TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP 32

Wednesday 15 December 2021 9am – 5pm

The Sebel, Cairns / Video conference

ADOPTED AGENDA

1 PRELIMINARIES

1.1 Welcome and apologies

The Chair will welcome members and observers to the 32nd meeting of the TRL RAG.

1.2 Adoption of agenda

The RAG will be invited to adopt the draft agenda.

1.3 Declaration of interests

Members and observers will be invited to declare any real or potential conflicts of interest and determine whether a member may or may not be present during discussion of or decisions made on the matter which is the subject of the conflict.

1.4 Action items from previous meetings

The RAG will be invited to note the status of action items arising from previous meetings.

1.5 Out of session correspondence

The RAG will be invited to note out of session correspondence on RAG matters since the previous meeting.

2 UPDATES FROM MEMBERS

2.1 Industry and Scientific members

Industry, scientific and government agency members and observers will be invited to provide verbal updates on matters concerning the Torres Strait TRL Fishery including updates on fishing patterns, behaviours, prices, and market trends this season.

2.2 Government agencies

The RAG will be invited to note updates from AFMA, TSRA and QDAF on matters concerning the Torres Strait TRL Fishery.

2.3 Papua New Guinea National Fisheries Authority

The RAG will be invited to note a verbal update from the PNG National Fisheries Authority.

2.4 Native Title

The RAG will be invited to note a verbal update from Malu Lamar (Torres Strait Island) Corporation RNTBC.

3 CATCH AND EFFORT ANALYSES FOR THE 2020-21 FISHING SEASON

The RAG will be invited to discuss TRL fishery catch and effort data for the 2020-21 fishing season, including catch-per-unit-effort (CPUE) analyses to be presented by the CSIRO.

4 RESULTS OF THE NOVEMBER 2021 PRE-SEASON SURVEY

The RAG is invited to discuss the results of the November 2021 pre-season survey to be presented by the CSIRO.

5 RECOMMENDED BIOLOGICAL CATCH

The RAG will be invited to provide advice on a recommended biological catch (RBC) for the TRL Fishery for the 2021-22 fishing season, based on estimates derived through the application of the empirical harvest control rule (eHCR). The RAG will also consider the options for managing the lower than expected total catch value for the 2021-22 fishing season and its implications for applying the eHCR, as per the recommendations of TRLRAG 31 (12 October 2021), to be presented by the CSIRO.

6 (NEW) COMPLIANCE MONITORING AND REPORTING OF DISCARDS

Traditional inhabitant members requested this agenda item to discuss the issue of reporting and compliance monitoring of discards in the fishery to ensure accurate reports of the total amount of lobsters being taken from the fishery.

7 OVERVIEW OF THE QUEENSLAND EAST COAST TRL FISHERY STOCK ASSESSMENT

The RAG is invited to note an overview of the Queensland East Coast TRL Fishery Stock Assessment presented by Fisheries Queensland Scientist, Fay Helidoniotis. Given that both the Torres Strait and Queensland East Coast fisheries are considered part of a single population, it is useful for the TRLRAG and the Queensland TRL Working Group liaise together on the stock assessments for the TRL fisheries and ensure consistency where possible.

8 INTERACTIONS BETWEEN THE TRL AND TORRES STRAIT PRAWN FISHERY

The RAG is invited to note a presentation from CSIRO on the results of the preliminary analyses of available observer data on TRL bycatch in the Torres Strait Prawn Fishery (TSPF) as collected from the AFMA Observer Program from 2007 to 2019.

9 RESEARCH PRIORITIES

The RAG will be invited to discuss and provide advice on future research priorities for the TRL Fishery.

10 OTHER BUSINESS

The RAG will be invited to raise any other matters for consideration.

11 DATE AND VENUE FOR NEXT MEETING

The RAG will be invited to discuss a suitable date for the next RAG meetings.

The Chair must approve the attendance of all observers at the meeting. Individuals wishing to join the meeting as an observer must contact the Executive Officer – Georgia Langdon (georgia.langdon@afma.gov.au)

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video conference	MEETING 32 15 December 2021
PRELIMINARIES Welcome and apologies	Agenda Item 1.1 For NOTING

RECOMMENDATIONS

1. That the RAG **NOTE**:
    a. an acknowledgement of Traditional Owners;
    b. the Chair's welcome address;
    c. apologies received from members unable to attend.

BACKGROUND

2. As at 1 December 2021, no apologies had been received.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
PRELIMINARIES Adoption of agenda	Agenda Item 1.2 For DECISION

RECOMMENDATIONS

1. That the RAG consider and **ADOPT** the agenda.

BACKGROUND

2. This meeting was noted by members at TRLRAG 30 (16 December 2020) with key agenda items including:
    a. consideration of the results of the November 2021 pre-season survey;
    b. consideration of the CPUE analyses for the 2020-21 fishing season; and
    c. consideration of the recommended biological catch (RBC) estimates derived through the application of the empirical harvest control rule (eHCR) under the TRL Harvest Strategy and provision of advice on a RBC for the 2021-22 fishing season.
3. A draft agenda was circulated to members on 16 November 2021. A revised (v3) agenda was circulated to members on 2 December 2021.
4. No comments were received on the draft agenda.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
PRELIMINARIES Declaration of interests	Agenda Item 1.3 For Decision

RECOMMENDATIONS

1. That RAG members and observers:
   a. **DECLARE** all real or potential conflicts of interest in the Torres Strait Rock Lobster Fishery at the commencement of the meeting (**Attachments 1.3a** and **1.3b**);
   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 RAG 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 RAG 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

2. 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.
3. RAG members are asked to confirm the standing list of declared interests (**Attachments 1.3a** and **1.3b**) is accurate and provide an update to be tabled if it is not.
4. 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.
5. 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.
6. 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.

TRLRAG Declarations of interests from most recent meetings

Name	Position	Declaration of interest
Members		
Ian Knuckey	Chair	Chair/Director of Fishwell Consulting Pty Ltd and Olrac Australia (electronic logbooks). Chair/member of other RAGs and MACs. Conducts various AFMA and FRDC funded research projects including FRDC Indigenous Capacity Building project. Nil interests in TRL Fishery and no research projects in the Torres Strait. In 2019, delivered components of TSRA Induction Program for Traditional Inhabitant members on PZJA advisory committees. Full declaration of interests provided at **Attachment 1.3b.**
Eva Plaganyi	Scientific Member	Lead scientist for PZJA funded TRL research projects conducted by CSIRO.
Andrew Penney	Scientific Member	Director of Pisces Australis Pty Ltd, an Australian registered marine/coastal research and management consultancy based in Canberra - interests in any opportunities in this regard. Currently Principal Investigator on FRDC Projects Nos 2017-180: Design and implementation of an Australian National Bycatch Report: Phase 1 – Scoping; and 2019-036: Implementation of dynamic reference points and harvest strategies to account for environmentally-driven changes in productivity in Australian fisheries, potentially red leg banana prawns or TRL. Independent scientific member on the AFMA Southeast RAG, the Tropical Rock Lobster RAG and the Small Pelagic Fishery RAG. Member of the AFMA ERA Technical Working Group. No shareholding and hold no positions relating to any other companies, including any fishing companies or industry associations.
Aaron Tom	Traditional Inhabitant Member	Traditional Inhabitant Gudumalulgal and TIB licence holder.
Les Pitt	Traditional Inhabitant Member	Traditional Inhabitant Kemer Kemer Meriam, TIB licence holder and runs an independent freezer facility on Erub Island.
Harry Nona	Traditional Inhabitant Member	Traditional Inhabitant Kaiwalagal and TIB licence holder.
James Ahmat	Traditional Inhabitant Member	Traditional Inhabitant Maluialgal and TIB licence holder.

James Billy	Traditional Inhabitant Member	Traditional Inhabitant Kulkalgal, TIB licence holder, Coxwains holder and free diver.
Brett Arlidge	Industry Member	General Manager MG Kailis Pty Ltd. MG Kailis Pty Ltd is a holder of 5 TVH licences. Seafood buyer from Torres Strait, QLD and PNG TRL fisheries.
Ray Moore	Industry Member	Torres Strait Master Fisherman licence holder and East Coast TRL Fishery licence holder.
Keith Brightman	TSRA Member	Nil. TSRA holds multiple TVH TRL fishing licences on behalf of Torres Strait Communities but does not benefit from them.
Jenny Keys	QDAF Member	To be declared.
Selina Stoute	AFMA Member	Nil.
Georgia Langdon	Executive Officer	Nil.
Observers		
Joseph Posu	PNG National Fisheries Authority	To be declared.
Ian Liviko	PNG National Fisheries Authority	To be declared.
Yen Loban	TSRA Board Member and TSRA Portfolio Member for Fisheries	TIB licence holder.
Maluwap Nona	Malu Lamar (Torres Strait Islander) Corporation RNTBC	To be declared.
Mark David	TRL WG Traditional Inhabitant Member	Traditional Inhabitant Kulkalgal and TIB licence holder.
Quinten Hirakawa	TSRA	TIB licence holder with a TRL endorsement
Fay Helidoniotis	Fisheries Queensland	To be declared.
Judy Upston	CSIRO	Nil pecuniary interests. Project staff for PZJA funded TRL research projects.
Rob Campbell	CSIRO	Independent fisheries consultant with no pecuniary interest in the Torres Strait rock lobster fishery. Former employee of CSIRO and former team member of PZJA funded TRL research projects.
Leo Dutra	CSIRO	No other interest in TRL fishery apart from involvement in research. Project lead for FRDC funded project: Shared science and Indigenous knowledge to support fisheries capacity building in Torres Strait. Member of TRL science survey project team.

Nicole Murphy	CSIRO	Nil pecuniary interests. Project staff for PZJA funded TRL research projects.
Laura Blamey	CSIRO	To be declared.
Marjoleine Roos	CSIRO/University of Queensland	To be declared.

Declaration of interests
Dr Ian Knuckey – October 2021

Ian Knuckey positions:

Director –	Fishwell Consulting Pty Ltd
Director –	Olrac Australia (Electronic logbooks)
Chair –	Northern Prawn Fishery Resource Assessment Group
Chair –	Tropical Rock Lobster Resource Assessment Group
Chair –	Victorian Rock Lobster and Giant Crab Assessment Group
Chair –	Victorian Central Zone Abalone Fisheries Resource Advisory Group
Chair –	Gulf of St Vincent's Prawn Fishery MAC Research Scientific Committee
Scientific Member –	Northern Prawn Management Advisory Committee
Scientific Member –	SESSF Shark Resource Assessment Group
Scientific Member –	SESSF Great Australian Bight Resource Assessment Group
Scientific Member –	Gulf of St Vincent's Prawn Fishery Management Advisory Committee
Scientific Member –	Tropical Tuna Resource Assessment Group
Scientific Member –	SESSF Resource Assessment Group
Member –	Victorian Marine and Coastal Council
Member –	The Geelong Agri Collective

Fishwell current projects:

DAWE Project	Multi-sector fisheries capacity building
AFMA 2020-0807	Bass Strait Scallop Fishery Survey – 2020-22
AFMA 2019-0836	Information the Bass Strait Central Zone Scallop Fishery Harvest Strategy and TAC setting process with economic data and MEY proxies
FRDC project	Principal Investigator for SA Peak Industry body project
AFMA project	Design sea cucumber fishery-independent survey for Coral Sea
FRDC 2019-027	Improving and promoting fish-trawl selectivity in the SESSF and GABTS
FRDC 2019-072	A survey to detect change in Danish Seine catch rates of Flathead and School Whiting resulting from CGG seismic exploration.
FRDC 2019-129	Potential transition of shark gillnet boats to longline fishing in Bass Strait - ecological, cross-sectoral, and economic implications
FRDC 2018-021	Development and evaluation of SESSF multi-species harvest strategies
Traffic Project	Shark Product Traceability
NT Fisheries	Design and implementation of a tropical snapper trawl survey
Sea Cucumber Ass.	Design and implementation of various sea cucumber dive surveys.
Australia Bay	Queensland Gulf of Carpentaria Developmental Fin Fish Trawl Fishery
Tas. Abalone	Scientific Advisor for Tasmanian Abalone Council Ltd
PEMSEA	Developing EAFM Plan for Red Snapper in Arafura and Timor Seas

Beach Energy	BACI study of Prion Marine Seismic Survey impacts relative biomass of scallops on beds in the immediate vicinity.
Expert Witness	Gladstone Harbour development impact

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
PRELIMINARIES Action items from previous meetings	Agenda Item 1.4 For Discussion and Advice

RECOMMENDATIONS

1. That the RAG:
   a. **NOTE** the progress against actions arising from previous meetings (**Attachment 1.4a**)
   b. **NOTE** the final meeting records for TRLRAG 30 (**Attachment 1.4b**) and TRLRAG 31 (**Attachment 1.4c**) held on 16 December 2020 and 12 October 2021 respectively.
   c. **PROVIDE ADVICE** on any new key events that have been added to the TRL Management History timeline (**Attachment 1.4d).**

BACKGROUND

Actions arising

2. Updates are provided on the status of actions arising from previous TRLRAG meetings and relevant TRLWG meetings at **Attachment 1.4a**.

Meeting records

3. The draft meeting record for TRLRAG 30 held on 16 December 2020 via video conference was provided out of session for comment on 11 January 2021. Minor comments were received from CSIRO.
4. The record was finalised out of session following the closure of the comment period and circulated to members on 27 January 2021. This included a tracked-change version showing the comments received. The final meeting record is provided at **Attachment 1.4b** for information.
5. The draft meeting record for TRLRAG 31 held on 12 October 2021 via video conference was provided out of session for comment on 16 November 2021. No comments were made on the record, and no changes were made.
6. The record was finalised out of session following the closure of the comment period and circulated to members on 1 December 2021. The final meeting record is provided at **Attachment 1.4c** for information.

TRL Management History Timeline

7. As an action arising from TRLRAG 14 (25-26 August 2015), AFMA and CSIRO were tasked with preparing a timeline of key events that have occurred in the Torres Strait Tropical Rock Lobster Fishery. A draft timeline was provided to TRLRAG 30 (16 December 2020).
8. The timeline is intended to be a living document, to be updated as relevant management events in the fishery occur. AFMA proposes that this document be a standing agenda item under Agenda Item 1.4 Actions Arising for the RAG to be updated as required.
9. The RAG is asked to provide advice on new key events that have been added to the Management History timeline since the last RAG meeting (provided at **Attachment 1.4d**).

Action items from previous TRLRAG meetings

#	Action Item	Meeting	Responsible Agency/ies	Due Date	Status
1.	AFMA and CSIRO prepare a timeline of key events that have occurred in the Torres Strait Tropical Rock Lobster Fishery (e.g. licence buy backs, weather events and regulation changes) and provide a paper to TRLRAG.	TRLRAG14 (25-26 August 2015)	AFMA CSIRO	TRLRAG17 (31 March 2016)	**Complete** A draft timeline was provided to TRLRAG 30 (16 Dec 2020) at **Attachment 1.4d.** The timeline is intended to be a living document, to be updated as relevant management events in the fishery occur. AFMA proposes that this document be a standing agenda item for the RAG to be updated as required. The RAG is asked to provide advice on new key events that have been added to the Management History timeline since the last RAG meeting.
2.	CSIRO to investigate the length frequency conversion factors from the catch weight data provided by MG Kailis.	TRLRAG25 (11-12 December 2018)	CSIRO	2019	**Ongoing** CSIRO will provide a verbal update on this action at the meeting.
3.	Considering assessment timelines, PNG NFA to provide CSIRO with a best estimate of PNG catches by mid-November. CSIRO to liaise closely with PNG regarding reporting timeframes and provision of catch data. In parallel, the RAG data sub-group to examine ways to adjust the stock assessment model to account for delayed catch data from PNG.	TRLRAG25 (11-12 December 2018)	PNG NFA CSIRO AFMA RAG Data Sub-Group	2019	**Ongoing** PNG provided AFMA with a summary of TRL catch by month and processed weight from 1 January to 31 August, which is included in **Attachment 3c.** The RAG may need to consider using an extrapolation approach to estimating total PNG catch in the absence of complete data sets on an ongoing basis – for discussion under **Agenda Item 3.** AFMA continues to liaise with PNG NFA to obtain best estimate catch data and logbook data as inputs to the eHRC calculations.

#	Action Item	Meeting	Responsible Agency/ies	Due Date	Status
4.	That the TRL RAG data subcommittee discuss which TVH CPUE series are the best to use within the model.	TRLRAG25 (11-12 December 2018)	AFMA RAG Data Sub-Group	2019	**Ongoing** The RAG Data Sub-Group last met on 18 June 2019, however this item was not considered. This item remains on the agenda for the Data Sub-group. Due to the timing of the black teatfish opening in the Torres Strait Beche-de-mer Fishery, which commenced on 30 April 2021, and the level of AFMA resources required to support a successful opening, AFMA had to reprioritise some of other fisheries work during the first half of 2021. As a result, the Data Sub-group did not meet this calendar year. To be placed on the agenda for the next RAG Data Sub-group meeting – to be discussed under **Agenda Item 10.**
5.	CSIRO to undertake further investigations to improve the GLM approach, and present the findings to the next meeting of the RAG.	TRLRAG26 (5 February 2019)	CSIRO	TRLRAG27	**Ongoing.** CSIRO will provide an update on this action at the meeting.
6.	AFMA and CSIRO to work closely with industry to develop an index or key of diver names and 'clean up' the data diver name dataset to feed in to the next seasons' CPUE standardisation.	TRLRAG27 (10-11 Dec 2019)	AFMA CSIRO	TRLRAG29	**Ongoing.** CSIRO will provide an update on this action at the meeting.
7.	That the RAG (or RAG Data Sub-Group) determine whether there are better measures of effort in the fishery (hours vs	TRLRAG27 (10-11 Dec 2019)	TRLRAG Data Sub-group	TRLRAG29	**Ongoing.** This item remains on the agenda for the Data Sub-group.

#	Action Item	Meeting	Responsible Agency/ies	Due Date	Status
	days; time spent travelling, searching and actively fishing), and clarifying "number of fishers/divers" on TDB02 catch disposal record book.				Due to the timing of the black teatfish opening in the Torres Strait Beche-de-mer Fishery, which commenced on 30 April 2021, and the level of AFMA resources required to support a successful opening, AFMA had to reprioritise some of other fisheries work during the first half of 2021. As a result, the Data Sub-group did not meet this calendar year. To be placed on the agenda for the next RAG Data Sub-group meeting – to be discussed under **Agenda Item 10.**
8.	AFMA to provide all available information and data on the Torres Strait Prawn Fishery (TSPF) observer program for further analysis by CSIRO and the RAG to examine the impacts of the TSPF on the TRL Fishery.	TRLRAG27 (10-11 Dec 2019)	AFMA CSIRO	TRLRAG29	**Ongoing.** CSIRO has prepared a preliminary analysis of available Torres Strait Prawn Fishery (TSPF) observer data to examine the interactions between the Torres Strait prawn and TRL fisheries (**Attachment 7a**). A brief presentation on the analysis will be presented by CSIRO under **Agenda Item 7**.
9.	Industry member Brett Arlidge to provide size distribution data on tailed PNG product to CSIRO when available.	TRLRAG28 (7 May 2020)	Brett Arlidge, industry member	TRLRAG30	**Ongoing.** Brett Arlidge will provide an update on this action at this meeting.
10.	AFMA to approach known TRL buyers and request the sharing of price data to support CSIRO's catch and effort data analysis.	TRLRAG29 (6 Oct 2020)	AFMA	TRLRAG30	**Ongoing.** AFMA has contacted key buyers in the Fishery to request price data. No responses have yet been received.

Relevant action items from previous TRLWG meetings*

#	Action Item	Meeting	Responsible Agency/ies	Due Date	Status
1.	Discard reporting and estimation be considered by the RAG (possibly by the RAG data subgroup)	TRLWG8 (8 November 2018)	AFMA RAG Data Sub-Group	2019	**Ongoing** This item remains on the agenda for the Data Sub-group. Due to the timing of the black teatfish opening in the Torres Strait Beche-de-mer Fishery, which commenced on 30 April 2021, and the level of AFMA resources required to support a successful opening, AFMA had to reprioritise some of other fisheries work during the first half of 2021. As a result, the Data Sub-group did not meet this calendar year. To be placed on the agenda for the next RAG Data Sub-group meeting – to be discussed under **Agenda Item 10.**
2.	RAG to consider the merit and options for improving the index of 0+ lobster abundance, through logbooks or other means. The Working Group noted that this would may be relevant to the RAG data sub-committee.	TRLWG8 (8 November 2018)	AFMA RAG Data Sub-Group	2019	**Ongoing** This item remains on the agenda for the Data Sub-group. Due to the timing of the black teatfish opening in the Torres Strait Beche-de-mer Fishery, which commenced on 30 April 2021, and the level of AFMA resources required to support a successful opening, AFMA had to reprioritise some of other fisheries work during the first half of 2021. As a result, the Data Sub-group did not meet this calendar year. To be placed on the agenda for the next RAG Data Sub-group meeting – to be discussed under **Agenda Item 10.**

*TRLWG actions not relevant to TRLRAG have not been included in the above.

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Australian Government
Australian Fisheries Management Authority

Contents

Meeting participants

Members

Name	Position	Declaration of interest
Ian Knuckey	Chair	Chair/Director of Fishwell Consulting Pty Ltd and Olrac Australia (electronic logbooks). Chair/member of other RAGs and MACs. Conducts various AFMA and FRDC funded research projects including FRDC Indigenous Capacity Building project. Nil interests in TRL Fishery and no research projects in the Torres Strait. In 2019, delivered components of TSRA Induction Program for Traditional Inhabitant members on PZJA advisory committees. Has been approached by TSRA to deliver capacity building workshops for the new Zenadth Kes board members. Full declaration of interests provided at **Attachment A.**
Dr Andrew Penney	Scientific member	Director of Pisces Australis Pty Ltd, an Australian registered marine/coastal research and management consultancy based in Canberra - interests in any opportunities in this regard. Currently Principal Investigator on FRDC Projects Nos 2017-180: Design and implementation of an Australian National Bycatch Report: Phase 1 – Scoping; and 2019-036: Implementation of dynamic reference points and harvest strategies to account for environmentally-driven changes in productivity in Australian fisheries, potentially red leg banana prawns or TRL. Independent scientific member on the AFMA Southeast RAG, the Tropical Rock Lobster RAG and the Small Pelagic Fishery RAG. Member of the AFMA ERA Technical Working Group. No shareholding and hold no positions relating to any other companies, including any fishing companies or industry associations.
Dr Éva Plagányi	Scientific member	Lead scientist for PZJA funded TRL research projects conducted by CSIRO.
Aaron Tom[1]	Traditional Inhabitant member	Traditional Inhabitant Gudumalulgal and TIB licence holder.
Harry Nona	Traditional Inhabitant member	Traditional Inhabitant Kaiwalalgal

[1] Joined the meeting at the end of Agenda Item 5

Name	Position	Declaration of interest
James Ahmat	Traditional Inhabitant member	Traditional Inhabitant Maluililgal
James Billy	Traditional Inhabitant member	Traditional Inhabitant Kulkalgal. TIB licence holder, Coxwains holder and free diver.
Brett Arlidge	Industry member	General Manager, MG Kailis Pty Ltd. MG Kailis Pty Ltd is a holder of 5 TVH licences. Seafood buyer from Torres Strait, Queensland and PNG TRL fisheries.
Selina Stoute	AFMA member	Nil.
Mark Anderson[2]	TSRA member	Nil. Employee of TSRA. TSRA holds multiple TVH TRL fishing licences on behalf of Torres Strait Communities but does not benefit from them.
Georgia Langdon	AFMA Executive Officer	Nil.

