successful adoption.

It would also be worth investigating whether using only one covered fisheye of the Kon's Covered Fisheyes BRD fitted to each net would have similar bycatch exclusion rates as the current Kon's Covered Fisheyes BRD. This could be examined by installing an underwater camera in front of and behind the covered fisheyes and recording the difference in bycatch exclusion rates between both of the covered fisheyes in the same codend. This would identify if the position of the covered fisheyes has an effect on bycatch exclusion rates and (following species analysis) any species-specific differences.

As this device is not likely to be suitable for banana prawn fishing because of the larger catches, a single covered fisheye located further away from the codend drawstrings may still be effective at reducing bycatch in the banana prawn fishery. Different configurations of the fisheyes could be investigated to assess effectiveness when vessels are targeting banana prawns and the nets are much fuller. The fisheyes could also be tailored to remove specific bycatch species currently not effectively removed by the Kon's Covered Fisheyes BRD however this would require further research.

The catch composition data collected during this trial could be analysed to determine if there is any species-specific differences in the bycatch, differences in TEP and at-risk species and to provide additional information for further fine-tuning of the device to further improve its effectiveness, including in relation to escapement of larger or different shaped bycatch species.

13 References

Burke. A, Barwick, M. and Jarrett. A. (2012). *Northern Prawn Fishery Bycatch Reduction Device Assessment*. NPF Industry Pty Ltd, Australia.

NPF Bycatch Strategy 2015-2018: http://www.afma.gov.au/wp-content/uploads/2014/02/NPF-Bycatch-Strategy-2015-18-FINAL-VERSION.pdf

Annexure 1: Kon's Covered Fisheyes BRD trial design

Purpose:

To trial methods for reducing bycatch in the Northern Prawn Fishery using the industry developed double fisheye BRD (Kon's Covered Fisheyes or KCF) in accordance the objectives of the NPF Bycatch Strategy 2015-18 to reduce the capture of small bycatch by 30% in three years.

Methods:

<u>Phase 1: Arrival and Calibration</u>

A. Field team travel to Karumba to rendezvous with vessel.

B. Consult with skipper about the experimental design including:
- separating each net when dumped on top of the hopper
- processing each net separately through the hopper
- discarding of bycatch to eliminate recapture
- prawn loss strategy
- any additional ways to manage the process

C. Prepare lug baskets with colour-coded surveyor tape for sea snakes (1 lug basket per net). Close handle gaps with tape (or plywood and cable ties) to stop snakes escaping through the holes and/or fingers being put through the handles.

D. Mark sections of the hopper for each net using colour-coded surveyor tape (see Fig 1)

E. Undertake initial trawls (approx. 4) with normal fishing gear to become familiar with sampling protocols and evaluate relative fishing performance of quad gear:
- Weighing total bycatch in each net separately for each shot.
- Sort prawn catch from each net separately for each shot.
- Record number and lengths of TEP and at-risk species from each net for every shot.
- Photograph all TEP and at-risk species with colour-coded scale tag.

F. Refine fishing performance to ensure equal fishing efficiency of nets to the extent possible, or document variance to enable this to be accounted for in analysis.

<u>NOTE:</u> the nets should already be fishing efficiently and comparably as the crew would have adjusted the chains at the start of the season. However, once the trial begins, there should be no fine-tuning or adjusting of the gears. The direct comparison to standard BRDs during each shot and the rotation schedule for nets will account for any fishing efficiency differences.

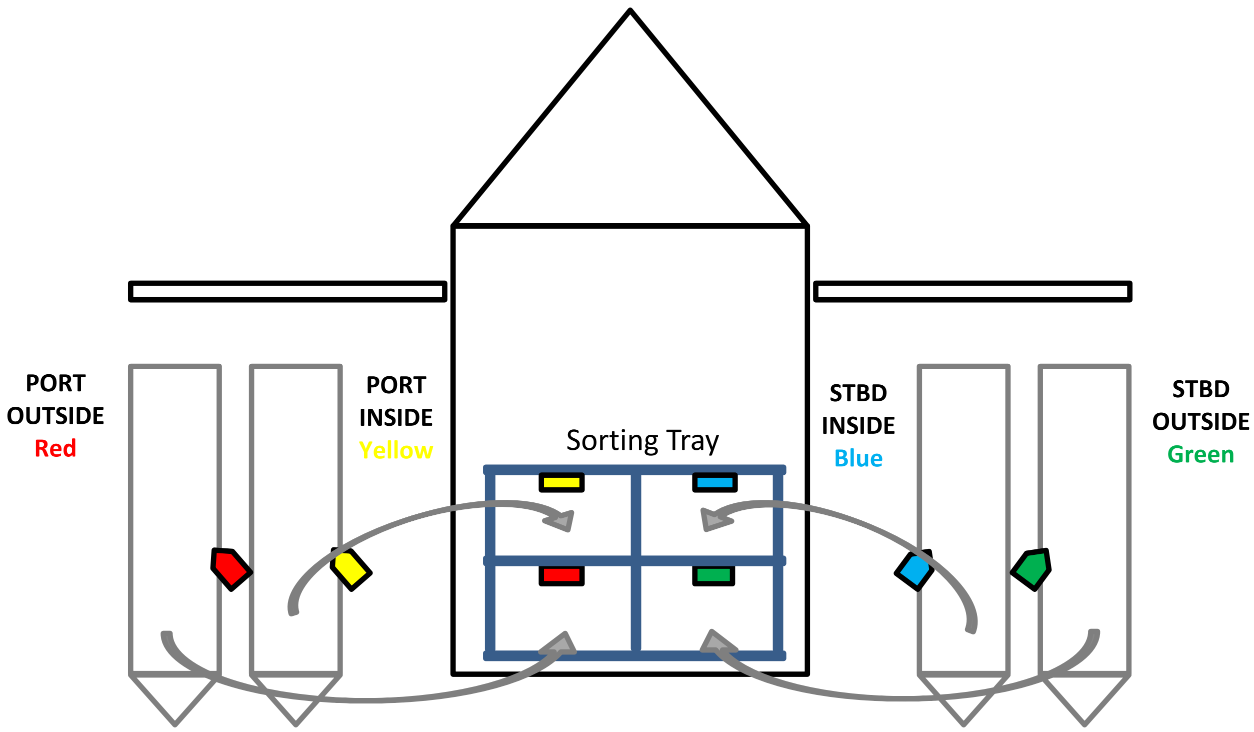

Figure 1: Diagrammatic representation of the colour coding to set up on back deck to facilitate separate codend catch processing. Diagram courtesy of CSIRO

One issue will be discarded bycatch being caught in the next shot. To test if this is happening, soak 40+kg of bycatch in methylene blue for the duration of one shot. Discard when the gear is next fully deployed. This is to test if the bycatch is recaptured; bycatch recaptures are more likely to occur in shallow water trawling. Therefore, it should be carried out in the depths likely to be fished by the vessel during the trial.

*If blue bycatch is recaptured, run the blue test again discarding the bycatch from the stern of the vessel. The bycatch chute is generally on the starboard side of the vessel, it may be possible that by discarding the bycatch over the stern of the vessel it is pushed past the open nets before it descends**

*NOTE: turning the vessel is not likely to counteract the recapture issue; weighing bycatch from quad gear will take up to an hour, too long for a vessel to be carrying out a turning manoeuver; bycatch will most likely be sucked into the whirlpool created behind the vessel in a turn and be pushed out, and possibly down, by the propeller wash; having a vessel in a turn for that duration will also change the fishing efficiency of each of the four nets differently.

Phase 2: Installation and trial of KCF BRD

G. Install one KCF in the Port Outside net and one KCF in the Starboard Inside net. Cover up existing SMP BRD in these two nets. Colour code each of the codend nets using the colour-coded surveyor tape supplied so crew will know where to dump the catch. Data collection to include:

- Weighing total bycatch in each net separately for each shot.
- Sort prawn catch from each net separately for each shot. Get species, weights and grades from crew for each net.
- Record number and lengths of TEP and at-risk species from each net for every shot.
- Photograph all TEP and at-risk species with colour-coded scale tag.
- Take a 10kg subsample from one Experimental BRD (KCF) net and one Control BRD (SMP) net for each shot and ID, where possible, to species level.
- Collect video footage on one shot during the night and last (dawn) shot to further evaluate performance.

H. At the end of the nights fishing, calculate the percentage of prawns for the Experimental BRDs versus Control BRDs for each shot and averaged across the night. This will show any possible prawn loss per shot and per night between the Experimental and Control BRDs. If possible, do this by prawn grade. If there is a loss, knowing the grade will help determine what size class might be escaping or being excluded. At the end of the three nights, average across all nights.

I. At the end of three fishing nights of the BRD trial, move codends as detailed in Table 1. This will require unstitching the whole codend and re-stitching it onto another trawl net throat as described in Table 1. <u>Ensure the surveyor tape is removed from each net before relocating and put tape on the new net in the positions as detailed in Table 1.</u>

J. Repeat data collection as described at H with codends in new positions.

K. Repeat H and I according to nights and BRD configuration in Table 1.

Rotating the BRDs is essential to ensure a statistically robust data collection by accounting for possible differences in the fishing efficiency between the four nets. If a problem occurs and a night of fishing is missed, continue with this schedule of rotation.

Table 1: BRD placements for trial

Night(s)	Port Outside	Port Inside	Starboard Inside	Starboard Outside
1	Calibration of standard nets (SMP @ 120 meshes)			
2,3,4	**KCF1**	SMP1	**KCF2**	SMP2
5,6,7	SMP2	**KCF1**	SMP1	**KCF2**
8,9,10	**KCF2**	SMP2	**KCF1**	SMP1
11,12,13	SMP1	**KCF2**	SMP2	**KCF1**

Prawn Loss/Gain

It is important to evaluate the nights prawn catch to determine if there's any loss or gain of product. There is an industry agreement that a <2.5% prawn loss is acceptable. This is the acceptable percentage of prawn loss specified in the NPF TED and BRD testing protocol.

After six nights of fishing, if the average prawn loss is greater than 2.5% for the KCFs then move the KCFs to 90 or 100 meshes from the codend drawstrings (in consultation with skipper and crew). Ensure you note on the datasheets that this has occurred. Fish for another one to two nights collecting data as detailed in Phase 2. After each nights fishing, calculate prawn loss or gain again.

Bycatch Loss/Gain

Calculate bycatch in the same manner as the prawn catch. This will give an indication of the effectiveness of the trialled BRD compared to the control BRD. Note: this is only an indication, scientific analysis of the data after the trial will be required to determine any significant changes and factoring in differences in the fishing efficiency of each net.

Equipment List

Item		**Item**	
Lug baskets (x10)		Dressmakers tape measure	
Lug basket lids (x4) to cover sea snakes		White board markers x 2	
Laptop to enter data daily		Colour-coded scale tags laminated (3 – 4)	
External hard drive for backup		Clipboard	
Land camera and SD card		Cable ties	
GoPro cameras		Duct tape	
Data sheets (AFMA observer section)		5m of 6mm rope for weighing luggies	
50kg scales x 2 (CSIRO)		ID books (Ben)	
Gloves/protective equipment		First aid kits	
Methylene blue			
Surveyors tape in red, green, yellow & blue			

Annexure 2: CSIRO Final Analysis of NPFI's 'Kon's Covered Fisheye' BRD Trial Data

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Final Analysis of NPFI 'Kon's Covered Fisheyes' BRD Trial Data

Emma Lawrence and Gary Fry

19 December 2016

Contents

1 Background

The Northern Prawn Fishery Industry (NPFI) initiated a bycatch reduction program in 2015 with a target of 30% bycatch reduction across the fleet by 2018. The NPF currently has eight Bycatch Reduction Devices (BRDs) approved for use in the NPF. Whilst some of these devices may reduce bycatch, potential prawn loss from the use of these devices continues to be of major concern for the fishing industry. As gear technology and understanding of fish behaviour improves, scientists and commercial fishers are able to better design and tailor BRDs to retain target species and allow bycatch species to escape.

In 2016, scientific data was collected by AFMA scientific observers during two industry-led trials to test a new BRDs; 'Kons Covered Fisheyes' developed by Kon Triantopoulos from A. Raptis & Sons Pty Ltd, against a currently approved BRD; ‘Square Mesh Panel’. Prior to the first at-sea trial, NPFI contacted CSIRO to request expert opinion on the sampling design of the trial. Once the data was collected, NPFI and AFMA requested CSIRO's expertise in statistically assessing the data for bycatch reduction levels and commercial prawn retention rates. This analysis will be used in a peer-reviewed report published by NPFI and AFMA.

2 Objective

To assess the performance of the ‘Kons Covered Fisheyes’ BRD against a currently used bycatch reduction device, ‘Square Mesh Panel’ BRD, using a Generalized Linear Mixed Model analysis of the at-sea trial data.

3 Methods

The data was collected during two at-sea trials by AFMA scientific observers onboard the ‘*FV Xanadu*’ during the two industry-led trials between 2nd June – 10th June 2016 and 31st October – 15th November 2016. The at-sea trials used two ‘Kon’s Covered Fisheyes’ and two ‘Square Mesh Panel’ BRDs, where each BRD was placed in one of the four main nets of the quad gear configuration. At the commencement of the first trial, the ‘Kon’s Covered Fisheyes’ BRDs were placed in the Port Inside and Starboard Outside nets and the ‘Square Mesh Panel’ BRDs were placed in the Port Outside and Starboard Inside nets. After every three nights fishing, the BRDs were rotated into a different quad gear position so each specific BRD was tested in each of the four main quad gear nets. Due to deterioration of weather and shortening of the first trial by three days, each BRD was only tested in three of the four positions. At the commencement of the second trial, the BRDs were placed in the positions of the main quad gear nets that were missed in the first trial and trialled for three nights before another full rotation was completed.

Total bycatch and total commercial prawn weights were recorded separately for each of the nets for each shot. This data was given to CSIRO for further analysis.

After trying various model forms we fitted a generalized liner mixed model (glmm) with a Gamma distribution to the bycatch data to determine the effectiveness of the treatment net after removing the effect of time trawled, position in the main quad gear, Trial Number (1 or 2) and accounting for correlation within a shot. Standard model diagnostics were checked and showed that the model fit was adequate.

A similar model was then fitted to the prawn catch data. Model diagnostics were checked and this model was shown to also be a good fit for the prawn data.

4 Results

There were nine nights of trawling completed during the first at-sea BRD trial and 15 nights of trawling during the second at-sea trial. The first trial was carried out within the Bountiful Island and Mornington Island region while the second trial started at Weipa for the first night then moved to the north Vanderlins region followed by the Groote Eylandt region (see Appendix 1).

There were large variations in both the total bycatch caught (Table 1) and the commercial prawns retained between each of the four quad gear nets for most shots (Table 2) during the two trials. While the prawn catch was similar across the two trials, approximately 6.5kg per hour of trawling for one main quad gear net, the bycatch caught during the second trial (34.51kg) was about half that of the first trial (71.39kg) (Table 3). This may be due to either differences in bycatch communities across the Gulf of Carpentaria or the different time of year the trials were undertaken.

The bycatch volume and commercial prawn data from the two trials was then combined for analysis. As there was always a control and treatment on the port and starboard side at any one time, the differences in the bycatch volumes and prawn catch (kg per hour) between the two nets for each side for each shot was compared. There was almost always more bycatch caught in the main quad gear nets with the ‘Square Mesh Panel’ (Control BRD) compared to the nets with the ‘Kon’s Covered Fisheyes’ (Treatment BRD) (Figure 1). There was only 10 trawls where one of the ‘Kons’ Covered Fisheyes’ BRD nets caught more bycatch than the adjacent ‘Square Mesh Panel’ BRD net and eight of these occurred during one rotation (for three nights; Trawls 52 to 59) on only one side. For the commercial prawn catches, there was a more even distribution of catch between the ‘Kon’s Covered Fisheyes’ BRD and ‘Square Mesh Panel’ BRD nets during the two at-sea trials (Figure 2).

Table 1. Comparison of the total bycatch (kgs) caught in each of the quad gear nets using the 'Kons Covered Fisheyes' (KCF) and 'Square Mesh Panel' (SMP) Bycatch Reduction Devices during the two at-sea trials. (BRDs: KCF1 – light green; KCF2 – dark green; SMP1 – light blue; SMP2 – dark blue).

Trip	Night Start Date	Shot Number	Port Outside	Port Inside	Starboard Inside	Starboard Outside
1	02-Jun-16	1	551	367	476	310
1	02-Jun-16	2	426	175	372	141
1	03-Jun-16	3	311	89	255	117
1	03-Jun-16	4	237	82	183	99
1	03-Jun-16	5	119	90	127	70
1	03-Jun-16	6	229	71	182	60
1	04-Jun-16	7	207	85	213	67
1	04-Jun-16	8	344	200	264	215
1	04-Jun-16	9	259	102	195	118
1	04-Jun-16	10	223	142	177	110
1	05-Jun-16	11	255	354	256	318
1	06-Jun-16	12	407	645	518	595
1	06-Jun-16	13	318	480	306	471
1	06-Jun-16	14	268	440	314	337
1	07-Jun-16	15	196	287	236	300
1	07-Jun-16	16	265	357	189	399
1	07-Jun-16	17	143	232	146	265
1	08-Jun-16	18	364	234	342	283
1	08-Jun-16	19	298	185	254	214
1	09-Jun-16	20	188	93	169	115
1	09-Jun-16	21	530	286	503	326
1	09-Jun-16	22	375	157	401	213
1	10-Jun-16	23	329	145	335	152
1	10-Jun-16	24	229	159	178	180
2	31-Oct-16	25	151	280	107	231
2	31-Oct-16	26	130	225	71	148
2	31-Oct-16	27	86	165	63	127
2	02-Nov-16	28	152	225	160	221
2	02-Nov-16	29	68	114	69	103
2	02-Nov-16	30	188	234	137	261
2	03-Nov-16	31	187	230	151	226
2	03-Nov-16	32	91	113	79	130
2	03-Nov-16	33	82	157	100	188
2	04-Nov-16	34	267	355	261	405
2	04-Nov-16	35	62	126	84	140
2	04-Nov-16	36	175	253	98	201
2	05-Nov-16	37	144	215	104	164
2	05-Nov-16	38	56	77	82	121
2	05-Nov-16	39	83	145	83	122
2	06-Nov-16	40	110	186	79	169
2	06-Nov-16	41	52	75	48	80
2	06-Nov-16	42	102	127	92	47

2	07-Nov-16	43	245	151	180	138
2	07-Nov-16	44	159	80	136	85
2	07-Nov-16	45	131	90	161	104
2	08-Nov-16	46	223	121	179	108
2	08-Nov-16	47	136	54	99	66
2	08-Nov-16	48	176	88	117	71
2	09-Nov-16	49	219	130	176	125
2	09-Nov-16	50	105	58	91	75
2	09-Nov-16	51	162	116	135	98
2	10-Nov-16	52	140	123	90	190
2	10-Nov-16	53	89	60	56	71
2	10-Nov-16	54	119	95	63	119
2	11-Nov-16	55	150	127	88	206
2	11-Nov-16	56	74	53	52	82
2	11-Nov-16	57	107	66	58	108
2	12-Nov-16	58	120	97	96	169
2	12-Nov-16	59	58	43	45	78
2	12-Nov-16	60	139	155	65	160
2	13-Nov-16	61	164	135	217	166
2	13-Nov-16	62	115	81	121	109
2	13-Nov-16	63	162	96	218	171
2	14-Nov-16	64	147	98	175	107
2	14-Nov-16	65	178	125	217	132
2	14-Nov-16	66	178	90	230	134
2	15-Nov-16	67	95	60	150	70
2	15-Nov-16	68	180	100	250	160
2	15-Nov-16	69	280	190	350	200

Table 2. Comparison of the commercial prawns retained (kgs) in each of the quad gear nets using the 'Kons Covered Fisheyes' (KCF) and 'Square Mesh Panel' (SMP) Bycatch Reduction Devices during the two at-sea trials. (BRDs: KCF1 – light green; KCF2 – dark green; SMP1 – light blue; SMP2 – dark blue).

Trip	Night Start Date	Shot Number	Port Outside	Port Inside	Starboard Inside	Starboard Outside
1	02-Jun-16	1	21.32	29.15	16.6	19.81
1	02-Jun-16	2	29.5	27.8	27.6	21.3
1	03-Jun-16	3	26.8	26.95	25.44	27.6
1	03-Jun-16	4	14.01	9.06	10.7	11.6
1	03-Jun-16	5	12.11	16.65	12.89	15.91
1	03-Jun-16	6	44.23	31.19	35.54	29.39
1	04-Jun-16	7	22.55	17	17.95	19.72
1	04-Jun-16	8	60.4	36.82	40.4	44
1	04-Jun-16	9	38.9	19.1	24	45
1	04-Jun-16	10	12.08	16.5	11.6	20.1
1	05-Jun-16	11	45	44.6	41.5	51.4
1	06-Jun-16	12	25.9	23.1	19.2	22.8
1	06-Jun-16	13	23.9	21.7	18.8	28.8
1	06-Jun-16	14	12.3	12.5	12.3	11.7
1	07-Jun-16	15	16.72	16.2	17.5	17.4
1	07-Jun-16	16	41	36.7	47.4	45.7
1	07-Jun-16	17	44.7	37.2	45.8	42
1	08-Jun-16	18	6.4	7.5	5.8	5.5
1	08-Jun-16	19	29.5	33.6	31.4	34.2
1	09-Jun-16	20	31.2	31.65	31.1	27.3
1	09-Jun-16	21	22.2	19.7	15.4	20.4
1	09-Jun-16	22	38.6	29.8	52.5	51.4
1	10-Jun-16	23	3.8	4.1	4	3.7
1	10-Jun-16	24	0.6	0.4	0.9	0.2
2	31-Oct-16	25	9.9	11	6.5	8.4
2	31-Oct-16	26	34.2	39.1	25.4	17.8
2	31-Oct-16	27	16.2	16.7	12.7	16
2	02-Nov-16	28	19.7	18.5	17.5	16.5
2	02-Nov-16	29	32.4	32.8	29.7	25.1
2	02-Nov-16	30	16	15.9	14.8	14.9
2	03-Nov-16	31	21.3	19.7	17.2	24.3
2	03-Nov-16	32	36.3	37	30.3	33.1
2	03-Nov-16	33	22.4	20.7	15.9	21.6
2	04-Nov-16	34	23.8	19.6	17.3	20.5
2	04-Nov-16	35	24	37.5	36.1	34
2	04-Nov-16	36	26.7	21.5	15.7	16.9
2	05-Nov-16	37	40.1	41.5	29.3	33
2	05-Nov-16	38	31.1	37.2	50	44.1
2	05-Nov-16	39	20.9	27.7	22.6	28.3
2	06-Nov-16	40	25.5	24.5	19.1	23.8
2	06-Nov-16	41	23.3	29	24.2	22.3
2	06-Nov-16	42	15.9	11.6	14.3	0.8

2	07-Nov-16	43	33.1	32.2	27.3	27.8
2	07-Nov-16	44	34	28.7	27.4	24.1
2	07-Nov-16	45	27.2	24.3	26.6	23.7
2	08-Nov-16	46	32.5	31.1	27.1	26.5
2	08-Nov-16	47	34	28.9	33.3	24.5
2	08-Nov-16	48	36.7	31.1	30.6	20.5
2	09-Nov-16	49	45.1	43.5	34.5	36
2	09-Nov-16	50	87.6	71.1	62.9	64.6
2	09-Nov-16	51	33.4	33.2	24.7	30.1
2	10-Nov-16	52	37.9	33.6	31.8	36
2	10-Nov-16	53	76.5	45.6	50.6	32.7
2	10-Nov-16	54	29.9	24.7	27.4	29
2	11-Nov-16	55	41.6	32.5	29.5	34.4
2	11-Nov-16	56	63.5	50.9	56.7	54
2	11-Nov-16	57	33.3	18.7	24	24
2	12-Nov-16	58	40.5	29.5	32.5	36.3
2	12-Nov-16	59	60.1	44.7	52.8	57.4
2	12-Nov-16	60	23.9	22.6	21.2	20.6
2	13-Nov-16	61	17.3	20.1	19.7	19.7
2	13-Nov-16	62	15.4	16.4	16.6	19.3
2	13-Nov-16	63	8.3	6.4	8.3	8.7
2	14-Nov-16	64	13.5	12.1	16	16.1
2	14-Nov-16	65	21.7	18.1	21.5	22.1
2	14-Nov-16	66	14.8	12.4	17.6	17.2
2	15-Nov-16	67	17.1	13.6	16.8	18.9
2	15-Nov-16	68	10.7	11.4	12.8	16
2	15-Nov-16	69	5.4	6.4	6.2	8.2

Table 3. Comparison of the average bycatch caught and commercial prawns retained (kgs) during the two at-sea trials.

	Trial 1	Trial 2
Bycatch Volume	71.39kg	34.51kg
Commercial Prawns	6.53kg	6.76kg

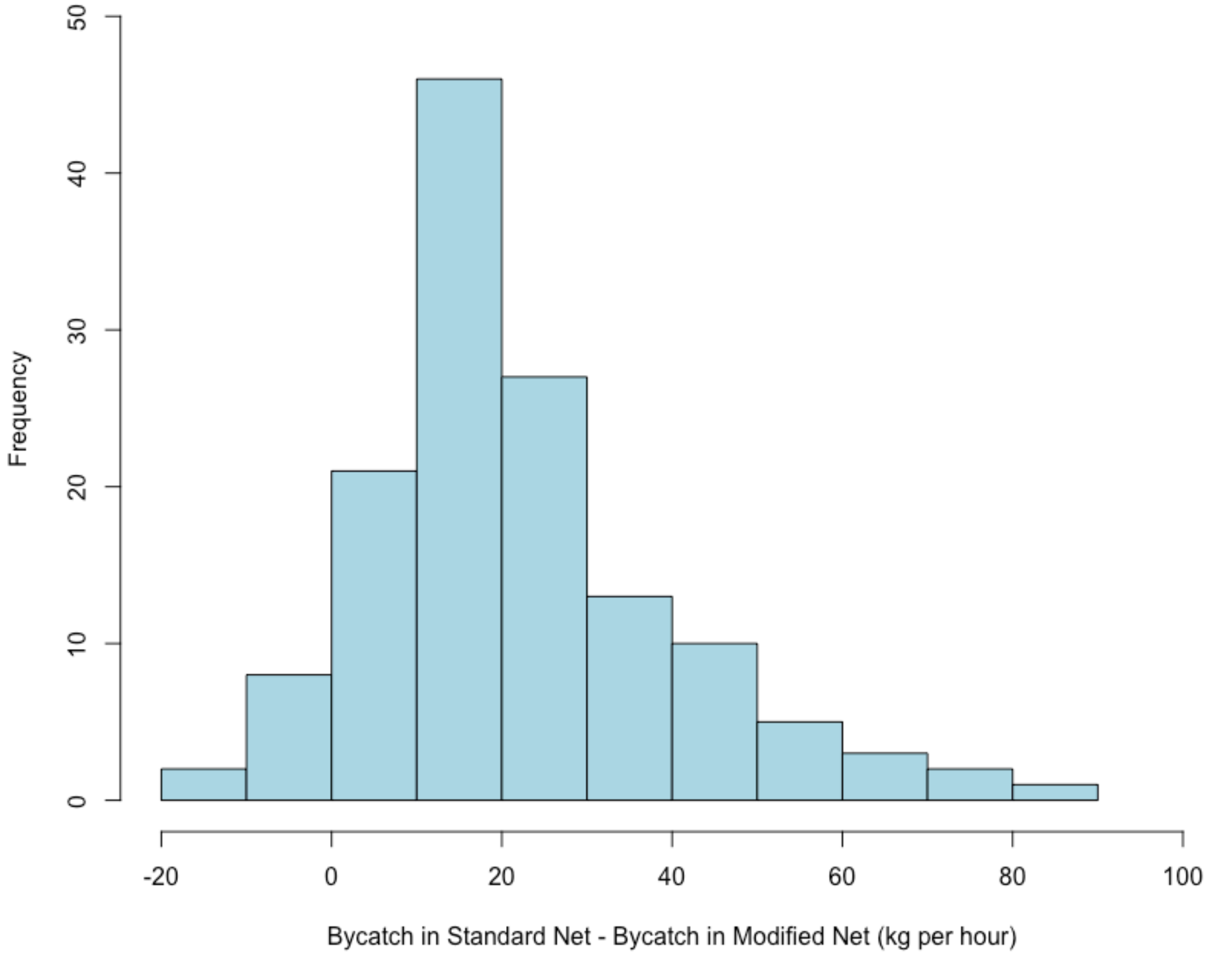

Figure 1. The frequency of the differences in total bycatch (kgs caught per hour of trawling) caught between the 'Kons Covered Fisheyes' BRD net and 'Square Mesh Panel' BRD net on each side during the two at-sea trials.