Observers

Name	Position	Declaration of interest
Dr Judy Upston	CSIRO observer	Scientist for PZJA funded TRL research projects conducted by CSIRO.
Roy Deng	CSIRO observer	Scientist for PZJA funded TRL research projects conducted by CSIRO.
Steven Edgar	CSIRO observer	Scientist for PZJA funded TRL research projects conducted by CSIRO.
Dr Leo Dutra	CSIRO observer	Scientist for PZJA funded TRL research projects conducted by CSIRO. Recently received Fisheries Research and Development Council (FRDC) funding to undertake a capacity building project. Also the project lead on an AFMA funded climate change project (2019/0830).
Nicole Murphy	CSIRO observer	Scientist for PZJA funded TRL research projects conducted by CSIRO. Project lead on AFMA funded Torres Strait Beche-de-mer project (2019/0826).
Dr Laura Blamey	CSIRO observer	Scientist for PZJA funded TRL research projects conducted by CSIRO.
Alex Kailis	Industry Observer	Group Director of MG Kailis Pty Ltd. MG Kailis Pty Ltd is a holder of 5 TVH licences. Seafood buyer from Torres Strait, Queensland and PNG TRL fisheries.
Patrick Mills	Industry observer	TRLRAG member for Kaiwalagal and Torres Strait Scientific Advisory Committee.

[2] Left the meeting during Agenda item 3, between 10:30am and 11am. Was absent from meeting from 1:20pm onwards.

Name	Position	Declaration of interest
Quinten Hirakawa	TSRA observer	TSRA senior project officer, TIB licence holder, with a TRL entry

1 Preliminaries

1.1 Welcome and apologies

1. The meeting commenced at 9:08 am on Wednesday 16 December 2020. Attendees were welcomed by the Chair who provided an Acknowledgement of Country.
2. Attendees at the RAG meeting are detailed in the meeting participant tables at the start of this meeting record.
3. Apologies were received from:
    a) Les Pit, Traditional Inhabitant member, Kemer Kemer Meriam; and
    b) Dr Ray Moore, Industry member.
4. Members and permanent observers not in attendance were:
    a) Samantha Miller, Queensland Department of Agriculture and Fisheries member;
    b) Malu Lamar RNTBC representative, permanent observer; and
    c) Papua New Guinea National Fisheries Authority (PNG NFA) representative, permanent observer.

1.2 Adoption of agenda

5. The RAG considered and adopted the draft agenda circulated to members on 13 November 2020 with the following items added to be discussed within the agenda:
    a) The independent scientific member suggested expanding the discussion under Agenda Item 5 – Recommended Biological Catch (RBC) to include discussions relating to the empirical harvest control rule (eHCR) and developing meta rules to deal with extra-ordinary circumstances (such as COVID-19) in future.
    b) A CSIRO Observer requested some time during Agenda Item 6 – Other Business, to present information to the RAG on a recently approved FRDC project on capacity building.
6. The draft agenda, adopted without change is at **Attachment B**.

1.3 Declaration of interests

7. As provided in PZJA Fisheries Management Paper No. 1 (FMP1), all members of the RAG must declare all real or potential conflicts of interest in the Torres Strait TRL Fishery at the commencement of the meeting.
8. Where it is determined that a direct conflict of interest exists, the RAG may allow the member(s) to continue to participate in the discussions relating to the matter but may also determine that, having made their contribution to the discussions, the member should retire from the meeting for the remainder of the discussions on that issue. The Chair noted that this is a standard RAG and Working Group process that aids in protecting the integrity of the advice provided by the group as well as the individual members.
9. The Chair requested that members update the record of declarations. These are detailed in the meeting participant tables at the start of this meeting record.

10. The RAG agreed that given no research priorities were being discussed at this meeting, there were no agenda items that would require the scientific members to leave the discussion.

11. The RAG acknowledged that although the eHCR provides automated outputs on an RBC, industry may be required to leave the meeting temporarily during discussions/recommendations relating to alternative RBC scenarios.

12. The RAG agreed that otherwise, it was acceptable for all RAG members and observers to participate in the discussions.

1.4 Action items

13. All updates on the status of actions items arising from previous TRLRAG, and where relevant, TRL Working Group meetings (**Agenda item paper 1.4a**), were taken as read and discussed by exception:

    a) Action item 1 – AFMA thanked Dr Ray Moore for his contributions to the updated draft TRL Management History timeline. The RAG acknowledged the importance of such a document in capturing changes and key events in the fishery through time. RAG members and observers were encouraged to read through the document out of session and provide any comments or updates to AFMA. The RAG also noted that although not considered management changes, the events of 2020 (i.e. COVID-19 related market disruptions, and more recently ongoing trade disruptions) will be important to include in the timeline.

1.5 Out of session correspondence

14. All out of session correspondence on RAG matters since the previous meeting was taken as read and were not explicitly discussed.

2 Updates from members

2.1 Industry and scientific members

15. The RAG noted verbal updates provided by industry and scientific members and observers on the trends and observations in the TRL fishery during the 2019-20 season, and the start of the 2020-21 season, in particular:

    a) That there are fewer lobsters around the inner and near western islands this December, compared with previous seasons. Lobster sizes are small and new recruits (1+) don't appear to be moving in to the fishery yet.

    b) Kulkalgal communities are also not seeing many 1+ lobsters around, with a slow start to the season so far, however there are high numbers of little crays (0+) on the reeftops. The weather and water temperatures seem normal, and conditions are expected to change when the north-west winds set in. There are lots of moulting lobsters that are residuals from the previous fishing season, which appear to be moulting later in the season than usual. COVID-19 and the current issues with lobster trade into China is impacting on prices in the outer islands. Prices ranges between buyers from $20/kg for <1kg lobsters, $28/kg for 1-1.5kg lobsters and $35 for >1.5kg lobsters, and from $30 to $36/kg.

    c) Fishing earlier in the 2020 calendar year was very good, and previous Decembers have been good with plenty of lobsters around, though this year is different. The Maluiligal traditional inhabitant member noted that there are differences in other species as well, including turtles. In this year's recent turtle breeding season there were very few turtles observed mating on top of the water which raises concerns for climate change as this is a frequent occurrence in previous years. He noted that while there are lots of turtles around, there are no male turtles. He reiterated that there are no lobsters around, which

is causing some operators to cease fishing, whilst waiting for the hookah season to start on 1 February 2021. This trend is very different to previous seasons.

d) Lobster numbers declined as expected in a normal year towards the end of the 2019-20 fishing season, however between the end of the season (30 September) and the start of the new season (1 December), there appears to be no new recruits.

e) Industry member Brett Arlidge noted that although it was a very disruptive year, prices improved as the year went on and as the pandemic situation in China improved. However, since China has banned the import of lobsters from Australia (in mid-November 2020), it is unlikely that Australia will be able to sell any live TRL in to China this season. MG Kailis is aiming to continue buying TRL from the Torres Strait, and is exploring alternative markets into Hong Kong, Taiwan, south east Asia and domestically, however the price will be very different from what industry are used to (down 30-40 per cent), and there may not be as much demand for live product. He reiterated other industry observations that the new recruits to the fishery are to come through and that many lobsters appear to be residual lobsters from the previous season. Sizes are small, though this is not unusual for December.

f) The Chair noted that in separate, informal discussions with a South Australian Rock Lobster industry operator, industry is experiencing a 30-50 per cent price cut on usual market prices due to the inability to export live to China. The AFMA executive officer also provided a brief summary of recent price information and trends in rock lobster fisheries in other jurisdictions around Australia:

   i. South Australia - $15-30/kg;

   ii. Tasmania beach price $35/kg;

   iii. Western Australia - $10-20/kg;

   iv. Many boats are increasing their ‘back of boat’ sales, and selling directly to restaurants;

   v. Some processors are cooking their product to sell both fresh, and frozen.

g) Noting that at TRLRAG 27 (10-11 December 2019), industry members advised that increased dugong numbers could have contributed to declining seagrass, the CSIRO scientific member questioned whether there were ongoing changes to seagrass coverage and if this was impacting on turtle and dugong populations or observations. Industry agreed to provide updates on this when discussing the results of the pre-season survey which includes seagrass coverage.

16. The RAG noted that CSIRO are collating all available data on water temperature in the Torres Strait. There are some gaps in water temperature data, with no consistent ongoing times series, however more recent monitoring programs undertaken by TSRA and other agencies will help contribute. There are no updates on water temperatures for this year however from the little data available, there have been some temperature anomalies. The impact on turtles is very well known, as warmer temperatures result in higher proportions of female turtles hatching which is an issue for turtle populations all around Australia. It is also known that warmer water temperatures can affect lobster growth, moulting and survival, so any additional data on water temperature is encouraged.

17. No additional specific updates were provided by scientific members.

2.2 Government agencies

18. The RAG noted an overview of key management updates relating to the TRL Fishery provided by the AFMA member, in particular:

Fisheries bilateral meeting between AFMA and PNG NFA

a) On Friday 27 November 2020, AFMA CEO Wez Norris met via videoconference with the acting Managing Director of PNG NFA, Mr Noan Pakop and other NFA staff to discuss

fisheries bilateral issues. This included general updates on fisheries, catch sharing arrangements for TRL, pearl shell, prawn and Spanish mackerel, updates on catch data from the PNG TRL fishery, whether PNG catches deemed as outside the Torres Strait Protected Zone (TSPZ) are within the area AFMA understands to be the PNG 'outside but near' area, opportunities for research collaboration and fisheries compliance updates.

b) AFMA continues to encourage the provision of timely and accurate catch and effort data by NFA to support TRL scientific and stock assessment processes, and PNG NFA remain interested in opportunities for collaborative research.

c) Further work is required to develop a common understanding of catch sharing arrangements in relation to outside but near areas to the TSPZ. NFA indicated that their understanding is that the global TRL TAC does not apply to areas outside the TSPZ, which is different to AFMA's understanding, and the way Australia accounts for catches in the Australian outside but near area.

d) NFA indicated that the recently agreed Memorandum of Understanding (MOU) between PNG and Fujian Zhong Hong Fishery Co., Ltd. is to undertake a feasibility study to set up an 'integrated and multi-use fishery industrial park' in the Western Province of PNG. The priority remains to engage with AFMA's PNG counterparts to learn and understand more about the MOU. AFMA continues to liaise with the Department of Foreign Affairs and Trade (DFAT) who are working closely with PNG at all levels of Government learn more.

e) The traditional inhabitant member for Maluililgal reiterated previously raised comments regarding the need for a representative of the TIB fishing industry to attend future fisheries bilateral meetings. AFMA expressed support for this, and noted that regular Treaty bilateral meetings are facilitated by DFAT, with a dedicated meeting for traditional inhabitants (referred to as the Traditional Inhabitants Meeting (TIM)) which is currently co-chaired by Councillor Getano Lui. The TSRA member committed to assist with connecting the traditional inhabitant member for Maluiligal with DFAT and the TIMs.

19. The RAG also noted a brief update provided by the TSRA member regarding TSRA activities relevant to the management of the TRL Fishery, namely:

a) As of 3 December 2020, the newly formed *Zenadth Kes Fishing Company* was formally registered as a company limited by guarantee, with 25 elected board members comprised of five members from each cluster nation.

b) Over the coming two years, the assets that TSRA currently holds on behalf of traditional inhabitants will be transitioned across to the Company in a staged approach.

c) The *Wapil (Many Fish)* project is continuing with funding in place to deliver fisheries related infrastructure and 90 traineeships for 14 outer island communities. Erub (Darnley Deep Seafoods) has commenced trading in fish products (TRL, coral trout and mackerel). Other communities including Saibai, Mabuyag, Masig and Mer are all in the planning phase.

2.3 Papua New Guinea National Fisheries Authority

20. No update was provided as a PNG National Fisheries Authority representative was not in attendance.

2.4 Native Title

21. A native title update was not provided as a representative from Malu Lamar (Torres Strait Islanders) Corporation Registered Native Title Body Corporate (RNTBC) was not in attendance

3 Catch and effort analyses for 2019-20 fishing season

22. The RAG considered an overview of total reported catches for Australia and PNG and the following catch and effort analyses for the Australian TRL Fishery for the 2019-20 season undertaken by CSIRO and presented by Dr Éva Plagányi, CSIRO Scientific Member. Further detail is available in Attachments 3e, 3f and 3g of the meeting papers. A copy of the presentation is provided at **Attachment C**.

Catch and Effort

23. Total reported catch for the Australian TRL fishery (1 December 2019 – 30 September 2020) was 361.3 tonnes, with 216.2 tonnes caught by the Traditional Inhabitant Boat (TIB) sector and 145.1 tonnes caught by the Transferable Vessel Holder (TVH) sector.

24. Total reported catch from Papua New Guinea was 90.4 tonnes (January – August 2020) however, the RAG noted that this number is incomplete for the PNG TRL season. Using the same methodology applied last year (at TRLRAG 27), and assuming an average monthly catch is also caught in the months yet to be reported, the total extrapolated PNG catch is increased to 126.4 tonnes (1 December 2019 – 30 November 2020).

25. This extrapolated PNG catch results in a total Torres Strait TRL catch of 487.7 tonnes, under a 582 tonne global TRL TAC, equating to 83.8% of the TAC.

26. Given the disruptions fishers experienced during the early impacts of COVID-19 on the markets, it was expected that the proportion of tailed product would increase in 2020, however the data indicates there was no strong signal for an increase in tail proportions since the last season.

27. The RAG noted that data coverage for voluntary data in the TIB sector was similar to the 2018-19 season, with the percentage of catch reported against Area-Fished increasing slightly. The RAG was reminded of the importance of providing the voluntary data where possible to help better understand changes in the fishery and the stock, particularly in anomalous seasons such as 2019-20.

28. Both the TVH and TIB sectors recorded significant effort decreases coinciding with initial COVID-19 outbreaks in early 2020, however catch rates for both sectors increased substantially later in the 2019-20 fishing season, and the annual CPUE point estimates were the highest values recorded in the past five seasons.

TVH CPUE Standardisation

29. The RAG noted that there was very little variance between the nominal CPUE index and the other standardised indices, that consider the effects of month, area, method, vessel, proportion of tails, Southern Oscillation Index and moon-phase.

30. The point estimates of each standardised index, and the nominal CPUE index for 2019-20 indicate that the TRL spawning stock is healthy, and is a positive indicator from the fishery to contribute to the empirical Harvest Control Rule (eHRC).

31. **The RAG noted that the "Int-1 model" is the previously agreed default model used in the eHCR.** The Int-1 GLM includes an 'area-by-month' interaction, but does not include a 'year-by-month' interaction that might have changed in the 2019-20 season. For this reason, another model was considered as a sensitivity test in the eHCR. More detail on this is provided under Agenda Item 5.

32. Two of the GLMs that account for 'year-by-month' effects (Int-2A and Int-2C) indicate large deviations in monthly fishing patterns in the 2019-20 fishing season, in particular for March, April and May. While this change in monthly fishing patterns is widely understood by the RAG through reports from industry, it is important that the data reflects these changes as well.

TIB CPUE Standardisation

33. Both the nominal and standardised indices all illustrate the highest CPUE on record for the TIB sector, which correlates with anecdotal reports of a good fishing season and high lobster abundance. The positive TIB CPUE index also reinforces that there are no concerning trends for

the fishery and the stock is looking healthy. The potential for positive bias in the CPUE point estimates was discussed when considering the recommended biological catch.

34. **The RAG noted that the "Seller model" is the default model used in the eHCR**, which accounts for an increase in the relative fishing efficiency of *Sellers* in recent seasons.

Further work for data analyses

35. The RAG noted a series of further work to be potentially undertaken, informed through discussions of the RAG data sub-group including:
    a) Investigation the potential for effort creep:
        i. Is 'vessel-effect' a proxy for skill of divers?
        ii. Increase in boat size; can larger boats search more?
        iii. Other changes in fishing gears leading to increased CPUE
    b) What factors influence the spatial distribution of lobsters and 'hot-spots', and what influences the spatial distribution of fishing effort?
    c) How do fishing aggregations influence CPUE, and what factors influence aggregation dynamics?
    d) Influences of COVID-19 impacts on CPUE and potential biases
    e) Influence of oceanographic conditions?
        i. Water temperatures
        ii. Prevailing winds

4 Results of the pre-season survey

36. The RAG considered a presentation provided by Dr Leo Dutra, CSIRO Scientific observer detailing the preliminary results of the 2020 pre-season survey (**Attachment D**).

37. The pre-season diver survey was conducted between 2-12 November 2020 aboard the "Wild Blue" with a CSIRO dive tender. The survey was undertaken by five divers; Mark Tonks, Nicole Murphy, Kinam Salee, Steven Edgar and Leo Dutra. The inclusion of an additional diver was to aid in transition from Mark Tonks as survey leader and to provide some contingency in planning due to possible impacts from COVID-19 and changing circumstances with travel restrictions.

38. Dive transects were conducted at 76 repeat pre-season sites, starting with shallow dives in the western Torres Strait while currents were at their weakest and moving in an easterly direction to utilise stronger currents for deeper dives.

39. The pre-season TRL surveys provide indices of abundance for recruiting age lobsters (age 1+) and recently-settled lobsters (age 0+), abundance indices by stratum (region) and length-frequency and sex ratios. At the time of the survey, most older lobsters (age 2+) have migrated and those that remain are mostly remnant males.
    a) At each survey site:
        i. Two divers swim with the current to survey a 500m transect, covering 2m each;
        ii. Lobsters are counted for each age-class and collected where possible;
        iii. Habitat is assessed (i.e. substrate type and biota);
        iv. Temperature/depth profiles are collected; and,
        v. lobsters are measured (TW), sex determined and datasheets completed.
    b) Age 1+ recruiting lobster counts and index:

i. The 2020 1+ abundance index for the mid-year only (MYO) sites was similar to the long-term average (2005-2020) and the survey variance was roughly average compared with higher variances observed in the 2018 and 2019 surveys.

ii. Lobster counts were generally consistent across the sites in 2020, but there were high counts of lobsters made along the eastern side in both 2020 and 2019, compared to 2018 where high lobster counts were made along the western side of the Torres Strait.

iii. The abundance index for 1+ lobsters in 2020 indicates that recruitment into the fishery is generally widespread across the different strata surveyed, with the highest recruitment recorded at Warraber Bridge, Kirkaldie and Buru, and the lowest recruitment recorded at Mabuyag.

iv. Warraber Bridge and Buru exhibited the greatest count variability among sites indicated by the larger standard error at these strata.

v. Warraber Bridge recorded one of the highest densities across all surveys in 2020, with Kirkaldie and Warraber Bridge above the long-term survey average, and Reef Edge and Buru about average.

c) Age 0+ recently settled lobster counts and index:

i. The 2020 0+ abundance index is above the long-term pre-season survey average index (2005-2020) and has steadily increased from its lowest point estimate in 2017.

ii. The 2020 survey indicated a typical lobster settlement pattern, with most 0+ lobsters counted on the western side of the survey area.

iii. The highest abundance of 0+ indices were recorded for Mabuyag and Buru strata, however unlike previous surveys, Warraber Bridge on the eastern side showed the third highest 0+ abundance index. Historically, 0+ observations were higher in numbers on the western side of the survey area.

iv. Abundance indices in 2020 were higher than average for Mabuyag, Buru and Warraber Bridge.

d) Size frequency and sex ratio:

i. Length frequency data in 2020 was similar to most surveys, comprised mostly of 1+ lobsters, although the number of 0+ observations was higher in 2020 (101 lobsters counted compared to 92 in 2019).

ii. The sex ratio of sampled lobsters was typical of previous surveys with 45 per cent males.

e) Habitat changes and temperature data:

i. Percentage coverage of seagrass was considerably down in 2020, with a very pronounced decline in seagrass coverage since 2019.

ii. Some minor sand incursions were observed at one site.

40. Noting the results summarised above, the RAG discussed the following:

a) Some divers have seen increased amounts of fine, white sand moving around more than normal, covering up the substrate, which has reportedly been getting worse throughout the 2019-20 season. This also reportedly is linked to the decline in seagrass coverage observed by fishers. The AFMA member queried whether other seagrass surveys (conducted by James Cook University, and the TSRA Ranger Program) would be useful in strengthening the RAGs understanding of seagrass habitat changes.

b) The increased number of 0+ lobsters in the eastern side of the survey area appears consistent with the reports and observations from industry about lots of smaller lobsters on the reef tops.

c) An industry member expressed a level of comfort and satisfaction with the CPUE analyses, experiences in the fishery in 2020 being congruent with the results of the 2019 pre-season survey and stock assessment.

41. The RAG noted that although 2020 exhibited slightly different trends in the data and indicators (i.e. higher catch rates exhibited by both the TIB and TVH sectors, and lower than average 1+ lobster index) there are positive trends with nothing alarming in the data to consider the stock is not in a healthy position, despite it being an anomalous fishing season.

42. On behalf of the RAG, the Chair acknowledged and thanked the CSIRO team for the significant level of work undertaken to complete the survey safely and successfully; and within a matter of weeks, analyse and report on the survey results in time for the RAG meeting.

5 Recommended Biological Catch

43. The RAG considered advice by the Scientific Member Dr Éva Plagányi on the RBC for the 2020-21 fishing season as derived through the application of the empirical harvest control rule (eHCR) under the final TRL harvest strategy (presentation at **Attachment E**), as detailed in agenda item paper 5a, *Torres Strait tropical rock lobster (TRL) Panulirus ornatus empirical Harvest Control Rule (eHCR) Recommended Biological Catch (RBC) for 2021.*

44. The eHCR is applied in December and outputs a RBC for the following year. This formula is the multiple of the average annual catch over the last 5 years (using available catch from TIB, TVH, PNG) and a statistic which measures the relative performance of the fishery based on the following data inputs:

- Pre-season survey recruiting lobster (1+) standardised relative numbers (70%);
- Pre-season survey recently-settled lobster (0+) standardised relative numbers (10%);
- nominal CPUE for TIB sector (10%); and,
- standardised CPUE for TVH sector (using data available up until end of October) (10%).

Average annual catch

45. The RAG noted that the eHCR uses the average catch over the past five years as a multiplier to inform the RBC. This dampens the influence of the most recent catch value. Nevertheless, if the recent value is negatively biased (as was possible in 2019-20 due to COVID-19) then it can have an effect on RBC calculations.

46. When considering total reported PNG catch for 2020, the total TRL 2020 catch was 77.6 per cent of the global TAC, with a substantial proportion of the shortfall attributable to impacts of COVID-19 in early 2020 (TRLRAG 28). However, if the PNG catch is extrapolated up, using the methodology from TRLRAG 27, the total TRL catch is increased to 83.3 per cent of the TAC. Without the scaling up of PNG catches, the 2020 PNG catch is quite low compared to previous years, noting that on average over the period 2004-2019, PNG have caught 94 per cent of their TAC allocation. The total reported catch for the TIB sector is also below the TIB TAC (75.1 per cent caught in 2019-20, and 79 per cent caught in 2018-19). By comparison, the TVH sector were almost fully caught (97.5 per cent caught in 2019-20 and 93 per cent caught in 2018-19).