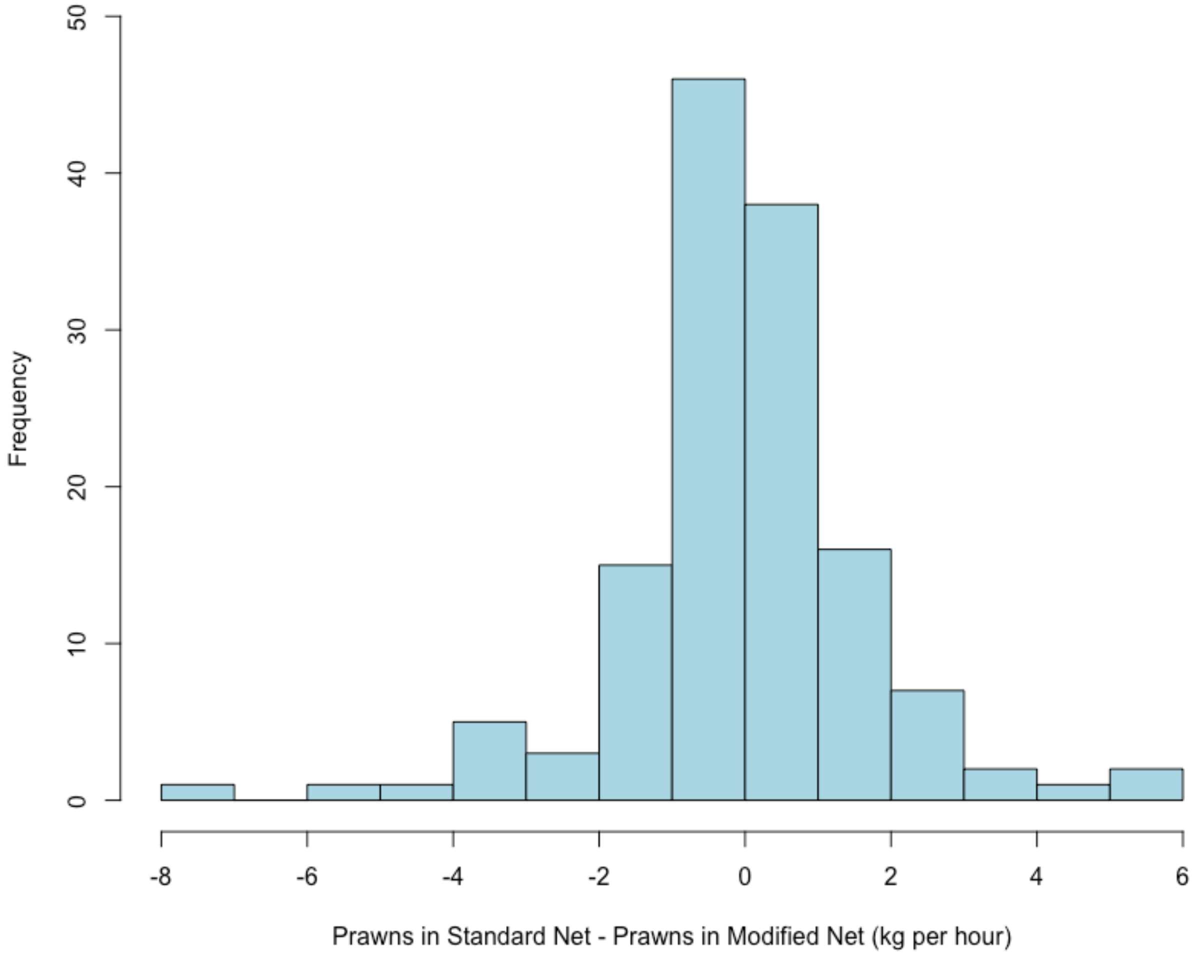

Figure 2. The frequency of the differences in commercial prawn catch (kgs caught per hour of trawling) between the 'Kons Covered Fisheyes' BRD net and 'Square Mesh Panel' BRD net on each side during the two at-sea trials.

4.1 Bycatch

The model for the bycatch data was fitted in R using the glmmPQL package in R and was of the form:

glmmPQL(Bycatch~offset(Duration)+Net+Position+Trial Number, random=~1|Shot, family=Gamma(link=log), data=AFMA_trial, maxit=100)

A summary of the fitted model is:

Random effects:

	Formula: ~1 |	Shot
	(Intercept)	Residual
StdDev:	0.4063487	0.1960974

Fixed effects: Bycatch ~ offset(Duration) + Net + Position + Trial Number

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.1652787	0.08940809	203	1.848588	0.0660
NetF	-0.4572924	0.02424490	203	-18.861384	0.0000
PositionPO	0.1774058	0.03375658	203	5.255445	0.0000
PositionSI	0.0574370	0.03375658	203	1.701506	0.0904
PositionSO	0.0200215	0.03384424	203	0.591576	0.5548
Trial 2	-0.6529772	0.10683954	67	-6.111756	0.0000

The results indicate that a large amount of the variability in the catches of bycatch is accounted for by the random effect i.e. the correlation between nets within a shot is very high. The fixed effects show significantly less bycatch was caught in the Treatment (F) nets ('Kon's Covered Fisheyes' BRD nets) compared to the control nets ('Square Mesh Panel' BRD nets). The transformed model coefficients indicate a reduction of approximately 36.7% in bycatch weights in the 'Kon's Covered Fisheyes' BRD nets (95% Confidence Interval: 33.6 – 39.6%) compared to the 'Square Mesh Panel' BRD nets. The catch rates in the different main quad gear positions are compared against the Port Inside and some significant differences were detected. The highest catch rates of bycatch were in the Port Outside and least in the Port Inside.

4.2 Commercial Prawns

The model for the commercial prawn data fitted was of the form:

glmmPQL(Prawns~offset(Duration)+Net+Position+Trial Number, random=~1|Shot, family=Gamma(link=log), data=AFMA_trial, maxit=100)

A summary of the fitted model is:

Random effects:

	Formula: ~1 |	Shot
	(Intercept)	Residual
StdDev:	0.6720651	0.1815889

Fixed effects: Prawns ~ offset(Duration) + Net + Position + Trial Number

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-2.4763864	0.14164021	203	-17.483640	0.0000
NetF	0.0052603	0.02245884	203	0.234218	0.8151
PositionPO	0.0846957	0.03125906	203	2.709476	0.0073
PositionSI	-0.0227372	0.03125906	203	-0.727379	0.4678
PositionSO	-0.0044679	0.03134030	203	-0.142560	0.8868
Trial 2	0.1650870	0.17331795	67	0.952509	0.3443

Again, most of the variability in commercial prawn catches is described by shot to shot variability. There were significantly more commercial prawns caught on the Port Outside net compared to the other main quad gear net positions. The fixed effects show negligible difference between the commercial prawns caught in the Treatment nets (‘Kon’s Covered Fisheyes’ BRD nets) compared to the Control nets (‘Square Mesh Panel’ BRD nets) with 0.5% more commercial prawns caught using the ‘Kon’s Covered Fisheyes’ BRD nets (Confidence Interval: -3.8 – 5.1%). This shows that there is a mean percentage increase of 0.5% in commercial prawn catches when using the ‘Kon’s Covered Fisheyes’ BRD with 95% confidence that any reduction in commercial prawn catch will be no more than 3.8% for any one trawl and an increase of 5.1% for any one trawl.

5 Interpretation

There is sufficient data to clearly show that there is significantly less bycatch caught in the nets with ‘Kons Covered Fisheyes’ BRDs installed compared to the nets with the standard ‘Square Mesh Panel’ BRD installed. This was mainly due to the quite notable and consistent reduction, around 36.7%, in bycatch volumes in these Treatment nets.

There was also no significant difference in commercial prawn catches between the nets fitted with ‘Kons Covered Fisheyes’ BRD compared to nets with the standard ‘Square Mesh Panel’ BRD. The initial analysis of the data from first trial showed that due to the complexity of the model fitted for this size sample and the large standard errors associated with the data, it was not possible to state that there no difference with any statistical confidence in commercial prawn catches between the Treatment and Control BRD nets.

By undertaking the second trial and increasing sample numbers, it was possible to demonstrate that was an overall mean increase in commercial prawn catches of 0.5% by weight. There is 95% certainty that the loss of commercial prawns using the ‘Kon’s Covered Fisheyes’ BRD is less than 3.8% in any one trawl and an increase in catch of up to 5.1% for any one trawl.

It was not possible to examine other variables such as dawn/dusk and bycatch volume effects on bycatch volumes and commercial prawn catches due to the small sample sizes and highly variable data from the two at-sea trials.

6 Appendix 1

The raw data from the two at-sea trials comparing the 'Kons Covered Fisheyes' BRD net and 'Square Mesh Panel' BRD net on total bycatch volumes and commercial prawn caught.

									Starboard Outside			Starboard Inside			Port Inside			Port Outside		
Trip	Shot	Date	Shot Start Time	Shot Finish Time	Start Latitude	Start Longitude	Finish Latitude	Finish Longitude	Net	Bycatch (kg)	Prawn Catch (kg)	Net	Bycatch (kgs)	Prawn Catch (kgs)	Net	Bycatch (kgs)	Prawn Catch (kgs)	Net	Bycatch (kgs)	Prawn Catch (kgs)
1	1	2/06/2016	18:15	21:15	17° 01 . 41'	140° 24 . 11'	16° 57 . 93'	140° 24 . 09'	F1	310	19.81	C1	476	16.6	F2	367	29.15	C2	551	21.32
1	2	2/06/2016	21:40	0:35	16° 58 . 12'	140° 23 . 79'	17° 01 . 52'	140° 23 . 79'	F1	141	21.3	C1	372	27.6	F2	175	27.8	C2	426	29.5
1	3	3/06/2016	0:50	3:55	17° 01 . 78'	140° 24 . 11'	16° 58 . 27'	140° 24 . 09'	F1	117	27.6	C1	255	25.44	F2	89	26.95	C2	311	26.8
1	4	3/06/2016	4:10	6:50	16° 58 . 02'	140° 23 . 78'	16° 59 . 77'	140° 23 . 80'	F1	99	11.6	C1	183	10.7	F2	82	9.06	C2	237	14.01
1	5	3/06/2016	18:35	22:25	17° 01 . 32'	140° 24 . 96'	17° 00 . 04'	140° 24 . 63'	F1	70	15.91	C1	127	12.89	F2	90	16.65	C2	119	12.11
1	6	3/06/2016	22:35	2:25	17° 00 . 56'	140° 24 . 64'	16° 58 . 70'	140° 24 . 63'	F1	60	29.39	C1	182	35.54	F2	71	31.19	C2	229	44.23
1	7	4/06/2016	2:35	6:25	16° 59 . 23'	140° 24 . 63'	16° 54 . 18'	140° 24 . 92'	F1	67	19.72	C1	213	17.95	F2	85	17	C2	207	22.55
1	8	4/06/2016	19:15	23:25	16° 22 . 79'	139° 01 . 04'	16° 22 . 78'	140° 56 . 15'	F1	215	44	C1	264	40.4	F2	200	36.82	C2	344	60.4
1	9	4/06/2016	23:35	3:30	16° 22 . 75'	138° 56 . 53'	16° 22 . 77'	139° 00 . 55'	F1	118	45	C1	195	24	F2	102	19.1	C2	259	38.9
1	10	5/06/2016	3:45	6:25	16° 22 . 78'	139° 00 . 95'	16° 25 . 52'	139° 00 . 27'	F1	110	20.1	C1	177	11.6	F2	142	16.5	C2	223	12.08
1	11	5/06/2016	22:40	2:55	16° 22 . 60'	138° 55 . 76'	16° 22 . 58'	138° 59 . 39'	C2	318	51.4	F1	256	41.5	C1	354	44.6	F2	255	45
1	12	6/06/2016	3:10	7:25	16° 22 . 57'	138° 58 . 76'	16° 22 . 59'	138° 57 . 62'	C2	595	22.8	F1	518	19.2	C1	645	23.1	F2	407	25.9
1	13	6/06/2016	18:15	22:25	16° 22 . 46'	139° 00 . 30'	16° 22 . 46'	138° 56 . 33'	C2	471	28.8	F1	306	18.8	C1	480	21.7	F2	318	23.9
1	14	6/06/2016	22:40	2:55	16° 22 . 44'	138° 56 . 83'	16° 23 . 14'	138° 45 . 34'	C2	337	11.7	F1	314	12.3	C1	440	12.5	F2	268	12.3
1	15	7/06/2016	3:05	6:55	16° 23 . 52'	138° 45 . 89'	16° 22 . 44'	139° 00 . 87'	C2	300	17.4	F1	236	17.5	C1	287	16.2	F2	196	16.72
1	16	7/06/2016	20:05	23:55	16° 29 . 56'	138° 57 . 21'	16° 29 . 85'	138° 56 . 63'	C2	399	45.7	F1	189	47.4	C1	357	36.7	F2	265	41
1	17	8/06/2016	0:10	4:25	16° 29 . 85'	138° 56 . 37'	16° 29 . 57'	138° 56 . 73'	C2	265	42	F1	146	45.8	C1	232	37.2	F2	143	44.7
1	18	8/06/2016	17:45	19:40	16° 29 . 51'	138° 57 . 07'	16° 29 . 79'	138° 56 . 76'	F2	283	5.5	C2	342	5.8	F1	234	7.5	C1	364	6.4
1	19	8/06/2016	19:55	0:30	16° 29 . 47'	138° 57 . 20'	16° 29 . 49'	138° 55 . 38'	F2	214	34.2	C2	254	31.4	F1	185	33.6	C1	298	29.5
1	20	9/06/2016	0:40	4:55	16° 29 . 50'	138° 54 . 88'	16° 29 . 58'	138° 53 . 59'	F2	115	27.3	C2	169	31.1	F1	93	31.65	C1	188	31.2

									Starboard Outside			Starboard Inside			Port Inside			Port Outside		
Trip	Shot	Date	Shot Start Time	Shot Finish Time	Start Latitude	Start Longitude	Finish Latitude	Finish Longitude	Net	Bycatch (kg)	Prawn Catch (kg)	Net	Bycatch (kgs)	Prawn Catch (kgs)	Net	Bycatch (kgs)	Prawn Catch (kgs)	Net	Bycatch (kgs)	Prawn Catch (kgs)
1	21	9/06/2016	18:55	22:55	17° 02 . 88'	140° 28 . 41'	16° 57 . 14'	140° 24 . 74'	F2	326	20.4	C2	503	15.4	F1	286	19.7	C1	530	22.2
1	22	9/06/2016	23:05	2:55	16° 56 . 95'	140° 24 . 21'	16° 59 . 59'	140° 25 . 78'	F2	213	51.4	C2	401	52.5	F1	157	29.8	C1	375	38.6
1	23	10/06/2016	3:05	7:00	17° 00 . 06'	140° 26 . 12'	17° 12 . 73'	140° 34 . 55'	F2	152	3.7	C2	335	4	F1	145	4.1	C1	329	3.8
1	24	10/06/2016	18:20	22:25	17° 07 . 98'	140° 31 . 93'	17° 14 . 84'	140° 35 . 66'	F2	180	0.2	C2	178	0.9	F1	159	0.4	C1	229	0.6
2	25	31/10/2016	18:05	20:45	12° 50 . 76'	141° 27 . 31'	12° 50 . 83'	141° 27 . 32'	SM1	231	8.4	FE1	107	6.5	SM2	280	11	FE2	151	9.9
2	26	31/10/2016	21:00	1:10	12° 50 . 39'	141° 27 . 35'	12° 55 . 15'	141° 27 . 32'	SM1	148	17.8	FE1	71	25.4	SM2	225	39.1	FE2	130	34.2
2	27	31/10/2016	1:25	5:20	12° 55 . 49'	141° 27 . 34'	12° 51 . 12'	141° 27 . 32'	SM1	127	16	FE1	63	12.7	SM2	165	16.7	FE2	86	16.2
2	28	2/11/2016	18:35	22:30	15° 05 . 55'	136° 46 . 95'	15° 05 . 59'	136° 41 . 77'	SM1	221	16.5	FE1	160	17.5	SM2	225	18.5	FE2	152	19.7
2	29	2/11/2016	22:40	2:45	15° 05 . 55'	136° 41 . 23'	15° 05 . 58'	136° 44 . 96'	SM1	103	25.1	FE1	69	29.7	SM2	114	32.8	FE2	68	32.4
2	30	2/11/2016	2:55	7:00	15° 05 . 59'	136° 44 . 42'	15° 05 . 55'	136° 44 . 35'	SM1	261	14.9	FE1	137	14.8	SM2	234	15.9	FE2	188	16
2	31	3/11/2016	18:40	22:35	14° 57 . 48'	136° 33 . 98'	14° 57 . 39'	136° 28 . 57'	SM1	226	24.3	FE1	151	17.2	SM2	230	19.7	FE2	187	21.3
2	32	3/11/2016	22:45	2:45	14° 57 . 37'	136° 28 . 04'	14° 57 . 38'	136° 31 . 69'	SM1	130	33.1	FE1	79	30.3	SM2	113	37	FE2	91	36.3
2	33	3/11/2016	2:55	7:10	14° 57 . 40'	136° 32 . 17'	14° 57 . 37'	136° 31 . 24'	SM1	188	21.6	FE1	100	15.9	SM2	157	20.7	FE2	82	22.4
2	34	4/11/2016	18:40	22:35	14° 56 . 27'	136° 33 . 70'	14° 56 . 29'	136° 31 . 19'	SM1	405	20.5	FE1	261	17.3	SM2	355	19.6	FE2	267	23.8
2	35	4/11/2016	22:45	2:45	14° 56 . 30'	136° 30 . 57'	14° 56 . 29'	136° 30 . 25'	SM1	140	34	FE1	84	36.1	SM2	126	37.5	FE2	62	24
2	36	4/11/2016	2:55	7:05	14° 56 . 31'	136° 30 . 73'	14° 56 . 30'	136° 31 . 49'	SM1	201	16.9	FE1	98	15.7	SM2	253	21.5	FE2	175	26.7
2	37	5/11/2016	18:35	22:30	14° 56 . 01'	136° 33 . 34'	14° 56 . 01'	136° 31 . 71'	SM1	164	33	FE1	104	29.3	SM2	215	41.5	FE2	144	40.1
2	38	5/11/2016	22:40	3:25	14° 56 . 04'	136° 32 . 29'	14° 55 . 99'	136° 31 . 26'	SM1	121	44.1	FE1	82	50	SM2	77	37.2	FE2	56	31.1
2	39	5/11/2016	3:40	7:00	14° 56 . 01'	136° 31 . 91'	14° 56 . 00'	136° 30 . 16'	SM1	122	28.3	FE1	83	22.6	SM2	145	27.7	FE2	83	20.9
2	40	6/11/2016	18:35	22:25	14° 55 . 95'	136° 33 . 31'	14° 55 . 93'	136° 30 . 99'	SM1	169	23.8	FE1	79	19.1	SM2	186	24.5	FE2	110	25.5
2	41	6/11/2016	22:40	2:40	14° 55 . 95'	136° 30 . 74'	14° 55 . 93'	136° 29 . 43'	SM1	80	22.3	FE1	48	24.2	SM2	75	29	FE2	52	23.3
2	42	6/11/2016	2:50	7:00	14° 55 . 96'	136° 28 . 96'	14° 55 . 93'	136° 30 . 67'	SM1	47	0.8	FE1	92	14.3	SM2	127	11.6	FE2	102	15.9
2	43	7/11/2016	18:50	22:30	14° 56 . 26'	136° 34 . 95'	14° 56 . 42'	136° 39 . 84'	FE2	138	27.8	SM1	180	27.3	FE1	151	32.2	SM2	245	33.1
2	44	7/11/2016	22:45	2:45	14° 56 . 40'	136° 39 . 32'	14° 56 . 79'	136° 37 . 07'	FE2	85	24.1	SM1	136	27.4	FE1	80	28.7	SM2	159	34
2	45	7/11/2016	3:00	7:00	14° 56 . 81'	136° 37 . 58'	14° 56 . 26'	136° 34 . 89'	FE2	104	23.7	SM1	161	26.6	FE1	90	24.3	SM2	131	27.2
2	46	8/11/2016	18:40	22:25	14° 56 . 17'	136° 34 . 99'	14° 56 . 53'	136° 38 . 15'	FE2	108	26.5	SM1	179	27.1	FE1	121	31.1	SM2	223	32.5
2	47	8/11/2016	22:40	2:40	14° 56 . 54'	136° 37 . 64'	14° 56 . 18'	136° 38 . 83'	FE2	66	24.5	SM1	99	33.3	FE1	54	28.9	SM2	136	34

									Starboard Outside			Starboard Inside			Port Inside			Port Outside		
Trip	**Shot**	**Date**	**Shot Start Time**	**Shot Finish Time**	**Start Latitude**	**Start Longitude**	**Finish Latitude**	**Finish Longitude**	**Net**	**Bycatch (kg)**	**Prawn Catch (kg)**	**Net**	**Bycatch (kgs)**	**Prawn Catch (kgs)**	**Net**	**Bycatch (kgs)**	**Prawn Catch (kgs)**	**Net**	**Bycatch (kgs)**	**Prawn Catch (kgs)**
2	48	8/11/2016	2:55	7:00	14° 56 . 52'	136° 38 . 68'	14° 56 . 18'	136° 38 . 27'	FE2	71	20.5	SM1	117	30.6	FE1	88	31.1	SM2	176	36.7
2	49	9/11/2016	18:35	22:25	14° 25 . 40'	136° 27 . 44'	14° 26 . 41'	136° 31 . 84'	FE2	125	36	SM1	176	34.5	FE1	130	43.5	SM2	219	45.1
2	50	9/11/2016	22:40	2:45	14° 26 . 30'	136° 31 . 46'	14° 25 . 85'	136° 29 . 44'	FE2	75	64.6	SM1	91	62.9	FE1	58	71.1	SM2	105	87.6
2	51	9/11/2016	2:55	7:05	14° 25 . 94'	136° 29 . 87'	14° 25 . 69'	136° 27 . 85'	FE2	98	30.1	SM1	135	24.7	FE1	116	33.2	SM2	162	33.4
2	52	10/11/2016	18:35	22:25	14° 25 . 32'	136° 27 . 41'	14° 26 . 32'	136° 31 . 88'	SM2	190	36	FE2	90	31.8	SM1	123	33.6	FE1	140	37.9
2	53	10/11/2016	22:40	2:45	14° 26 . 25'	136° 31 . 47'	14° 25 . 75'	136° 29 . 31'	SM2	71	32.7	FE2	56	50.6	SM1	60	45.6	FE1	89	76.5
2	54	10/11/2016	2:55	6:45	14° 25 . 87'	136° 29 . 80'	14° 25 . 96'	136° 28 . 53'	SM2	119	29	FE2	63	27.4	SM1	95	24.7	FE1	119	29.9
2	55	11/11/2016	18:35	22:25	14° 26 . 57'	136° 31 . 05'	14° 26 . 03'	136° 28 . 62'	SM2	206	34.4	FE2	88	29.5	SM1	127	32.5	FE1	150	41.6
2	56	11/11/2016	22:40	2:50	14° 26 . 14'	136° 29 . 07'	14° 25 . 82'	136° 27 . 71'	SM2	82	54	FE2	52	56.7	SM1	53	50.9	FE1	74	63.5
2	57	11/11/2016	3:00	7:00	14° 25 . 90'	136° 28 . 02'	14° 26 . 16'	136° 29 . 20'	SM2	108	24	FE2	58	24	SM1	66	18.7	FE1	107	33.3
2	58	12/11/2016	18:30	22:25	14° 26 . 71'	136° 31 . 35'	14° 26 . 05'	136° 28 . 37'	SM2	169	36.3	FE2	96	32.5	SM1	97	29.5	FE1	120	40.5
2	59	12/11/2016	22:40	2:45	14° 26 . 17'	136° 28 . 91'	14° 25 . 93'	136° 27 . 86'	SM2	78	57.4	FE2	45	52.8	SM1	43	44.7	FE1	58	60.1
2	60	12/11/2016	3:00	6:55	14° 25 . 83'	136° 27 . 41'	14° 26 . 35'	136° 29 . 65'	SM2	160	20.6	FE2	65	21.2	SM1	155	22.6	FE1	139	23.9
2	61	13/11/2016	18:40	22:25	14° 25 . 84'	136° 27 . 17'	14° 19 . 72'	136° 16 . 42'	FE1	166	19.7	SM2	217	19.7	FE2	135	20.1	SM1	164	17.3
2	62	13/11/2016	22:40	2:45	14° 19 . 25'	136° 16 . 31'	14° 19 . 65'	136° 16 . 43'	FE1	109	19.3	SM2	121	16.6	FE2	81	16.4	SM1	115	15.4
2	63	13/11/2016	2:55	7:00	14° 19 . 15'	136° 16 . 35'	14° 14 . 14'	136° 14 . 57'	FE1	171	8.7	SM2	218	8.3	FE2	96	6.4	SM1	162	8.3
2	64	14/11/2016	18:35	22:30	14° 14 . 32'	136° 12 . 79'	14° 19 . 41'	136° 12 . 06'	FE1	107	16.1	SM2	175	16	FE2	98	12.1	SM1	147	13.5
2	65	14/11/2016	22:40	2:45	14° 19 . 54'	136° 11 . 63'	14° 21 . 38'	136° 10 . 69'	FE1	132	22.1	SM2	217	21.5	FE2	125	18.1	SM1	178	21.7
2	66	14/11/2016	2:55	7:05	14° 20 . 97'	136° 10 . 86'	14° 15 . 98'	136° 11 . 79'	FE1	134	17.2	SM2	230	17.6	FE2	90	12.4	SM1	178	14.8
2	67	15/11/2016	18:35	22:30	13° 16 . 50'	136° 32 . 85'	13° 17 . 17'	136° 30 . 00'	FE1	70	18.9	SM2	150	16.8	FE2	60	13.6	SM1	95	17.1
2	68	15/11/2016	22:40	2:45	13° 17 . 48'	136° 29 . 67'	13° 25 . 30'	136° 40 . 82'	FE1	160	16	SM2	250	12.8	FE2	100	11.4	SM1	180	10.7
2	69	15/11/2016	3:00	7:00	13° 25 . 71'	136° 40 . 86'	13° 30 . 88'	136° 41 . 60'	FE1	200	8.2	SM2	350	6.2	FE2	190	6.4	SM1	280	5.4

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Analysis of NPFI BRD Trial Data 2018

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Contents

1 Introduction

The Northern Prawn Fishery conducted trials of two new Bycatch Reduction Devices (BRDs) in May-June 2018 and a third new BRD in November 2018 against the currently approved BRD; the Square Mesh Panel BRD. The three new devices were modifications of the approved Kon's Covered Fisheye device and both were tested as single 'fisheyes' positioned at 60 or 65 meshes from the codend drawstrings while the control Square Mesh Panel BRD was positioned at 120 meshes from the codend drawstring. The trials were done in accordance with the objectives of the NPF Bycatch Strategy 2015-18 to reduce the capture of small bycatch by 30% in 3 years. The Single Kon's Covered Fisheye BRD was trialled on the vessel Ocean Producer, and the FishEX70 BRD trialled on the vessel Newfish II, in May-June 2018 with the new devices positioned at 65 meshes from the codend drawstrings. The third new BRD, the Tom's Fisheye BRD was trialled on the vessel Eylandt Pearl, in November 2018 and was positioned at 60 meshes from the codend drawstrings. The data was collected by AFMA scientific observers and given to CSIRO for analysis.