47. The 2019 pre-season survey suggested that 2020 would be a good TRL fishing year, and the 2020 CPUE data generally aligned with a TRL abundance higher than average. Despite this, catches appeared to be lower than expected. If the lower than expected catch is not a function of stock abundance, but is due to other reasons (i.e. COVID)) then using the actual catch value may unjustifiably bias the RBC downwards.

48. A comparison of TIB and TVH relative proportions of the total annual catch taken in each month illustrates a significant difference for the TVH sector in 2020, with substantially less catch in February and reduced catch in March (due to market disruptions). This is compensated by increased catches in April, followed by an extended increase in effort through till July as the TVH allocation limit is approached (Figure 1). By comparison, the TIB sector demonstrates less catch than usual in February, followed by increased effort until August, reducing to average levels as

the end of the season is reached (Figure 2). PNG also fished less over February and March, with their highest reported catches in May (Figure 3).

Alternative scenarios – Average catch

49. To inform discussions on whether ad-hoc adjustments to the eHCR inputs were warranted by COVID-19 impacts, a number of alternative scenarios (or sensitivities) were investigated by CSIRO to explore the potential impacts of average catch on RBC calculations.

50. The RAG considered five alternative scenarios for calculating average catch (2016 - 2020) as an input to the eHCR:

    a) Using the actual reported total catch;

    b) Substituting the TAC value for the 2020 actual catch – based on the argument that if catch rates were good, lobster abundance was high, but due to a late start to the season (from COVID-19 impacts) the TAC was unable to be fully caught (discussed at TRLRAG 28);

    c) Substituting increased catch for PNG – based on the assumption that only PNG caught their TAC allocation, and uses actual catches for the TIB and TVH sectors;

    d) Assuming in 2019-20 season that fishers would have caught the same percentage (95%) of the TAC as they did in the 2018-19 season; and

    e) Extrapolating the PNG catch through to the end of the season using the same method as last year (TRLRAG 27).

51. A summary of the average catch alternative scenario values was provided to TRL RAG as outlined in Table 1.

Table 1. Examples of alternative scenarios for calculating an average catch value for input in to the eHCR.

Season	Total catch_actual (t)	Substitutin TAC for 2020 catch	Substituting increased catch for PNG	Assuming in 2020 would have caught same percentage (95%) of TAC as in 2019
2016	758.2	758.2	758.2	758.2
2017	390.8	390.8	390.8	390.8
2018	412.2	412.2	412.2	412.2
2019	583.6	583.6	583.6	583.6
2020	451.7	285.0	553.4	553.5
Average	**519.3**	**545.4**	**539.6**	**539.7**

52. Given the lower than expected fishing effort in the 2019-20 season, the RAG was asked to consider whether the levels of catch reflect what was expected, or were they biased downwards due to impacts from COVID-19.

Catch per unit effort trends

53. Catch rates for the TIB sector in February were the highest catch rates on record relative to all previous point estimates available since 2004; both nominal and standardised indices were the highest in the series, both being approximately 50 per cent higher than the average value of the respective series.

54. The RAG noted that given the differences in fishing patterns by month, and a ‘pause’ in fishing early in the season, it could be expected the lobsters grew in size while not being fished, and also may have aggregated as they were not being significantly disturbed on the reefs, which may have enhanced catch rates once fishing resumed. These trends could also be confounded by some inter-sector interactions (causing a positive bias) which may become increasingly important to understand as a review of input controls in the fishery is commenced.

55. When comparing both TIB 'Seller' series and TVH 'Int-1' CPUE indices with the 2019 stock assessment-based 2+ lobster biomass estimate, the results suggest that the two CPUE indices show similar trends with the estimated stock biomass, that is increasing over the recent period which provides confidence that the stock assessment predictions accurately reflected the observed catch rates the following year

56. Consistent with TRLRAG 27 advice, the TIB 'Seller' series and TVH 'Int-1' series were used as default inputs to the eHCR for 2020 RBC calculations. However, as 'year-by-month' interactions were expected to be different this season CSIRO did examine two alternative CPUE standardisations (nominal TIB and TVH 'Int-2C' which includes a 'year-by-month' interaction, because year-by-month interactions were expected to be different this year) and did not result in a substantial difference in RBC calculations relative to comparable scenarios (using alternative average catch values).

Application of the empirical Harvest Control Rule (eHCR)

57. When examining recent trends in eHCR indices, both the TIB CPUE and TVH CPUE indices showed very positive slopes, and both the pre-season 1+ and 0+ survey indices exhibited positive trends (Figure 4). Although the 0+ index is less reliable, the positive trend provides an indication of what is to be expected in future seasons. The RAG noted that the eHCR is shown to be reasonably robust. It captures longer-term trends over a five-year period, it places substantially more weighting (70%) on the pre-season survey which is not affected by trade and other disruptions. Also, using a five-year average (including average catch) helps to dampen the influence of a single anomalous year.

58. Table 2 illustrates a comparison of all eHCR RBC outputs under all alternative scenarios, ranging between 614.9 tonnes and 647.5 tonnes.

Table 2. Comparison of eHCR RBC under alternative scenarios.

Key sensitivities / scenario		Average catch input	TVH model	TIB model	TVH CPUE	TIB CPUE	PSS 0+	PSS 1+	RBC (tonnes)	Difference to Scenario 1
1	Scenario 1 (using actual catch)	519.3	Int-1	Seller	1.51	1.15	3.301	4.143	**614.9**	-
2	Substitute TAC for 2020 catch	545.4	Int-1	Seller	1.51	1.15	3.301	4.143	**645.8**	30.9
3	Substitute increased catch for PNG	539.6	Int-1	Seller	1.51	1.15	3.301	4.143	**639.0**	24
4	Assume 2020 has same proportion of TAC caught (95%) as in 2019	539.7	Int-1	Seller	1.51	1.15	3.301	4.143	**639.1**	24.2
5	Alternative CPUE standardisation	519.3	Int-2C	Nominal	1.47	1.34	3.301	4.143	**616.3**	1.3
6	Alternative CPUE standardisation & average catch	545.4	Int-2C	Nominal	1.47	1.34	3.301	4.143	**647.5**	32.2
7	PNG extrapolated catch	526.5	Int-1	Seller	1.51	1.34	3.301	4.143	**623.5**	8.6

59. Having regard to the outcomes of the alternative scenarios presented in Table 1, the RAG considered whether to recommend the default implementation of the eHCR (as per last year), or to undertake an ad-hoc adjustment and discussed the following key points:

a) The independent scientific member expressed concern that having a series of RBC options available, and no clear guidance to determine what is appropriate, that the RAG could be “RBC shopping”. He added that anecdotal reports from industry about not seeing many recruits in the fishery and some reported sand incursions coupled with a decreased pre-season 1+ index (although increasing over the longer-term) may be slightly concerning and therefore warrant being precautionary as Table 1 is discussed.

b) The Chair acknowledged that “RBC shopping” is an issue that must be considered when assessing options with different RBCs, however with the extensive work that has been undertaken to develop and test the eHCR, the RAG preference should be to proceed with the agreed inputs unless there is sufficient evidence that would support a deviation of the default application of the eHCR. He noted that some of the alternative scenarios are likely beyond what could be reasonably justified without further detailed analyses. The CSIRO scientific member reiterated that some of the alternative scenarios (scenarios 5 and 6 in Table 1 above) are not reasonably applicable but were presented as sensitivities to the RAG, to illustrate that there is little difference between different GLM standardisations.

c) An industry member agreed that 2019-20 was an anomalous year. Had fishing occurred as normal, total catch would likely have been higher. He added that the TIB sector had an opportunity to catch the remaining TAC but there were few crays on the ground as they underwent their usual migration into the Gulf of Papua. He noted that MG Kailis purchases a considerable amount of PNG TRL catch, and considered that the actual PNG catch is likely considerably higher than what is reported.

d) A traditional inhabitant member added that early in the year TIB catches were high, and effort was high because fishers needed to continue to make a living, even though the prices were down. The TSRA observer added that typically once the hookah season opens, there would be an increase in TIB catches however due to the impacts of COVID, low market prices and fuel prices, catches were not as high. Another traditional inhabitant industry member claimed that the TAC was under-caught due to the inability to employ non-indigenous crew on TIB boats, however impacts such as fuel prices and crewing requirements have been taken into account, hence this point was refuted as that has been the case consistently through time and is therefore not a viable factor in this instance.

e) The RAG noted that scenario 2 is not very realistic as there have been numerous seasons where both sectors have not fully caught their TACs, however it is presented to illustrate what the maximum benefits would be relative to scenario 1.

f) Scenario 4 assumes that if COVID-19 hadn’t impacted, it could have been predicted that the average catch proportion for all sectors would have been similar to the 2018-19 fishing season, assuming that 95 per cent of the total TAC would have been caught.

g) An industry member agreed that only two scenarios (scenario 4 and scenario 7, the default) are reasonable, and that scenario 4 using an assumed total catch proportion of 95% is more likely. Traditional inhabitant industry members also shared this same view.

h) For an abundance of clarity, AFMA restated that there is an agreed harvest strategy with very clear decision rules that guide how the TAC is set each year. As such, the advice needs to be very clear if it is to depart from the agreed process. The harvest strategy already accounts for variability on impacts of fishing (e.g. weather conditions, fuel prices). The current situation is contemplating extraordinary variability that has impacted people’s ability to go fishing.

60. The Chair recognised industry’s conflict of interest at this point of the RBC discussion. To maintain the integrity of the RAGs advice, the Chair requested that industry members temporarily leave the meeting while the remaining members discussed and provided advice on an agreed application of the eHCR.

    a) Noting that TVH sector was almost fully caught and that the preferred approach for handling PNG catch is to use the extrapolation method (consistent with the eHCR application in 2019), the AFMA member proposed a variation on scenario 4 that applied

only a proportional scale up of catches only to the TIB sector catches, which were considered under caught this season.

i. After CSIRO undertook some preliminary calculations using this adjustment, the RBC output was 637 tonnes.

b) The scientific member agreed that an ad-hoc adjustment of this nature could be justified, provided that the reasons for scaling-up the TIB catches were clear in explaining why they were anomalous.

c) The independent scientific member expressed concern over applying a scaled-up approach without sufficient time and rationale to understand clear reasons why the TIB sector catches have been scaled-up. The RAG agreed that the forthcoming 2020-21 season is likely to experience similar disruptions, and therefore further analysis and discussion will be required.

d) RAG members considered that the CPUE series for the TIB sector could be positively biased. This assumes that the lobsters would have grown larger and aggregated, and that some inter-sector competition was absent in the early months of the season, resulting in different fishing patterns, and higher catch rates. Most notably, the TIB CPUE nominal and standardised index was the highest in the series, and relatively higher than can be explained by past high stock abundances (based on the fishery independent survey, which is the main indicator of abundance, and stock assessment) (i.e. in previous high abundance years, the TIB CPUE wasn't nearly as high). The 2020 nominal and standardised TIB CPUE relative to 2019 increased 32% and 22% respectively. By comparison, total average catch could be considered to be negatively biased.

61. **The RAG members (excluding industry members) acknowledged that the 2019-20 season was an anomalous year due to the impacts of COVID-19, which has impacted the eHCR indicators in different ways. The RAG members agreed that the total average catch could be considered negatively biased, but the recent increase in catch per unit effort series for the TIB sector could be considered positively biased. In lieu of additional information to understand the COVID-19 impacts on those indicators, RAG members agreed to recommend the default application of eHCR (scenario 7) using the PNG extrapolated catch and no further ad-hoc adjustments to the eHCR inputs.**

62. **In the absence of pre-agreed meta rules to guide how extraordinary anomalous years are handled within the harvest strategy, when outside the bounds of MSE tested ranges, RAG members also acknowledged that further work and discussions will be required as a priority to better understand the anticipated impacts associated with ongoing trade disruptions in the 2020-21 season.**

63. With industry members re-joining the discussion, the Chair explained the rationale for the above advice to industry members. A TSRA observer queried why the RAG member advice differed from the original traditional inhabitant views put forward earlier in the meeting. It was explained to Industry members that there was no clear way of discerning that either of the biases (i.e. assuming that the TIB TAC would have been fully caught in the absence of COVID-19 (considered anomalously low) or the unusually high TIB CPUE trends (considered unusually higher than normal) were more influential than the other.

64. Agreeing with the rationale and that the difference in RBCs between scenarios was not significant, an industry member agreed with the recommended approach and agreed that the eHCR is working well.

65. The RAG noted that in recommending an RBC, other sources of mortality (included both Torres Strait and PNG Traditional catch, and recreational catch) should be considered. Traditional inhabitant members advised that there has been no major change in recent levels of traditional or recreational catch of TRL.

66. **Having regard to RAG member advice on which scenario of the eHCR was to be applied, the RAG recommendation resulted in an RBC value of 623.5 tonnes for the 2020-21 season with no deduction of catches taken by non-commercial fishing sectors.**

6 Other business

67. The RAG noted a brief presentation from Dr Leo Dutra, CSIRO observer regarding an FRDC funded project aimed at providing opportunities to Torres Strait industry representatives to learn about the latest developments in fisheries research and management and build capacity through co-authoring talks with CSIRO researchers and attending international fisheries conferences.

68. Traditional inhabitant members noted that those willing to participate will be required to submit and expression of interest to attend or present, and must seek nomination from a relevant Traditional owner representative body, Research Advisory or Working Group. The project will involve successful nominees submitting a conference abstract and committing to post-conference communication activities (i.e. presentations at RAG and relevant Working Group meetings).

7 Date and venue of next meeting

69. The RAG noted that:

    a) The second RAG Data Sub-group meeting is proposed for 30-31 March 2020 noting industry member availability.

    b) The next TRL RAG meeting (TRLRAG 31) is tentatively scheduled for May 2021 to consider data sub-group outcomes, and research priorities for the TRL Fishery. Members noted that another TRLRAG meeting may be required in early 2021 to consider ongoing impacts of trade disruptions and how that might impact application of the eHCR in 2021.

70. The 30th TRL RAG meeting was closed in prayer at 2:00pm on Wednesday 16 December 2020.

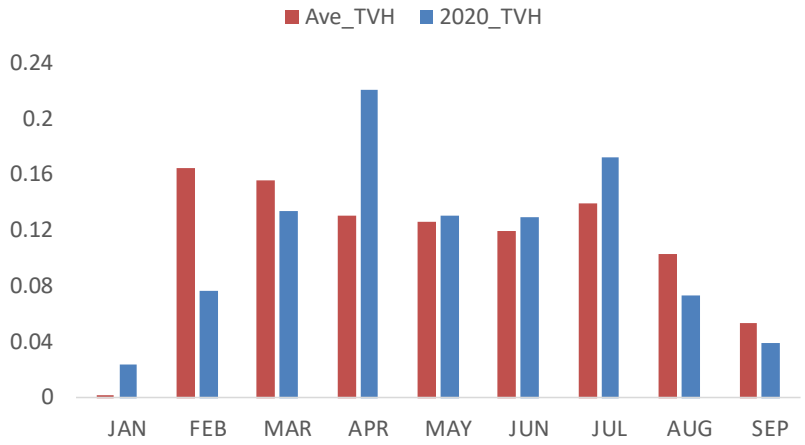


Figure 1. TVH proportion fished per month relative to average.

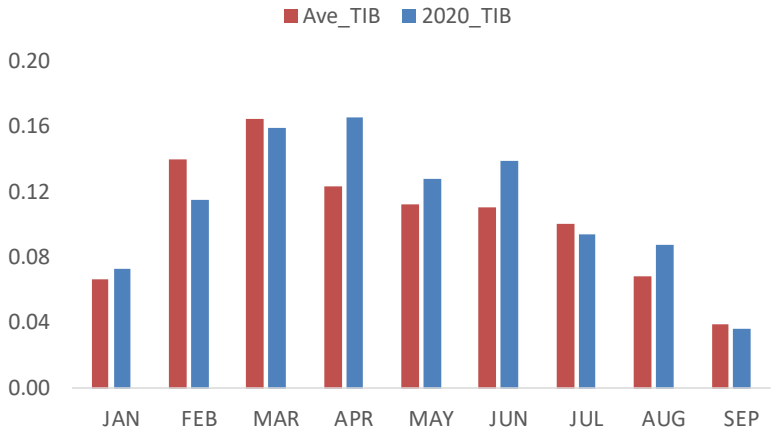


Figure 2. TIB proportion fished per month relative to average.

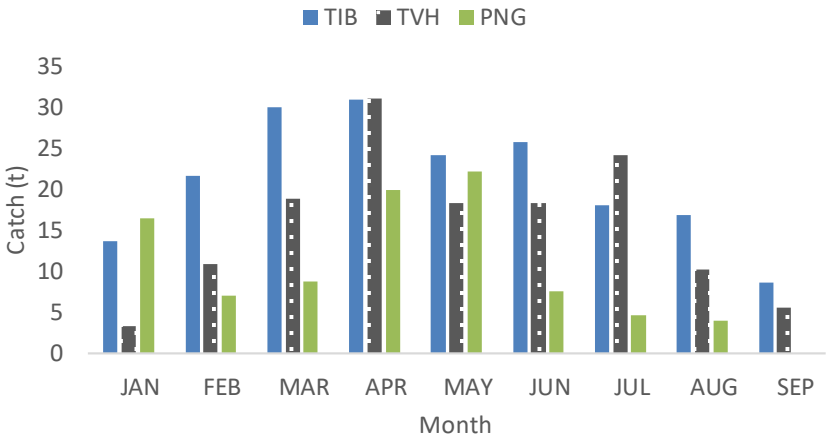


Figure 3. Total catch per month by sector.

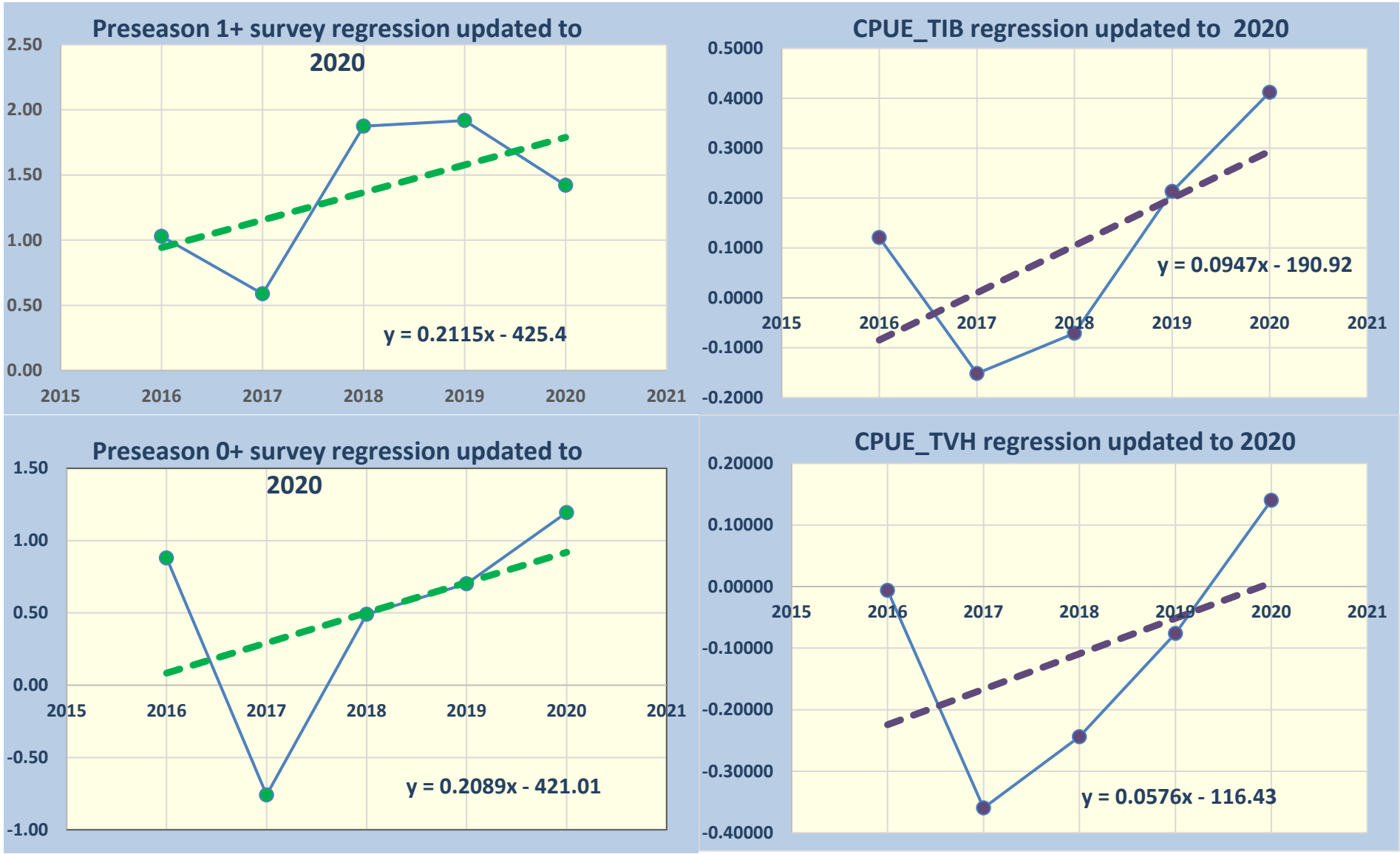


Figure 4. Regression slopes of each eHCR index; pre-season 1+ survey, pre-season 0+ survey; TIB CPUE and TVH CPUE.

Declaration of interests

Dr Ian Knuckey – October 2020

Positions:

Director –	Fishwell Consulting Pty Ltd
Director –	Olrac Australia (Electronic logbooks)
Deputy Chair –	Victorian Marine and Coastal Council
Chair / Director –	Australian Seafood Co-products & ASCo Fertilisers (seafood waste)
Chair –	Northern Prawn Fishery Resource Assessment Group
Chair –	Tropical Rock Lobster Resource Assessment Group
Chair –	Victorian Rock Lobster and Giant Crab Assessment Group
Chair –	Victorian Central Zone Abalone Fisheries Resource Advisory Grou
Chair –	Gulf of St Vincent's Prawn Fishery MAC Research Scientific Committee
Scientific Member –	Northern Prawn Management Advisory Committee
Scientific Member –	SESSF Shark Resource Assessment Group
Scientific Member –	Great Australian Bight Resource Assessment Group
Scientific Member –	Gulf of St Vincent's Prawn Fishery Management Advisory Committee
Scientific Member –	Tropical Tuna Resource Assessment Group
Scientific participant –	SEMAC, SESSF Resource Assessment Group

Current projects:

AFMA 2020/0807	Bass Strait Scallop Fishery Survey – 2020-22
FRDC 2017/069	Indigenous Capacity Building
FRDC 2016/116	5-year RD&E Plan for NT fisheries and aquaculture
Traffic Project	Shark Product Traceability
FRDC 2018/021	Development and Évaluation of SESSF multi-species harvest strategies
FRDC 2017/014	Informing structural reform of South Australia's Marine Scalefish Fishery
NT Fisheries	Design and implementation of a tropical snapper trawl survey
Sea Cucumber Ass.	Design and implementation of a sea cucumber dive survey
FRDC 2019-072	A survey to detect change in Danish Seine catch rates of Flathead and School Whiting resulting from CGG seismic exploration.

ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG 30)

WEDNESDAY 16 December 2020
9:00 AM – 12:00 PM AEST

1:00 PM – 3:00 PM (if required)

Video Conference

ADOPTED AGENDA

1 PRELIMINARIES

1.1 Welcome and apologies

The Chair will welcome members and observers to the 30th meeting of the RAG.

1.2 Adoption of agenda

The RAG will be invited to adopt the draft agenda.

1.3 Declaration of interests

Members and observers will be invited to declare any real or potential conflicts of interest and determine whether a member may or may not be present during discussion of or decisions made on the matter which is the subject of the conflict.

1.4 Action items from previous meetings

The RAG will be invited to note the status of action items arising from previous meetings.

1.5 Out-of-session correspondence

The RAG will be invited to note out of session correspondence on RAG matters since the previous meeting.

2 UPDATES FROM MEMBERS

2.1 Industry & Scientific members

Industry and scientific members will be invited to provide a verbal update on matters concerning the Torres Strait TRL Fishery, in particular, providing comment on fishing patterns, behaviours, prices, and market trends this season.

2.2 Government agencies

The RAG will be invited to note updates from AFMA, TSRA and QDAF on matters concerning the Torres Strait TRL Fishery.

2.3 PNG National Fisheries Authority

The RAG will be invited to note a verbal update from the PNG National Fisheries Authority.

2.4 Native Title

The RAG will be invited to note a verbal update from Malu Lamar (Torres Strait Islander) Corporation RNTBC.

3 CATCH AND EFFORT ANALYSES FOR THE 2019-20 FISHING SEASON

The RAG will be invited to discuss TRL Fishery catch and effort data for the 2019-20 fishing season, including catch-per-unit-effort (CPUE) analyses to be presented by the CSIRO.

4 RESULTS OF THE NOVEMBER 2020 PRE-SEASON SURVEY

The RAG will be invited to discuss the results of the November 2020 pre-season survey to be presented by the CSIRO.

5 RECOMMENDED BIOLOGICAL CATCH

The RAG will be invited to provide advice on a recommended biological catch (RBC) for the TRL Fishery for the 2020-21 fishing season, based on estimates derived through the application of the empirical harvest control rule (eHCR) under the TRL Harvest Strategy.

6 OTHER BUSINESS

The RAG will be invited to raise other business for consideration.

7 DATE AND VENUE FOR NEXT MEETING

The RAG will be invited to discuss a suitable date for the next meeting.

The Chair must approve the attendance of all observers at the meeting. Individuals wishing to join the meeting as an observer must contact the Executive Officer – Georgia Langdon (georgia.langdon@afma.gov.au)

CPUE-Based Annual Abundance Indices for Torres Strait Rock Lobster

Roy Deng, Éva Plagányi, Judy Upston, Steven Edgar, Nicole Murphy
Mark Tonks, Kinam Salee, Leo Dutra

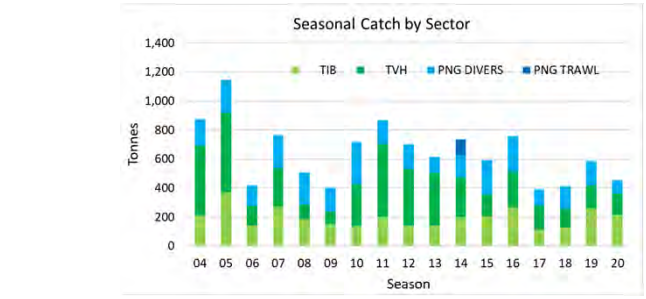
CSIRO Oceans and Atmosphere
www.csiro.au

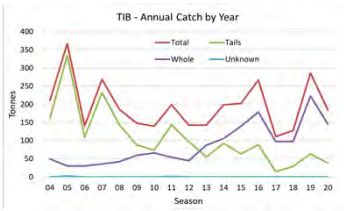
TRLRAG30 Dec 2020

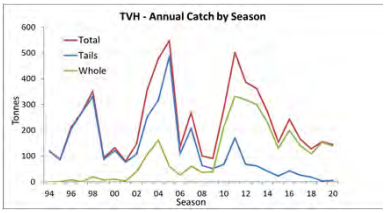
TRL Catches per sector

SEASON	TIB	TVH	PNG-DIVERS	PNG_TRAWL	TS_TOTAL	EAST_COAST
2010	140.0	282.6	292.8	0.0	715.5	128.8
2011	199.1	503.5	165.0	0.0	867.6	146.6
2012	142.4	387.3	173.7	0.0	703.4	157.6
2013	142.5	361.7	108.3	0.0	612.5	166.2
2014	198.8	273.2	151.4	109.8	733.2	176.4
2015	202.6	152.7	235.7	0.0	591.0	125.0
2016	267.1	243.0	248.0	0.0	758.2	194.0
2017	111.5	166.3	113.0	0.0	390.8	194.9
2018	127.4	128.3	156.4	0.0	412.2	159.8
2019	260.6	155.9	167.0	0.0	583.6	108.0
2020	216.2	145.1	90.4	0.0	451.7	111.0
Last 5 year mean	196.6	167.7	155.0	0.0	519.3	153.6

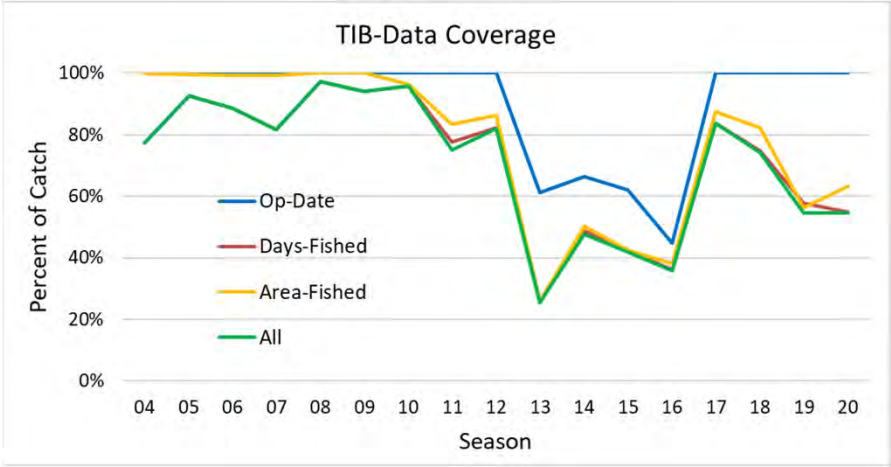
Catch by sector and Product form



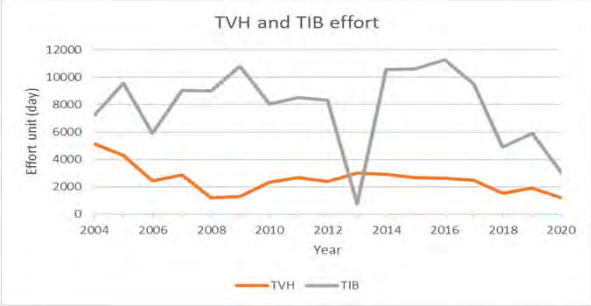




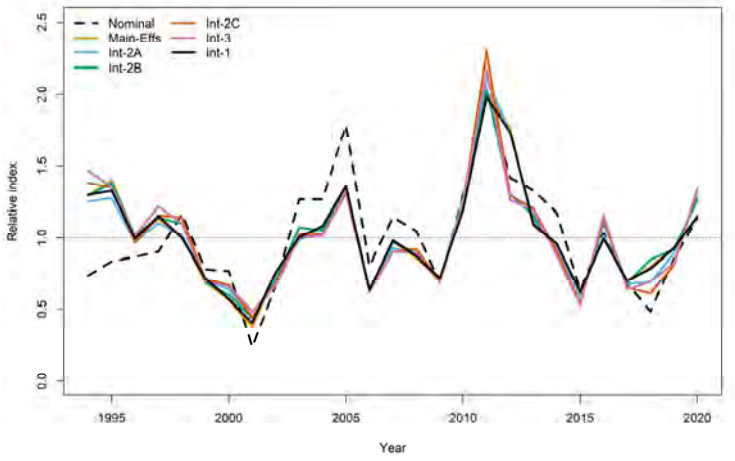
Data Records – missing information



Lower than expected effort in 2020



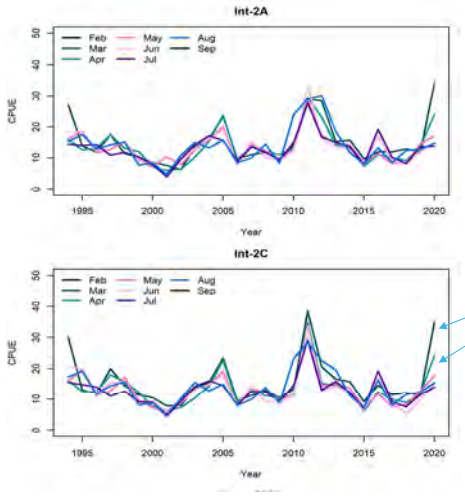
TVH CPUE standardisation



Int-1 is default used in eHCR:

*CPUE = Intercept + Year +Month + Month*Area*
+ Vessel +Fishing-Method + Proportion-Tails + SOI + Moon
/ distribution = gamma, link = log

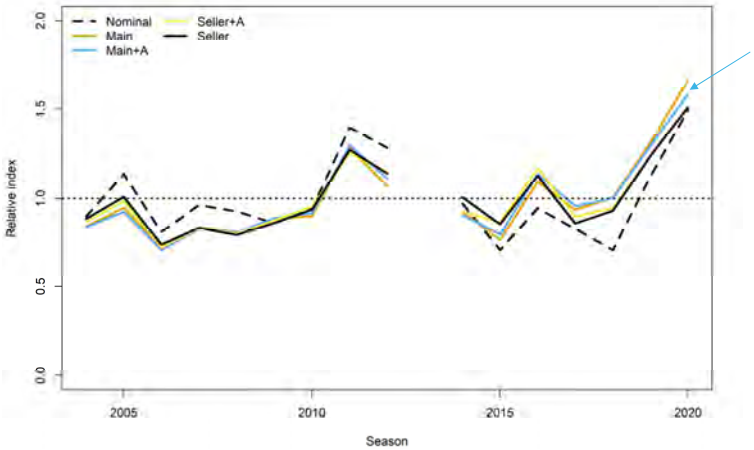
2020 deviations in monthly fishing pattern



Example TVH models including combinations of year/month and area interactions

As expected some large differences in 2020 for March, April, May (high values)

TIB CPUE standardisation

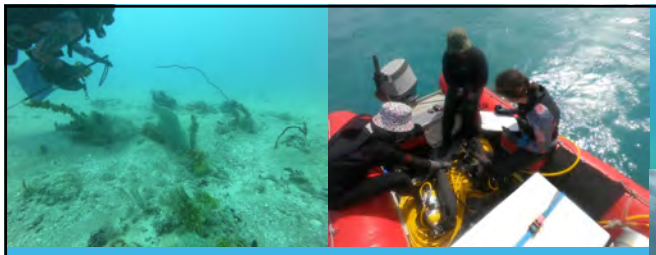


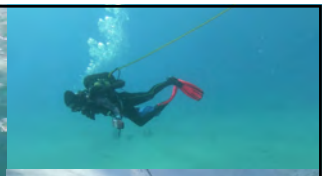
Highest CPUE on record

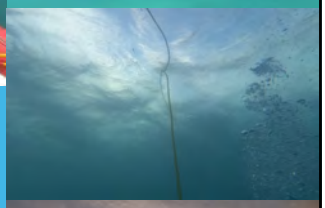
'**Seller**' is default used in eHCR: accounts for increase in the relative fishing efficiency of *Sellers* in recent seasons

Further work

- Investigate potential for effort creep:
  - Is 'vessel-effect' a proxy for skill of divers?
  - Increase in boat size (can larger boats search more)
  - Other changes in fishing gears leading to increased CPUE
- What factors influence the spatial distribution of lobsters and 'hot-spots', and what influences the spatial distribution of fishing effort?
- How do fishing aggregations influence CPUE, and what factors influence aggregation dynamics?
- Influences of COVID-19 impacts on CPUE & potential biases
- Influence of oceanographic conditions?
  - Water temperatures
  - Prevailing winds







Thank you

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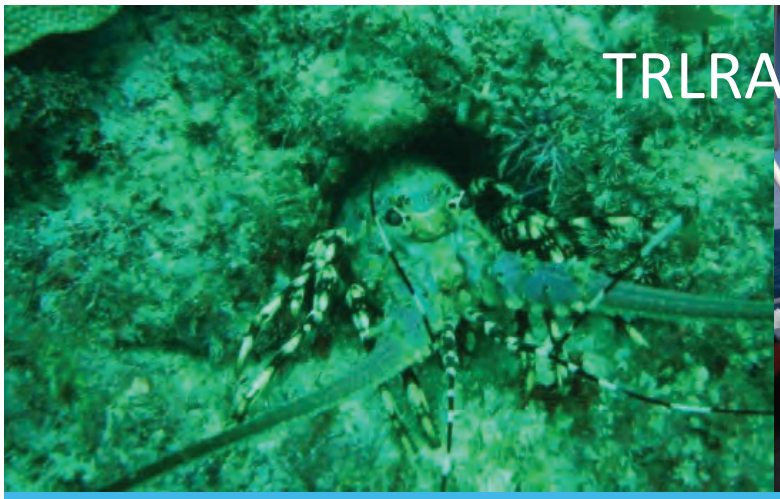
Kinam Salee
Leo Dutra



RESULTS OF TRL 2020 PRE-SEASON SURVEY

Leo Dutra, Nicole Murphy, Mark Tonks, Steven Edgar, Kinam Salee, Roy Deng, Judy Upston and Eva Plaganyi

TRL RAG Meeting #30 – Item # 4
16 December 2020

CSIRO Oceans and Atmosphere
www.csiro.au

Australian Fisheries Management Authority

Trip Details

Dive surveys were conducted between November 2-12 2020 using the *"Wild Blue"* and CSIRO tender

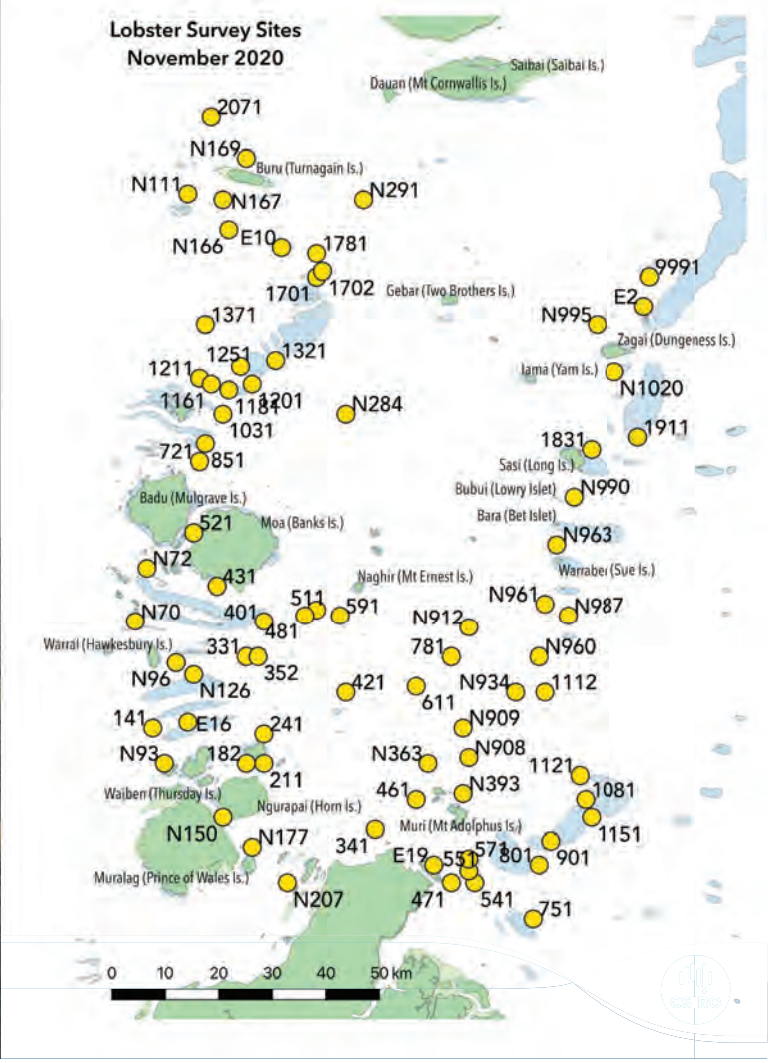
Divers: Mark Tonks, Nicole Murphy (senior dive supervisor & lead field logistics), Kinam Salee, Steven Edgar and Leo Dutra (lead science survey)

Sites

Photo: N. Murphy

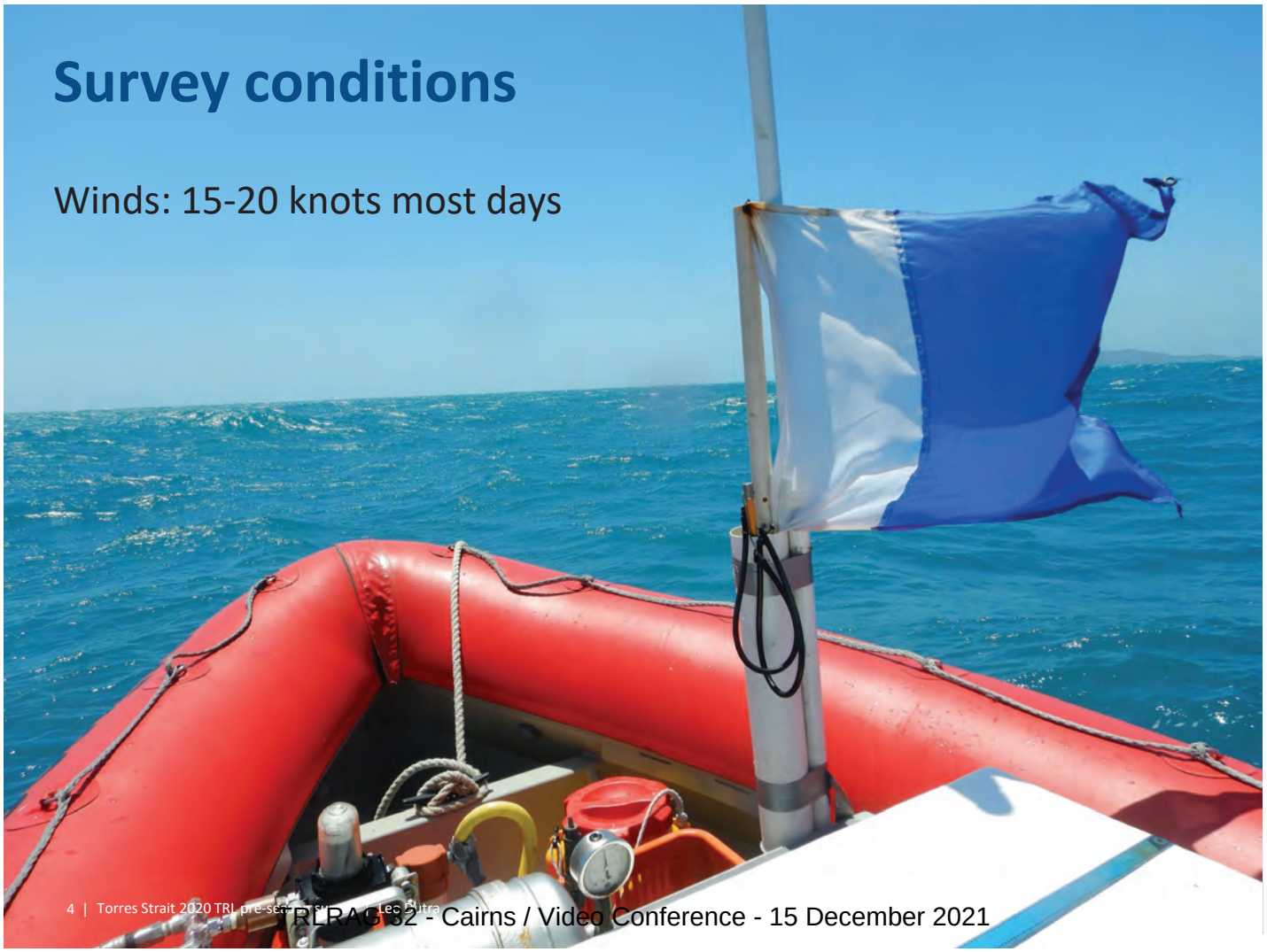
Dive surveys were conducted at 76 sites

Started in the western side



Survey conditions

Winds: 15-20 knots most days

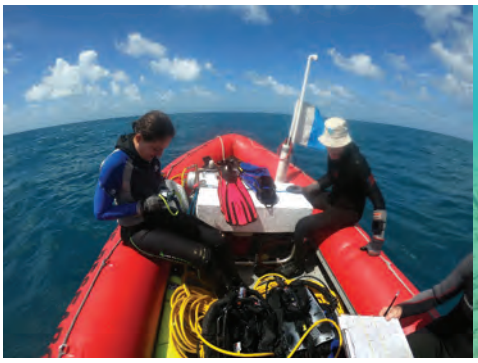


Survey conditions

Diving on neap tides, therefore reduced current for many dives

Good visibility ranging from 1-8m
Most dives around 2m

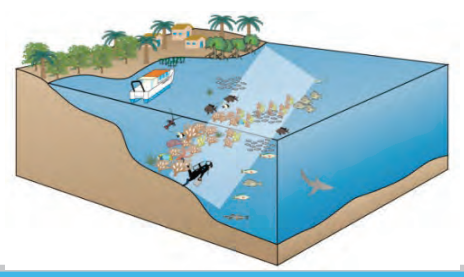
Lowest visibility recorded 1m (2 dives)

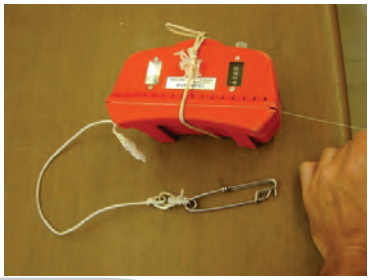


Diving survey method

At each survey site:

- 2 divers scanning standard transect using Chainman® device
  - Direction and distance swum is recorded, as well as:
  - Lobsters counted for each age-class and collected where possible
  - Depth, visibility, current strength
  - Habitat characterisation: substrate type and biota
  - Temperature and depth profiles
- On the surface: lobsters are measured (TW), sex determined and datasheets completed





Pre-season age classes

Pre-season TRL surveys provide abundance indices for:

- Recruiting (Age 1+)
- Recently-settled (Age 0+)

Note: Most (Age 2+) have migrated

2+

1+

0+

What information does survey give us?