2 Methods

2.1 Sample Design

Due to time constraints in repeatedly installing and removing the control Square Mesh Panel BRDs and test BRDs (either the Single Kon's Covered Fisheye, FishEX70 or Tom's Fisheye BRD) in the four codends, both of the control and test BRDs were installed in each of the four nets. Using standard codend mesh pieces, one of the control or test BRDs in a codend was covered up in turn so as to trial each BRD type in each of the four net positions in the quad gear to achieve a balanced design. The control and test BRD types were trialled in each of the four net positions for three consecutive nights. The experimental design used in the May-June 2018 trial is shown in Table 1.

Table 1. The experimental design of BRD net position across the quad gear during the May-June 2018 trial using the Ocean Producer to test the Single Kon's Covered Fisheye BRD and the Newfish II to test the FishEX70 BRD against the control Square Mesh Panel BRD.

Night	Port Outside (Net1)	Port Inside (Net2)	Starboard Inside (Net3)	Starboard Outside (Net4)
1	Calibration of standard nets (Square Mesh Panel @ 120 meshes)			
2-4	Test	Test	Control	Control
5-7	Test	Control	Control	Test
8-10	Control	Control	Test	Test
11-13	control	Test	Test	Control

The Ocean Producer did not undertake the final rotation of nets (see Appendix 1). While the Newfish II completed all rotations, a damaged net in the middle of the trial meant that the Port side nets did not perform correctly for the remainder of the trial (even though they were repaired). There were also ten instances of the nets being TED'd (blockage at the TED causing loss of catch) on this vessel.

The experimental design for the trial in November 2018 differed slightly from the May-June 2018 trial. The control and test BRD types were trialled in each of the four net positions for four consecutive nights and the BRD net position configuration differed by having, at any one time, one control Square Mesh Panel BRD and one test Tom's Fisheye BRD in the Port or Starboard side. The experimental design used in the November 2018 trial is shown in Table 2.

Table 2. The experimental design of BRD net position across the quad gear during the November 2018 trial using the Eylandt Pearl to test the Tom's Fisheye BRD against the control Square Mesh Panel BRD.

Night	Port Outside (Net1)	Port Inside (Net2)	Starboard Inside (Net3)	Starboard Outside (Net4)
1	Calibration of standard nets (Square Mesh Panel @ 120 meshes)			
2-5	Test	Control	Test	Control
6-9	Control	Test	Control	Test
10-13	Test	Control	Test	Control
14-17	Control	Test	Control	Test

Total bycatch and total commercial prawn weights were recorded separately for each of the nets for each shot. We first looked at the mean catch of prawns and bycatch per hour for each net type on each vessel. We then removed any data that was not indicative of usual fishing practices (gear failure, TED blockage), before fitting models to the data.

After trying various model forms we fitted a generalized liner mixed model (GLMM) with a Gamma distribution to the bycatch data to determine the effectiveness of the treatment net after removing the effect of time trawled (model offset), position in the main quad gear (main effect) and accounting for correlation within a shot (random effect). The models were fitted separately for each of the vessels. Standard model diagnostics were checked and showed that the model fits was adequate.

Similar models were then fitted to the commercial prawn catch data. Model diagnostics were checked and these models were shown to also be a good fit for the prawn data.

3 Results

3.1 Single Kon's Covered Fisheye BRD

The Ocean Producer completed twelve nights trawling. Each BRD was used at least nine times in each net position on the vessel (Table 3). The trawl duration was mostly between two and three and a half hours.

Table 3. Number of times each BRD was used in each position in the quad gear on the Ocean Producer

Position	Single Kon's Covered Fisheye	Square Mesh Panel
Starboard Outside	11	18
Starboard Inside	20	9
Port Inside	18	11
Port Outside	9	20

There were large variations in both the total bycatch caught and the commercial prawns retained between each of the four quad gear nets for most shots (Appendix 1). The nets with the Square Mesh Panel BRD caught, on average, both more bycatch and commercial prawns (Table 4).

Table 4. Comparison of the average bycatch caught and commercial prawns retained (kgs/hour) during the at-sea trial on the Ocean Producer.

	Single Kon's Covered Fisheye	Square Mesh Panel
Bycatch Volume	56.38	72.63
Commercial Prawns	4.73	5.17

3.1.1 Bycatch

We initially tried to fit the model for the bycatch data using the glmer function (lme4 package) in R, however due to convergence problems we used the glmmPQL function (MASS package) in R. While glmer offers a slightly more accurate statistical approximation, we expect the differences would be minor and so we are satisfied that the modelled estimates are accurate.

The model for the bycatch data was fitted in R using the glmmPQL package in R and was of the form:

glmmPQL(Bycatch~offset(Duration)+Net+Position, random=~1|Shot, family=Gamma(link=log))

A summary of the model output is:

Random effects:

	Formula: ~1 | Shot	
	(Intercept)	Residual
StdDev:	0.4344056	0.1293628

Fixed effects: Bycatch ~ offset(log(Duration)) + Net + Position

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.12299597	0.08753173	83	1.405159	0.1637
NetS-KCF	-0.26459378	0.02590091	83	-10.215616	0.0000
PositionPO	0.00737341	0.03564716	83	0.206844	0.8366
PositionSI	-0.01230708	0.03477496	83	-0.353906	0.7243
PositionSO	-0.10858524	0.03528731	83	-3.077175	0.0028

The results indicate that a large amount of the variability in the catches of bycatch is accounted for by the random effect i.e. the correlation between nets within a shot is very high. The fixed effects show a significantly lower mean bycatch rate in the Single Kon's Covered Fisheye BRD nets compared to the Square Mesh Panel BRD nets ($p<0.0001$). Applying the exponential transformation to the model coefficients allows us to estimate the difference in bycatch in the two net types. The transformed model coefficients indicate a reduction of approximately 23.25% in bycatch weights in the Single Kon's Covered Fisheye BRD nets (95% Confidence Interval: 19.25 to 27.05%) compared to the Square Mesh Panel BRD nets. The catch rates in the different main quad gear positions are compared against the Port Inside and some significant differences were detected. The highest catch rates of bycatch were in the Port Outside and least in the Starboard Outside.

3.1.2 Commercial prawn catch

We again initially tried to fit the model for the commercial prawn data using the glmer function (lme4 package) in R, however due to convergence problems we used the glmmPQL function (MASS package) in R.

The model for the commercial prawn data was fitted in R using the glmmPQL package in R and was of the form:

glmmPQL(Prawns~offset(Duration)+Net+Position, random=~1|Shot, family=Gamma(link=log))

A summary of the model output is:

Random effects:

	Formula: ~1 | Shot	
	(Intercept)	Residual
StdDev:	0.9983746	0.2080645

Fixed effects: Prawns ~ offset(log(Duration)) + Net + Position

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-2.7227073	0.19906539	80	-13.677452	0.0000
NetS-KCF	-0.0338933	0.04251337	80	-0.797239	0.4277
PositionPO	-0.0923199	0.05851009	80	-1.577846	0.1185
PositionSI	-0.1143642	0.05691224	80	-2.009484	0.0479
PositionSO	-0.1657935	0.05817422	80	-2.849949	0.0056

Again, most of the variability in commercial prawn catches is described by shot to shot variability. There were significantly more commercial prawns caught on the Port Inside net compared to the Starboard Outside and Starboard Inside. There is no evidence of a significant difference between the mean catch rate of commercial prawns caught in the Single Kon's Covered Fisheye BRD nets compared to the Square Mesh Panel BRD nets. The model indicates a reduction in commercial prawn catch of 3.33% using the Single Kon's Covered Fisheye BRD nets (Confidence Interval: -5.07 – 11.06%). This 95% confidence interval is quite wide indicating that the loss could be as high as 11% or conversely, there could be a mean increase of up to 5%.

3.2 FishEX70 BRD

The Newfish II completed twelve nights of at-sea trawling. Each BRD was used at least sixteen times in each net position on the vessel (Table 5). The trawl duration was mostly between three and four hours.

Table 5. Number of times each BRD was used in each position in the quad gear on the Newfish II

Position	FishEX70	Square Mesh Panel
Starboard Outside	16	22
Starboard Inside	20	18
Port Inside	20	18
Port Outside	20	28

There were large variations in both the total bycatch caught and the commercial prawns retained between each of the four quad gear nets for most shots (Appendix 1). The nets with the Square Mesh Panel BRD caught, on average, both more bycatch and commercial prawns (Table 6). The catch rates on the Square Mesh Panel BRD are comparable between this trial and the trial conducted using the Single Kon's Covered Fisheye BRD on the Ocean Producer.

Table 6. Comparison of the average bycatch caught and commercial prawns retained (kgs/hour) during the at-sea trial on the Newfish II.

	FishEX70	Square Mesh Panel
Bycatch Volume	58.80	110.98
Commercial Prawns	3.78	5.04

Of particular concern is the low catch rate of commercial prawns using the FishEX70 BRD. We removed all records from the analysis where gear failure had occurred (either TED'd or following the repair of the Port side nets) and recalculated the mean catch rates (Table 7). The difference in prawn catches between the two nets are less, indicating that the effect of the FishEX70 BRD will most likely be exacerbated if we do not remove these records from the analysis.

Table 7. Comparison of the average bycatch caught and commercial prawns retained (kgs/hour) during the at-sea trial on the Newfish II, after removing records where the gear failed.

	FishEX70	Square Mesh Panel
Bycatch Volume	66.37	119.38
Commercial Prawns	4.38	5.18

3.2.1 Bycatch

We initially tried to fit the model for the bycatch data using the glmer function (lme4 package) in R based on only the data where the gear performed correctly, however due to convergence problems we used the glmmPQL function (MASS package) in R.

The model for the bycatch data was fitted in R using the glmmPQL package in R and was of the form:

glmmPQL(Bycatch~offset(Duration)+Net+Position, random=~1|Shot, family=Gamma(link=log))

A summary of the model output is:

Random effects:

Formula: ~1 | Shot

(Intercept) Residual

StdDev:	0.4479757	0.2342977			

Fixed effects: Bycatch ~ offset(log(Duration)) + Net + Position

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.5726158	0.10344688	63	5.535360	0.0000
NetFishEX70	-0.5415937	0.05954144	63	-9.096081	0.0000
PositionPO	0.0238960	0.09018370	63	0.264971	0.7919
PositionSI	-0.0407817	0.08158009	63	-0.499898	0.6189
PositionSO	-0.1024297	0.08058160	63	-1.271131	0.2084

The fixed effects show the mean bycatch was significantly less in the FishEX70 BRD nets compared to the Square Mesh Panel BRD nets ($p<0.0001$). The transformed model coefficients indicate a reduction of approximately 41.82% in bycatch weights in the FishEX70 BRD nets (95% Confidence Interval: 34.62 to 48.23%) compared to the Square Mesh Panel BRD nets. The catch rates in the different main quad gear positions are compared against the Port Inside and no significant differences were detected.

3.2.2 Commercial prawn catch

We again initially tried to fit the model for the commercial prawn data using the glmer function (lme4 package) in R based on only the data where the gear performed correctly, however due to convergence problems we used the glmmPQL function (MASS package) in R.

The model for the commercial prawn data was fitted in R using the glmmPQL package in R and was of the form:

glmmPQL(Prawns~offset(Duration)+Net+Position, random=~1|Shot, family=Gamma(link=log))

A summary of the model output is:

Random effects:

Formula: ~1 | Shot

	(Intercept)	Residual
StdDev:	0.5457728	0.2744936

Fixed effects: Prawns ~ offset(log(Duration)) + Net + Position

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-2.5954524	0.12375346	63	-20.972766	0.0000
NetFishEX70	0.0013169	0.06987834	63	0.018845	0.9850
PositionPO	0.0230932	0.10568415	63	0.218511	0.8277

PositionSI	-0.0706131	0.09567397	63	-0.738060	0.4632
PositionSO	0.0350117	0.09448309	63	0.370560	0.7122

There is no evidence of a significant difference between the mean commercial prawn catch rate for the FishEX70 BRD nets compared to the Square Mesh Panel BRD nets. The model indicates an increase in commercial prawn catch of 0.13% using the FishEX70 BRD nets (Confidence Interval: -12.68 – 14.83%). This 95% confidence interval is wide indicating that the loss could be as high as 12.6% or conversely, there could be a mean increase of up to 14.8%.

3.2.3 Sensitivity test

Removing the nets which were affected by gear failure reduced the dataset from 152 to 105 observations and made the data much less balanced (Table 10). All but one of the nets on the Port Outside, in the remaining dataset, were Square Mesh Panel BRDs.

Table 8. Number of times each net was used in each position in quad on the Newfish II after the data affected by gear failure was removed

Position	FishEX70	Square Mesh Panel
Starboard Outside	14	22
Starboard Inside	19	17
Port Inside	8	7
Port Outside	1	17

To test the sensitivity of the model to this lack of balance in the data, we removed all of the Port Outside records and refitted the bycatch model. The Reduction in bycatch was estimated as 41.01%, a value very close to that estimated by the model fitted to the broader data (41.82%). Similarly, the estimate in mean prawn catch was a reduction of 0.6%, a value close to the broader model (increase of 0.13%). Given the similarity between the models, we have confidence that the model can handle the unbalanced data and see no reason to remove the Port Outside nets from the analysis.

3.3 Tom's Fisheye BRD

The Eylandt Pearl completed sixteen nights of at-sea trawling. Each BRD was used 32 times in each net position on the vessel (Table 8). The trawl duration was mostly between three and four hours.

Table 9. Number of times each BRD was used in each position in the quad gear on the Eylandt Pearl

Position	Tom's Fisheye	Square Mesh Panel
Starboard Outside	32	32
Starboard Inside	32	32
Port Inside	32	32
Port Outside	32	32

There were large variations in both the total bycatch caught and the commercial prawns retained between each of the four quad gear nets for most shots (Appendix 1). The nets with the Square Mesh Panel BRD caught, on average, more bycatch but a very similar amount of commercial prawns when compared to the Tom's Fisheye BRD (Table 9).

Table 10. Comparison of the average bycatch caught and commercial prawns retained (kgs/hour) during the at-sea trial on the Eylandt Pearl.

	Tom's Fisheye	Square Mesh Panel
Bycatch Volume	57.46	103.35
Commercial Prawns	8.23	8.28

3.3.1 Bycatch

We initially tried to fit the model for the bycatch data using the glmer function (lme4 package) in R, however due to convergence problems we used the glmmPQL function (MASS package) in R:

The model for the bycatch data was fitted in R using the glmmPQL package in R and was of the form:

glmmPQL(Bycatch~offset(Duration) + Net + Position, random=~1|Shot, family=Gamma(link=log))

A summary of the model output is:

Random effects:

Formula: ~1 | Shot

	(Intercept)	Residual
StdDev:	0.7120319	0.1422119

Fixed effects: Bycatch ~ offset(log(Duration)) + Net + Position

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.3270023	0.09284700	182	3.521948	0.0005
NetTomFE	-0.5749697	0.01824617	182	-31.511805	0.0000

PositionPO	-0.0363627	0.02587585	182	-1.405275	0.1616
PositionSI	-0.0638446	0.02573378	182	-2.480964	0.0140
PositionSO	-0.0291946	0.02559679	182	-1.140557	0.2556

The results indicate that a large amount of the variability in the catches of bycatch is accounted for by the random effect i.e. the correlation between nets within a shot is very high. The fixed effects show a significantly lower mean bycatch rate in the Tom's Fisheye BRD nets compared to the Square Mesh Panel BRD nets ($p<0.0001$). Applying the exponential transformation to the model coefficients allows us to estimate the difference in bycatch for the two net types. The transformed model coefficients indicate a reduction of approximately 43.73% in bycatch weights in the Tom's Fisheye BRD nets (95% Confidence Interval: 41.68 to 45.70%) compared to the Square Mesh Panel BRD nets. The catch rates in the different main quad gear positions are compared against the Port Inside and some significant differences were detected. The highest catch rates of bycatch were in the Port Inside and least in the Starboard Inside.

3.3.2 Commercial prawn catch

The model for the commercial prawn data was fitted using the glmer function in R (lme4 package) and was of the form:

glmer(Prawns~offset(Duration) + Net + Position+ (1|Shot), family=Gamma(link=log))

A summary of the model output is:

Random effects:

	Formula: ~1 | Shot	
	(Intercept)	Residual
StdDev:	0.3177	0.1661

	Value	Std.Error	t-value	p-value
(Intercept)	-2.133e+00	1.010e-01	-21.134	<2e-16
NetTomFE	-9.161e-05	1.400e-02	-0.007	0.995
PositionPO	-1.100e-02	1.987e-02	-0.554	0.580
PositionSI	8.838e-03	1.973e-02	0.448	0.654
PositionSO	8.789e-03	1.959e-02	0.449	0.654

Again, a lot of the variability in commercial prawn catches is described by shot to shot variability. There is no evidence of a significant difference in commercial prawn catch between the different net positions. There is also no evidence of a significant difference between the mean catch rate of commercial prawns caught in the Tom's Fisheye BRD nets compared to the Square Mesh Panel BRD nets. The model indicates a reduction in commercial prawn catch of 0.01% using the Tom's Fisheye BRD nets (Confidence Interval: -2.72 to 2.77%). This 95% confidence interval fairly evenly spreads 0 so we are fairly certain that the difference in prawn catch between the two net types is minimal.

4 Conclusion and recommendations

There is sufficient data to clearly show that there is significantly less bycatch caught in the nets with all of the trialled BRDs; the Single Kon's Covered Fisheye, FishEX70 and Tom's Fisheye BRDs installed compared to the nets with the standard Square Mesh Panel BRD installed. In terms of bycatch reduction, the FishEX70 BRD and Tom's Fisheye BRD were noticeably better than the Single Kon's Covered Fisheye BRD, achieving a mean reduction in bycatch of 41% and 44% compared to the 23% of the Single Kon's Covered Fisheye BRD.

There was no significant difference in mean commercial prawn catches between the nets fitted with either of the three trialled BRDs compared to nets with the standard Square Mesh Panel BRD. The confidence intervals around the estimates are very wide so it was not possible to state that there was no difference with any statistical confidence.

To improve the estimates of the difference between prawn catches more trials would need to be conducted. Undertaking shots of more comparable duration during the May-June 2018 trial would have ensured a more balanced sample and help in improving the estimates by reducing some of the variability in the data.

Finally, given the gear failure resulting in the loss of all data on the Port Side of one vessel part-way through the trial, we would recommend in the future always ensuring there is one test BRD net and one control BRD net on each side of the vessel. This is more of a 'risk-management' strategy to maximise balance in the dataset in the event of malfunction.

5 Appendix 1

Table 11 Data collected on board the Ocean Producer trialling the Single Kon's Covered Fisheye (S-KCF) BRD against the standard Square Mesh Panel (SMP) BRD

						Starboard Outside			Starboard Inside			Port Inside			Port Outside		
Shot	Date	Shot Start Time	Shot Finish Time	Start Latitude	Start Longitude	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)
1	25-May	23:25	01:50	16 26 18	138 20 30	SMP	264.02	2.98	SMP	293.64	3.36	S-KCF	214.41	2.59	S-KCF	213.97	3.03
2	26-May	02:25	05:00	16 22 87	138 11 26	SMP	439.43	2.57	SMP	439.34	2.66	S-KCF	329.11	2.89	S-KCF	339.37	2.63
3	26-May	22:30	00:20	15 42 51	137 09 46	SMP	199	3	SMP	208.43	3.57	S-KCF	168.24	3.76	S-KCF	162.95	4.05
4	27-May	18:00	20:00	15 38 03	137 08 89	SMP	114.95	2.05	SMP	134.26	2.74	S-KCF	99.78	2.22	S-KCF	94.77	2.23
5	27-May	20:20	22:44	15 40 83	137 09 42	SMP	97.17	4.83	SMP	102.19	4.81	S-KCF	86.81	5.19	S-KCF	82.28	4.72
6	27-May	23:05	02:05	15 41 18	137 09 24	SMP	144.66	7.34	SMP	159.09	7.91	S-KCF	129.84	7.16	S-KCF	130.2	6.8
7	28-May	18:15	20:25	15 26 69	136 53 35	SMP	126.88	10.12	SMP	141.66	10.34	S-KCF	98.22	13.78	S-KCF	127.93	14.07
8	28-May	21:00	22:45	15 26 42	136 51 72	SMP	103.37	23.63	SMP	104.9	27.1	S-KCF	92.89	29.11	S-KCF	92.9	24.1
9	28-May	23:10	01:45	15 26 65	136 52 63	SMP	81.25	25.75	SMP	101.75	25.25	S-KCF	81.7	25.3	S-KCF	111.6	25.4
10	30-May	18:30	20:50	12 08 96	136 43 13	SMP	197.98	9.02	S-KCF	151.01	10.99	S-KCF	151.6	10.4	SMP	166.33	10.67
11	30-May	21:15	00:15	12 08 78	136 44 23	SMP	290.71	19.29	S-KCF	219.58	17.42	S-KCF	195.12	16.88	SMP	262.62	19.38
12	31-May	00:50	04:00	12 08 90	136 44 44	SMP	203.64	13.36	S-KCF	177.36	14.64	S-KCF	172.59	14.41	SMP	229.3	12.7
13	31-May	04:25	06:00	12 08 89	136 44 01	SMP	90.09	6.91	S-KCF	97.97	7.03	S-KCF	102.5	6.5	SMP	100.61	8.39
14	31-May	18:00	21:40	12 09 16	136 42 64	SMP	249.29	17.71	S-KCF	182.6	19.4	S-KCF	199.25	17.75	SMP	259.62	17.38
15	31-May	22:05	01:40	12 08 64	136 44 79	SMP	230.04	16.96	S-KCF	193.96	18.04	S-KCF	192.53	24.47	SMP	250.19	21.81
16	1-Jun	04:10	06:00	12 08 87	136 42 37	SMP	249.94	17.06	S-KCF	159.13	12.87	S-KCF	185.58	21.42	SMP	245.7	16.3
17	1-Jun	18:20	21:55	11 30 04	136 21 63	SMP	302.87	29.13	S-KCF	286.16	25.84	S-KCF	259.32	27.68	SMP	344.82	27.18
18	2-Jun	02:10	05:20	11 38 93	135 51 27	SMP	486.58	0.42	S-KCF	451.66	0.34	S-KCF	341.09	0.91	SMP	521.85	0.15
19	2-Jun	19:45	23:35	11 50 41	134 48 54	S-KCF	257	-	S-KCF	292	-	SMP	462	-	SMP	452	-
20	3-Jun	18:10	21:00	11 47 92	134 42 91	S-KCF	44.4	7.6	S-KCF	98.29	18.71	SMP	143.54	23.46	SMP	142.42	24.58

21	3-Jun	21:30	01:00	11 47 30	134 42 65	S-KCF	92.58	14.42	S-KCF	59.98	12.02	SMP	173.38	23.62	SMP	162.05	24.95
22	4-Jun	01:15	04:30	11 46 72	134 42 29	S-KCF	159.49	42.51	S-KCF	134.49	42.51	SMP	148.28	73.72	SMP	133.28	73.72
23	4-Jun	17:30	21:10	11 45 65	134 40 91	S-KCF	129.53	7.47	S-KCF	144.74	7.26	SMP	184	8	SMP	180.37	6.63
24	4-Jun	21:30	00:50	11 47 30	134 43 31	S-KCF	96.15	25.85	S-KCF	99.05	27.95	SMP	123.85	18.15	SMP	150.55	21.45
25	5-Jun	01:15	04:50	11 47 47	134 43 48	S-KCF	79.65	7.35	S-KCF	145.29	16.71	SMP	163.44	18.56	SMP	160.06	16.94
26	6-Jun	04:10	06:30	11 01 93	132 21 02	S-KCF	116.15	5.85	S-KCF	127.08	4.92	SMP	166.92	5.08	SMP	161.47	5.53
27	6-Jun	19:45	22:55	10 59 84	132 19 74	S-KCF	155.85	21.15	S-KCF	144.39	22.61	SMP	181.1	25.9	SMP	200.02	21.98
28	6-Jun	23:15	02:30	10 58 33	132 21 69	S-KCF	92.81	14.19	S-KCF	121.62	10.38	SMP	138.48	8.52	SMP	133.65	8.35
29	7-Jun	02:50	07:00	10 59 86	132 19 38	S-KCF	155.11	6.89	S-KCF	166.6	5.4	SMP	205.34	6.66	SMP	192.03	4.97

Table 12 Data collected on Newfish II whilst trialling the FishEX70 BRD (FX70) against the standard Square Mesh Panel (SMP) BRD. The cells highlighted in yellow indicated that the net was TED'd and those in red indicate records where the net was not fishing correctly.

						Starboard Outside			Starboard Inside			Port Inside			Port Outside		
Shot	Date	Shot Start Time	Shot Finish Time	Start Latitude	Start Longitude	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)
1	26-May	19:45	23:25	16 57 04	140 24 81	FX70	50	0.95	FX70	211	1.84	SMP	185	6.65	SMP	290	7.34
2	26-May	23:45	03:40	16 52 23	140 26 45	FX70	224	16.04	FX70	218	6.62	SMP	585	20.22	SMP	635	4.94
3	27-May	04:10	07:20	16 53 72	140 28 67	FX70	106	13.74	FX70	187	2.7	SMP	151	9.4	SMP	239	11.4
4	27-May	20:15	23:30	16 42 88	139 53 92	FX70	260	20	FX70	558	22.1	SMP	868	21.79	SMP	909	18.6
5	28-May	00:05	04:35	16 45 72	139 57 31	FX70	174	10.83	FX70	125	16.25	SMP	494	6.53	SMP	394	6.11
6	28-May	18:55	22:55	15 56 95	139 47 05	FX70	230	9.5	FX70	33	5.34	SMP	64	0.5	SMP	441	8.6
7	28-May	23:35	03:40	15 59 58	139 39 13	FX70	243	6.51	FX70	205	5.1	SMP	305	4.71	SMP	452	7.9
8	29-May	03:55	07:45	16 03 26	139 27 30	FX70	83	3.99	FX70	121	3.81	SMP	160	4.86	SMP	165	5.29
9	29-May	18:15	21:50	16 20 92	138 59 67	SMP	501	18.69	FX70	299	25.65	FX70	337	13.3	SMP	487	18.29
10	29-May	22:05	02:20	16 20 99	138 59 51	SMP	370	35.2	FX70	230	35.27	FX70	321	28.66	SMP	486	33.67
11	30-May	03:55	07:35	16 21 79	138 52 81	SMP	399	16.03	FX70	289	18.14	FX70	254	16.02	SMP	457	17.87
12	30-May	18:30	22:40	16 19 86	139 00 71	SMP	353	16.89	FX70	182	12.54	FX70	290	9.55	SMP	74	1.26
13	30-May	22:50	02:50	16 19 54	138 54 48	SMP	669	35.08	FX70	323	27.08	FX70	161	8.94	SMP	601	48.54
14	31-May	03:15	07:45	16 20 12	138 49 62	SMP	483	17.07	FX70	277	23.23	FX70	269	20.77	SMP	446	23.5
15	31-May	18:35	20:20	16 23 99	138 57 34	SMP	135	10.11	FX70	125	9.54	FX70	98	12	SMP	147	10.74
16	31-May	20:35	23:05	16 23 69	138 50 64	SMP	282	17.49	FX70	198	16.71	FX70	196	14.03	SMP	322	17.76
17	31-May	23:15	03:25	16 21 94	138 51 07	SMP	364	27.94	FX70	296	28.75	FX70	77	4.22	SMP	423	27.31
18	1-Jun	03:50	06:50	16 19 81	138 50 94	SMP	782	17.67	FX70	366	13.59	FX70	197	2.55	SMP	569	15.83
19	1-Jun	18:30	19:50	16 19 78	138 45 16	SMP	597	2.8	SMP	445	5.09	FX70	261	8.84	FX70	244	5.67
20	1-Jun	20:10	21:45	16 21 10	138 49 42	SMP	391	8.91	SMP	370	9.79	FX70	98	3.32	FX70	115	4.93
21	1-Jun	22:45	00:45	16 20 66	138 47 65	SMP	377	18.27	SMP	493	21.74	FX70	201	8.56	FX70	166	19.01
22	2-Jun	01:10	05:35	16 21 16	138 49 35	SMP	764	36	SMP	788	31.58	FX70	181	7.01	FX70	147	7.76
23	2-Jun	18:40	22:00	16 15 50	138 59 99	SMP	389	11.14	SMP	411	9.24	FX70	217	3.39	FX70	113	2.09
24	2-Jun	22:20	00:10	16 15 42	138 59 61	SMP	133	7	SMP	109	3.99	FX70	94	5.61	FX70	93	2.41
25	3-Jun	01:05	04:00	16 19 46	138 51 96	SMP	282	18.02	SMP	260	20.1	FX70	153	17.36	FX70	68	6.85
26	3-Jun	19:05	22:15	16 20 57	138 53 18	SMP	213	32.1	SMP	222	33.42	FX70	138	31.63	FX70	122	23.08

27	3-Jun	22:30	02:10	16 19 78	138 52 26	SMP	193	26.86	SMP	205	25.11	FX70	90	19.67	FX70	74	10.54
28	4-Jun	02:30	07:25	16 19 76	138 53 27	SMP	306	19.02	SMP	446	19.25	FX70	165	10.42	FX70	135	4.91
29	4-Jun	22:20	01:50	16 24 72	138 46 21	FX70	178	16.46	SMP	305	24.48	SMP	300	19.9	FX70	192	17.71
30	5-Jun	02:05	05:30	16 25 64	138 58 00	FX70	132	9.62	SMP	289	6.42	SMP	161	18.68	FX70	438	2.06
31	5-Jun	05:50	08:10	16 24 21	138 45 97	FX70	145	4.5	SMP	466	4.4	SMP	59	0.65	FX70	377	3.3
32	5-Jun	18:35	21:30	16 18 53	138 57 13	FX70	114	26.03	SMP	209	20.71	SMP	155	24.64	FX70	131	13.53
33	5-Jun	21:30	00:55	16 22 44	138 48 21	FX70	147	22.62	SMP	234	20.88	SMP	247	22.79	FX70	94	5.7
34	6-Jun	01:05	04:15	16 21 36	138 57 39	FX70	114	15.95	SMP	125	14.51	SMP	158	21.46	FX70	76	8.81
35	6-Jun	04:30	06:30	16 23 64	138 46 27	FX70	77	8.01	SMP	183	7.47	SMP	141	3.9	FX70	95	5.07
36	6-Jun	18:50	22:05	16 48 49	140 16 64	FX70	156	18.92	SMP	176	14.37	SMP	162	22.51	FX70	136	9.34
37	6-Jun	22:45	01:45	16 57 27	140 19 94	SMP	197	28.11	FX70	85	5.2	SMP	152	17.63	FX70	87	3.06
38	7-Jun	02:00	05:05	16 47 64	140 18 91	SMP	178	12.4	FX70	152	18.28	SMP	127	13.05	FX70	155	14.68

Table 13 Data collected on Eylandt Pearl whilst trialling the Tom's Fisheye BRD (TomFE) against the standard Square Mesh Panel (SMP) BRD. The cells highlighted in yellow indicated that the net was TED'd and those in red indicate shots where prawn weights from each bag were unable to be separated and therefore the total prawn weight divided equally between the four codends.

						Starboard Outside			Starboard Inside			Port Inside			Port Outside		
Shot	Date	Shot Start Time	Shot Finish Time	Start Latitude	Start Longitude	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)	BRD	Bycatch (kg)	Prawn Catch (kg)
1	27-Oct	18:30	22:00	13 16 72	136 49 64	SMP	254.51	3.44	TomFE	159.52	4.48	SMP	306.56	5.49	TomFE	147.5	3.5
2	27-Oct	22:15	02:00	13 21 57	136 47 21	SMP	282.27	9.91	TomFE	148.02	9.98	SMP	294.09	9.73	TomFE	150.51	9.49
3	28-Oct	02:15	06:00	13 18 50	136 45 82	SMP	169.77	14.57	TomFE	112.61	13.39	SMP	173.43	15.23	TomFE	109.7	18.3
4	29-Oct	18:15	20:30	12 41 00	141 21 86	SMP	396.59	23.41	TomFE	163.69	21.31	SMP	415.86	29.14	TomFE	279.52	20.48
5	29-Oct	20:45	23:45	12 41 09	141 20 20	SMP	156.39	39.61	TomFE	102.68	40.32	SMP	233.39	42.61	TomFE	89.47	35.53
6	30-Oct	00:05	03:15	12 43 82	141 28 25	SMP	356.21	42.79	TomFE	191.64	38.36	SMP	404.42	54.58	TomFE	233.72	43.88
7	30-Oct	03:30	06:45	12 46 40	141 30 14	SMP	950.93	34.07	TomFE	462.14	37.86	SMP	1223.7	46.3	TomFE	598.06	39.94
8	30-Oct	18:15	20:00	12 48 30	141 30 27	SMP	346.91	28.09	TomFE	217.55	27.45	SMP	322.71	27.29	TomFE	86.77	23.23
9	30-Oct	20:15	23:15	12 45 99	141 30 01	SMP	80.49	45.51	TomFE	46.47	49.53	SMP	86.19	44.81	TomFE	49.14	46.86
10	30-Oct	23:30	02:45	12 45 76	141 29 96	SMP	136.27	57.75	TomFE	78.1	62.9	SMP	173.74	51.26	TomFE	87.97	50.03
11	31-Oct	03:00	06:00	12 49 14	141 30 35	SMP	179.59	42.41	TomFE	115.54	50.46	SMP	196.46	37.54	TomFE	124.18	42.82
12	31-Oct	06:15	08:00	12 46 47	141 30 05	SMP	848.75	11.25	TomFE	290.75	11.25	SMP	627.75	11.25	TomFE	286.75	11.25
13	31-Oct	18:00	20:00	12 49 41	141 30 15	SMP	299.19	11.81	TomFE	204.64	14.36	SMP	291.93	14.07	TomFE	163.6	12.4
14	31-Oct	20:15	23:15	12 48 60	141 30 09	SMP	119.44	42.56	TomFE	91.99	42.01	SMP	160.32	44.68	TomFE	63.46	42.54
15	31-Oct	23:30	02:45	12 47 56	141 30 01	SMP	94.66	54.34	TomFE	57.69	57.69	SMP	160.29	54.71	TomFE	48.83	48.83
16	1-Nov	03:00	06:00	12 49 02	141 30 10	SMP	205.51	33.49	TomFE	144.95	36.05	SMP	267.95	41.05	TomFE	143.81	36.19
17	1-Nov	18:00	20:00	12 47 16	141 30 09	TomFE	167.6	16.4	SMP	357.6	17.4	TomFE	221.6	13.4	SMP	417.6	12.4
18	1-Nov	20:15	23:15	12 46 18	141 30 01	TomFE	50.49	45.51	SMP	85.23	43.77	TomFE	53.5	42.5	SMP	71.48	44.52
19	1-Nov	23:30	02:45	12 49 03	141 30 02	TomFE	48.91	46.09	SMP	85.43	32.57	TomFE	34.71	25.29	SMP	93.23	34.77
20	2-Nov	03:00	06:00	12 48 64	141 30 19	TomFE	74.82	35.18	SMP	117.94	34.06	TomFE	77.86	33.14	SMP	130.68	35.32
21	2-Nov	18:00	20:00	12 44 45	141 30 16	TomFE	143.12	9.88	SMP	277.29	11.71	TomFE	196.35	8.65	SMP	274.31	7.69
22	2-Nov	20:15	23:30	12 41 39	141 30 15	TomFE	86.02	23.98	SMP	115.7	20.3	TomFE	76.56	20.44	SMP	146.7	26.3
23	2-Nov	23:45	03:15	12 43 40	141 30 13	TomFE	58.85	27.15	SMP	99.08	24.92	TomFE	66.32	24.68	SMP	93.47	26.53
24	3-Nov	03:30	07:00	12 42 66	141 30 13	TomFE	227.62	25.38	SMP	346.64	25.38	TomFE	234.62	25.38	SMP	313.62	25.38
25	3-Nov	19:15	22:00	12 48 19	141 23 14	TomFE	227.08	21.92	SMP	307.32	20.68	TomFE	190.94	21.06	SMP	318.35	22.65
26	3-Nov	22:15	01:15	12 45 44	141 24 38	TomFE	235.5	39.5	SMP	355.5	39.5	TomFE	182.5	39.5	SMP	382.5	39.5

27	4-Nov	01:30	04:30	12 47 40	141 23 47	TomFE	92.09	32.91	SMP	178.44	31.56	TomFE	112.59	31.41	SMP	198.29	25.71
28	4-Nov	04:45	07:15	12 44 87	141 24 62	TomFE	238.92	6.08	SMP	363.92	6.08	TomFE	183.92	6.08	SMP	371.92	6.08
29	4-Nov	18:00	20:30	12 47 07	141 24 24	TomFE	225.13	9.87	SMP	296.23	12.77	TomFE	157.33	8.67	SMP	343.84	8.16
30	4-Nov	20:45	00:05	12 46 01	141 24 55	TomFE	103.42	27.58	SMP	193.05	29.95	TomFE	110.18	25.82	SMP	186.4	23.6
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33	5-Nov	18:00	20:20	13 00 13	141 18 68	SMP	543.13	15.87	TomFE	307.13	15.87	SMP	719.13	15.87	TomFE	315.13	15.87
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35	6-Nov	00:05	03:15	12 56 08	141 20 89	SMP	453.81	20.19	TomFE	229.39	19.61	SMP	480.5	19.5	TomFE	250.11	19.89
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37	6-Nov	18:30	21:00	12 54 54	141 23 68	SMP	269.96	10.04	TomFE	168.31	9.69	SMP	313.23	9.77	TomFE	171.48	10.52
38	6-Nov	21:15	00:30	12 49 70	141 19 85	SMP	199.2	20.8	TomFE	118.96	18.04	SMP	184.74	15.26	TomFE	73.45	16.55
39	7-Nov	00:45	04:15	12 51 28	141 19 85	SMP	197.57	22.43	TomFE	103.68	24.32	SMP	187.94	19.06	TomFE	112.79	25.21
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44	8-Nov	04:30	07:15	12 47 07	141 20 30	SMP	285.32	7.68	TomFE	159.47	9.53	SMP	462.86	12.14	TomFE	310.54	11.46
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46	8-Nov	21:00	00:30	12 45 57	141 21 10	SMP	129.79	32.21	TomFE	66.02	29.98	SMP	115.09	32.91	TomFE	67.6	29.4
47	9-Nov	00:45	04:15	12 44 57	141 21 21	SMP	121.18	18.82	TomFE	63.53	18.47	SMP	118.94	19.06	TomFE	73.33	19.67
48	9-Nov	04:30	07:30	12 45 70	141 21 09	SMP	292.99	8.01	TomFE	150.57	8.43	SMP	268.08	7.92	TomFE	170.1	7.9
49	9-Nov	18:00	20:45	12 40 36	141 22 62	TomFE	161.13	12.87	SMP	226.41	13.59	TomFE	87.83	14.17	SMP	257.85	11.15
50	9-Nov	21:00	00:30	12 42 77	141 21 89	TomFE	101.62	14.38	SMP	182.63	12.37	TomFE	102.81	16.19	SMP	201.03	15.97
51	10-Nov	00:45	04:15	12 41 82	141 22 75	TomFE	198.8	13.2	SMP	296.84	13.16	TomFE	208.11	11.89	SMP	162.61	3.39
52	10-Nov	04:30	06:00	12 40 61	141 24 76	TomFE	261.25	18.75	SMP	481.25	18.75	TomFE	260.25	18.75	SMP	551.25	18.75
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54	10-Nov	18:00	20:00	12 40 21	141 26 62	TomFE	208.34	16.66	SMP	315.85	17.15	TomFE	225.72	16.28	SMP	334.26	15.74
55	10-Nov	20:15	23:45	12 41 13	141 26 70	TomFE	61.78	50.22	SMP	117.08	48.92	TomFE	62.93	49.07	SMP	113.69	53.31
56	11-Nov	00:30	03:45	12 41 08	141 26 70	TomFE	41.12	36.88	SMP	66.97	35.03	TomFE	48.05	32.95	SMP	70.21	34.79
57	11-Nov	04:00	07:00	12 40 73	141 26 71	TomFE	158.95	27.05	SMP	204.24	23.76	TomFE	106.46	23.54	SMP	183.25	23.75
58	11-Nov	18:00	20:15	12 39 09	141 26 20	TomFE	92.14	22.86	SMP	207.42	23.58	TomFE	131.09	22.91	SMP	210.31	21.69
59	11-Nov	20:30	00:15	12 39 66	141 26 89	TomFE	40.58	45.29	SMP	62.87	48.13	TomFE	39.71	40.42	SMP	85.44	41.56

60	12-Nov	00:30	04:30	12 40 30	141 26 88	TomFE	32.95	33.05	SMP	58.57	29.43	TomFE	38.14	30.86	SMP	69.43	32.57
61	12-Nov	04:45	07:50	12 39 14	141 20 89	TomFE	123.35	20.65	SMP	133.03	14.97	TomFE	89.91	16.09	SMP	190.45	20.55
62	12-Nov	18:00	20:30	12 38 48	141 26 97	TomFE	77.39	12.61	SMP	198.61	13.39	TomFE	87.29	14.71	SMP	196.38	14.62
63	12-Nov	20:45	23:30	12 38 96	141 26 96	TomFE	267.07	14.93	SMP	465.07	14.93	TomFE	233.07	14.93	SMP	435.07	14.93
64	12-Nov	23:45	02:45	12 41 56	141 30 13	TomFE	144.31	19.69	SMP	224.48	19.52	TomFE	150.09	20.91	SMP	226.1	20.9

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TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MANAGEMENT **Stock assessment update**	Agenda Item No. 4.3

RECOMMENDATIONS

4.3.1 That the Management Advisory Committee **NOTE:**

a) a stock assessment for tiger prawns in the Torres Strait was completed in 2019 and is available at **attachment B**.

b) that the 2019 stock assessment has shown that tiger prawn stocks in the Torres Strait are in a healthy state with high CPUE and biomass levels ranging between 60-88% of virgin biomass.

BACKGROUND

The 2019 stock assessment of tiger prawns in the Torres Strait (**attachment A**) was completed in mid-2019. Results of the assessment considered by the HSWG at its meeting on 30 July 2019 and a concise summary was provided at TSPMAC 19 during the teleconference on 17 September 2019.

DISCUSSION

Overall the assessment has shown that tiger prawn stocks in the Torres Strait are in a healthy state with high CPUE and biomass levels ranging between 60-88% of virgin biomass. A presentation on the assessment results will be provided during the MAC meeting.

This was the first assessment update in more than five years and it is expected that the results will enable ABARES to update the status report for the Torres Strait prawn fishery tiger prawn stocks from 'uncertain' to 'Not overfished and Not subject overfishing'.

The MAC is asked to consider the assessment and provide comments, noting that implications for revised harvest strategy triggers and setting future TAEs will be covered under subsequent agenda items.

Updated Tiger Prawn Stock Assessment for the Torres Strait Prawn Fishery

A Final Report to AFMA for the TSPMAC and TSSAC

Project: 180802

May 2019

Clive Turnbull

Fisheries Consultant

Executive Summary

1. The twenty-one past and present owners of the 30 vessels that have done the majority of the fishing in the TSPF since the 2004 tiger prawn stock assessment were surveyed to collect information on any changes to the vessel and fishing configuration that could have impacted on fishing power. The new data was merged with the data collected on TSPF vessels for the 2004 assessment and used to estimate the trend in fishing power for the years 1980-2018. The new fishing power model was based on the 2004 model but included the additional factors; headline length, vessel size (hull units) and whether or not the vessel was licensed to fish in the Northern Prawn Fishery. These factors were all significant and helped improve the fit of the fishing power model.

2. The updated fishing power analysis resulted in a trend similar to that of the 2004 assessment for the years 1980-2001. The 4% decrease in fishing power suggested by David Die to allow for the 10% reduction in headline length during 2002-03 compares well with the fishing power estimated for those years. The trend in the fleet fishing power since 2004 was relatively flat and the fishing power of the current fleet is similar to that of the vessels fishing during 2000 & 2001.

3. There is only a small difference between the 2004 and 2019 assessments in the parameter estimates for the Beverton-Holt and Ricker Spawner Recruitment Curves. The largest change occurred in the Beverton-Holt curve which is now almost the same as the Ricker curve. This change could be a result of the additional data for high levels of spawners and recruitment that occurred post 2005.

4. The median MSY estimated using the Beverton-Holt Spawner-Recruitment curve decreased from 676 tonnes to 617 tonnes bringing it closer to the Ricker estimate which was 606 tonne for both assessments. The 2019 MSY 95% Confidence Intervals are closer to the median for both Spawner-Recruitment curves than the estimates from the 2004 assessment.

5. The estimates of Emsy for the 2004 assessment were calculated by dividing MSY by the standardised CPUE for 2003 (73.5 kg/d). Using recent CPUE to calculate Emsy as 2018 fishing days is problematic because it does not account for the higher CPUE resulting from the large stock size and the inverse relationship between CPUE and fishing effort. A sensitivity analysis suggests that a 5 year running average of the standardised tiger prawn CPUE may be the best option for smoothing over the annual variability in the Emsy estimates.

6. Post 2008 the annual tiger prawn harvest has been well below the estimates of MSY and the tiger prawn biomass, at 60-88% of Bvirgin, has been well above Bmsy. As a result the post 2008 annual CPUE has been approximately twice that of the years 1991-2003. There are no reasons for concern regarding the stock size and sustainability.

7. The harvest strategy triggers are reviewed and discussed in relation to the updated estimates of MSY, Emsy, Bmsy and the stock biomass. The 680 tonne tiger prawn catch trigger is appropriate but should be separated from the 4,000 day effort trigger as it is consecutive years of harvest levels above MSY that will impact the tiger prawn stock biomass. The purpose of the effort trigger needs to be discussed by the TSPMAC as the estimates of Emsy are highly variable and sensitive to the CPUE that is used to calculate Emsy. The effort trigger could be regarded as an Emey limit reference point as fishing effort above this level is more likely to just reduce the profitability of fishing than be a risk to the stock sustainability.

Introduction

This update of the Torres Strait Prawn Fishery (TSPF) tiger prawn stock assessment was requested by AFMA to determine the current status of the tiger prawn stock and whether the current harvest strategy trigger points are set at levels that should ensure a long term sustainable tiger prawn harvest. Lower tiger prawn catch rates combined with low fishing effort in 2016 and especially 2017 raised concern as to the status of the tiger prawn stock.

In addition, the 2015 tiger prawn catch was 553 tonnes, which is 82% of the Maximum Sustainable Yield (MSY) estimate from the 2004 assessment, while the fishing effort was just under 3,000 days. This raised concerns about the current Emsy cap. The stock assessment on which the current management arrangements and trigger points are based was conducted in 2004 (O'Neill and Turnbull, 2006) and hence an update to re-evaluate the status of this stock was considered timely.

Objectives / performance indicators

1. Update the fishing power for the Torres Strait tiger prawn fishery to account for changes that may have occurred in fishing power of the TSP fleet since the 2004 assessment.

2. Use the updated fishing power to standardise the nominal (unadjusted) monthly tiger prawn Catch Per Unit of Effort (CPUE) from logbook data for the years 1980-2018 to provide a more effective measure or index of tiger prawn abundance.

3. Use the Deriso-Schnute delay-difference model from the 2004 assessment to re-estimate MSY, Bmsy, Emsy and Bt:Bvirgin by fitting the model to the time-series of catch and standardised tiger prawn CPUE data from January 1980 to December 2018.

Outputs

A final report to AFMA for TSPMAC and TSSAC detailing the stock assessment model estimates of MSY, Bmsy, Emsy and the current biomass relative to the estimate of the virgin biomass (Bt:Bvirgin). Based on this information recommend levels of MSY and Emsy for use in the harvest strategy trigger points and the reasoning for the suggested levels.

Methods

The mythology used in this update of the TSPF tiger prawn stock assessment was based on those detailed in (O'Neill and Turnbull, 2006). The tiger prawn stock assessment was updated using the same Deriso-Schnute delay-difference model, coded in the statistical program "MATLAB" that was used for the 2004 assessment. Most of the data processing, fishing power analysis, standardisation of CPUE and the plotting of results were conducted in the statistical programming language "R".

The twenty-one past and present owners of the 30 vessels that have done the majority of the fishing in the TSPF since the 2004 tiger prawn stock assessment were surveyed to collect information on any changes to the vessel and fishing configuration that could have impacted on fishing power. The owners were initially contacted by email to; explain the purpose of the survey, list the information that was being sought and to arrange a suitable time to telephone or meet with them to work through the survey questions. Although a few of the owners were met in person in Cairns, most of the contact was via mobile telephone. The new data was merged with the data collected on TSPF vessels for the 2004 assessment.

The new fishing power model was based on the 2004 model but included the additional factors; headline length, vessel size (hull units) and whether or not the vessel was licensed to fish in the Northern Prawn Fishery. These factors were all significant and helped improve the fit of the fishing power model. The non-vessel factors in the model account for the effects of; year, month, area (north and south 10 degrees latitude, the East of Warrior closure and the Australian Territorial waters north of the fisheries Jurisdiction line), full v's part-night of fishing and lunar phase. The vessel / fishing gear factors that were used in the 2004 assessment and that were also included in this assessment were; engine horsepower, propeller nozzle, gps, computer mapping, BRD and/or TED, net type (double, triple, quad), otter boards (flat, bison, louvre/kilfoil).

The fishing power trend was used to standardise the nominal (unadjusted) monthly tiger prawn Catch Per Unit of Effort (CPUE) from logbook data for the years 1980-2018 resulting in a more effective measure or index of tiger prawn abundance. The standardised CPUE and monthly tiger prawn harvest (catch) were inputs to the same delay-difference model that was used for the 2004 assessment. The model parameters that were estimated were the tiger prawn catchability coefficient (the relationship between biomass and fishing mortality), annual recruitment for the years 1980-2018 and the two parameters for the function used to describe the monthly recruitment pattern. This was achieved by minimising the difference between the "predicted" CPUE generated by the model and the standardised "observed" CPUE from logbook data. The Beverton-Holt and Ricker Spawner-Recruitment equations were then fitted to the annual spawner and recruitment stock numbers generated by the tiger prawn model.

Finally the management reference points; Maximum Sustainable Yield (MSY), the tiger prawn Biomass needed for MSY (Bmsy), the current size of the tiger prawn stock in relation to the estimate of the virgin biomass (Bt:Bvirgin) and the fishing Effort in days that would result in a harvest of MSY (Emsy) were estimated using the same MATLAB code as that used for the 2004 assessment.

Results

Survey coverage

Figure 1 is a plot of the proportion of daily vessel fishing records that linked to the combined vessel/gear information obtained from the 2000-02 and 2019 surveys. The coverage was 80-100 percent of the fishing effort post 2003; the highest for the whole time-series.

The 2019 owner survey, a 2001 copy of the Queensland fishing vessel table and the current version of the Queensland fishing vessel table, which is available online, were used to source size data (Hull units, length, breadth and draft) for most vessels that have ever fished in the TSPF. There were only a few vessels that fished the early years for which information could not be obtained.

Note that prior to 1989 logbooks were only compulsory for NPF endorsed vessels therefore the logbook data accounts for only 12-67% of the total fishing effort during 1980-1988.

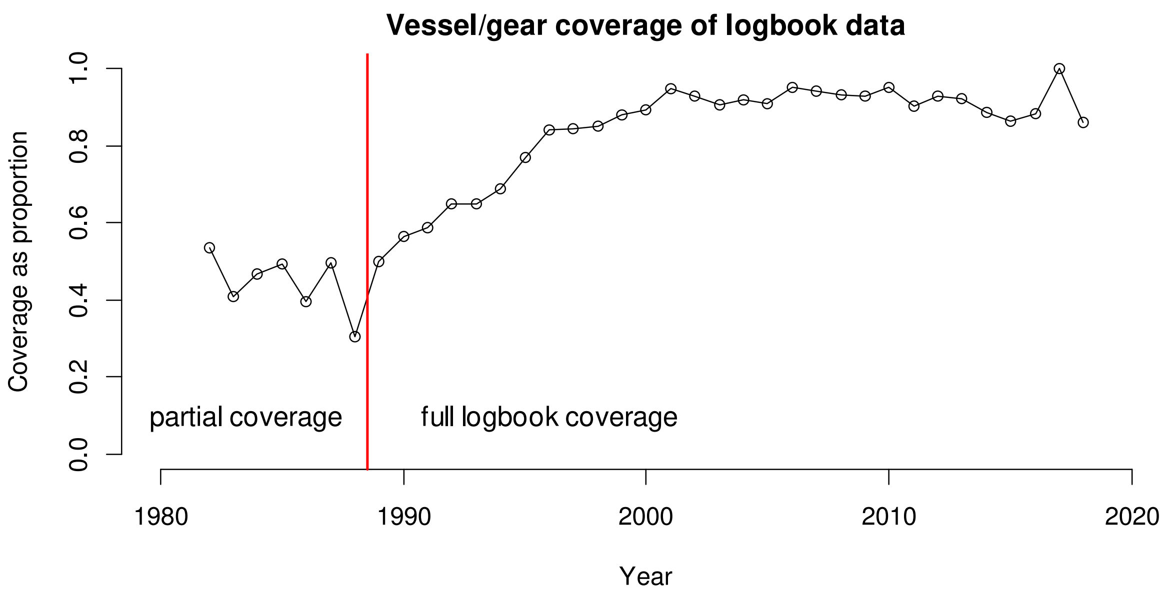

Figure 1 Vessel and fishing gear coverage of all logbook data as a proportion. Note that prior to 1989 logbooks were only compulsory for NPF endorsed vessels therefore the logbook data only accounts for 12-67% of the total fishing effort.