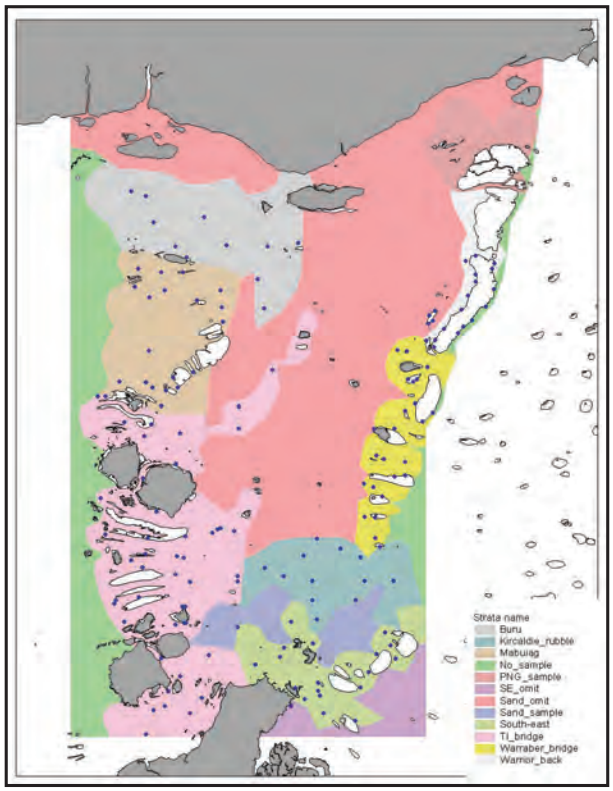
Survey data are used to produce:

- Overall abundance index (Age 1+ and 0+)
- Abundance indices by Stratum (region)
- Length-frequency and sex ratio

Stratum

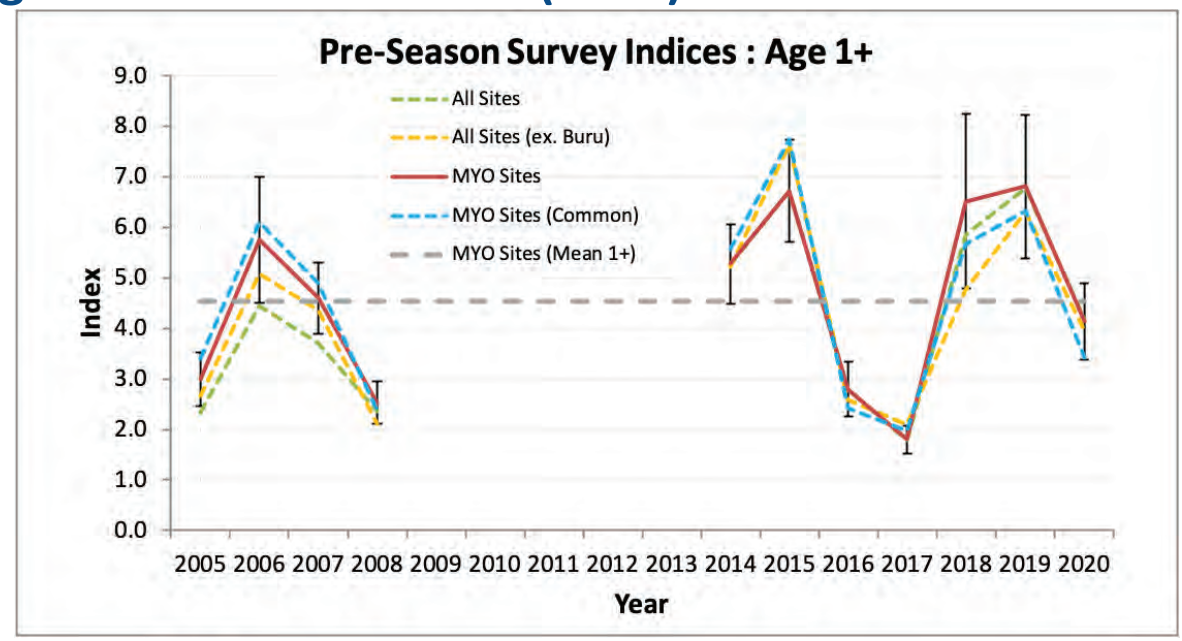
- Torres Strait divided into strata
- 7 key strata used in analyses:
  - Buru
  - Mabuiag
  - Kircaldie
  - TI Bridge
  - Warraber Bridge
  - Reef Edge
  - South-East

Note: Survey sites were originally randomly selected within each stratum



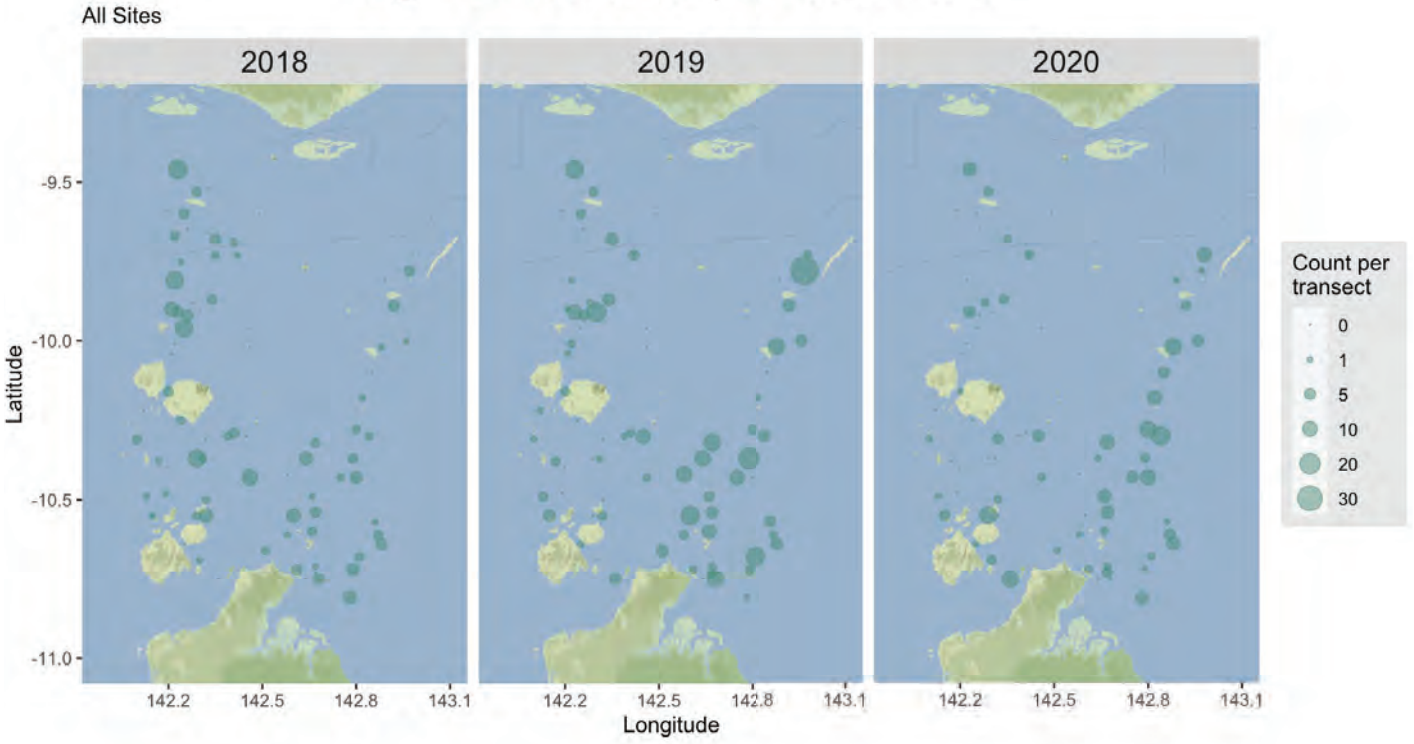
Age 1+ TRL Results

Age 1+ abundance index (2020)



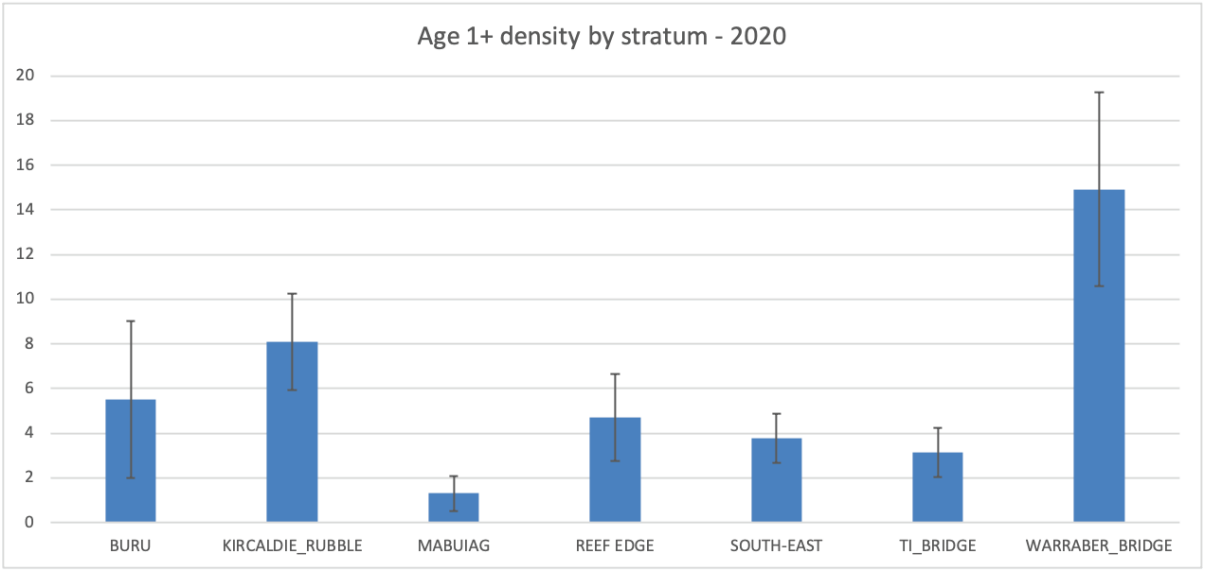
- 2020 index is similar to long-term average (grey line)
- Survey variance was roughly average (note high variances 2018-19)

Age 1+ Counts per transect

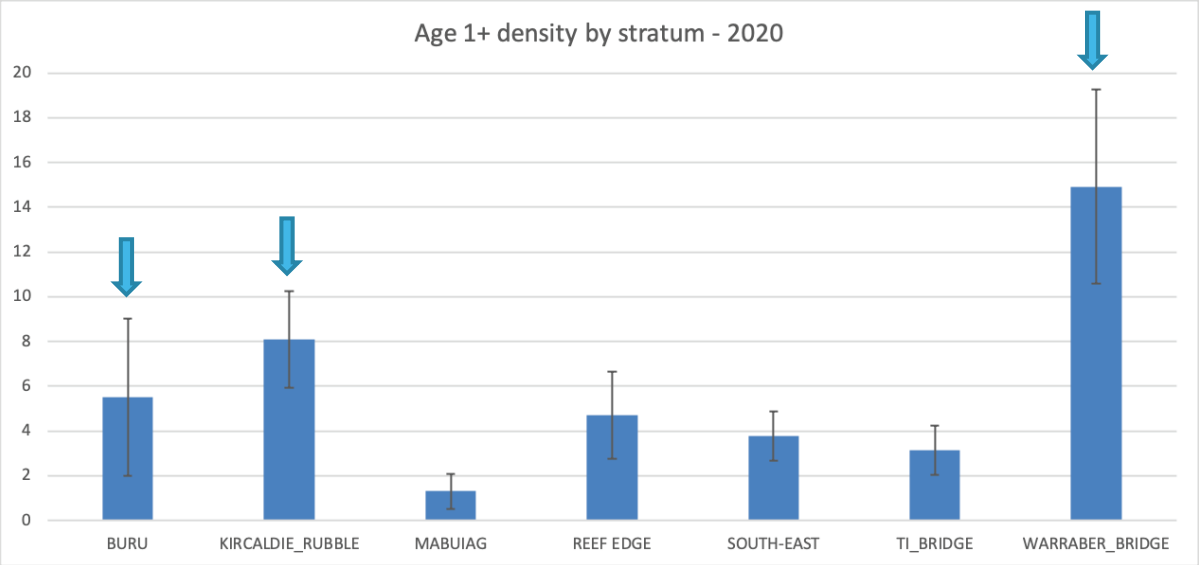


- 2018 - Higher counts along western side
- 2019 and 2020 - Higher counts on the eastern side

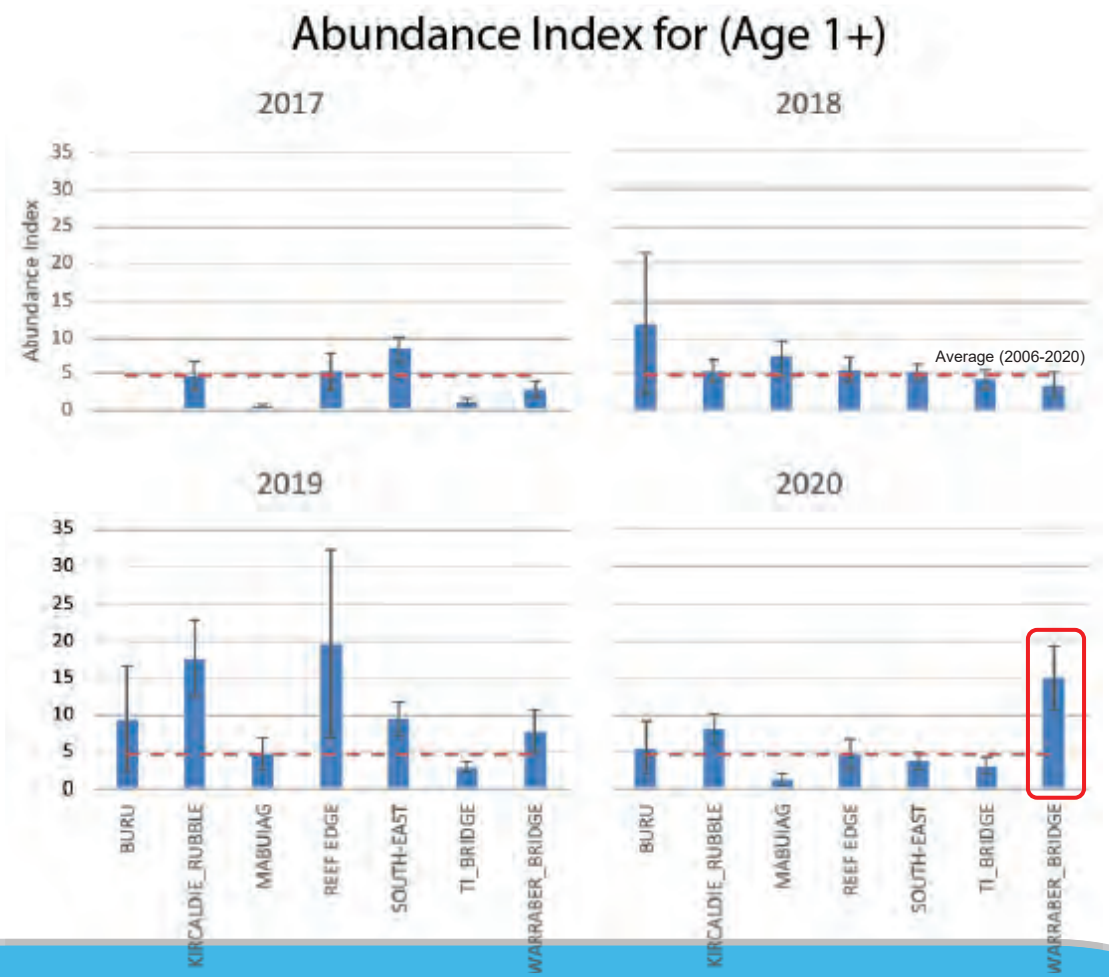
Age 1+ index by stratum (2020)



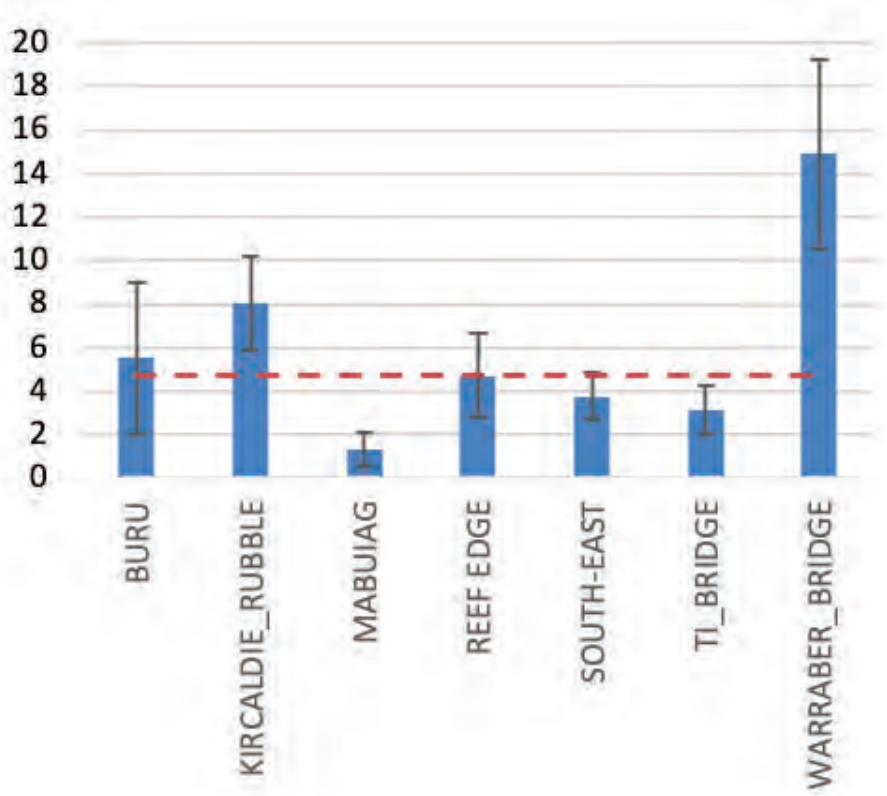
Age 1+ index by stratum (2020)



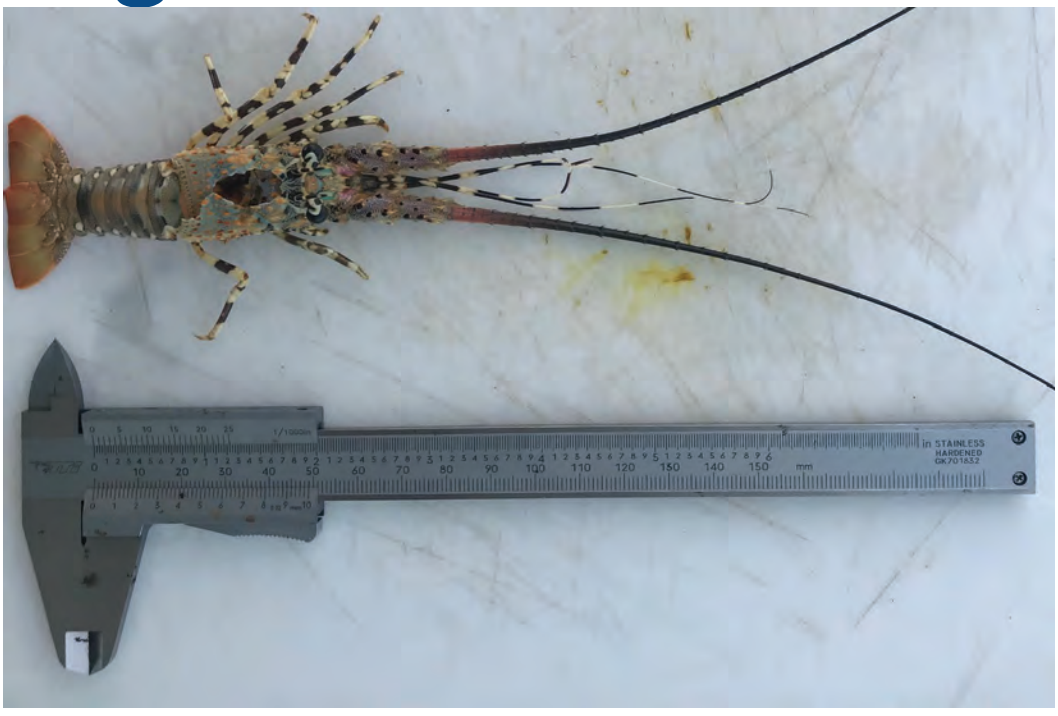
- Warraber Bridge, Kircaldie, and Buru stratums with highest indices
- High standard error for Buru and Warraber Bridge because of high count variability between sites