Fishing Power

The annual trend in fishing power from the 2019 analysis was very similar to that from the 2004 assessment for the years 1980-2001 (Figure 2). During 2002-03 there was a mandated 10% reduction in headline length that was implemented at the request of industry as a way to address sustainability. This was reversed at the end of 2003 by as it was a problem for both industry and enforcement when vessels were frequently moving between the Torres Strait and Queensland trawl fisheries and the benefits in terms of sustainability were marginal. Headline length was not a factor in the 2004 fishing power analysis because it was not significant. Most vessels in the initial gear survey had always used the maximum net size so there was insufficient information in the data to estimate the effect of headline length. Dr David Die in his review (Die 2003) suggested applying a 4% reduction in fishing power for 2002-03 to account for the 10% change in headline length.

Although the 10% reduction was reversed at the start of 2004 not all vessels immediately changed back to the larger net size. In addition, since the NPF restructure some vessels are using slightly smaller nets because they are restricted in the NPF on headline length and they use the same nets in both fisheries. This has allowed the fishing power model to now estimate the effect of headline length and the new fishing power trend closely matches the 4% reduction suggested by Dr Die.

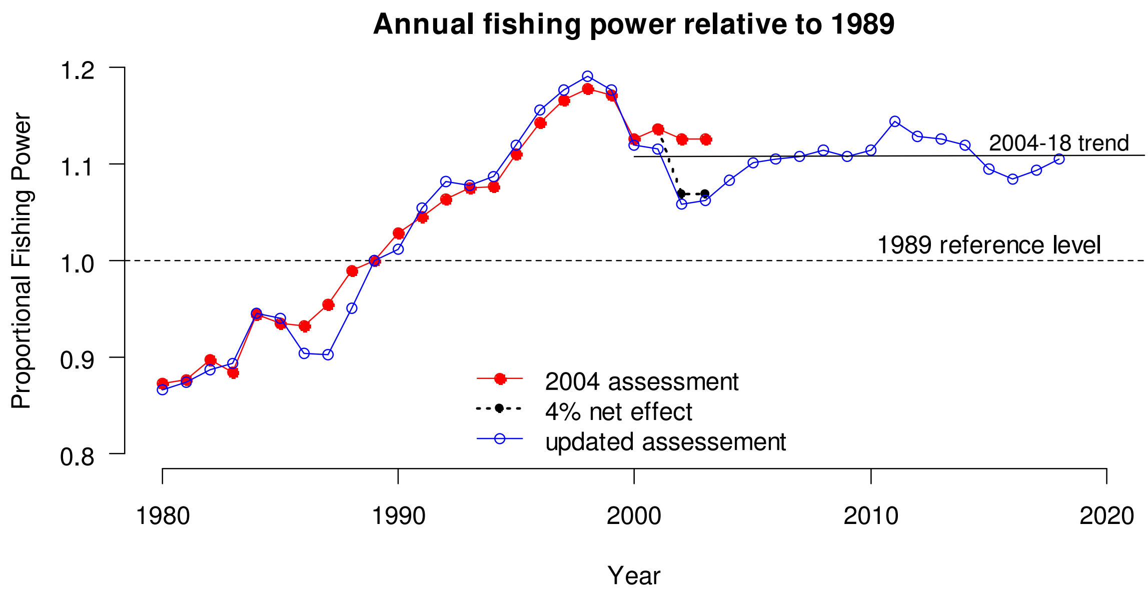

Figure 2 Annual fishing power estimates relative to 1989.

Although fishing power post 2003 has been variable due to which vessels and net configurations have done the majority of the fishing each year; the overall trend is horizontal (Figure 2). This indicates the average fleet fishing power has not increased therefore factors other than fishing power are responsible for the elevated tiger prawn CPUE post 2005.

Standardised CPUE

Figure 3 compares the nominal (unadjusted) tiger prawn CPUE obtained from the daily vessel logbook records with the standardised CPUE. The effect of fishing power can be seen as an elevation of the pre 1989 CPUEs and a down rating of the post 1989 CPUEs.

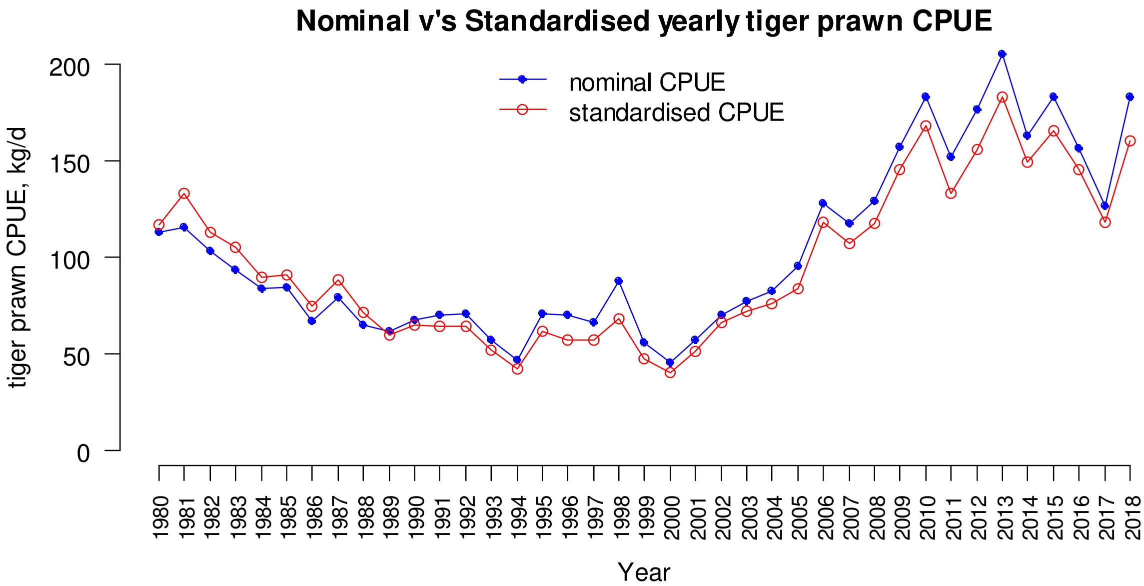

Figure 3 Comparison of annual nominal and standardised tiger prawn CPUE.

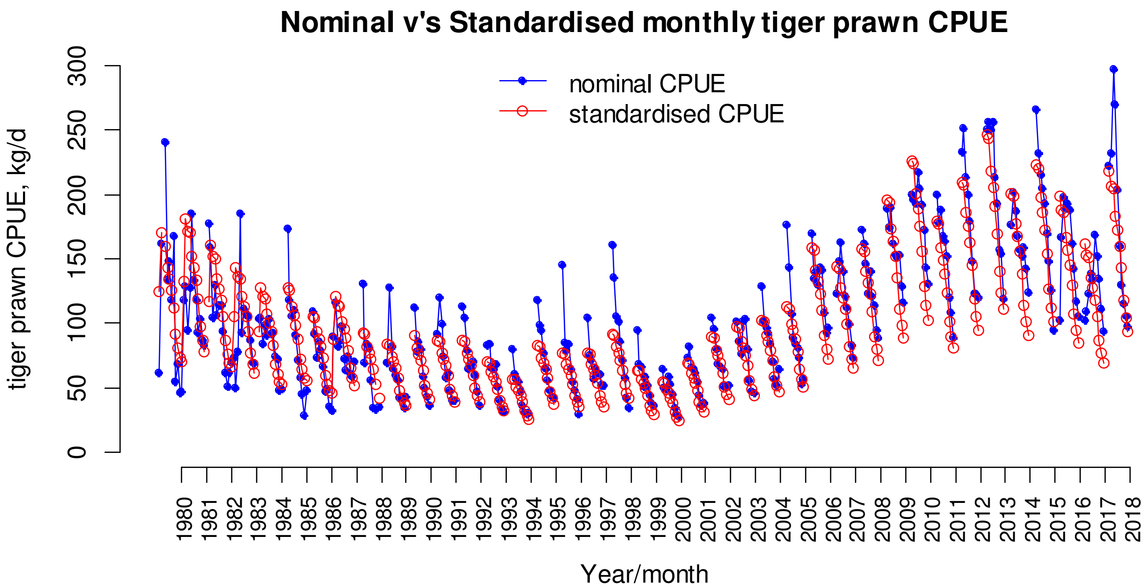

Figure 4 Comparison of the monthly nominal and standardised tiger prawn CPUE

In the monthly CPUE comparison (Figure 4) the drop in CPUE during the fishing season is clearly visible. This is a result of recruitment occurring in the early months of the season followed by a decrease in the tiger prawn biomass due to the combined effects of fishing and natural mortality. The annual CPUE trend in Figure 3 is also visible as the overall pattern of the monthly CPUE plotted in Figure 4.

Spawner-Recruitment Curves

There is only a small difference between the 2004 and 2019 assessments in the parameter estimates for the Beverton-Holt and Ricker Spawner Recruitment Curves (Table 1). The largest change occurred in the Beverton-Holt curve which is now almost the same as the Ricker curve within the range of the spawner index data (Figure 5). This change could be a result of the additional data for higher levels of spawners that occurred post 2005.

Table 1 Spawner-Recruitment relationship parameter estimates for the Beverton-Holt and Ricker curves.

Parameters	2004	2019	2004	2019
Spawner Recruit parameter	Beverton-Holt	Beverton-Holt	Ricker	Ricker
alpha	0.03296	0.0542	13.76	12.71
beta	1.32E-08	1.03E-08	7.89E-08	6.80E-08

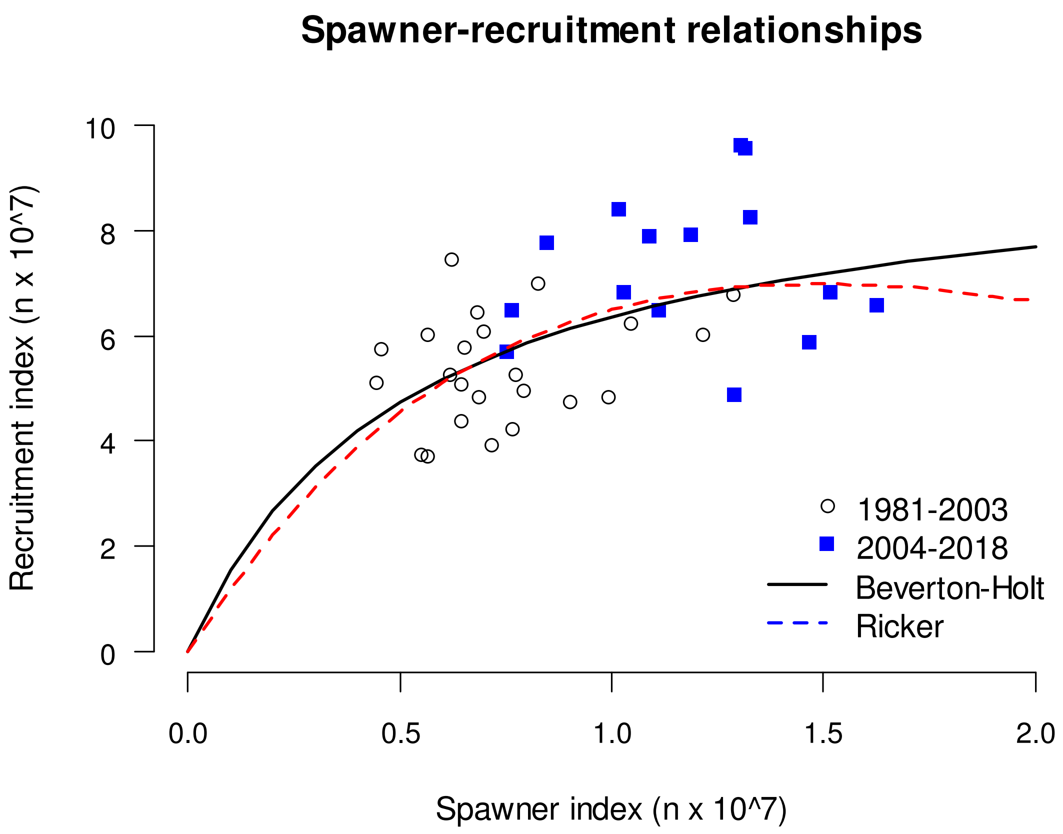

Figure 5 The Beverton-Holt and Ricker Spawner-Recruitment curves fitted to the annual spawner and recruitment stock numbers generated by the tiger prawn model for the years 1981-2003 (black open circles) and 2004-2018 (blue squares).

Biomass trajectory

The model estimates of the virgin biomass (Bvirgin), the Biomass at MSY (Bmsy) and Bmsy as a proportion of Bvirgin are listed in Table 2 for the Beverton-Holt and Ricker Spawner-Recruitment Curves (SRC). These were used to plots the biomass trajectories in Figure 6.

Table 2 The model estimates of B_{MSY}, B_0 in tonnes and B_{MSY} as proportion of B_0.

Spawner-Recruit Curve	Beverton-Holt	Ricker
B_0	1073	1044
B_{MSY}	346	415
B_{MSY} : B_0	0.323	0.397

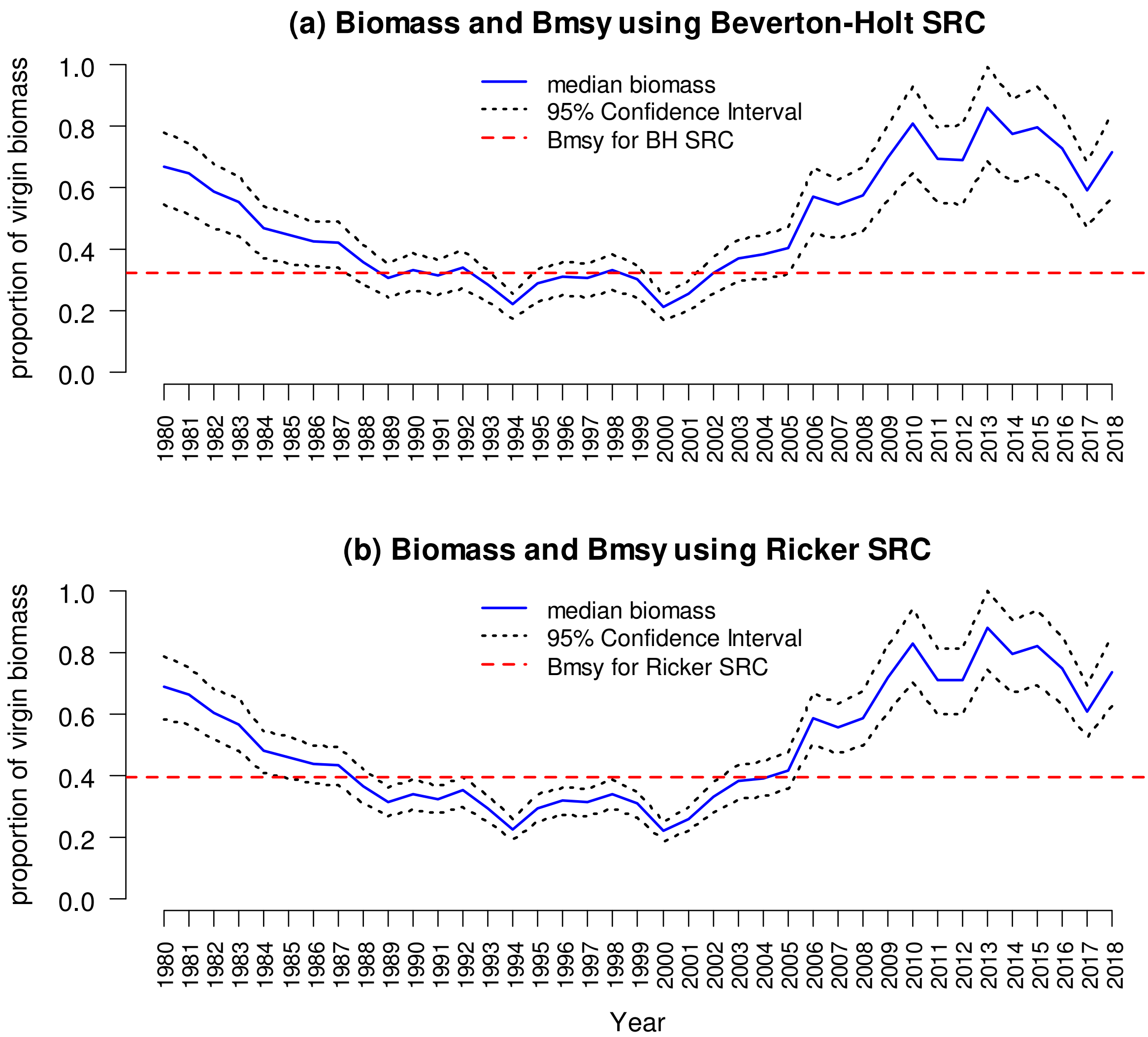

Figure 6 Yearly tiger prawn biomass and B_{MSY} as a proportion of the virgin biomass based on (a) the Beverton-Holt and (b) the Ricker spawner-recruitment curves.

The "Period of highest fishing effort", 1991-2003 (Turnbull and Cocking 2018) matches the years when the biomass was varying from slightly above to below the "red dashed" B_{MSY} reference lines in Figure 6. During the years 1991-2003 the mean annual tiger prawn catches were 668 (465:965) tonnes and three times the catch was above MSY (676 tonnes Beverten-Holt) for two consecutive years; 1991-2, 1997-98 and 2002-3.

Post 2005 the model estimates of annual tiger prawn biomass varied between 60-88% of the estimated virgin biomass and was well above the estimates of the Biomass required for Maximum Sustainable (Bmsy) using both the Beverton-Holt (Figure 6(a)) and Ricker (Figure 6(b) spawner-recruitment curves. Based on these results there are no reasons for concern with regard to the health of the tiger prawn stock in recent years.

Maximum Sustainable Yield

The median (middle value) of the estimates of Maximum Sustainable Yield (MSY) from the 2004 and 2019 assessments (Table 3 and Figure 7) ranged from 606 to 676 tonnes. The median MSY estimated using the Beverton-Holt Spawner-Recruitment has dropped from 676 tonnes to 617 tonnes bringing it closer to the Ricker estimate which was 606 tonne for both assessments. The 2019 MSY 95% Confidence Intervals are closer to the median for both Spawner-Recruitment curves than for the 2004 assessment. The catch trigger of 680 tonnes is within the 95% Confidence Intervals of all estimates.

Table 3 Maximum Sustainable Yield estimates from the 2004 and 2019 tiger prawn stock assessments.

Spawner-Recruit Curve	Assessment Year	MSY	lower 95% CI	upper 95% CI
Beverton-Holt	2004	676	523	899
Beverton-Holt	2019	617	507	763
Ricker	2004	606	436	722
Ricker	2019	606	483	697

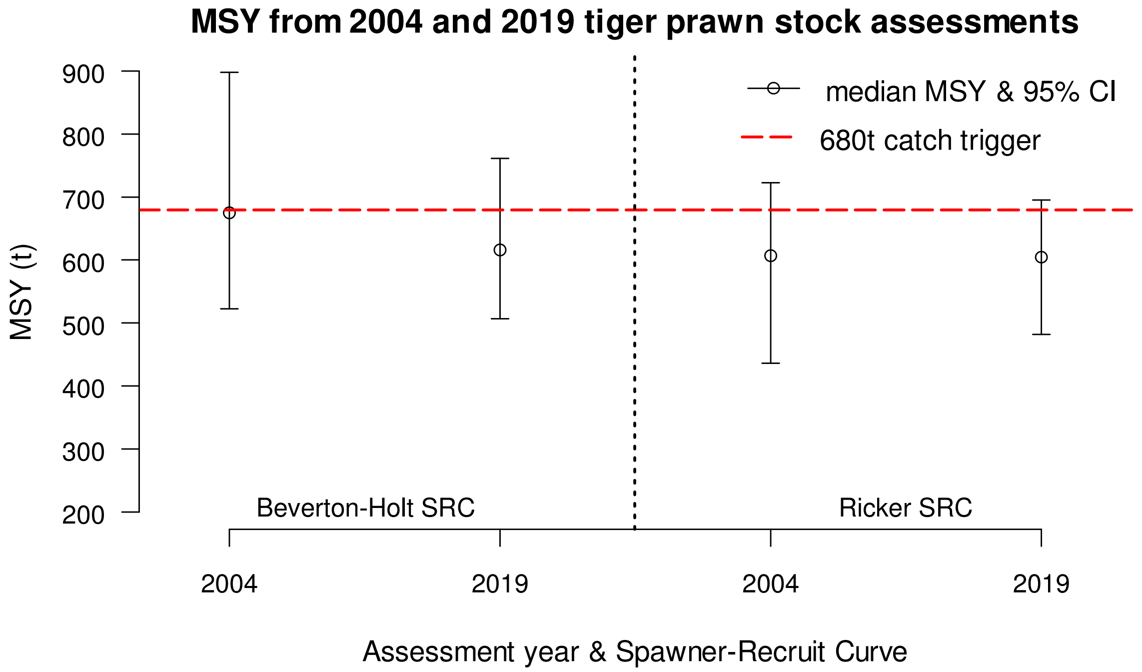

Figure 7 Maximum Sustainable Yield (MSY) estimates for the 2004 and 2019 tiger prawn stock assessments.

Effort at Maximum Sustainable Yield (E_{MSY})

The estimates of Emsy for the 2004 assessment were calculated by dividing MSY by the standardised CPUE for 2003 (73.5 kg/d). Using the same CPUE for the 2019 assessment results in similar, although slightly lower Emsy estimates (Table 4 and Figure 8(a)). In contrast, if the 2018 annual standardised CPUE of 160.3 kg/day is applied, Emsy changes to 3846 and 3778 days for the BH and Ricker SRCs respectively (Table 4 and Figure 8(b)).

Table 4 Fishing Effort for Maximum Sustainable Yield (E_{MSY}) calculated using the 2003 and 2018 annual standardised CPUE.

Spawner-Recruit Curve	Assessment Year	Emsy (2003 days)	lower 95% CI	upper 95% CI
Beverton-Holt	2004	9197	7116	12231
Beverton-Holt	2019	8389	6903	10374
Ricker	2004	8245	5932	9823
Ricker	2019	8240	6568	9480
		Emsy (2018 days)		
Beverton-Holt	2004	4217	3263	5608
Beverton-Holt	2019	3846	3165	4757
Ricker	2004	3780	2720	4504
Ricker	2019	3778	3011	4347

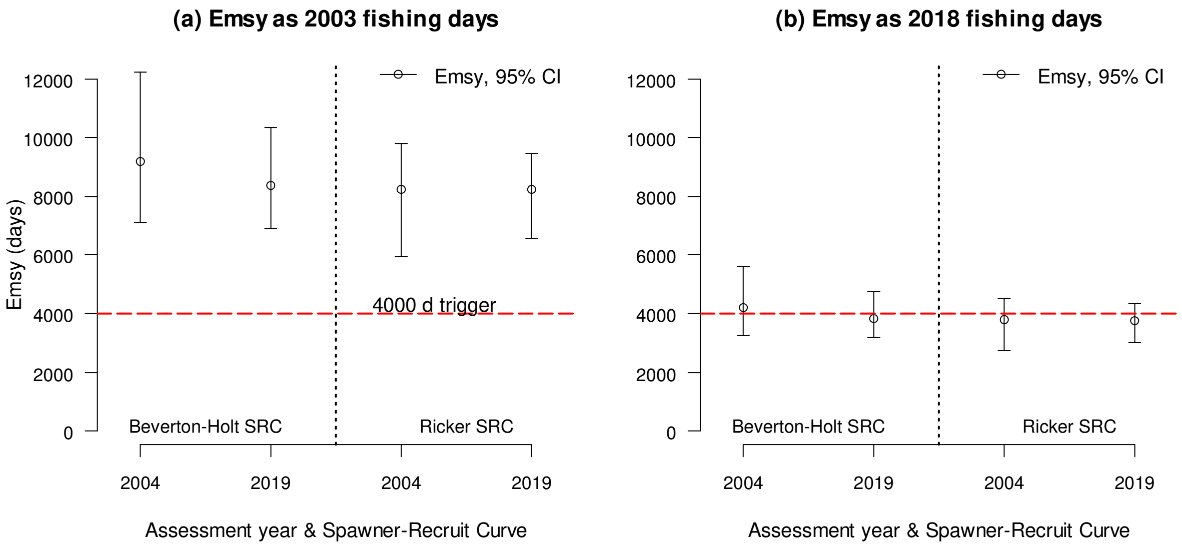

Figure 8 Emsy estimates as 2003 and 2018 fishing days.

Sensitivity Analysis of Emsy to Standardised tiger prawn CPUE

The above results demonstrate that by just using the most recent CPUE to update Emsy to “2018 days of fishing effort” may be inappropriate because this method does not account for all of the reasons behind the elevated CPUE post 2005. The fishing efficiency or fishing power has not significantly increased since 2003 therefore the increased CPUE is mainly a result of the higher tiger prawn biomass and the lower number of active vessels and annual fishing effort.

This raises the question “What CPUE should be used when updating the Emsy estimate? The following sensitivity analysis (Figure 9 and Table 5) based on the 2019 Beverton-Holt MSY estimate, compares Emsy estimated using the yearly standardised CPUE with a 3 year running average and a 5 year running average. The results show that Emsy in highly variable when using the yearly standardised CPUE for the years1985 to 2018. The 3 year running average of CPUE helps to stabilise the variation in Emsy between years and the 5 year running average of CPUE provides the most stable Emsy estimates. The plot also illustrates the inverse relationship between CPUE and Emsy.

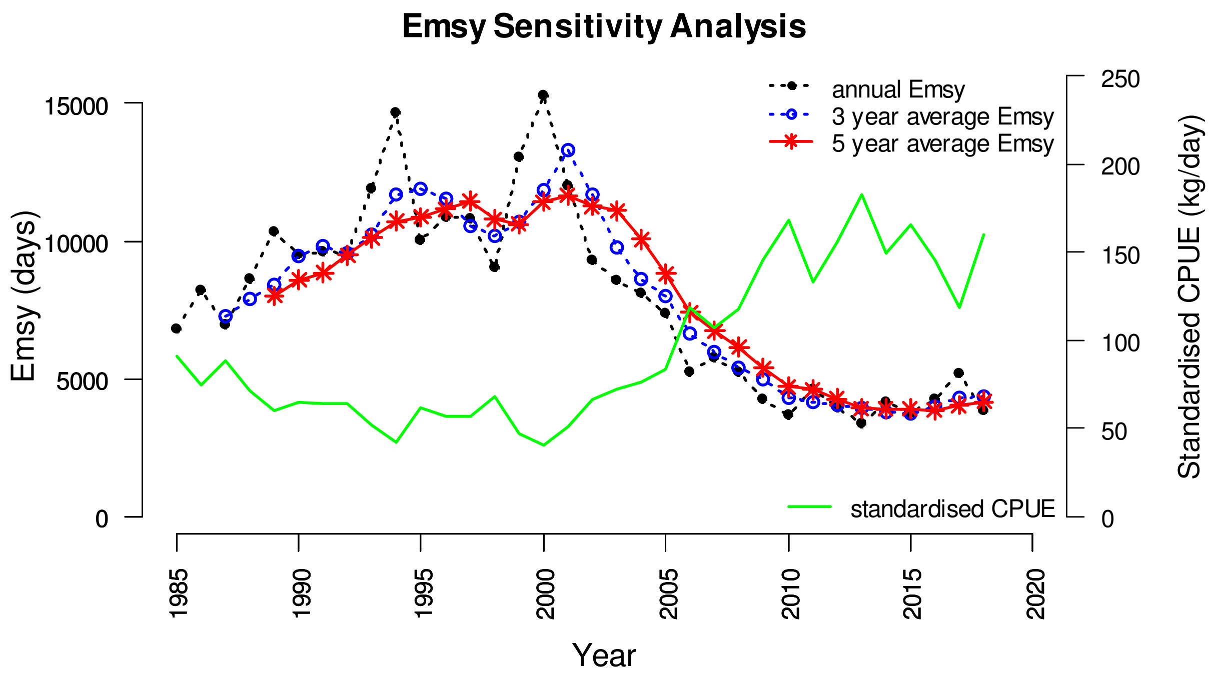

Figure 9 A comparison of Emsy calculated using; the annual standardised CPUE, a 3 year running average CPUE and a 5 year running average CPUE. The annual standardised CPUE is shown as a green line and is scaled to the right x-axis.

Table 5 Data for figure 9.

year	Standardised tiger prawn CPUE			Emsy estimates		
	annual	3 year average	5 year average	annual	3 year average	5 year average
1985	90.8			6795		
1986	74.9			8234		
1987	88.4	84.7		6983	7285	
1988	71.6	78.3		8613	7879	
1989	59.7	73.2	77.1	10338	8426	8004
1990	64.9	65.4	71.9	9502	9432	8580
1991	64.2	62.9	69.8	9608	9802	8844
1992	64.4	64.5	65.0	9582	9564	9496
1993	51.9	60.2	61.0	11878	10252	10109
1994	42.1	52.8	57.5	14673	11687	10729
1995	61.4	51.8	56.8	10044	11910	10861
1996	56.8	53.4	55.3	10860	11548	11152
1997	57.1	58.5	53.9	10804	10556	11454
1998	68.3	60.7	57.1	9038	10160	10799
1999	47.3	57.6	58.2	13035	10717	10603
2000	40.4	52.0	54.0	15275	11866	11429
2001	51.3	46.3	52.9	12023	13312	11667
2002	66.4	52.7	54.7	9289	11705	11270
2003	72.2	63.3	55.5	8551	9748	11112
2004	76.1	71.6	61.3	8107	8622	10069
2005	83.8	77.4	70.0	7363	7977	8819
2006	118.2	92.7	83.3	5218	6655	7403
2007	106.9	103.0	91.4	5771	5991	6748
2008	117.5	114.2	100.5	5251	5402	6139
2009	145.6	123.3	114.4	4239	5003	5393
2010	168.3	143.8	131.3	3666	4291	4699
2011	133.2	149.0	134.3	4631	4140	4594
2012	156.1	152.6	144.1	3952	4044	4280
2013	183.1	157.5	157.3	3370	3918	3923
2014	149.3	162.9	158.0	4131	3789	3905
2015	165.9	166.1	157.5	3719	3714	3916
2016	145.6	153.6	160.0	4237	4016	3856
2017	118.4	143.3	152.5	5212	4305	4046
2018	160.3	141.4	147.9	3850	4363	4171

Relationship between Catch Rate and Fishing Effort

There is a curved inverse relationship between the standardised CPUE and the prior months fishing effort (Figure 10(a)). As fishing effort in the previous month increases CPUE appears to drop rapidly at first then more slowly. Because the CPUE and effort data are both skewed upwards they need to be transformed to perform a linear regression. A logarithmic transformation normalised the distribution of the CPUE data and a square root transformation normalised the fishing effort data.

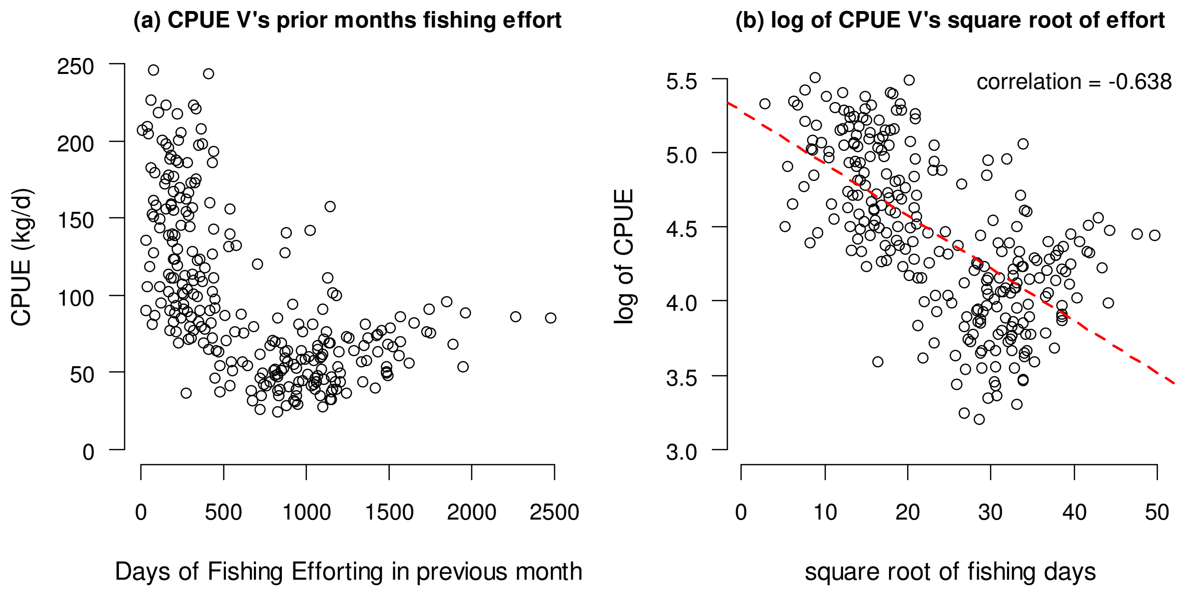

Figure 10 Correlation between CPUE and the prior month of fishing effort.

There is a negative linear correlation between the transformed data sets (Figure 10(b)). The explanation of this relationship is that high fishing effort at the start of a season fishes the stock down quicker resulting in a lower CPUE in subsequent months. Conversely, if fishing effort is low during the early months CPUE remains high until recruitment reduces and the combination of fishing and natural mortality start to reduce the stock size. Therefore if fishing effort increases as a result of improvements in the economics of prawn trawling, the average CPUE is likely to decrease, resulting in an increased Emsy estimate.

Discussion

The updated estimates of MSY, Emsy, Bmsy and the current stock biomass in relation to the virgin biomass, provide the data needed to review the harvest strategy triggers. The current trigger points in the harvest strategy (AFMA 2011, See Appendix) are an annual catch of more than 680 tonne of tiger prawn and/or 4000 days of annual fishing effort over two consecutive years.

Based on the results of this assessment it appears that during 1991-2003 the tiger prawn stock was varying around the stock size that is most productive (Bmsy). If the Harvest Strategy had existed during 1991-2003 when the number of vessels fishing and effort were highest, the catch trigger would have been activated on three occasions; 1991-2, 1997-98 and 2002-3. The effort trigger of 4,000 days would have been activated every year. Although the fishery was harvesting tiger prawn at MSY (mean 668, range 465:965 tonnes) and appeared to be sustainable; economically a lower number of vessels and fishing effort would have been more profitable.

As biomass increases the slope of the Spawner-Recruitment curves become smaller and the Ricker curve becomes slightly negative (Figure 5). The implication of this is that maintaining the biomass too close to Bvirgin is not desirable as there is little or no increase in recruitment. Economically and from a management perspective it is better to aim to operate a fishery slightly above Bmsy as this reduces the possibility of a stock collapse and improves the economics of fishing through higher CPUE whilst still allowing a harvest that is on average close to but below MSY.

Recruitment in prawn fisheries is highly variable (Figure 5) therefore occasional harvests above MSY in years when the biomass is high are to be expected and are not a concern. Post 2008 the annual tiger prawn harvest has been well below the estimates of MSY and the tiger prawn biomass, at 60-88% of Bvirgin, has been well above Bmsy (33% Beverton-Holt, 40% Ricker). These are the main reasons for the mean annual CPUE post 2008 being roughly twice that of the years 1991-2003. Hence there are no reasons for concern regarding the stock size and sustainability.

The current tiger harvest rate is sustainable and could be increased if the economics of trawling improved allowing a slightly higher level of fishing effort. Although higher than the updated median value of the Beverton-Holt MSY estimate the 680 tonne tiger prawn catch trigger is within the 95% Confidence Intervals of all the MSY estimates. Occasional catches above MSY when the biomass is high are sustainable. Consideration should be given to separating the catch triggers from the effort trigger because it is years of consecutive fishing above MSY that will impact the prawn stock biomass (i.e. remove the “and/or” that is currently between the harvest strategy triggers 1a, 1b and 1c).

The 2015 season was the only year that catch was above the lower 95% Confidence Intervals of the updated MSY estimates. The 2015 the biomass was 80% of Bvirgin which is well above Bmsy and hence quite sustainable. The fact that the 2015 harvest was taken by only 2,969 days of fishing is a result of the high biomass and hence a high CPUE that allowed the harvest to be taken by a relatively small amount of fishing effort (compared to 1991-2003). This is an example of fishing at the Effort for maximum economic yield (Emey).

The estimates of Emsy for the 2004 assessment were calculated by dividing MSY by the standardised CPUE for 2003 (73.5 kg/d). Using recent CPUE to calculate Emsy as 2018 fishing days is problematic because it does not account for the higher CPUE resulting from the large stock size and the inverse relationship between CPUE and fishing effort. A sensitivity analysis was conducted to help address the question “What CPUE should be used when updating the Emsy estimate?” This analysis shows that using a single year standardised CPUE results in highly variable estimates of Emsy. A 5 year running average appears to be the best option for smoothing over the variability.

The purpose of the effort trigger needs to be discussed by TSPMAC as the estimates of Emsy are highly variable and sensitive to the CPUE that is used to calculate Emsy. The effort trigger is a good concept that fits with the use of a TAE as the primary management control of the fishery harvest. The use of a Total Allowable Effort (TAE) as opposed to a Total Allowable Catch (TAC) suits the variable nature of recruitment in prawn fisheries by allowing additional harvest in years when biomass is high whilst restricting harvest in years when it is low because of a lower CPUE. The 4,000 day trigger is close to the median values of all of the Emsy estimates using the 2018 CPUE (Table 4 and Figure 8). Biomass in 2018 was 80% (Beverton-Holt) or 82% (Ricker) of virgin biomass which is the main reason that CPUE is so much higher than in 2003 when the biomass was 37% (Beverton-Holt) or 38% (Ricker). The lower number of active vessels and annual fishing effort are the other reasons that annual CPUE is higher because the fishing mortality is lower and spread over the fishing season instead of high and concentrated in the early months. Perhaps the effort trigger could be viewed as an Emey limit reference point as fishing effort above this level is more likely to just reduce the profitability of fishing (because of reduced CPUE) than be a risk to the stock sustainability.

References

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Appendix

Extract from: Harvest Strategy for the Torres Strait Prawn Fishery, 2011

6.2 Decision rules and trigger points

Decision Rule: TAE for the fishery to be set based on the MSY for Tiger prawn up to 9,200 days (maximum) for the maximum period allowable under the Plan (currently 3 years) unless triggers are reached.

Trigger 1: *If any one of the trigger points below is reached within the Australian area of jurisdiction each year over two (2) consecutive years:*

Trigger 1a – *If ≥ 4000[1] days of TAE has been utilised in a season; and/or*

Trigger 1b – *If ≥ 680[2] tonnes of Tiger prawns has been caught in a season; and/or*

Trigger 1c – *If ≥ 620[4] tonnes of Endeavour prawns has been caught in a season;*
then

Decision Rule 1:

a) PZJA agencies to commence indentifying research requirements including updating of the stock assessment and bio-economic modelling;
b) reconvene Harvest Strategy Working Group to oversee research and further development of the TSPF Harvest Strategy;
c) estimate B_{MEY} using results obtained from both updated and historical research data; and
d) revisit target reference points and trigger points to develop decision rules for setting the TAE based on B_{MEY} and taking into consideration the revised and updated research outputs, the current status of the fishery and social environment in which the fishery operates (including decisions rules detailing what is done when stock assessments are undertaken and when they aren't undertaken).

[1] Effort triggers are monitored using VMS data.
[2] Catch triggers are monitored through the logbook data.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MANAGEMENT Torres Strait Prawn Fishery Harvest Strategy triggers	Agenda Item No. 4.4

RECOMMENDATIONS

4.4.1 That the Management Advisory Committee **NOTE**:

a) advice form the Harvest Strategy Working Group to amend the Torres Strait Harvest Strategy to remove effort based triggers and replace them with catch rate based triggers that reflect changes in biomass within a season.

b) that the Harvest Strategy Working Group will meet via teleconference again in Mid-January 2020 to finalise advice to the MAC on revised trigger levels.

BACKGROUND

The Harvest Strategy Working Group (HSWG) met on 30 July 2019 to consider the effectiveness of current triggers in the Torres Strait Prawn Fishery Harvest Strategy. The HSWG raised concerns with using effort-based triggers as they do not give any indication of the underlying stock biomass level and therefore are not very useful at indicating sustainability within a fishing season. This concern was also highlighted in an independent review of the harvest strategy (**Attachment A**).

The HSWG suggested that what is needed is an effective set of triggers that detects declines in the stock and thereby reduces the risk of overfishing. This is the way stocks are normally managed in effort-controlled fisheries.

The HSWG recommended that triggers could be based on nominal Catch Per Unit Effort (CPUE) (which can be monitored by industry, and as such, is cost effective) with consideration of economic conditions such as prawn and fuel prices, which can be monitored annually. The purpose of the CPUE based trigger is to provide a review point (concerning catch rates) at which the MAC would consider management options. At this same point, the MAC would also consider economic indicators and conditions to determine if further management action is needed.

This is considered a practical option for the short to medium term given there are no set economic targets for the fishery and the effort levels have not reached a point where further investment in optimising the harvest strategy (e.g. through management strategy evaluation) is cost effective.

TSPMAC supported the development of proposed CPUE base triggers at its teleconference on 17 September and an additional paper on proposed trigger levels was developed by an independent consultant, Andrew Penney (**Attachment B**).

DISCUSSION

The Penney paper (Attachment B) highlighted the challenges with the current effort and catch triggers noting they are inappropriate for an effort controlled fishery and recommended that they be removed.

The recommendations include the addition of two levels of catch rate based triggers: the first at the half way point between the target and limit levels; and the second is a trigger at the limit reference point where there is a high risk of recruitment impairment. The use of these two trigger levels is a sensible approach and would provide the MAC, AFMA and industry with early warning of when stocks are declining and a point where effective management actions can be applied.

The HSWG noted that given nominal and standardised catch per unit effort CPUE show a strong correlation (98.1%), nominal CPUE can safely be used to monitor stocks (that is, an indicator) between stock assessments. Using nominal CPUE will be much cheaper than calculating standardised CPUE, and could be monitored easily by industry and AFMA.

In accordance with the Commonwealth harvest strategy policy, limit reference points are set at half the biomass at maximum sustainable yield ($0.5B_{MSY}$). This is consistent with the approach taken in the Torres Strait Prawn Fishery and the Penney report notes one option is to set the lower catch rate trigger at $0.5B_{MSY}$. However, setting the lower trigger at a level closer to MSY would be more precautionary and this can be considered by the MAC.

Setting the first trigger point at a level between the target and limit reference point requires some consideration of where an appropriate target level should be for the fishery. However, through this process we are not setting a specific target for the fishery. Rather, we are aiming to identify a suitable trigger level to indicate when the stock is moving away from optimal fishing levels and towards the unsafe, limit reference point.

As noted in the Penney report, the precautionary trigger needs to be set high enough to allow for action that can prevent further stock decline. One suggestion is to consider a proxy for maximum economic yield as an interim target and set the trigger between that level and the limit reference point. Based on the current stock assessment we know that catch rates are good at the moment and it is likely the fishery is currently at or around the MEY level. As such we could consider setting the first trigger level at a point between the current good catch rates (roughly around B_{60}) and the limit reference point.

TSPMAC members are asked to consider the proposed trigger levels outlined in the work by Andrew Penney, along with recommendations from the HSWG (**Attachment C**). The HSWG agreed to meet again (planned for mid-Jan 2020) to develop recommendations on suitable trigger levels. Final changes to the Torres Prawn Fishery Harvest Strategy that reflect the new catch rate triggers will also developed, and will be provided to the MAC in January, prior to the meeting on 28-29 January.

Use of indicators and triggers in the Torres Strait Tiger Prawn Fishery

Andrew Penney
Pisces Australis (Pty) Ltd

Introduction

The usual purpose of conducting a fisheries stock assessment is to generate management advice on how best to manage a fished stock into the future. To achieve this, stock assessments are designed to provide information relevant to the management 'levers' available to fisheries managers, such as controlling catch, effort or area management options like seasonal or permanent closures. Commercial fisheries are generally managed using two broad classes of management controls:

- Input Controls: whereby the amount of fishing effort (the 'input' to the fishery) is capped to indirectly limit the level of fishing mortality on the stock. Such controls may include limited entry (limits on fishing licences), limits on total allowable effort (TAE, number of days that may be fished or sets that may be made -), limits on gear size (net length, net width, line length or number of hooks) or limits on fishing power (vessel size, capacity or engine power).
- Output controls: whereby catch itself (the 'output' of the fishery) is capped to directly control the level of fishing mortality on the stock. Such controls may include total allowable catches (TACs), individual quotas (IQs) and individual transferable quotas (ITQs).

These primary controls may be supplemented by 'technical measures' whereby fishing mortality, usually on selected components of the catch, is further limited by controlling elements of gear design or deployment. Such measures may include mesh size of nets (to allow escape of juvenile fish or unwanted species), escape or exclusion devices (to exclude or allow escape of vulnerable or protected species), or other aspects of gear design (such a footrope modifications to reduce impact on the seabed, or hook shape specifications to reduce catches of turtles).

Management 'levers' in effort managed fisheries

Most Australian Commonwealth fisheries are primarily managed using output controls, in the form of TACs in combination with transferable quotas set at catch levels estimated by a stock assessment to allow for optimal catches, while ensuring that the biomass of the stock remains at or near a target level, with a high probability of being above a limit level. However, Australian prawn fisheries, including the Torres Strait Prawn Fishery (TSPF), are managed using effort controls, limiting the number of days or the amount of gear that can be fished in a year.

The fishing mortality level exerted on a stock by an effort managed fishery is controlled by capping the amount of fishing effort at a level estimated (by a stock assessment) or expected (from past performance of the fishery) to limit the fishing mortality on the stock to a level considered to be 'sustainable'. Conventionally, and under the Commonwealth Fisheries Harvest Strategy Policy, 'sustainable' is considered to mean that fishing mortality is low enough to prevent the stock from declining to a limit reference level at which recruitment is likely to be impaired, and that the stock is maintained near some target level that is expected to provide long-term maximum catches.

In effort-controlled fisheries, fishing effort is therefore the management 'lever', and management intervention involves periodic revision of the maximum total allowable effort (TAE), usually in response to the results of a stock assessment, to ensure that fishing effort (and potential fishing mortality) is capped at a level considered 'sustainable' given the current status of the stock in relation to targets and limits.

Fisheries indicators and triggers

In contrast to a management lever (which is actively controlled), a fisheries indicator is a piece of information or data set that provides a reliable index of the status of some component of a fish stock or fishery. Essentially, a fisheries indicator is any data or information that would be influential if it was used in a stock assessment (Haddon and Penney 2018). All of the requirements for data to be reliable and influential in a stock assessment apply to the use of such information as fisheries indicators. To be useful and reliable as a fisheries indicator, data need to be:

- Representative: data need to be representative of the stock, or of a stock component of particular interest, such as recruits, spawning fish or the harvestable biomass.
- Reliable: data must not be so uncertain that they do not provide a reliable measure, index or trend. There should be some measure of variance or uncertainty around the data to allow the reliability of the data to be evaluated.
- Consistent: if data are being used to evaluate trends over time, they need to have been collected in substantially the same way over time, or be able to be adjusted for changes in data collection methodology. If data collection practices have changed in a way that renders data for one period incomparable with data from another, then they should be standardised to correct for such changes.

These tests would usually be applied to each data set used in a stock assessment, either prior to using the data in the assessment, or in the assessment itself. When using fisheries indicators outside of an assessment, this step of evaluating the reliability of data sets as indices of stock status needs to be done when selecting which data to use as indicators. To be feasible and convenient, a fisheries indicator should also be:

- Simple: Indicators should be quick and easy to calculate using readily available data, such as industry logbook data, preferably in-house by AFMA staff. Calculation of indicator values and comparison with triggers should be quick and involve little or no additional cost.

Triggers are then simply reference levels on an indicator, chosen at levels considered to provide a meaningful warning of some circumstance warranting further attention, and perhaps management action. A trigger indicates that the indicator concerned has increased or declined to a pre-determined level that suggests a change in status of the stock that needs further investigation.

Process in a stock assessment year

In a year in which a stock assessment is conducted, management advice would usually be based on the results of the stock assessment. Stock assessment determination of the biomass of the stock in relation to targets and limits would be used to provide advice on whether TAE levels need to be adjusted to ensure that catches remain at levels appropriate to maintaining biomass near a chosen target. Stock assessment results would be directly used to provide advice on adjusting the TAE management lever, such as maximum allowable days fished. Indicators would not be separately used to support management advice, although they may be important datasets and indices used in the assessment.

Process in a non-stock assessment year

In a year when no stock assessment is conducted, the chosen indicators would be calculated and reviewed in relation to pre-determined trigger levels, to determine whether any of the trigger levels have been breached. Action taken in response to the breach of a trigger should be predetermined, but could range from requiring further analysis to determine whether the indicator has indeed detected a change in status of the stock, to some precautionary management action to adjust fishing effort in response to the indicator.

Selection of indicators for the Torres Strait Tiger Prawn Fishery

The Torres Strait tiger prawn assessment applies a Deriso-Schnute delay-difference model to standardised CPUE and monthly tiger prawn catches, together with assumptions regarding biological productivity parameters such as natural mortality rate. Delay-difference models provide an intermediate option between age-aggregated production models and full integrated age-structured models, using simplifying assumptions that allow age-structured dynamics to be simplified to a single equation estimating biomass from previous year biomass + time-lagged recruitment + growth. These models are useful when there are limited data available, particularly in the absence of age-composition data, such as for prawn fisheries.

The model is fitted by minimising the difference between the predicted CPUE generated by the model and the standardised observed CPUE from logbook data. In the absence of age-composition data, model results are therefore strongly driven by standardised CPUE. This is clear from the similarity between CPUE trends (Figure 1) and estimated biomass trend (Figure 2) of tiger prawns in the TSPF from 1980 to 2018 (reproduced from Turnbull 2019).

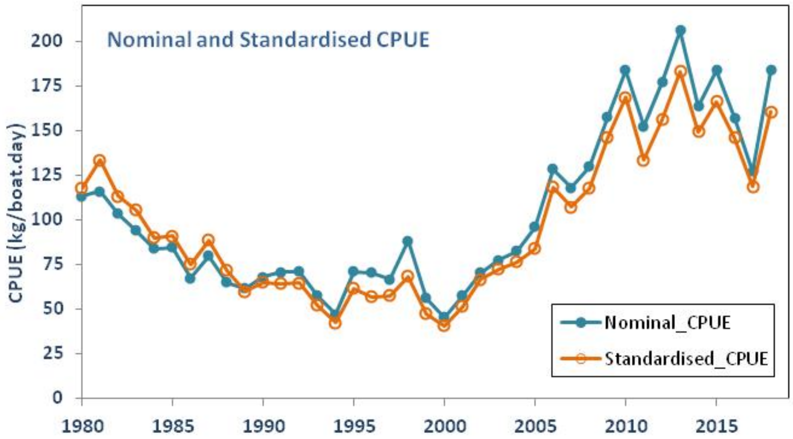

Figure 1. Comparisons of trends in nominal and standardised CPUE of Tiger Prawn in the Torres Strait Prawn fishery from 1980 to 2018 (reproduced from Turnbull 2019).

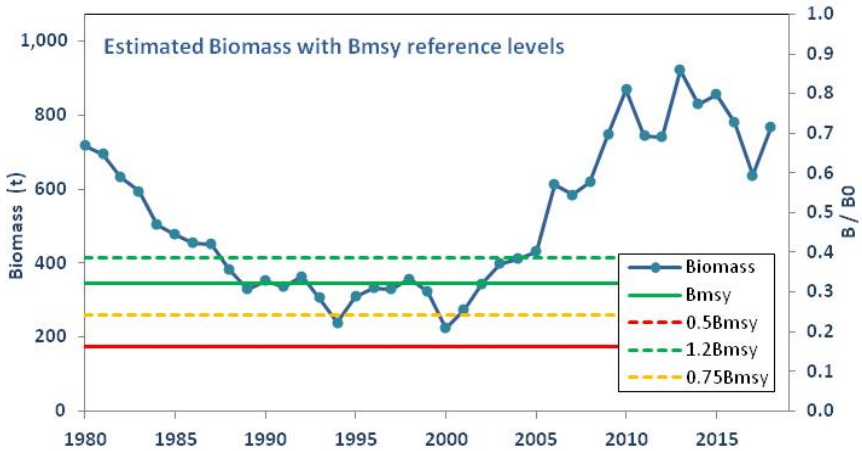

Figure 2. Trend in estimated biomass of Tiger Prawn in the Torres Strait prawn fishery from 2018 to 2018 (reproduced from Turnbull 2019), showing biomass status in relation to the estimated level of B_{MSY} and other MSY-related reference levels.

There is a strong correlation between biomass and both nominal and standardised CPUE. The relationship differs for the period 1980–1997 (over which vessel power factors in the fishery were increasing) and the period 1999 - 2018 (over which power factors were relatively stable). The relationship between CPUE and biomass is well estimated, particularly since 2000, after which there is an over 97% correlation between biomass and nominal or standardised CPUE (Figure 3 right panel).

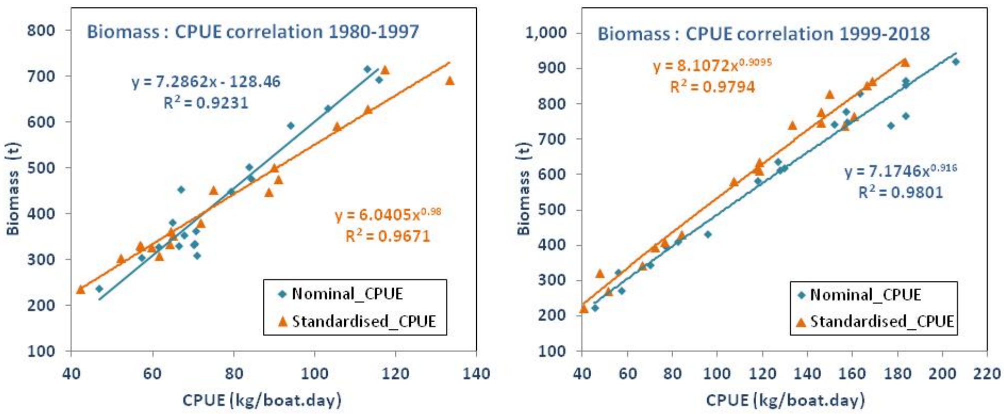

Figure 3. Correlation between CPUE indices (nominal; and standardised) and stock-assessment estimated biomass of Torres Strait Tiger Prawn.

CPUE is therefore a highly reliable predictor of model-estimated tiger prawn biomass and, in the absence of a stock assessment, can serve as an ideal indicator for tiger prawn biomass in the TSPF. Factors other than fishing that affect recruitment and biomass, such as environmental temperature or rainfall effects, will also be reflected in CPUE, and so will be picked up by this indicator.