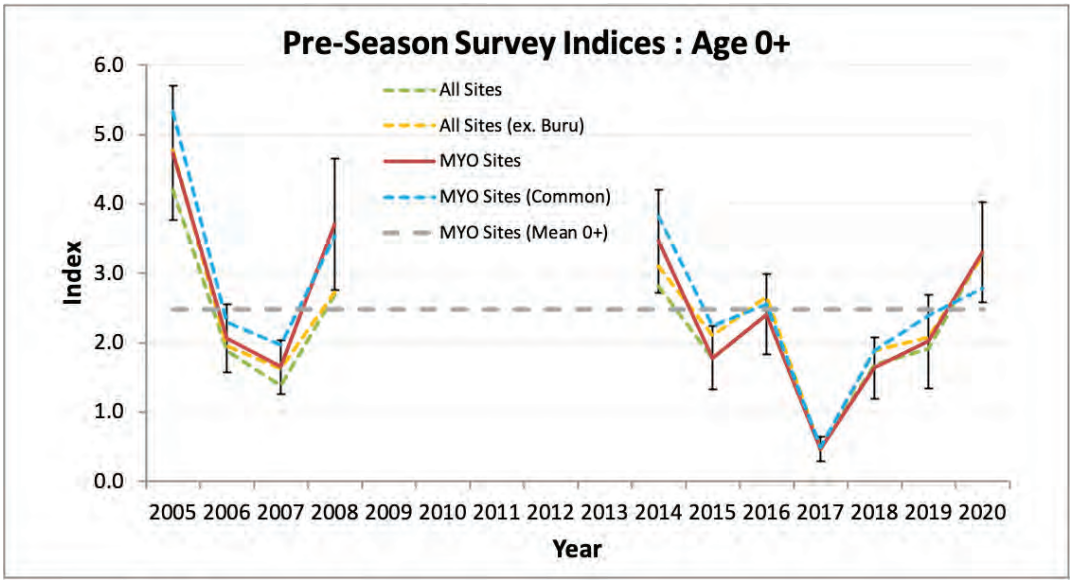
Age 1+ index in 2020



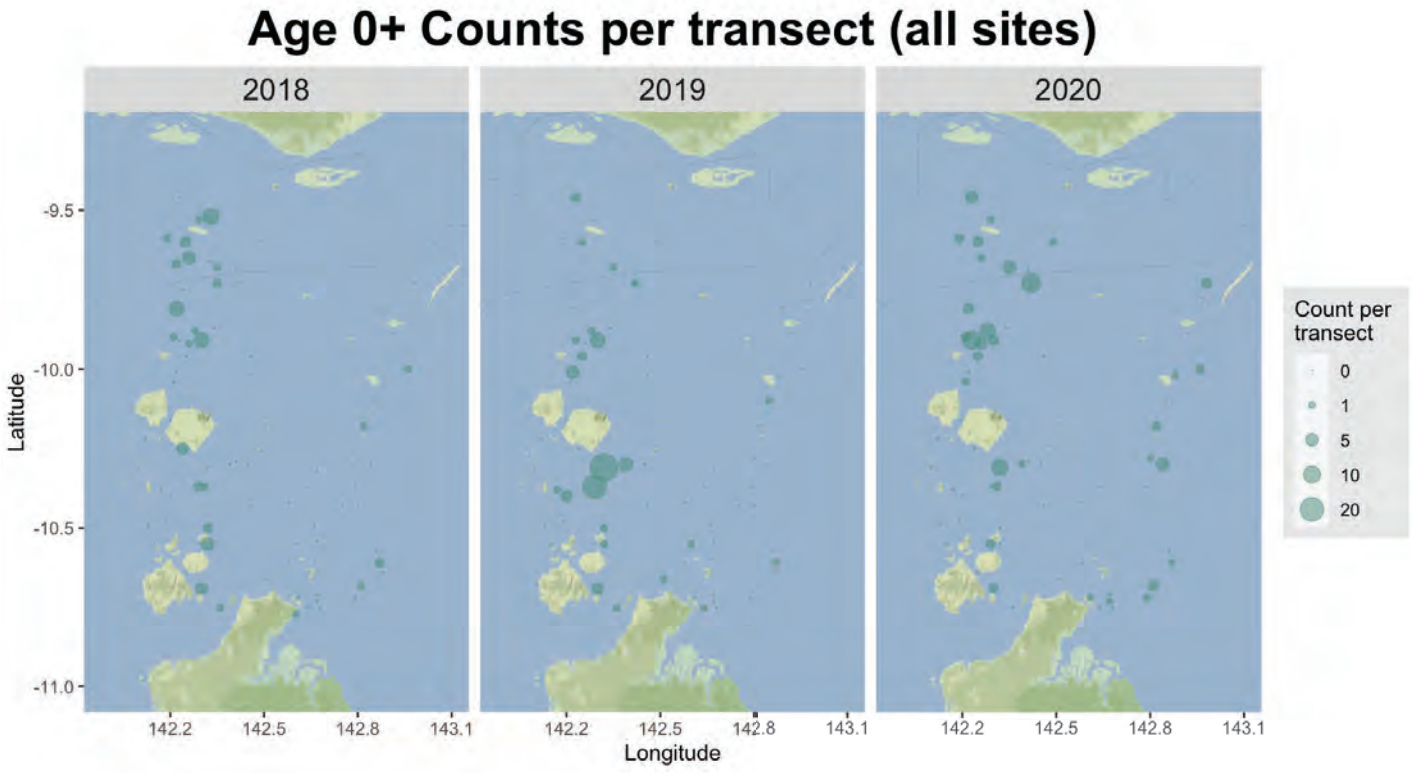
Age 0+ TRL Results



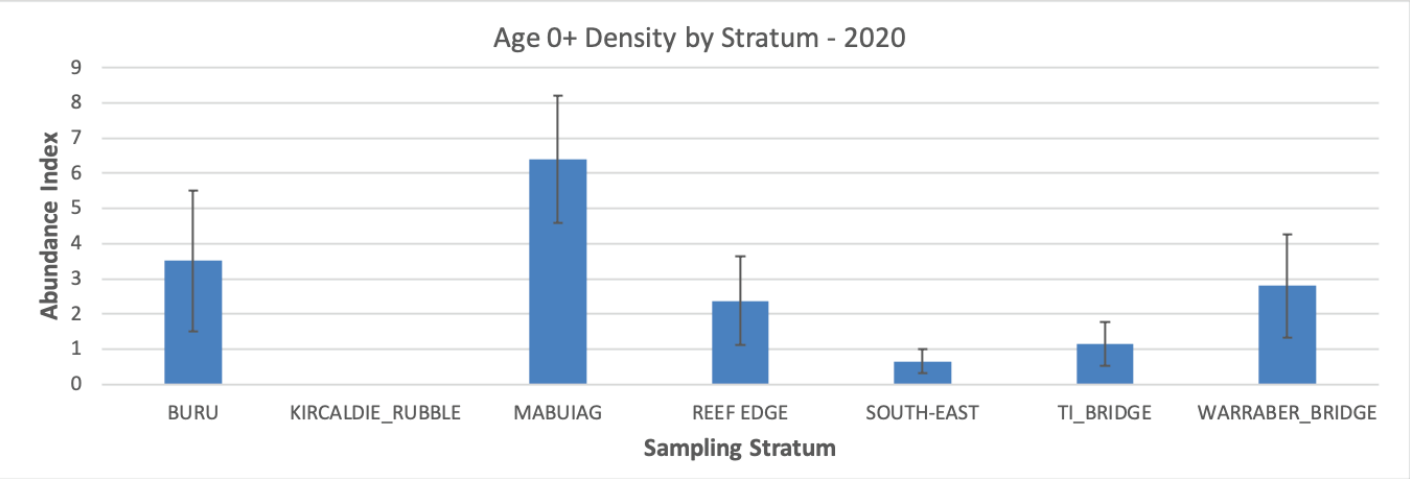
Age 0+ abundance index (2020)



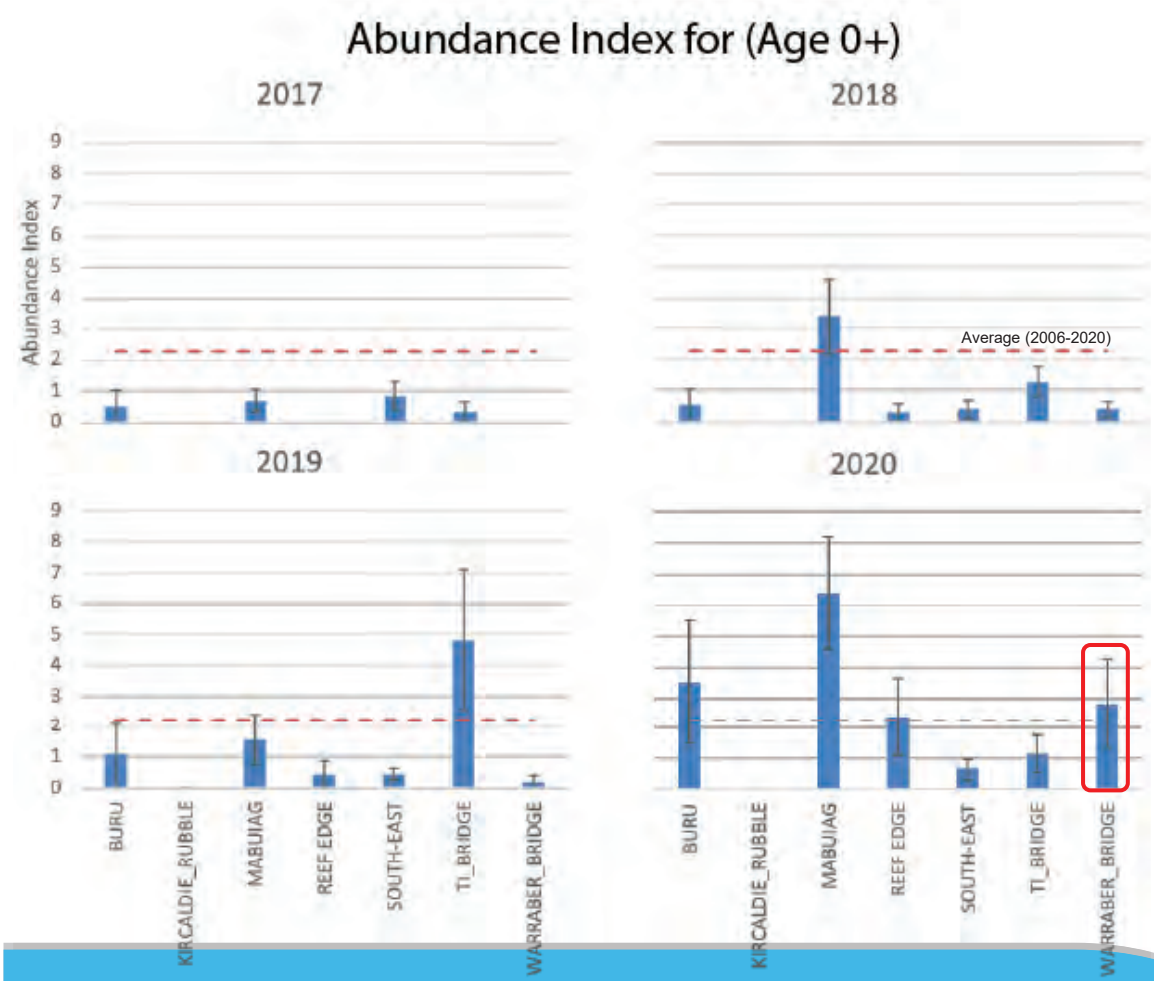
- Steady increase from its lowest in 2017
- Above the long-term pre-season survey average index (2005-2020)



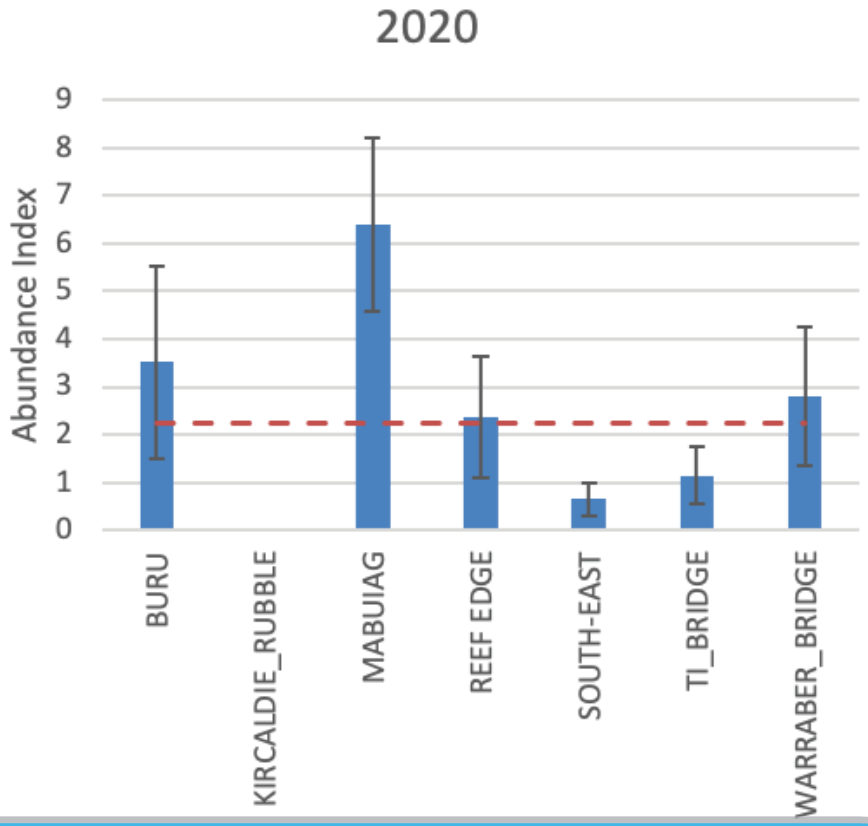
- 0+ settle typically on western side of survey area



- Highest abundance indices recorded for Mabuiag and Buru

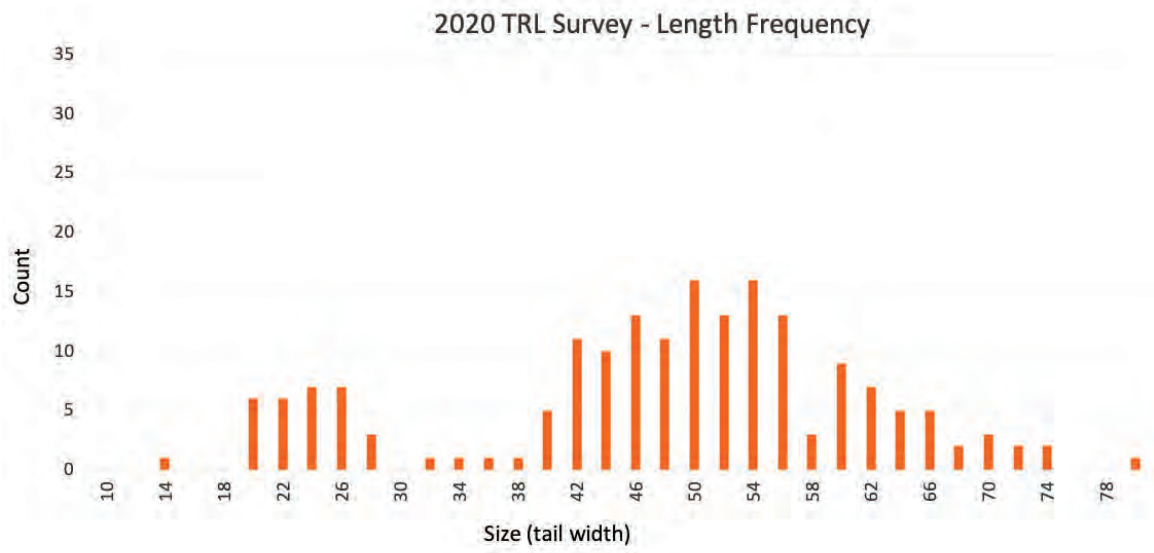


Age 0+ index in 2020

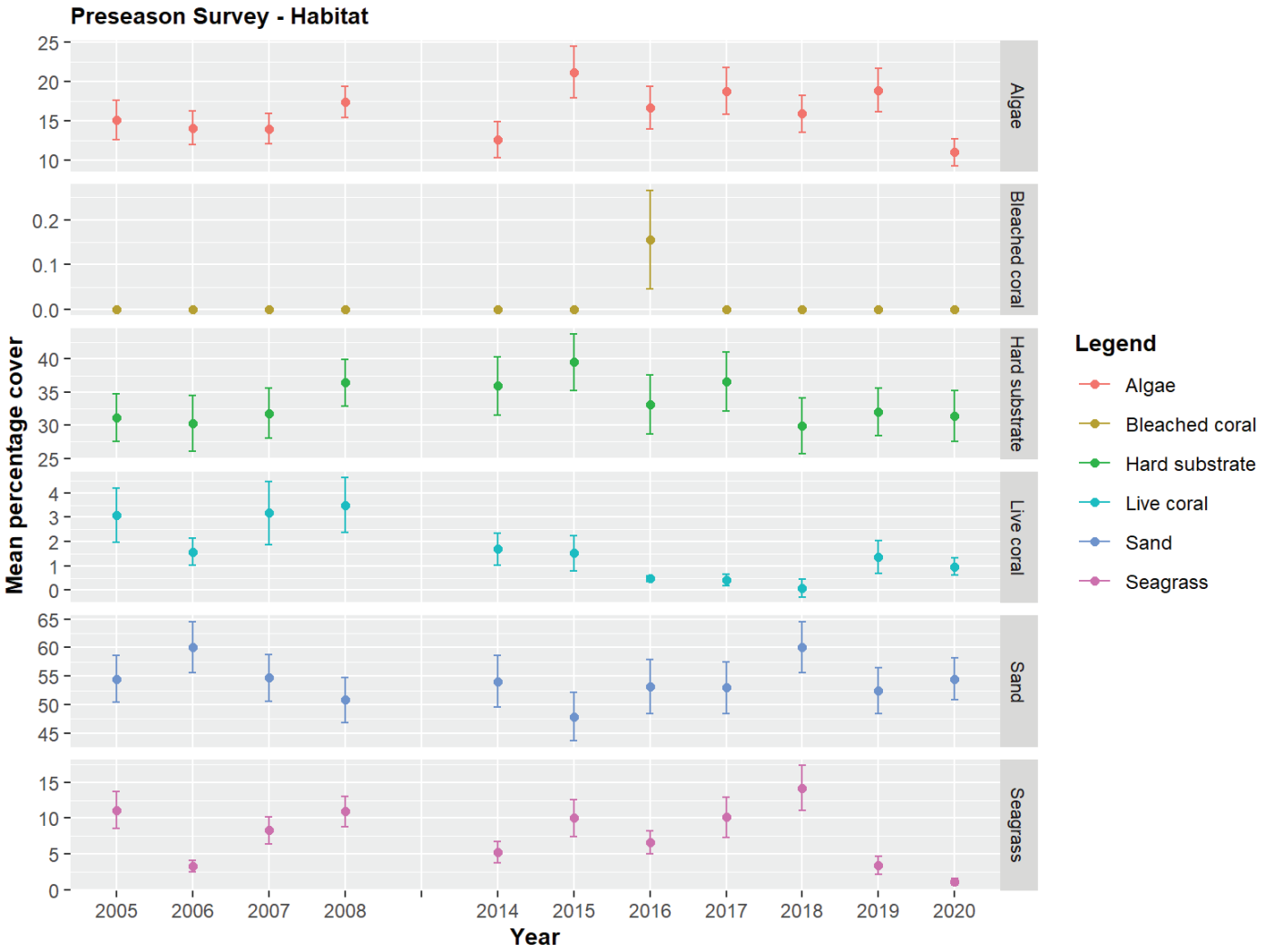


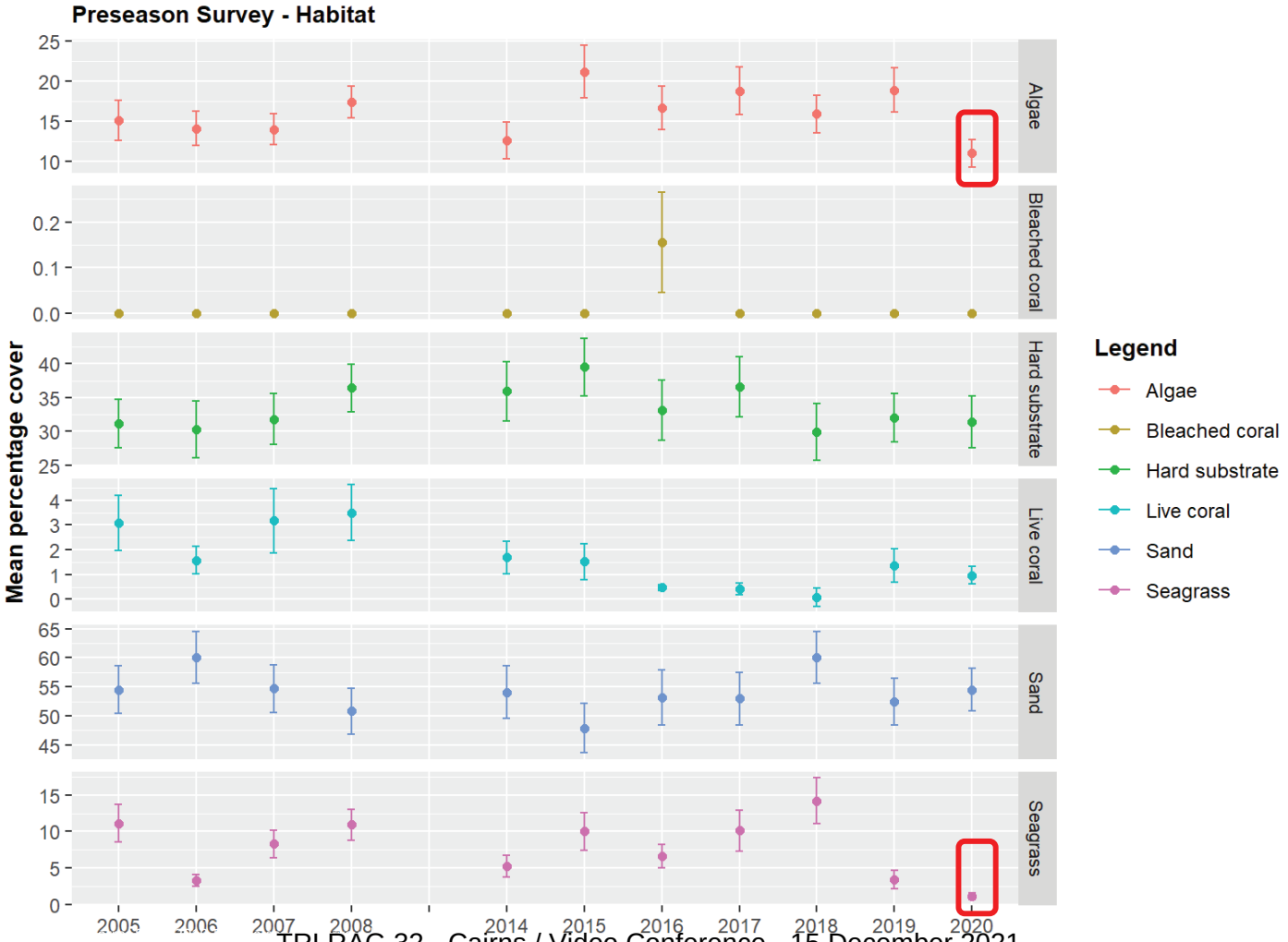
Length frequency and sex ratio (2020)

2020 length frequency similar to most surveys



Sex ratio typically around 1:1


Preseason Survey - Habitat
Mean percentage cover
Year
Algae
Bleached coral
Hard substrate
Live coral
Sand
Seagrass
Legend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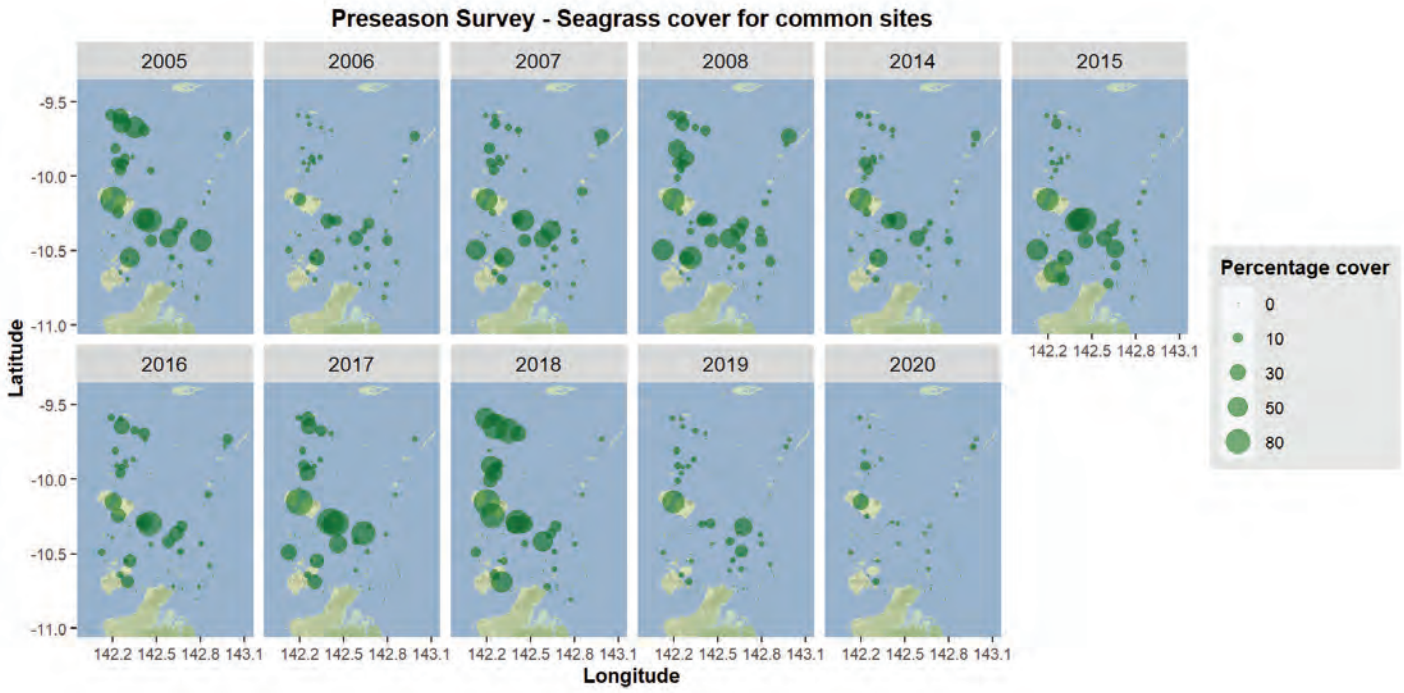
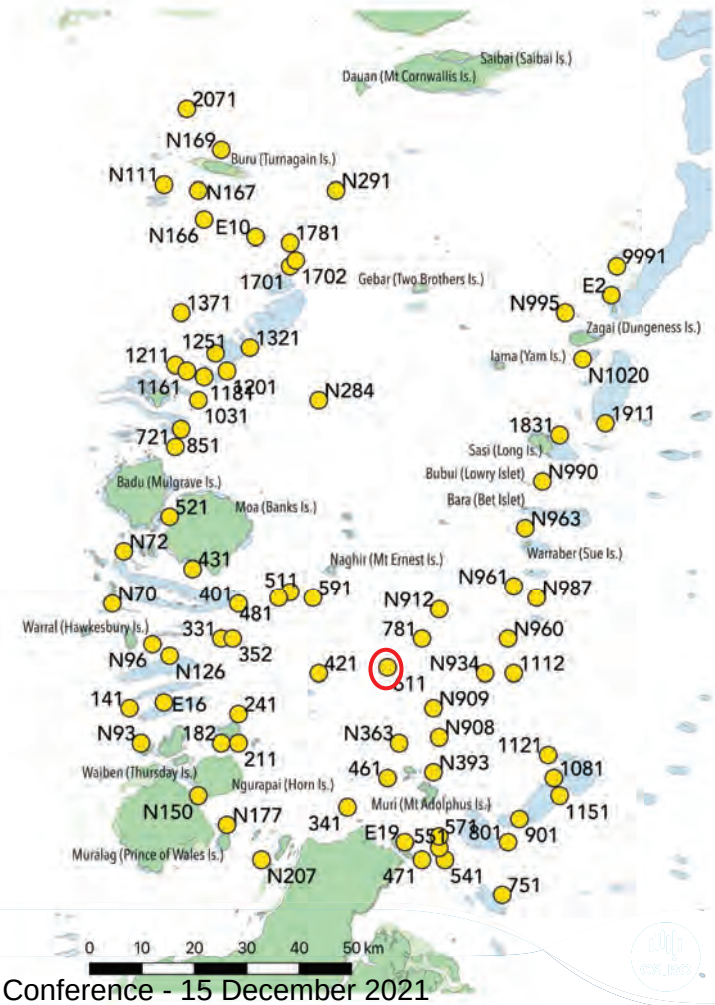