Regarding other indicators, fishing effort is the controlled management lever for the fishery, and so is not suitable for use as an indicator. (In the same way that catch in a TAC controlled fishery is not a useful indicator of stock status.) The amount of effort provides no indication of the status of the stock. Catch is also related to the amount of fishing effort (mediated by CPUE), and does not provide an indication of stock status. Under-performance against the TAE cap or expected catch may be useful indicators of other constraints on the fishery (such as economic constraints, low interest in fishing or weather limitations), but they are not useful indicators of stock status.

Nominal or standardised CPUE?

The rate at which fish are caught for a given unit of fishing effort is affected by many other factors besides stock abundance. Time of year, fishing area, depth, fishing vessel power and other factors can affect the efficiency of fishing and can bias nominal (non-standardised) CPUE. For this reason, CPUE should always be standardised to correct for the effects of factors other than stock abundance, to provide a standardised CPUE index that is representative of stock abundance.

Standardisation is undertaken for Torres Strait prawn CPUE before this is used in stock assessments. This standardisation corrects for the effects of year, month, area, full vs. part-night of fishing and lunar phase. Most importantly, however, this standardisation corrects for the effect of a known increase in fishing power of Torres Strait prawn vessels since 1989 (Figure 4), as a result of changes over time in engine horsepower, propeller nozzles, GPS, computer mapping, use of BRD and/or TED devices, net type and otter board type (see Turnbull 2019 for details).

There was a clear increase in fishing power of vessels from 1980 to 1999. However, fishing power has remained relatively stable since 2000. Standardisation to compensate for fishing power results in the standardised CPUE index being tilted up in early years and down in recent years (see Figure 1), crossing the nominal index in 1989, the reference year to which the power factors are normalised.

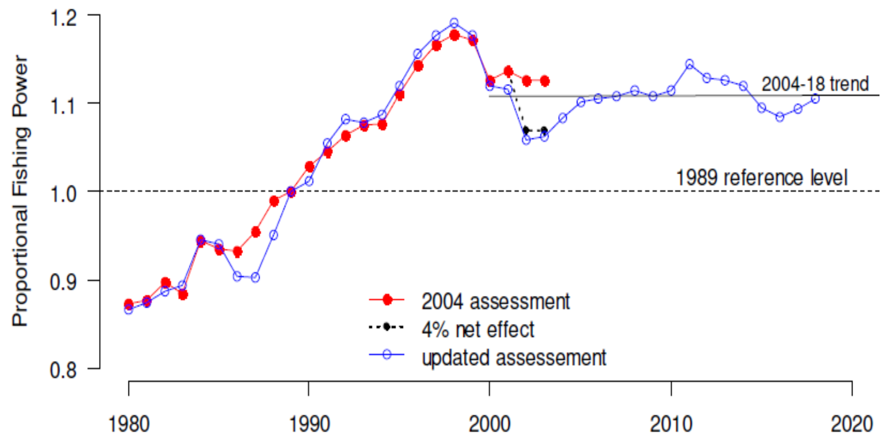

Figure 4. Estimated change in fishing power of vessels fishing in the Torres Strait Prawn Fishery relative to 1989 (reprinted from Turnbull 2019).

Despite this, it is clear that nominal and standardised CPUE remain highly correlated, both showing similar trends, particularly since 2000 after fishing power stabilised. The relationship between nominal and standardised CPUE differs for the periods 1980–1994 (when CPUE was declining), 1995–1998 (when CPUE was varying around a low level) and 2000–2018 (when CPUE was increasing) (Figure 5). Since 2000, when power factors have been fairly stable, there is very high correlation between nominal and standardised CPUE (r^2 = 0.9958). It is therefore not necessary to standardise tiger prawn CPUE to provide a reliable indicator, and recent nominal CPUE is practically as good as standardised CPUE as an index of biomass.

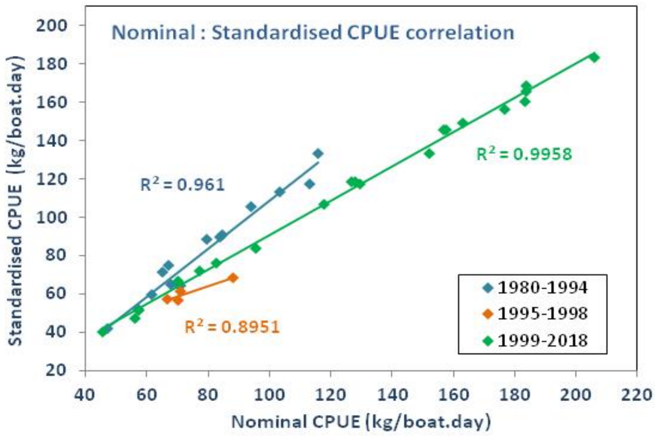

Figure 5. Correlation between nominal and standardised tiger prawn CPUE and in the Torres Strait Prawn Fishery over 1980–1994, 1995–1998 and 2000–2018.

Trigger levels on a CPUE indicator

Trigger levels to set on a nominal CPUE indicator, and action to be taken in response to breach of a trigger, depend on the purpose for which these will be used. Options need to be developed and discussed by the TSPF Harvest Strategy Working Group before preparing proposals for consideration by the TSP Management Advisory Committee and Torres Strait Protected Zone Joint Authority.

Action in response to a breach of a CPUE indicator

Action to be taken in response to a breach of CPUE triggers should be pre-determined and documented. Options for action to take also need to be proposed and discussed by the TSP Harvest Strategy Working Group before proposal are made in this regard. Most simply, breaches of a trigger could require AFMA initially, and subsequently the TS Scientific Advisory Committee or TS MAC, to consider whether any further action should be taken. Such action may include further analysis, including conducting a stock assessment, to confirm what the indicator is showing. For a variable stock such as prawns, action in response to an initial breach in one year might involve watching the indicator to see whether it breaches the trigger again in the following year, before further action is taken.

Conclusions and next steps

- CPUE is undoubtedly the best indicator to use for monitoring of Torres Strait tiger prawn stock status in years between stock assessments. Tiger prawn CPUE is an ideal indicator, being highly correlated with stock assessment model-estimated biomass.
- Particularly since 2000, nominal CPUE provides as good an indicator as standardised CPUE. Although there have been power factor increases in this fishery, power factors have been relatively stable since 2000 and there is high correlation between recent nominal and standardised CPUE. Nominal CPUE is quick and easy to calculate.
- Further analysis needs to be done to evaluate options around averaging or smoothing CPUE before using it as an indicator. It is clear that CPUE has fluctuated strongly at a high level, evidently in response to recruitment fluctuations, since 2010. Smoothed CPUE would be more appropriate to use as an indicator, but the degree of smoothing needs to be evaluated.
- Consideration also needs to be given to whether to use CPUE across all months in the fishing season as an indicator, or to use CPUE only for selected months. Tiger prawn CPUE typically varies quite strongly across the season, reflecting annual recruitment, followed by growth, followed by fishing down of the resulting produced biomass. Overall CPUE is a good predictor of model-estimated biomass, but CPUE over certain selected months may be a better indicator. This should be evaluated.
- Options can then be developed for trigger levels on nominal CPUE, chosen to alert managers and fishers to indications of a significant change in status of the stock. Options might include CPUE declining below some chosen target level, or declining to half way between a target and limit level (see reference levels in Figure 2). There may be more than one trigger level, indicating differing levels of possible risk to the stock or the fishery.
- Once trigger options have been developed, and their purpose clearly defined, options can be developed for action to be taken in response to a breach of a trigger. Such action should at least include more detailed analysis to confirm whether the indicator has indeed breached the established trigger level.
- Following discussion and adoption by the TSP Harvest Strategy WG, proposed options would be submitted to the TSP MAC for consideration.
- If and when approved by the MAC, the Torres Strait Prawn Harvest Strategy would be amended to incorporate the revised indicators and triggers.

References

Haddon M. and Penney A. (2018) Use of reference points, proxies and fisheries indicators in classification of Status of Key Australian Fish Stocks. Report to the FRDC SAFS Advisory Group.

Turnbull C. and L. Cocking (2018) Torres Strait Prawn Fishery Data Summary 2018. Australian Fisheries Management Authority. Canberra, Australia. 33 pp.

Turnbull C. (2019) Updated Tiger Prawn stock assessment for the Torres Strait Prawn Fishery. Final Report to AFMA for the TSPMAC and TSSAC, Project: 180802, May 2019. 16 pp.

Torres Strait Prawn Fishery Harvest Strategy Working Group

Meeting 2 Record

28 October 2019

Teleconference

Australian Government

Australian Fisheries Management Authority

Box 7051, Canberra Business Centre, ACT 2610 / Ph (02) 6225 5555 / Fax (02) 6225 5500 / AFMA Direct 1300 723 621 afma.gov.au

Meeting participants

Members

Name	Position
Mr Andrew Penney	Independent Scientist
Mr Clive Turnbull	TSPMAC scientific member and stock assessment scientist
Ms Lisa Cocking	AFMA Representative
Mr Jim Newman	TSPMAC industry member

Observers

Name	Position
Sayan Chakrabarty	AFMA economist
Mr Robert Curtotti	ABARES economist

Apologies

David Power, the AFMA manager of the TSPF was an apology for the meeting.

Discussion

AFMA thanked Mr Penney for his discussion paper, and noted that the paper would be presented to the TSPMAC in February. The working group should discuss the paper and provide any comments before it is finalised. AFMA Acknowledged that it would draft a discussion paper for the MAC, with the HSWG recommendations and considerations on the paper and suggestions for the harvest strategy triggers, and other elements going forward. Mr Andrew Penney ran the working group through the key points to be discussed from the harvest strategy trigger discussion paper. The working group noted the following key points:

- Given nominal and standardised CPUE are very close (98.1% correlation), nominal can safely be used to monitor stocks (the indicator) between stock assessment years. Using nominal CPUE will be much cheaper than needing to calculate standardised CPUE, and could be monitored by industry easily.
- Annual nominal CPUE is a slightly better indicator of stock biomass than peak season CPUE (Mar-May) The working group and TSPMAC could consider the pros and cons of using mean annual CPUE (Nominal CPUE) versus the mean CPUE of the high recruitment months (Mar-May CPUE). Mr Turnbull noted that the data summary uses the mean of nightly catches from each vessel and that nominal CPUE presented in Mr Penney's discussion paper is the same as the annual CPUE presented in the Data Summary. Mr Penney noted that he would edit the discussion paper to reflect this point.
- When the stock is higher, CPUE will bounce around a lot, and using a running average wouldn't be accurate, because the average line will lag behind the actual if there is a trend. Using a three year running average is the most consistent.
- There are a number of different trigger levels/ scenarios that could be used which are explained in the paper. Some are more precautionary than others. The working group and MAC need to decide which trigger levels are best suited for the fishery, or develop their own version if they can come up with something they think is more suitable.

- Fig 10 demonstrates that a Blim at $0.5B_{MSY}$ is safe biologically, however industry probably don't want to let the stock go that low, as it is unlikely to be economical. Mr Penney recommended a precautionary trigger, or even limit, which could be as high as setting the limit reference point at Bmsy. This would provide a very precautionary limit, meaning the MAC could consider what is happening with the stock quite early, potentially allowing the stock to stay at higher levels, closer to a more economically viable biomass. If the triggers are set at MSY, or the levels suggested in the scenarios, it may mean the stock has dropped a fair bit below what may be economical to fishers. In the absence of an estimate of MEY for this fishery, and difficulty calculating it, the industry could provide direct advice on what level of CPUE is economical, which could be used to set precautionary triggers in the harvest strategy. This is something the MAC should discuss, including discussion around MEY versus MSY targets.
- In TRL the industry set the limit and target above the biological limit, because if the stock went below that level, they wouldn't be able to make a living out of the fishery. This was their choice and recommendation.
- The working group agreed to meet again to discuss which scenario, or version of, they think fits best, to advise the TSPMAC.
- The group acknowledged the need to set good decision rules around what will happen when a trigger is reached, particularly given fishers change which species they are targeting, which will effect CPUE for that species, and could provide false concerns with a "reduced" CPUE being attributed to biological concerns rather than targeting changes.
- Setting a higher precautionary trigger will give us time to check and validate this, to check whether targeting has shifted, or there may be declines in the stock.
- An control rules that are recommended need to undergo MSE testing before they are implemented, to gauge their effects. The TSPMAC should consider options and timelines for changing triggers, versus reviewing targets and setting control rules over the next few years.
- The group discussed the setting of the TAE, and acknowledged the TAE level is not of real concern if we set appropriate triggers. If we set the precautionary trigger at a genuinely (around MSY) precautionary level, we don't need to worry too much about the effort cap right now, because the effort is so under-fished, and even if fishing increases, we will know about it through the trigger and will review the stock.
- Also, the MSE testing from the 2009 spatial management project indicated that there is a 99% probability that a 9,200 effort level would keep the stock above Blim (of 0.5Bmsy). This is 2,333 days higher than the current Australian allowable effort of 6,867.
- A constant effort harvest strategy is a very good system for reducing impacts on the stock. This is because as the stock decreases, there are less fish on the ground, meaning you catch less fish and have less impact. It is self-regulating and like a "constant F" system.

The committee agreed to meet again to discuss specific recommendations to go into the TSPMAC paper, once the minutes of this meeting are distributed.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MANAGEMENT Total Allowable Effort Limit 2021-2023	Agenda Item No. 4.5

RECOMMENDATION

That the Torres Strait Prawn Management Advisory Committee (TSPMAC):

4.4.1 **DISCUSS** the process for setting the TSPF Total Allowable Effort limit for 2021-2023.

4.4.2 **RECOMMEND** that the PZJA set the Total Allowable Effort in the TSPF at 9,200 days for the 2021, 2022 and 2023 seasons, noting the recommendation from the harvest strategy working group for a continuous TAE model.

4.4.3 **NOTE** that the proposed three year Total Allowable Effort is consistent with the *TSPF Management Plan 2009*, the new recommended harvest strategy triggers and sustainability reference points.

4.4.4 **NOTE** the Total Allowable Effort can be changed by the PZJA if needed within or between seasons by determination or emergency determination, if the stock assessment indicates a new Total Allowable Effort is required.

BACKGROUND

When does the TAE need to be set and for how long?

Under subsection 2.5(1) of the *Torres Strait Prawn Fishery Management Plan 2009* (the Plan) the PZJA must determine the Total Allowable Effort (TAE) for the TSPF prior to the start of a season (1 February), “based on the reference points determined under section 2.4, or other management strategy”.

The TAE can be set for a maximum of three years, and the PZJA aims to maximise the stability of the TAE where possible. Setting the TAE for multi-year periods reduces the administrative costs of setting an annual TAE, and provides greater certainty for industry with business planning.

Along these lines, in 2010, the PZJA started setting the TAE for three year periods. It reverted to one year TAE in 2014 following the native title ruling, allowing time for the new consultative structure to settle before considering setting another three year TAE. The TAE has been set for between two and three years since, depending on whether management changes specifically relevant to the TAE were underway.

In 2018, the TSPMAC recommended a 2 year TAE be set for 2019-20 given the tiger prawn stock assessment was being updated. This would allow sufficient time for the update, and the TSPMAC to consider the new stock assessment before setting the TAE again in 2021.

The TAE limit (9,200 days) has not changed since the 2006 effort reduction.

How do we decide what level to set the TAE at?

The *TSPF Harvest Strategy 2008* currently outlines the rules for setting the TAE. The harvest strategy currently includes measures that aim to limit overall effort (fishing days) to sustainable levels through a TAE limit. Adjusting the limit on fishing days is the primary management tool to limit effort and consequently fishing mortality to sustainable levels (the amount of effort that will allow the maximum sustainable yield; E_{MSY}). When the harvest strategy was first developed, the TAE was set at 9,200 days which is around the average effort level sustained during the peak of the fishery through the 1990s. It is also the estimate of E_{MSY} from the 2004 Tiger Prawn stock assessment. This value had a 90 percent confidence interval of 7,116 to 12,231 days and was based on catch and effort data from the years 1980 to 2003 using the Beverton-Holt stock recruitment relationship.

As outlined in papers 4.3 and 4.4, the updated stock assessment, and recommended changes to the harvest strategy are suggesting the TAE limit, and sustainability of the fishery be managed in a slightly different way, using a continuous TAE limit of 9,200 days for the TSPF, combined with a series of CPUE-based triggers that would be monitored.

DISCUSSION

In 2018, the TSPMAC suggested a harvest strategy working group (HSWG) be established to develop new triggers for the TSPF harvest strategy. This was following advice that current triggers were not flexible enough to deal with changes in catch rates between seasons. The HSWG met in July and October 2019 to discuss these triggers, and the updated Tiger Prawn stock assessment and options for triggers.

The 2019 stock assessment indicates a healthy stock (with high CPUE and biomass levels ranging between 60-88% of virgin biomass. Catch rates (catch per unit effort - CPUE) in the fishery have also increased substantially over the last ten years, and while there are no sustainability concerns, the assessment model does produce a lower TAE for the fishery. The lower TAE output arises as the model uses CPUE as the indicator of abundance and because catch rates have gone up considerably since the last assessment, the model recommends a lower TAE limit to maintain abundance at the MSY level.

However, given the recent stock assessment result and continued, relatively low effort in the fishery, the HSWG noted it would be counterproductive to reduce the TAE. It was noted that what is needed is an effective set of triggers that detects declines in the stock to reduce risk of overfishing.

Under section 2.6 of the Plan, the TAE can be increased during a season or within the three year period by determination. The TAE can also be decreased during a season or within the three year period by emergency determination. This acts as a safeguard if changes to the stock become evident during the three year TAE period or within a season.

PZJA agencies aim to set the TAE for a given season as early as possible to provide operators adequate time to make necessary business decisions before the commencement of the season.

Given the advice of the HSWG, AFMA is recommending that a three year TAE limit be set at 9,200 days for the 2021, 2022 and 2023 fishing seasons. This is the effort level which has been used since 2006. AFMA will continue to monitor the harvest strategy triggers during the season to ensure any changes to the stock are detected. If new triggers are agreed to by the TSPMAC, these will be monitored. If changes are detected, information will be provided to the TSPMAC for consideration. This decision is also noting that the PZJA can change the TAE at any time by determination, or emergency determination if required.

FINANCIAL IMPLICATIONS

A TAE of 9,200 days is cost neutral to fishers as the levy regulations are based on a flat rate per licence and per unit allocated, not on the number of days available to fish. There may be some costs associated with the determination of the TAE including staff time for administering a decision of the PZJA.

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TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	**Meeting No. 20** **29-30 January 2020**
REPORTS **Collecting species of interest as part of logbook data**	Agenda Item No. 4.6

RECOMMENDATION

4.6.1 That the Torres Strait Prawn Management Advisory Committee (TSPMAC) **DISCUSS** the species of interest to the traditional sector and consider the best way to monitor catch and release for these species.

BACKGROUND

The TSPMAC's previous consideration on species of interest resolved that the TSPF observer program would include monitoring for species of interest. These species are considered particularly important to communities for cultural and subsistence purposes.

The first species of interest list was developed by the TSRA and the then traditional inhabitant PZJA forum members. This list was updated in 2010, following advice from new TSPMAC traditional inhabitant members. The current list is at Table 1.

Table 1. Species of interest to the traditional sector.

Scientific Name	**Common Name**
Panulirus ornatus	Ornate Crayfish
Mugil cephalus	Sea Mullet
Siganus lineatus	Goldlined Rabbitfish
Choerodon Schoenleinii	Black spot Tusk Fish / Parrot fish
Epinephelus quoyanus	Gold Spot Rockcod / Long fin rockcod
Plectorhinchus chrysotaenia	Painted Sweetlip / Goldlined Sweetlips
Diagramma labiosum	Painted Sweetlip / Slatey Bream
Cephalopholis sonnerati	Tomato Cod
Acanthurus dussumieri	Pencil Surgeonfish
Naso unicornis	Bluespine Unicornfish

DISCUSSION

Historically there have been 2-3 observed fishing trips in the fishery each year, of between 37 - 70 observer days (2.3% of the seasonal fishing effort). Six years of observer data on species of interest is available.

Tropical rock lobster (TRL) is the only species to be reported in each of the six years of observer data (Table 2). In 2014-15, nine black jewfish were observed, of which five were reported dead. One ornate mantis shrimp was reported in the same year and was dead (Table 3).

Across the observed years TRL is the most interacted species. High numbers can be caught if a trawl shot coincides with a 'march'. TRL is a no-take species and most are released alive. A small fraction of the catch is dead on few occasions. Operators shift their fishing position when this occurs given the importance of the species to traditional inhabitants and there is no commercial benefit from catching TRL.

AFMA is of the view that the species of interest should continue to a part of the observer program, despite most of them being rarely observed. However, due to the small sample size, it cannot be concluded that some or all of the species of interest are not being caught.

It would be useful for TSPMAC to discuss the current monitoring program, other options for monitoring, and provide advice on the best way forward.

Table 2. Reported catch and life status for tropical rock lobster (*Panulirus ornatus*) between 2012 and 2018. Includes total number of observer days for each year.

	Catch of *Panulirus ornatus* – Tropical Rock Lobster			
year	**Number caught**	**Alive**	**Dead**	**Number of observer days**
2018	222	222		62
2017	18	18		70
2015/16	174	172	2	44
2014/15	597	582	15	50
2013/14	244	243	1	47
2012/13	823*	807	16	37

* **Note**: There was a large take during the second observer trip in 2012/13 of 793 TRL. This was associated with the march of TRL, which occurs a few days each season. Note the majority of lobsters were released alive during this trip. When industry hit the march like this, they tend to move away as it is not financially viable, as TRL are not able to be retained and sold.

Table 3. Other species of interest caught during the 2014/15 financial year.

Scientific Name	Common Name	Number Caught	Alive	Dead
Dictyosquilla tuberculata	Brown Striped Mantis Shrimp	1	0	1
Protonibea diacanthus	Black Jewfish	9	4	5

FINANCIAL IMPLICATIONS

There are no direct costs associated with collecting information on species of interest to the traditional sector using current arrangements.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MANAGEMENT **Preliminary results of a Management Strategy Evaluation of varying the season closure opening (Clive Turnbull)**	Agenda Item No. 4.7

RECOMMENDATION
That the Torres Strait Prawn Management Advisory Committee (TSPMAC):

3.5.1 NOTES the progress on a Management Strategy Evaluation of different season opening dates for the TSPF.

3.5.2 DISCUSSES the simulation scenarios and criteria being used to evaluate the effect of varying the seasonal closure opening.

3.5.3 **ADVISES** on the most useful scenarios to be tested.

BACKGROUND
In 2018, AFMA identified a research need, to assess the impact season dates may have on fishery catch rates and profitability. This was a result of the ongoing discussion around season date at TSPMAC meetings, and between industry, with little analysis to actually estimate the impacts different season dates may have on the stock and profitability. The project was supported for funding by the Torres Strait Scientific Advisory Committee and funded in the 2019-20 financial year research call.

Forward projection size based model for tiger prawn

An age and size based tiger prawn simulation model has been developed for the TSP. The model uses outputs from the update of the tiger prawn Stock Assessment. These outputs include estimates of tiger prawn catchability (Q), the Beverton-Holt Spawner-Recruit parameters, the monthly recruitment pattern and the monthly biomass trajectory for 2018. Estimates of other parameters such as growth rates, size to weight relationship and prawn net selectivity are available from other TSPF research reports.

The benefits of using a size base model instead of the delay-difference model used for the Stock Assessment update are that it can predict the prawn sizes and hence expected prawn grades. During each time step (month) in the model a growth transition matrix is used to increase the size of male and female tiger prawns in a way that allows variability in growth and hence simulates the distribution of prawn sizes that are observed in the fishery. In contrast the delay-difference model does not track prawn size and the average male and female growth parameters are combined into a more general biomass growth estimate.

The model can simulate the tiger prawn stock forward from the end of the 2018 season for several seasons whilst applying one of the "simulation scenarios" proposed below. The effect of varying the timing of the season dates can then be evaluated in terms CPUE, value of catch per unit of effort and the effect on the tiger prawn biomass and prawn sizes. The advantage of using 2018 as the starting point for forward simulations is that the biomass trajectory from the Stock Assessment update can be used and the model can be validated by using the observed fishing effort for 2019 season. Under this scenario the predicted CPUEs for 2019 should closely match to the observed.

The initial model runs will be "deterministic" with no variation in the parameters for the Spawner-Recruit relationship and the monthly recruitment pattern. These results will be used to determine which scenarios to compare in the final model simulations that will be "stochastic". A "stochastic" simulation of variation in recruitment strength can be achieved by running a scenario 1000 times whilst using the variability obtained from the Stock Assessment in the Spawner-Recruit and recruitment pattern parameters (Figure 1). The output of the stochastic runs also allows estimation of the 95% confidence intervals for the evaluation criteria.

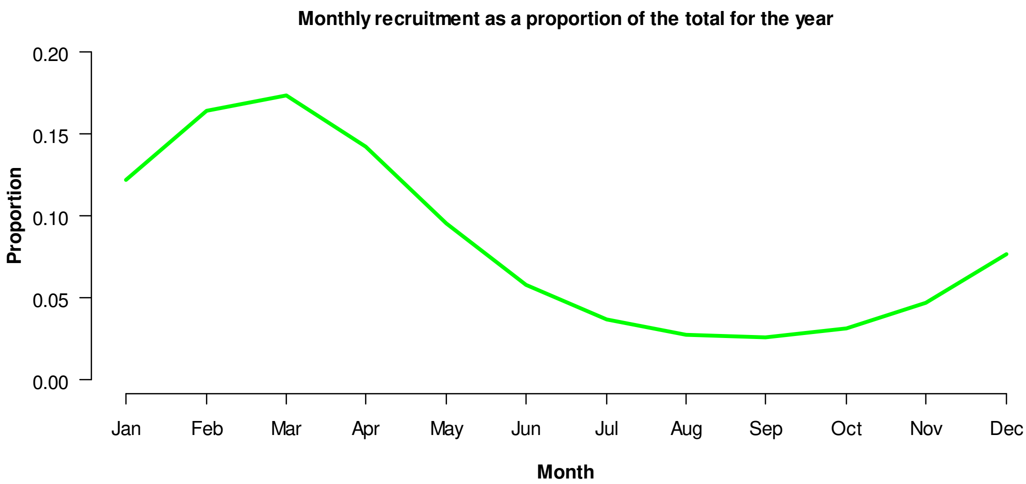

Figure 1 The predicted monthly tiger prawn recruitment as a proportion of annual recruitment based on a two parameter curve that were estimated in the tiger prawn stock assessment update.

DISCUSSION

The proposed model outputs for assessment of each simulation scenario

1. The mean annual tiger prawn CPUE – the primary assessment criterion. This can be converted to $ per unit of fishing effort using the estimated prawn grades and current beach prices data.
2. Monthly tiger prawn CPUE and biomass trajectory – to examine the impact of each month of Fishing Mortality.
3. The predicted tiger prawn size distribution for each month which can then be converted to tiger prawn grade.

The proposed simulation scenarios

The response of the fishing fleet to the timing of a closure opening is the main determinate of annual catch rates, catches and the seasonal biomass trajectory. The monthly fishing effort will partly determine the extent to which the prawn biomass is fished down each month. This fish down will be reduced or negated during months of high prawn recruitment which is generally February to April based on the output of the tiger prawn stock assessment (Figure 1).