Habitat changes

- Minor sand incursions




Thank you
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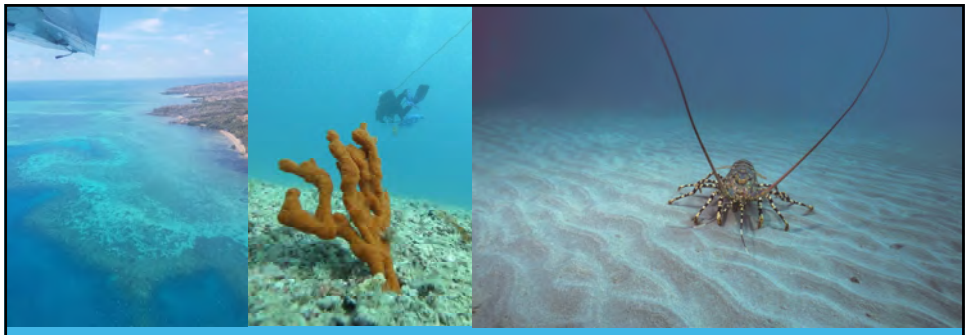

Torres Strait tropical rock lobster (TRL) *Panulirus ornatus* empirical Harvest Control Rule (eHCR) Recommended Biological Catch (RBC) for 2020/21

Éva Plagányi, Roy Deng, Steven Edgar, Judy Upston, Leo Dutra, Nicole Murphy
Mark Tonks, Kinam Salee

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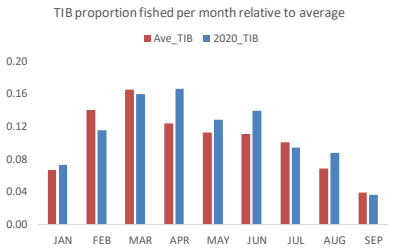
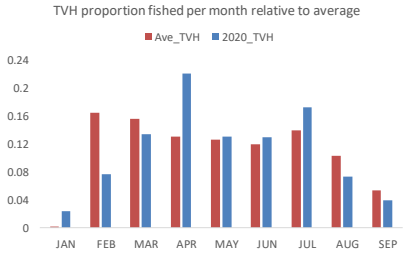
TRLRAG30 Dec 2020

TRL Catches per sector

SEASON	TIB	TVH	AUS-TOTAL	PNG-TOTAL	TS_TOTAL	TAC	Catch/ TAC
2013	142.5	361.7	504.2	108.3	612.5	871	70.3%
2014	198.8	273.2	472.0	261.2	733.2	616	119.0%
2015	202.6	152.7	355.3	235.7	591.0	769	76.9%
2016	267.1	243.0	510.1	248.0	758.2	796	95.2%
2017	111.5	166.3	277.8	113.0	390.8	495	79.0%
2018	127.4	128.3	255.7	156.4	412.1	320	128.8%
2019	260.6	155.9	416.5	167.0	583.5	641	95.1%
2020	216.2	145.1	361.3	90.4	451.7	582	73.2%

2020 Monthly Fishing Pattern compared with Average





Less catch than usual in February

Increased catches Apr-Jun

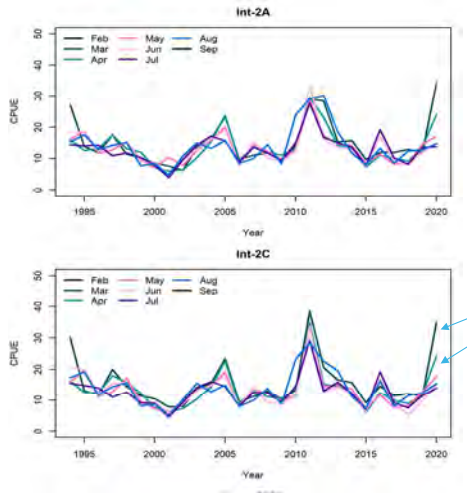
Increase in Aug but not Sept

Substantially less catch in February; reduce din March

Increase in April and July

Less fishing Aug-Sep

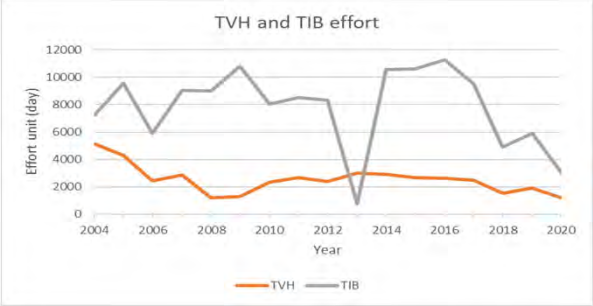
2020 deviations in monthly fishing pattern



Example TVH models including combinations of year/month and area interactions

As expected some large differences in 2020 for March, April, May (high values)

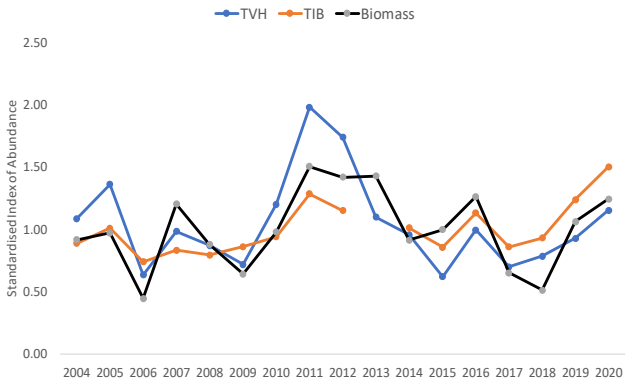
Lower than expected effort in 2020



Average Catch : Alternative Scenarios

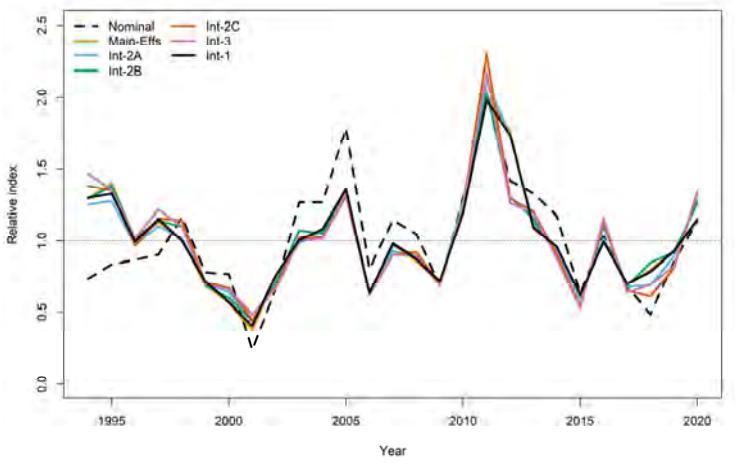
SEASON	Total Catch_actual (t)	Substituting TAC for 2020 catch	Substituting increased catch for PNG	Assuming in 2020 would have caught same percentage (95%) of TAC as in 2019
2016	758.2	758.2	758.2	758.2
2017	390.8	390.8	390.8	390.8
2018	412.2	412.2	412.2	412.2
2019	583.6	583.6	583.6	583.6
2020	451.7	582.0	553.4	553.5
AVERAGE	**519.3**	**545.4**	**539.6**	**539.7**

Comparison of CPUE indices and 2019 stock assessment spawning biomass estimate



Consistent increase in trends

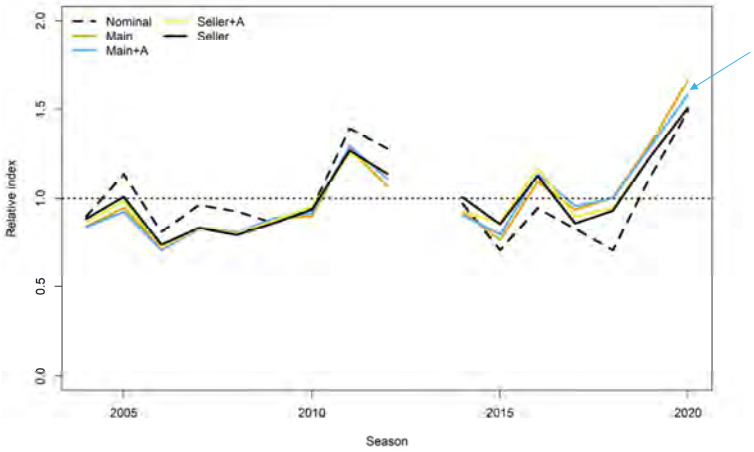
TVH CPUE standardisation



Int-1 is default used in eHCR:

*CPUE = Intercept + Year +Month + Month*Area + Vessel +Fishing-Method + Proportion-Tails + SOI + Moon* / distribution = gamma, link = log

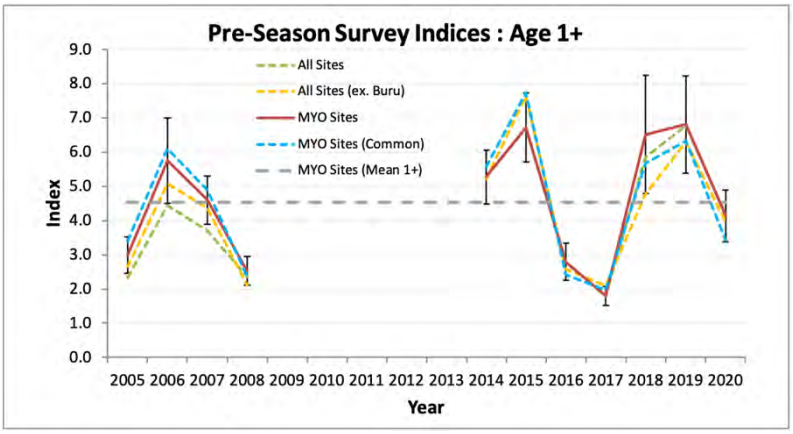
TIB CPUE standardisation



Highest CPUE on record

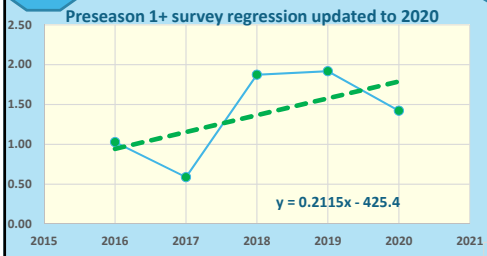
'**Seller**' is default used in eHCR: accounts for increase in the relative fishing efficiency of *Sellers* in recent seasons

Age 1+ abundance index (2020)

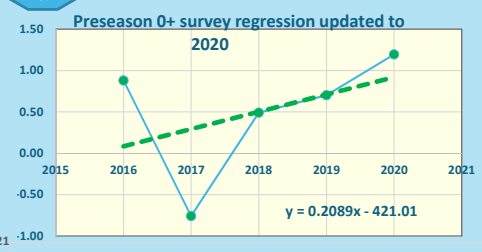


Slopes of recent data* to inform eHCR

70%



10%



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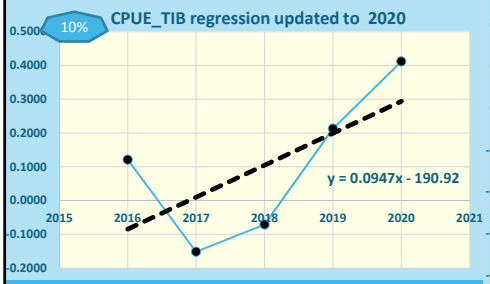
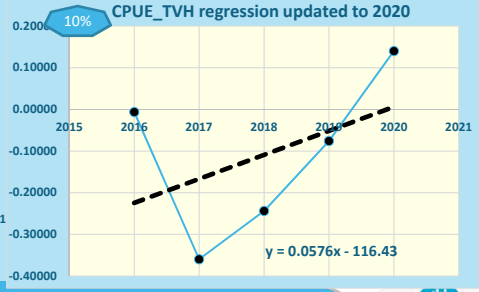


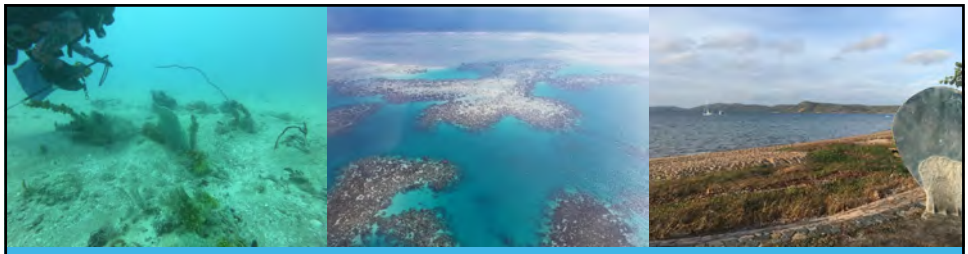
10%



*log-transformed values

eHCR Recommended Biological Catch (RBC)

Key sensitivities	Average Catch input	TVH model	TIB model	TIB CPUE	TVH CPUE	Ps 0+	Ps 1+	RBC (t)	Diff to SCENARIO 1
Scenario 1 (using actual catch)	519.3	Int-1	Seller	1.51	1.15	3.301	4.143	**614.9**	
Substitute TAC for 2020 catch	545.4	Int-1	Seller	1.51	1.15	3.301	4.143	**645.8**	30.9
Substitute increased catch for PNG	539.6	Int-1	Seller	1.51	1.15	3.301	4.143	**639.0**	24
Assume 2020 has same proportion of TAC caught as in 2019	539.7	Int-1	Seller	1.51	1.15	3.301	4.143	**639.1**	24.2
Alternative CPUE standardisation	519.3	Int-2C	Nominal	1.47	1.34	3.301	4.143	**616.3**	1.3
Alternative CPUE standardisation & Average Catch	545.4	Int-2C	Nominal	1.47	1.34	3.301	4.143	**647.5**	32.2



Thank you

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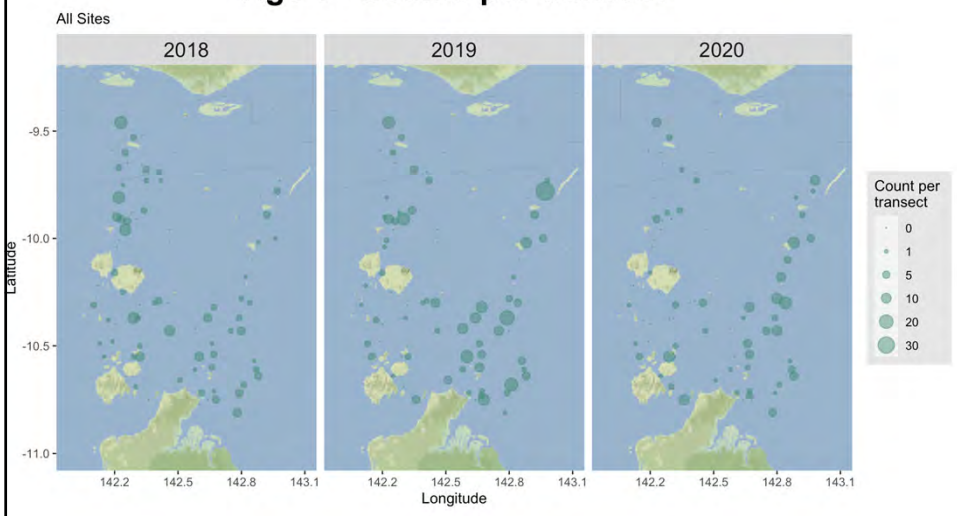
Age 1+ Counts per transect



- 2018 - Higher counts along western side
- 2019 and 2020 - Higher counts on the eastern side

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Australian Fisheries Management Authority

Contents

Meeting participants

Members

Name	Position	Declaration of interest
Ian Knuckey	Chair	Full declaration of interests provided at **Attachment A.**
Andrew Penney	Scientific member	Director of Pisces Australis Pty Ltd, an Australian registered marine/coastal research and management consultancy based in Canberra - interests in any opportunities in this regard. Currently Principal Investigator on FRDC Projects Nos 2017-180: Design and implementation of an Australian National Bycatch Report: Phase 1 – Scoping; and 2019-036: Implementation of dynamic reference points and harvest strategies to account for environmentally-driven changes in productivity in Australian fisheries, potentially red leg banana prawns or TRL. Independent scientific member on the AFMA Southeast RAG, the Tropical Rock Lobster RAG and the Small Pelagic Fishery RAG. Member of the AFMA ERA Technical Working Group. No shareholding and hold no positions relating to any other companies, including any fishing companies or industry associations.
Éva Plagányi	Scientific member	Lead scientist for PZJA funded TRL research projects conducted by CSIRO. Contribute to other Torres Strait research projects that receive research funding, including currently Shared science and Indigenous knowledge to support fisheries capacity building in Torres Strait. No other interests in the fishery. Independent scientific member of HCRAG and NPFRAG.
Les Pitt	Traditional Inhabitant member	Traditional Inhabitant Kemer Kemer Meriam and TIB licence holder.
Ray Moore	Industry member	Torres Strait Master Fisherman licence holder and East Coast TRL Fishery licence holder.
Brett Arlidge	Industry member	General Manager, MG Kailis Pty Ltd. MG Kailis Pty Ltd is a holder of 5 TVH licences. Seafood buyer from Torres Strait, Queensland and PNG TRL fisheries.
Selina Stoute	AFMA member	Nil.
Mark Anderson	TSRA member	Economic Development and Fisheries Program manager. Employee of TSRA. TSRA holds multiple TVH TRL fishing licences on behalf of Torres Strait Communities but does not benefit from them.
Georgia Langdon	AFMA Executive Officer	Nil.

Observers

Name	Position	Declaration of interest
Judy Upston	CSIRO observer	Scientist for PZJA funded TRL research projects conducted by CSIRO.
Rob Campbell#	Scientific observer	Independent fisheries consultant with no pecuniary interest in the Torres Strait rock lobster fishery. Former employee of CSIRO and former team member of PZJA funded TRL research projects.
Leo Dutra^	CSIRO observer	No other interest in TRL fishery apart from involvement in research. Project lead for FRDC funded project: Shared science and Indigenous knowledge to support fisheries capacity building in Torres Strait. Member of TRL science survey project team.
Graham Hirakawa	Industry observer	TIB licence holder.
Quinten Hirakawa	TSRA observer	TIB licence holder with a TRL endorsement

left the meeting 10:10am

^ left the meeting at 9:30am

1 Preliminaries

1.1 Welcome and apologies

1. The meeting commenced at 9:09 am (Queensland time) on Tuesday 12 October 2021. Attendees were welcomed by the Chair, who stated an Acknowledgement of Country on behalf of each participant joining the meeting.
2. Attendees at the RAG meeting are detailed in the meeting participant tables at the start of this meeting record.
3. Apologies were received from:
    a) Harry Nona, Traditional inhabitant member, Kaiwalagal
    b) James Ahmat, Traditional inhabitant member, Maluylagal
    c) James Billy, Traditional inhabitant member, Kulkalgal
    d) Aaron Tom, Traditional inhabitant member, Gudumalulgal
    e) Yen Loban, TSRA Observer, Fisheries Portfolio member.
4. Members and permanent observers not in attendance were:
    a) QDAF member
    b) Malu Lamar RNTBC representative, observer
    c) Papua New Guinea National Fisheries Authority representative, observer
5. The RAG noted that the members present did not necessarily equate to a quorum, in accordance with *Fisheries Management Paper 1* (FMP 1), which states that a sensible size for a quorum is a sufficient number of members to conduct business with an adequate spread of responsibility, experience and representation. In the case of RAGs, the number shall be two-thirds of the members.
6. The RAG members in attendance agreed that the outcomes of the meeting would be sent out of session to the other members not present for their input before finalising the meeting record.

1.2 Adoption of agenda

7. The draft agenda was adopted without change (**Attachment B**).

1.3 Declaration of interests

8. As provided in PZJA FMP 1, all members of the RAG must declare all real or potential conflicts of interest in the Torres Strait TRL Fishery at the commencement of the meeting.
9. Where it is determined that a direct conflict of interest exists, the RAG may allow the member to continue to participate in the discussions relating to the matter but may also determine that, having made their contribution to the discussions, the member should retire from the meeting for the remainder of the discussions on that issue.
10. The Chair requested that members and observers introduce themselves and state their updated declarations of interest. These are detailed in the meeting participant tables at the start of this meeting record.
11. The RAG accepted each member and observers' declared interests and agreed that all members could participate in each agenda item discussion, including agenda item 3 as the RAG was not going to be making formal recommendations relating to the RBC value. No members objected to this process.
12. Given the focussed discussion on research priorities, the RAG also agreed that the scientific members and observers would be permitted to participate in discussions under agenda item 5 however, they could be asked to leave the meeting temporarily for the formulation of RAG recommendations relating to research priorities.