Possible “fleet responses” to a closure opening can be quantified for input to the simulation in terms of: (1) annual fishing effort and (2) the proportion of fishing effort in each month. There are an infinite number of variations on these quantities therefore input from the MAC is required on which scenarios to test. Which are the most plausible or likely scenarios? Also which ones are more extreme and less likely but potentially bad for the fishery if they did occur?

Below are the proposed closure scenarios:

1. Season opens on the first day of; February or March or April
   (Should variations of the end of season date (30th November) be simulated? Is there any need to do that?)

2. Monthly Fishing effort scenarios (Figure 2)
   a. Use the mean of the years 2016-19 to simulate a February season opening.
   b. Use the mean of years the 2008-15 to simulate a March season opening.
   c. Use (b) with the March effort redistributed into April and May; 80% to April and 20% to May, to simulate an April season opening.
   d. Simulate a February season opening but with the highest proportion of effort in February then March. This simulates the “pulse fishing” at the start of a season that has frequently occurred after the introduction of a seasonal closure. This scenario has 0.2 as a proportion (or 20%) of the annual total in February. March to October use the proportions from scenario (b) x 0.8 to scale them down and the remainder (1 - sum(February to October) is in November.

3. Total annual fishing effort
   a. Status quo – low effort – average of 2009-19?
   b. Higher effort e.g. 2005-06?

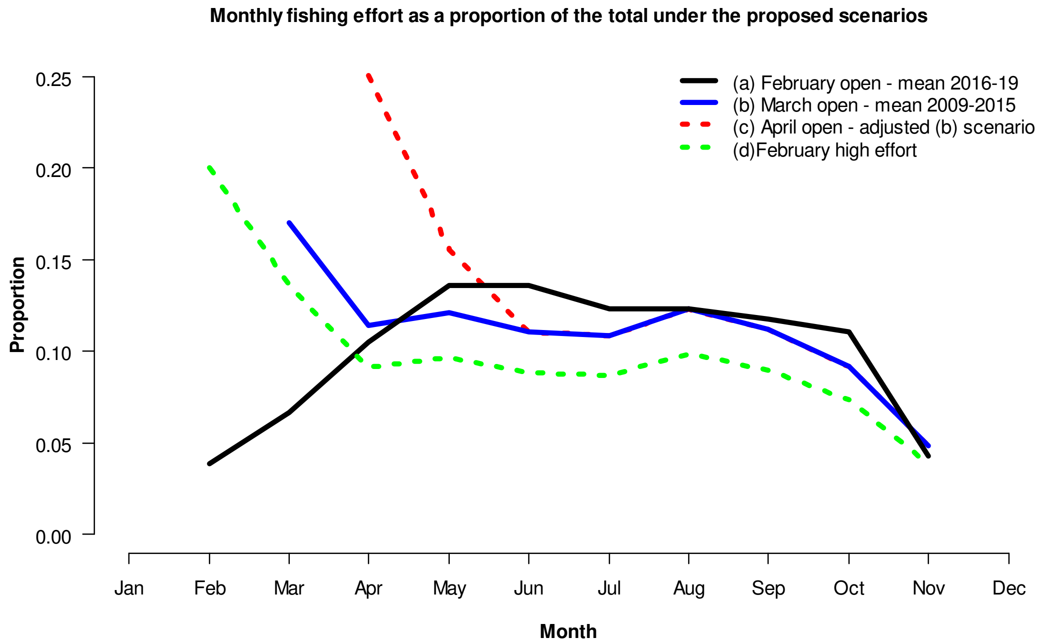

Figure 2 Monthly fishing effort a proportion of the annual total for the proposed monthly fishing scenarios. Note: the proportions for each scenario sum to 1.

Observed monthly fishing effort

Figure 3 shows the observed monthly fishing proportions for the years 2016 to 2019 when February was open to fishing. The dashed black line is the mean or average pattern based on those years, i.e. scenario (a).

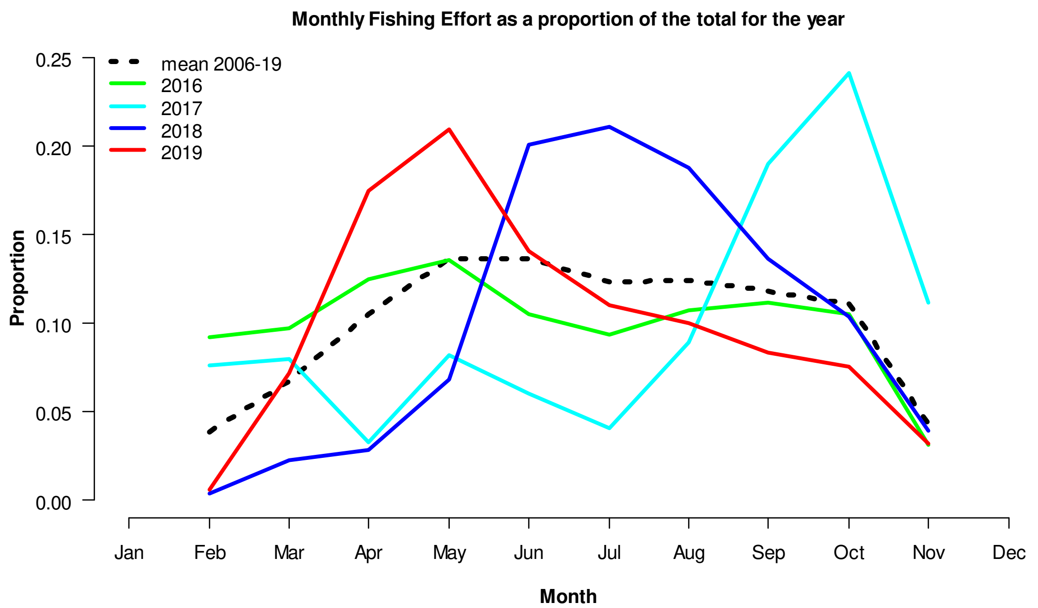

Figure 3 Observed monthly fishing effort as proportions of the annual totals for the years with February open (2016-2019). The dashed black line is the mean pattern for the four seasons.

Note: The analysis of monthly grade data for the 2016 to 2019 seasons will be presented at the meeting.
It may also be possible to present the results of some preliminary simulation runs.

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MANAGEMENT Outcomes and future potential extension work form research project "Improved TSPF profitability and pathways for a sustained flow of TSPF benefits to Torres Strait Island Communities"	Agenda Item No. 4.8

RECOMMENDATIONS

4.8.1 That the TSPMAC **NOTES** the outcomes of the past research project "*Improved TSPF profitability and pathways for a sustained flow of TSPF benefits to Torres Strait Island Communities".*

4.8.2 The TSPMAC **DISCUSSES** the possible initiatives for improving flow of benefits in the fishery, identified through the research project, and their feasibility for progression.

4.8.3 The TSPMAC **DISCUSSES** the steps for pursuing any flow of benefits initiatives that are considered feasible, including possible monitoring and evaluation processes.

BACKGROUND

In 2014, the TSSAC funded a research project "*Improved TSPF profitability and pathways for a sustained flow of TSPF benefits to Torres Strait Island Communities".* This project was initiated due to declining participation and profitability of the TSPF. The TSPMAC over several years of discussion, concluded that a number of the changes to management arrangements that may improve fishery profitability, such as changing gear and boat restrictions, were not supported by Torres Strait communities. The committee thought that an economically efficient TSPF with defined pathways for more meaningful TS Islander involvement and flow of benefits (FoB) to Island communities was also likely to be a more valued, stable, and resilient contributor to the region, and mean communities may be more likely to support changes to improve profitability.

The project outcomes and draft report were discussed at TSPMAC 16 in 2015, and the report was finalised in July 2015.

DISCUSSION

At TSPMAC 18, the committee noted the past project, and the need to review the outcomes, to assess whether projects to improve FoB or profitability can be pursued, or whether additional research is required to explore any of the suggested initiatives. The full report is at Attachment 4.8A.

There were two broad messages of the project:

1. that Industry need to be able to operate in a way that is economically viable for each operator, which may vary. So flexible management arrangements are beneficial. A vessel efficiency trial was identified as the best option for increasing flexibility for operators, with little risk given it would be a trial with restrictions and safeguards.
2. The FoB options identified during the project need to be critically assessed for feasibility. PZJA agencies need to consider questions such as:

- when a “benefit” could be implemented;
- the costs associated with it; and
- whether the “benefit” will provide ongoing opportunities for communities, through training, employment or other ongoing projects, or be a one off/ short term gain only.

The report also made five other recommendations around further exploring FoB:

1. The objectives of any future FoB program involving the TSPF and Traditional Owners in the area of the fishery should be clearly described. This will help to determine the relevance and value of flow of benefit opportunities, assisting a more structured evaluation approach.
2. Further development of more significant flow of benefit opportunities should be based on agreed strategic objectives for the fishery, which should also reflect traditional owner perspectives. Development of these strategic objectives will also reflect current regulatory and policy objectives for the fishery.
3. The Australian Government’s My Pathways program appears to offer one of the best avenues for funding support, including shared funding with other stakeholders, for the implementation of more significant flow of benefit opportunities. Close liaison between My Pathways coordinators and appropriate TSPF, community and PZJA agency representatives is encouraged.
4. Agreed flow of benefit arrangements that can be implemented directly between prawn fishermen and Traditional Owners in their communities should be initiated as soon as possible.
5. A structured monitoring and evaluation approach should be developed for any larger scale future FoB initiatives (for example training Traditional Owners’ as fishery observers). For smaller scale opportunities, particularly those involving TSPF licencees, a simple qualitative evaluation exercise during TSPMAC meetings would be sufficient as well as cost effective.

Table 1 (and attachment 4.8B) includes a list of possible initiatives for increasing FoB, suggested from the project. There is discussion against each option regarding any progress to date, and ideas for the TSPMAC to discuss, including pros and cons of pursuing each initiative. The TSPMAC should also discuss any other possible FoB that could be considered, which are relevant to current fishery objectives.

How do we measure FoB?

This project was initially launched in hope that improving FoB may also increase Torres Strait community support in allowing more flexible management arrangements for the fishery. However in some cases some of the increased benefits to communities could bear a significant cost to industry. As raised in point five above, there will be considerable work required with developing a structured monitoring and evaluation approach, particularly for larger scale FoB projects, to ensure the PZJA can quantify and assess the benefits, if they are worthwhile, and whether benefits outweigh any other costs (i.e. to TSPF licence holders).

Where to from here

The TSPMAC should consider the suggested initiatives, and whether they, or any additional initiatives are worth pursuing, including what steps are needed to pursue them(if they are small or large scale).

Table 1. Possible initiatives to improve FoB to Torres Strait Communities from the Torres Strait Prawn Fishery. The table includes the initiative, current progress (if any) and things the TSPMAC should consider when discussing the potential of the initiative.

Possible initiative	Progress and ideas regarding this possible initiative	Things to consider
Part time logistics support person (2 days/week?) to facilitate logistical support, spares, maintenance for TSPF boats. At sea training programs for traditional owners (particularly younger residents).	Over the past three years, at least one TSPF licence holder has offered traineeships for trades (such as electrician/ boiler maker training) to communities. There were many logistical difficulties and nothing eventuated in terms of traineeships. However, several boats do employ Torres Strait Islanders as crew from time to time, or more permanently, however no formal training has been pursued for traditional inhabitants to gain training/ hours towards master fisherman tickets etc.	If a formal training program which assisted with pairing TSI's with boats for paid work/ training towards fishing tickets, or other training, was established, who could provide such a program? Initiative 1 may have additional challenges, as the costs of having a middle man for organising spare parts may outweigh the benefits of the skipper doing this themselves, given how time critical getting parts can be.
Encourage regular sale of prawns through community shops and freezer facilities.	There is nothing currently stopping fishers from selling directly to community members, freezers or local stores (i.e. IBIS).	The TSPMAC should discuss with TIB members whether this would be seen to benefit communities. If so, how would this be facilitated.
Increase the utilisation of by-product/bycatch through similar arrangements with communities.	Nothing has been done to pursue this to date. Note that byproduct is already sold by license holders (similar to target species). However bycatch isn't and may be able to be utilised through sale for fishmeal or similar.	It would help to review any current fishmeal projects that have been undertaken to gain a better understanding of the feasibility of harvest and sale of fishmeal in the TSPF. This to consider include: • Is the species mix of bycatch quality suitable for fishmeal (quality) • Is there enough quantity to justify the nvestment • Is there demand in the market for fishmeal • What is the infrastructure and set up cost • What would be required of industry to offload product to communities for processing, noting travel and offload time could be an unfeasible burden to industry. Volumes of bycatch and freezer storage space may require boats

		to offload bycatch every 2-3 days.
Examine the suitability of using trawl bycatch species for bait in the Coral Trout line sector.	This idea has not been progressed to date.	There may be a percentage of the bycatch that could be used for bait in the Coral Trout sector. Identifying the species and catch quantities would be needed and agreements made with the industry and communities for implementation if shown to be feasible.
Use TSPF bycatch as the basis of solid feed for grow out of ranched TRL in areas close to communities.	This idea has not been progressed to date.	Given TRL are vegetarian, what is the feasibility of converting meal into acceptable and nutritional pellet form? There is not yet a ranching industry in the Torres Strait but a feasibility for pelletising may be a useful contribution.
Potential to store frozen prawns in community freezers as a contingency arrangement if required.	This suggestion isn't considered to be viable.	This suggestion probably wouldn't provide much flow of benefit and would seldom be needed by fishers.
Seafood branding to capitalise on clean environment, unique culture, and point of origin difference.	The TSRA currently have a project pursuing this branding idea.	The TSRA has undertaken a project to research viable options for Torres Strait Islanders to have greater ownership of the export supply chains to international markets and develop a Torres Strait seafood brand. Currently, the majority of seafood projects are exported through Cairns by a third party, reducing the value captured by the fishery in the region. The project was finalised in July 2019 and identified gaps in capability and infrastructure. A key barrier for fishers is the complexity of information surrounding the establishment and access to export markets. To address this gap, the project has published the 'Torres Strait Fisheries Exports' Handbook'. The handbook is a step by step guide through the exporting process; covering research and planning; regulations and documentation; and marketing and communication. Is there further work that could be done on this project, and how does it relate

		to the TSPF?
Potential for TO's to be trained as fishery observers and operate from home communities e.g. Masig Island;	This suggestion was being pursued by AFMA and TSRA in 2018/19, however no formal progress made on a plan for traditional inhabitant observers, as logistically, it may not be worthwhile pursuing.	The TSPF only undertakes around 30-60 observer days per year, depending on fishing effort. Boats can only generally accommodate one extra person in addition to crew, so most wouldn't be able to house a trained and trainee observer. Torres Strait Islanders are always invited to apply for fishery observer roles through the standard process, where more employment would also be available is likely to be outside of the Torres Strait.

Attachment X – excerpt from TSPMAC 16 minutes regarding project outcomes

Item 3.7 Flow of Benefits to Torres Strait Communities final report

My Bodsworth presented a summary of his research project looking at the profitability of the TSPF and FoB from the TSPF to Torres Strait communities. The project provided two clear outcomes:

3. that Industry need to be able to operate in a way that is economically viable for each operator, which may vary. So flexible management arrangements are beneficial. A vessel efficiency trial was identified as the best option for increasing flexibility for operators, with little risk given it would be a trial with restrictions and safeguards.
4. The FoB options identified during the project need to be critically assessed for feasibility. PZJA agencies need to consider questions such as:
    - when a "benefit" could be implemented;
    - the costs associated with it; and
    - whether the "benefit" will provide ongoing opportunities for communities through training, employment or other ongoing projects or be a one off/ short term gain only.

The TSPMAC acknowledged there are some benefits to everyone, as there is greater potential for more FoB if the restrictions on licence holder profitability are reduced. Further, many of the FoB ideas could be progressed through seeking support from other government funded programs such as activities through MyPathway. The TSPMAC also acknowledged some small projects already undertaken to provide community members opportunities on boats. They may have just worked a night or two in exchange for a few boxes of prawns and have been very appreciative of the opportunity.

The committee discussed a number of other matters including:

Marketing

The costs of marketing campaigns most likely outweigh the benefits in this fishery (around $1/kg increase in product price), and the domestic prawn marketing (Love Australian Prawns campaign) of the past few years is probably already giving benefits to the TSPF. That said, FRDC now offer funding for projects focused around marketing as they have lots of initiatives around seafood marketing right now.

Moving forward with long term issues

The PI also noted there were some matters raised that run across all Torres Strait fisheries that were great insights to move forward with. Commercial fishers and community members alike all have desire to move forward with Torres Strait fisheries, noting there can be a lot of road blocks to progress. Moving on from old discussions and forward in decisions is vital to the future of Torres Strait Fisheries. During the finfish consultation some community members noted that they have been talking about getting freezers on islands for the last 20 years but most still don't have freezers that are operational. Some community members have grown old waiting for opportunities to arise. A stakeholder engagement plan was also raised as an important tool that could facilitate better engagement in all Torres Strait fisheries.

Cost recovery model
The PI discussed the need to review the cost recovery approach in the Torres Strait, given the TSPF is cost recovered, and there are a number of inefficiencies embedded in the processes for PZJA managed fisheries due to the complex management environment.

Bycatch and environment
The committee discussed the by-catches of TRL that sometimes occur on prawn trawlers, and noted that even if large catches sometimes occur, the bycatch on a prawn trawler is very low compared to the overall harvest from the TRL fishery each year. This perspective is important when considering the possible effects of fairly small numbers of TRL occasionally caught on trawlers.
The communities clarified their ongoing concerns around boats that have sunk in the region. Although a notice to mariners is always s issued and placed in communities, communities were eager to receive an incident report and letter to the Prescribed Body Corporates informing them about the boats once the incident cases have closed. The letter would tell PBCs which environmental hazards are on board and whether the boat is going to be salvaged so they are informed of any ongoing hazards in their region. The TSPMAC Chair, who is also the AMSA CEO explained that the diesel fuel used on boats isn't hazardous because it evaporates as soon as it hits the surface of the water.
The committee noted that some of the boats in this fishery also fish in other fisheries in the east coast and gulf. The level of effort in the TSPF is sometimes reflective of the situation in other fisheries in relation to catches and costs of operating. If other fisheries are less viable in a given season, sometimes effort in the TSPF can increase. The TPSF is a careful balance between providing viability of these local fisheries while still allowing efficient profitable fisheries in other areas.

ACTION ITEM 16.10: TSPMAC Chair to write a letter to ASMA and MSQ requesting a letter, including the incident report, be sent to the PBC and communities in the Torres Strait if a vessel sinks in the region. The report should include simple information about the final outcome or an incident (i.e. will the boat be retrieved, how much fuel and other items on board).

Attachment 4.8B – evaluation matrix of possible initiatives for improving flow of benefits to communities.

	Evaluation Criteria (or filters) for TSPF Flow of benefit Candidates . Range for scores is 1-5 with 5 being most beneficial/valuable.							
Flow of benefit Candidates	Economic Efficiency	Level of Impact (contribution)	Practicality (implementation)	Fits community capabilities	Mutual Value (communities & TSPF)	supports strategic objectives	summed scores	weighted scores
Part time logistics support person (2 days/week?) to facilitate logistical support, spares, maintenance for TSPF boats.	4	4	3	3	4	5	23	23
Encourage regular sale of prawns through community shops and freezer facilities.	3	3	4	4	4	4	22	22
Examine the suitability of using trawl bycatch species for bait in the Coral Trout line sector.	4	2	4	4	4	4	22	22
Seafood branding to capitalise on clean environment, unique culture, and point of origin difference.	3	3	3	3	4	5	21	21
Increase the utilisation of by-product/bycatch through similar arrangements with communities.	4	2	3	4	4	3	20	20
Potential to store frozen prawns in community freezers as a contingency arrangement if required.	2	2	3	4	4	4	19	19
At sea training programs for traditional owners (particularly younger residents).	3	3	2	2	4	4	18	18
Potential for TO's to be trained as fishery observers and operate from home communities e.g. Masig Island;	4	2	3	2	3	4	18	16
Use TSPF bycatch as the basis of solid feed for grow out of ranched TRL in areas close to communities.	3	2	2	2	3	3	15	15
Weighting applied per filter	1	1	1	1	1	1		

Note: evaluation criteria (or filters) are intended to guide selection of the most appropriate flow of benefit options (candidates). Criteria may be changed to reflect current objectives, or priorities for the fishery. For example these may be aligned with the st

Economic Efficiency: consider - scale of outcomes, financial viability, economically efficient (benefits exceed costs), low cost to TSPF operators

Level of Impact (contribution): consider - labour (increase supply), increase vessel utilisation, increase catch, increase catch value, increase beach price

Practicality (implementation): consider - set up costs, timeframe for benefits, likely rate and extent of adoption, champions interested, realistic level of cooperation available, extent of external involvement or funding

Fits community capabilities: consider - does it fit with existing skills, community knowledge - or will it require training, does it require additional facilities/investment, alignment with aspirations

Mutual Value (communities & TSPF): consider - extent of benefits accruing to fishers and communities, strategic alignment for TO's, and for TSPF Industry

Supports strategic objectives: consider - builds relationships, supply chain resilience incl mothership, R&D leverage, extends flow of benefits etc

TORRES STRAIT PRAWN MANAGEMENT ADVISORY COMMITTEE	Meeting No. 20 29-30 January 2020
MEETING ADMINISTRATION Actions arising	**Agenda Item No. 6.2** For Discussion

RECOMMENDATIONS

6.2.1 That the Working Group **REVIEW** the TSPF Five Year Research Plan 2020 - 2025 (**Attachment 4a**) which was presented to TSSAC in December 2019.

6.2.2 **DISCUSS** the identified priorities, and any other priorities which should be added to the plan for 2021-2026.

6.2.3 **NOTE** that the next update of the TSPF research plan is due in November 2020 and TSPMAC research priorities will be added in that update.

KEY ISSUES

1. Each year, PZJA Management Advisory Committees, Working Groups and Resource Assessment Groups are tasked with identifying research priorities for their fishery, which fit within the themes of the Torres Strait Strategic Research Plan (SRP) (**Table 1**), for their respective fisheries and updating their five year fishery research plans each year.
2. The TSPF five year rolling research plan was submitted to the TSSAC in December 2019, with no amendments from 2018.
3. The TSPMAC did not recommend any further changes as no urgent research was considered necessary given the small tactical research budget available for 2020.
4. 1 research priority is listed in the plan, titled "*Environment drivers of prawn recruitment in the TSPF and biomass including the impacts of climate change*".
5. This priority was considered by the TSSAC in 2019 and was not initially supported. The TSSAC commented that: *"The committee questioned the timing of this environmental drivers project, noting the low effort in the fishery, and given higher catch rates this year. They agreed this project wasn't a priority this year and should be further developed by the Torres Strait Prawn Management Advisory Committee. In particular, it was unclear whether the first question to be answered was if there have been changes to prawn distribution, and if so, is it related to climate change or other factors. This project may also* be covered by the broader climate change project now proposed".
6. The TSPMAC's initial discussions at TSPMAC 18 (June 2018), were simply to pursue this project in order to explore any possible environmental or climate change factors that may be prawn recruitment in the TSPF, noting the very low effort in 2017 (934 days) and lower catch rates (around 152 kg/day/boat as opposed to over 200 in past years).
7. The TSPMAC should discuss this research priority again, and clarify the specific needs, urgencies, and whether it is still a priority, particularly noting the broader climate change project currently underway in the Torres Strait.
8. The TSPMAC should also discuss other possible research priorities. One possible priority includes the possible need to conduct a management strategy evaluation regarding the

harvest strategy triggers and decisions rules in the future. This would likely be a long term objective, and its urgency will be identified through discussions under agenda item 4.4

BACKGROUND

9. The Torres Strait Scientific Advisory Committee operates under a Five Year Strategic Research Plan (SRP). The SRP is the overarching document providing the TSSAC's strategic themes which guide priority setting for research in the Torres Strait fisheries over a five year period. The document identifies three research themes, and under these, strategies and possible research activities against these themes. The document also provides guidance to researchers on research application development and the TSSAC and PZJA forums in assessing applications through the assessment criteria in the SRPs appendices. The SRP was finalised by the TSSAC in mid-July 2018.

10. The TSSAC requires each fishery to develop a five year fisheries research plan, which fits into the themes identified in this SRP.

Torres Strait Fisheries Strategic Research Plan 2018-2023

11. The SRP specifies the research priorities and strategies that the PZJA intend to pursue in Torres Strait fisheries, and provides background to the processes used to call for, and assess, research proposals. The research priorities can be broad, covering all topics within the SRP, some of which may be funded by AFMA, and some of which may require funding from other funding bodies.

Table 1. Torres Strait fisheries strategic research themes, strategies and research activities

Theme 1: Protecting the Torres Strait marine environment for the benefit of Traditional Inhabitants	
Aim: Effective management of fishery stocks based on understanding species and their biology and ecological dependencies so it can support Traditional Inhabitant social and economic needs.	
Strategy 1a - Fishery stocks, biology and marine environment	Possible research activities under this theme may include: a. Stock assessment and fishery harvest strategies for key commercial species. b. Ecological risk assessments and management strategies for fisheries. c. Minimising marine debris in the Torres Strait. d. Addressing the effects of climate change on Torres Strait fisheries through adaptation pathways for management, the fishing industry and communities. e. Incorporating Traditional Ecological Knowledge into fisheries management. f. Methods for estimating traditional and recreational catch to improve fisheries sustainability.
Strategy 1b – Catch sharing with Papua New Guinea	Possible research activities under this theme may include: a. Status of commercial stocks and catches by all sectors within PNG jurisdiction of the TSPZ. b. Good cross-jurisdictional fisheries management through better monitoring and use of technology.
Theme 2: Social and Economic Benefits	
Aim: Increase social and economic benefits to Traditional Inhabitants from Torres Strait Fisheries.	
Strategy 2a - Promoting social benefits and economic development in the Torres Strait, including employment opportunities for Traditional Inhabitants	Possible research activities under this theme may include: a. Models for managing/administering Traditional Inhabitant quota b. Understanding what influences participation in commercial fishing by Traditional Inhabitants. c. Understanding the role and contribution of women in fisheries. d. Capacity building for the governance of industry representative bodies e. Methods for valuing social outcomes for participation in Torres Strait fisheries. f. Identifying opportunities and take-up strategies to increase economic benefits from Torres Strait fisheries.
Theme 3: Technology and Innovation	
Aim: To have policies and technology that promote economic, environmental and social benefits from the fishing sector.	
Strategy 3a – Develop technology to support the management of Torres Strait fisheries.	Possible research activities under this theme may include: a. Electronic reporting and monitoring in the Torres Strait, including for small craft. b. Technologies or systems that support more efficient and effective fisheries management and fishing industry operations.

Five year rolling fishery research plan 2020/21 – 2024-2025 for the Torres Strait Prawn Fishery. Shading represents the years funding could be given for this project.

Fishery	Proposed Project	Objectives and component tasks	Year project to be carried out and indicative cost*						Other funding bodies[1]	Evaluation		
			2020/21	2021/22	2022/23	2023/24	2024/25	Notes on project timings		Priority essential /desirable	Priority ranking (1-5 – 1 being highest priority)	Theme[2]
TSPF	**Environment drivers of prawn recruitment in the TSPF and biomass including the impacts of climate change.** **NOTE: this project will be undergoing further discussion at the January meeting, following advice from TSPMAC to clarify the project intensions.**	This project aims to explore any possible environmental or climate change factors that may be effecting prawn recruitment into the TSPF, noting the changes the last few years.		$60 000 (only $15000 to be funded by TSSAC and rest cost recovered)				This project requires review by the TSPMAC in January 2020, following TSSAC advice to clarify the project intention.		Essential or highly desirable	1	