2 Updates from members

13. The RAG noted verbal updates provided by industry members and observers on the performance of the TRL fishery during the 2020-21 season, in particular that:
    a) Cray movement in the eastern islands has been slow with very little live cray activity. Issues with the community freezer coupled with unfavourable weather has had an impact on all fisheries in the Eastern communities.
    b) An inner island fisher echoed similar sentiments stating that there has not been a lot of movement of cray and fishing this season has been slow, though not from a lack of fishing effort from his boat.
    c) Fishers are not fishing differently compared to previous seasons, and effort is considered to be higher, but if there are no crays on the ground, there are no dinghies out fishing.
    d) Fuel prices and high overhead costs have had an impact on fishing effort.
    e) Between COVID-19 impacts last season, the ban on Australian lobster product into China and subsequent uncertainty of markets, there has been a considerable negative sentiment across the TRL industry, in both the Torres Strait and the East Coast.
    f) Several TIB dinghy fishers pulled out of the fishery early on in the season and sought out alternative employment. Low fishing effort early on in the season (February in particular) is thought to be attributed to impacts on prices and partly low lobster abundance. Industry members agreed that abundance on the ground reflected the 2020 pre-season survey results.
    g) Lack of industry enthusiasm, lower prices and COVID-19 lockdowns all contributed to the TVH sector having limited diver availability resulting in one TVH boat (*Reality III*) not working for most of the season as there was only enough crew/divers to run the *Cape Grafton*. This is largely considered to be why the TVH catches were down this season.

h) The East Coast TRL Fishery experienced similar challenges, with prices and diver availability, though the TAC was around 74% caught which is an improvement on the previous two seasons.

i) The start of the 2020-21 season saw very low Cairns prices (approximately $37/kg, normally around $80-$85/kg). December 2020 production was reportedly half the amount of the next lowest production year in the past five years. January 2021 production did not improve much though the prices increased to around $41/kg (normally $40-$50 higher). February saw more industry operators out fishing and prices increased to $47/kg, with March prices even higher.

j) TRL production increased from April through to August, particularly in the TIB sector, and by September prices had returned back to 'almost normal'. Initially in the season, TRL markets included Hong Kong, Taiwan and domestic. Prices in mainland China increased substantially without the usual availability of Western Australian spiny lobster and South Australian rock lobster, which had positive flow on effects for tropical rock lobsters from other tropical areas (e.g. Vietnam lobsters were $30-$40 higher than ever before). As a result, most Australian tropical rock lobster in the 2020-21 season was sold to south east Asian markets including Thailand, Malaysia and Vietnam.

k) There has not been any live TRL Papua New Guinea (PNG) product available since the start of the pandemic. Only frozen tailed product is being purchased via sea freight.

3 TRL data considerations for setting the 2021-22 season RBC

Reported catch

14. The RAG considered an overview of total reported catches the Australia and PNG TRL Fisheries.

15. Total reported catch for the Australian TRL Fishery for the 2020-21 season (1 December 2020-30 September 2021) was 234.35 tonnes (55.68 per cent of the global TAC), with 118.43 tonnes (42.72 per cent of the TIB TAC) caught by the Traditional Inhabitant Boat (TIB) sector and 115.92 tonnes (81.50 per cent of the TVH TAC) caught by the TVH sector.

16. Total reported catch from Papua New Guinea (January to August 2021) was 84.4 tonnes, however the RAG noted that the total catches for the PNG TRL fishery provided by the National Fisheries Authority (NFA) (refer to TRLRAG 31 – Attachment 3b) was summed incorrectly, as the total columns included the summation of tail weight, converted tail weight and whole weight. The corrected total reported catch for both inside and outside the Torres Strait Protected Zone in PNG jurisdiction is 65.45 tonnes from January to August 2021.

17. The RAG also noted that the matter of the PNG outside but near area remains unresolved. AFMA advised that previous advice from the PNG NFA has been that those catches have been taken in what AFMA understands to be the PNG outside but near area and is therefore included in the total PNG catch for the Torres Strait TRL Fishery. The RAG also noted that the latest advice from the PNG NFA is that they have ceased providing exemptions to prawn trawlers to land any trawl caught TRL, however an industry member raised that some trawl caught TRL had been offered to the market recently, which may indicate that some illegal, unregulated and unreported (IUU) trawler-caught lobster is occurring.

Implications for empirical Harvest Control Rule (eHCR)

18. Having considered the available catch information for both the Australian and PNG TRL fisheries, and acknowledging that the 2020-21 global TAC is substantially under-caught, the RAG discussed the implications of a reduced average total catch value (possibly due to reasons highlighted in Agenda Item 2) on the empirical Harvest Control Rule used to calculate a recommended biological catch (RBC) for the 2021-22 fishing season.

19. The formula for the eHCR includes a multiplier of the average total catch (TIB, TVH and PNG) over the last five years, and a statistic which measures the relative performance of the fishery based on:

    a) The pre-season survey recruiting lobster (1+) standardised relative numbers (70 per cent weighting);

    b) The pre-season survey recently-settled lobster (0+) standardised relative numbers (10 per cent weighting);

    c) The nominal CPUE for the TIB sector (10 per cent weighting); and

    d) The standardised CPUE for the TVH sector (10 per cent weighting).

20. The RAG acknowledged that the pre-season survey inputs (80 per cent) are unaffected by the factors that have impacted the 2020-21 season, and that the influence of some of these factors can be accounted for in the standardisation of CPUE (accounting for the other 20 per cent of the eHCR).

21. However, the RAG noted that the main concern this season is the lower than expected total catch which impacts the average catch multiplier over the past five years. A low catch year (as in 2019-20) may not be as influential on the eHCR when the total catch is averaged over a five year period, however if the negative average total catch trend was ongoing, it would start to drive the RBC calculation down.

22. While the eHCR has been extensively tested to handle a series of uncertainties and has been demonstrated to be fairly robust, the impacts of exceptional circumstances such as COVID-19 and market collapse, are not accounted for. TRLRAG 30 discussed the need to develop and formally agree some meta rules to help manage exceptional circumstances which may be outside the bounds of conditions the harvest control rule was tested for, rather than continuing to make ad-hoc adjustments.

23. The average catch multiplier is considered to be a check and balance mechanism. If for example, the pre-season survey indicated the upcoming season was going to be an average season, in the absence of any exceptional circumstances, it could be expected that the TAC would be close to, or fully caught. However, if the total catch was artificially low (due to exceptional circumstances) then the RAG may consider making some adjustments to account for the lower catches so as to not unnecessarily reduce the TAC. Alternatively, the RAG could consider applying the default eHCR which will reduce the TAC for next season though is not necessarily scientifically justified.

24. The RAG also acknowledged that neither the catch and effort data, nor the pre-season survey results had yet been analysed, but considered possible preliminary approaches for making adjustments to the 2019-20 and 2020-21 catch values that are used to calculate the average total catch multiplier in the eHCR:

    a) using the actual average total catch value (default application of the eHCR);

    b) using the TAC value without any scaling up of catches; or

    c) using an average proportion of the TAC caught by the entire fishery over the 3 or 5 most recent years (pre COVID-19 impacted years) and applying this proportion to the 2019-20 and 2020-21 TACs to obtain respective catch values for use in calculating the average; it was noted that the average proportion for any year would be capped at 1.

25. The independent scientific member raised some concerns with the level of influence the average catch multiplier has on the eHCR and as an index of abundance. He expressed a preference to use the TAC value as the best estimate of total catch as an ad-hoc adjustment (without any scaling up), claiming that given the TRL fishery is an established, high value fishery with established catching and export mechanisms, it is reasonable to expect that the TAC would be close to or fully caught.

26. The CSIRO scientific member noted that, while a number of major fishery harvest strategies incorporate an average catch multiplier, part of the reason it was included for the TRL Fishery eHCR is because the fishery was undergoing significant change at the time of harvest strategy

implementation including the separation of sectoral catches and the implementation of a quota management system, meaning that an average static value of catches was not appropriate.

27. Notwithstanding that the eHCR can be reviewed in future (though not in time to set a TAC for the 2021-22 season), the CSIRO scientific member's preference was to use an average value that replaces the 2020-21 catch with an estimate based on the percentage of catch against TAC over the preceding 5 years. The RAG noted that to avoid compounding averages, the best approach would be to apply any ad-hoc adjustment that is made this year to the 2019-20 total catch value as well, and then use an average of the proportion of catch against the TAC for the years prior (being stock assessment derived TACs).
28. The RAG considered that the average proportion of catch taken against TAC should apply to the global TAC (rather than by sector i.e. TIB, TVH and PNG separately) for a number of reasons:
    a) the proportion of catch against TAC in earlier years for the Australian fishery was not split between sectors (pre-quota);
    b) due to COVID-19 impacts, PNG have not been able to access their catch entitlements in Australian waters in both the 2019-20 and 2020-21 fishing seasons; and
    c) in some years, the TAC was overcaught (and therefore needs to be capped at 100 per cent; to be incorporated in future harvest strategy revisions).
29. Further, there are benefits in using the proportion of catch against TAC (rather than the TAC value) particularly for the PNG sector, given that there is no CPUE data for the PNG Fishery and the only available information is the total catch.
30. **Noting that not all RAG members were present for the discussion, and that the fishery dependent data had not yet been analysed or corroborated with industry anecdotes, the RAG recommended that CSIRO present two different options (as discussed) for dealing with the under-catch in both the 2019-20 and 2020-21 fishing season's data in the eHCR at the next RAG meeting.**
    - **Option 1:** replace the actual catch values and substitute them with the TAC value in outlier years (2019-20 and 2020-21); use the actual catches in the three years prior (2016-17, 2017-18 and 2018-19) and apply an average of all five years catch values.
    - **Option 2:** noting that there has been a change in the relative proportion of the TAC caught between the TIB and TVH sectors in recent years, use the combined sector (TIB, TVH and PNG) average catch proportion against the global TAC over the recent five-year period, capping any overcatch at 100 per cent of the TAC, and apply this proportion to the TAC for 2019-20 and 2020-21 to obtain an estimated catch value for those years.

4 Climate change impacts on Torres Strait Fisheries

31. Due to time restraints, this agenda item was not presented or discussed.

5 TRL Fishery Research Priorities

32. Due to time restraints, this agenda item was not presented or discussed.

6 Date and venue for next meeting

33. Due to time restraints, and agenda item 3 being the highest priority for discussion, the RAG agreed that agenda items 4 and 5 could be addressed in a subsequent video-conference meeting, or out-of-session.
34. The 31st TRLRAG meeting was closed at 11:03am (Queensland time) on Tuesday 12 October 2021.

Declaration of interests

Ian Knuckey – October 2021

Ian Knuckey positions:

Director –	Fishwell Consulting Pty Ltd
Director –	Olrac Australia (Electronic logbooks)
Chair –	Northern Prawn Fishery Resource Assessment Group
Chair –	Tropical Rock Lobster Resource Assessment Group
Chair –	Victorian Rock Lobster and Giant Crab Assessment Group
Chair –	Victorian Central Zone Abalone Fisheries Resource Advisory Group
Chair –	Gulf of St Vincent's Prawn Fishery MAC Research Scientific Committee
Scientific Member –	Northern Prawn Management Advisory Committee
Scientific Member –	SESSF Shark Resource Assessment Group
Scientific Member –	SESSF Great Australian Bight Resource Assessment Group
Scientific Member –	Gulf of St Vincent's Prawn Fishery Management Advisory Committee
Scientific Member –	Tropical Tuna Resource Assessment Group
Scientific Member –	SESSF Resource Assessment Group
Member –	Victorian Marine and Coastal Council
Member –	The Geelong Agri Collective

Fishwell current projects:

DAWE Project	Multi-sector fisheries capacity building
AFMA 2020-0807	Bass Strait Scallop Fishery Survey – 2020-22
AFMA 2019-0836	Information the Bass Strait Central Zone Scallop Fishery Harvest Strategy and TAC setting process with economic data and MEY proxies
FRDC project	Principal Investigator for SA Peak Industry body project
AFMA project	Design sea cucumber fishery-independent survey for Coral Sea
FRDC 2019-027	Improving and promoting fish-trawl selectivity in the SESSF and GABTS
FRDC 2019-072	A survey to detect change in Danish Seine catch rates of Flathead and School Whiting resulting from CGG seismic exploration.
FRDC 2019-129	Potential transition of shark gillnet boats to longline fishing in Bass Strait - ecological, cross-sectoral, and economic implications
FRDC 2018-021	Development and evaluation of SESSF multi-species harvest strategies
Traffic Project	Shark Product Traceability
NT Fisheries	Design and implementation of a tropical snapper trawl survey

Sea Cucumber Ass.	Design and implementation of various sea cucumber dive surveys.
Australia Bay	Queensland Gulf of Carpentaria Developmental Fin Fish Trawl Fishery
Tas. Abalone	Scientific Advisor for Tasmanian Abalone Council Ltd
PEMSEA	Developing EAFM Plan for Red Snapper in Arafura and Timor Seas
Beach Energy	BACI study of Prion Marine Seismic Survey impacts relative biomass of scallops on beds in the immediate vicinity.
Expert Witness	Gladstone Harbour development impacts

31st MEETING OF THE PZJA TORRES STRAIT TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG 31)

Tuesday 12 October 2021 | 9am – 11am

Videoconference

ADOPTED AGENDA

1 PRELIMINARIES

1.1 Welcome and apologies

The Chair will welcome members and observers to the 31st meeting of the TRL RAG.

1.2 Adoption of agenda

The RAG will be invited to adopt the draft agenda.

1.3 Declaration of interests

Members and observers will be invited to declare any real or potential conflicts of interest and determine whether a member may or may not be present during discussion of or decisions made on the matter which is the subject of the conflict.

2 UPDATES FROM MEMBERS

Industry, scientific and government agency members and observers will be invited to provide verbal updates on matters concerning the TRL Fishery.

Industry members in particular, are encouraged to provide updates on fishing patterns, behaviours, prices, and market trends this season.

Detailed updates from industry members will be important to help the RAG better understand fishing patterns this season which may be considered uncharacteristic of a standard fishing season. It will be important for the RAG to consider the potential impacts of these trends when setting a Recommended Biological Catch for the TRL fishery in the 2021-22 fishing season.

3 TRL DATA CONSIDERATIONS FOR SETTING THE 2021-22 SEASON RBC

The RAG will discuss and provide advice on options and implications for setting a Recommended Biological Catch for the TRL Fishery in the 2021-22 fishing season, noting that the TAC is expected to be significantly under caught.

As at 8 September 2021, 111 tonnes (39.87% of the TAC) has been caught by the TIB sector, and 107 tonnes (75.28% of the TAC) by the TVH sector.

4 CLIMATE CHANGE IMPACTS ON TORRES STRAIT FISHERIES

The RAG is invited to note a pre-recorded video presentation from Leo Dutra (CSIRO) on the outcomes of the project '*Scoping a future project to address impacts form climate variability and change on key Torres Strait Fisheries*'.

5 TRL FISHERY RESEARCH PRIORITIES

The RAG will discuss and provide advice on research priorities for the 2022/23 – 2026/27 five year period.

The Chair must approve the attendance of all observers at the meeting. Individuals wishing to join the meeting as an observer must contact the Executive Officer – Georgia Langdon (georgia.langdon@afma.gov.au)

Timeline of key events in the Torres Strait Tropical Rock Lobster Fishery[1]
Last updated December 2021

Commonly used acronyms and terms:

- **FMN** means Torres Strait Fisheries Management Notice.
- **FMI** means Torres Strait Fisheries Management Instrument.
- **LN** means Logbook Notice
- **PZJA** means Protected Zone Joint Authority.
- **TRL** means Tropical Rock Lobster.
- **TRL Fishery** means the Torres Strait Tropical Rock Lobster Fishery.
- **Instrument** means the *Torres Strait Fisheries (Tropical Rock Lobster) Management Instrument 2018*
- **Management Plan** means the *Torres Strait Fisheries (Quotas for Tropical Rock Lobster (Kaiar)) Management Plan 2018*

Time period	Topic/Keywords	Description
1960	Fishery development	Commercial fishing for TRL by the non-Traditional Inhabitant sector began in the Torres Strait
1970s-1980s	Fishery development	Traditional Inhabitant fishers begin to enter the fishery.
Dec-1978	Treaty, PNG	Torres Strait Treaty signed
Feb-1985	Legislation, regulations, PZJA	Torres Strait Treaty entered into force, *Torres Strait Fisheries Act 1984* and *Torres Strait Fisheries Regulations 1985* commenced and the PZJA is established
Feb-1985	Regulations	Under FMN 1: • Method restrictions introduced - only diving, collection by hand and use of spear permitted
Feb-1985	PNG, catch sharing	Agreement between PNG and Australia for the joint management of the TRL fishery concluded.

[1] This is intended to be a living document and is to be updated as key events happen.

Time period	Topic/Keywords	Description
Jul-1985	Regulations	Under FMN 9 (replaced FMN 1): • Method restrictions amended to introduce a time period within which the method restrictions are in place – only diving, collection by hand and use of spear permitted between 15 Jul-31 Oct
Jan-1986	Management arrangements	Introduction of prohibition on prawn trawlers taking TRL during the annual migration period (1 Jul-31 Oct) in order to reduce fishing pressure on the lobster population - in place until 1987, when all prawn trawlers were prohibited from taking TRL
Jun-1986	Regulations	Under FMN 12 (replaced FMN 9): • Method restrictions amended to change the dates between which methods are restricted – only diving, collection by hand and use of spear permitted between 1 July - 31 October only
Mar-1988	Regulations	Under FMN 19: • Introduction of prohibition on the take, processing or carrying of TRL by boats with a prawn endorsement
Jun-1988	Regulations	Under FMN 22: • Minimum size limit introduced - 100 mm tail length
Oct-1988	Regulations	Under FMN 24 (replaced FMN 12): • Method restrictions amended - only diving, collection by hand and use of spear permitted, no underwater breathing apparatus except hookah, no underwater mechanical propulsion • Introduction of exemption which can be sought for some method restrictions, specifically the use of underwater breathing apparatus and underwater mechanical propulsion • Traditional fishing bag limits introduced - 3 per person up to 6 per boat
October 1988	Management objectives	PZJA agrees to six key management objectives for the fishery: - To conserve the stock of tropical rock lobster - To maximise the opportunities for traditional inhabitants of both countries to participate, including by managing the fishery for tropical rock lobster as a dive fishery - To promote the dive fisheries for tropical rock lobster in Torres Strait - Encouragement and facilitation of participation by Australian traditional inhabitants for whom future expansion of the fishery should be reserved - Containment of the capacity of the existing commercially licensed fleet and elimination of entrepreneurial speculation and subsequent upgrading/replacement of commercially licensed dinghies with large boats

Time period	Topic/Keywords	Description
		- To minimise impact of any new management measures on existing operators.
March 1989	Traditional Inhabitant access, identification, definition	Tropical Rock Lobster Working Party agrees to Island Coordinating Council suggestion that “amnesty” Papua New Guineans be considered Traditional Inhabitants for fisheries management purposes. Following this, PZJA agrees to “measures to be used for identifying those Papuans resident in Torres Strait who should be treated as Australian traditional inhabitants for all fisheries management and enforcement purposes, including community fishing rights” in the fishery.
Aug-1989	Regulations	Under FMN 31 (replaced FMN 24): • No substantive changes to FMN 24
November 1989	PNG, catch sharing, cross-endorsement	Catch-sharing arrangements for the fishery agreed by PNG and Australia. 27 PNG lobster dinghies to be allowed to operate in Australian TSPZ waters, while Australian operations in PNG waters are precluded.
1989	Management arrangements, fishery surveys	Fishery independent surveys commence in the TRL Fishery
February 1990	PNG, catch sharing, cross-endorsement	Catch-sharing arrangements come into effect 15 February, but no PNG boats begin fishing.
Oct-1990	Regulations	Under FMN 34 (replaced FMN 22): • No substantive changes to FMN 22
1991-1992	Traditional Inhabitant access, identification, definition	PZJA establishes a working group to consider the involvement in PZJA fisheries of Torres Strait Islanders and Aboriginals living in the Northern Peninsula Area of Cape York and Australian citizens of Papua New Guinean origin.
June 1991	PNG, catch sharing, cross-endorsement	Cross-endorsements issued to 4 PNG mother ships with 18 dinghies on 14 June. PNG boats agreed to respect home reefs closures, not go ashore on Australian territory, and make no contact with Australian inhabitants, Australian vessels, or PNG traditional fishers.
Jun-1992	Native title	Mabo High Court decision recognises existence of native title (Aboriginal and Torres Strait Islander rights and interests to land and waters according to their traditional law and customs)

Time period	Topic/Keywords	Description
1993	Community licensing	Concerns about the current licensing systems run by the PZJA and Queensland for community fishing begin to be raised by Island Coordinating Council. Concerns include that Traditional Inhabitants living outside the Island Coordinating Council area are excluded from obtaining licences, the administrative and financial burden placed on island councils by the systems, a lack of detailed information to inform fisheries management decisions, and the fact that island chairmen rather than individual fishers are legally responsible for any fishing violations.
February 1993	PNG, catch-sharing, cross-endorsement	New PNG catch-sharing arrangements commence on 15 February 1993 for a three-year period to 14 February 1996. Allow for cross-endorsement of 27 PNG dinghies and associated freezer boats. Nominations received for cross-endorsement of 3 PNG TRL freezer boats with 27 associated dinghies.
Oct-1993	Regulations	Under FMN 38 (replaced FMN 31): • Introduction of prohibition on taking TRL using hookah between 1 Oct-30 Nov • Traditional fishing bag limits amended - 3 without a boat, 3 with 1 person in a boat, 6 with more than 1 person in a boat • All other requirements remained unchanged - method restrictions
Dec-1993	Native title, legislation	*Native Title Act 1993* commences, legislating the framework for recognition of native title (including over maritime areas) in Australia following the High Court's Mabo decision. The Act covers the determination of whether native title exists, acts affecting native title, and compensation for acts affecting native title.
1994	Logbooks	Noted under LN 8: • Tropical Rock Lobster Logbook TRL02 implemented – voluntary, records frozen tails only
1994	Legislation, TSRA	Torres Strait Regional Authority established under the *Aboriginal and Torres Strait Islander Commission Act 1989*
April-June 1995	Single jurisdiction, licensing	PZJA establishes Task Force to investigate the feasibility of introducing single jurisdiction fisheries management and to advise on matters such as eligibility criteria for entry to the newly created fisheries. Investment warning is issued.
Jul-1995	Regulations	Under FMN 42 (amended FMN 38): • No changes to regulation of fishing provided under FMN 38. Amendments made to correct a drafting error that excluded several words from the section relating to bag limits for traditional fishing.
October 1996	Single jurisdiction, licensing,	PZJA endorses single jurisdiction (the management of all Torres Strait fisheries by the PZJA, rather than a division of responsibility between the PZJA and the Queensland government) and the Task Force's

Time period	Topic/Keywords	Description
	community licences, TIB licensing	recommendations for licensing reform. Due to opposition from Islander representatives, related to broader issues such as autonomy and the desire for a regional agreement for Islander control over Torres Strait waters, the implementation of these reforms was delayed and then boycotted until agreement was reached in 1999.
Mar-1997	Regulations	Under FMN 44 (amended FMN 38): • Method restrictions amended - only collection by hand, use of spear or other handheld implement permitted, no underwater breathing apparatus except hookah, no underwater mechanical propulsion
May-1997	Logbooks	Under LN 8: • Tropical Rock Lobster Logbook TRL03 implemented – both TRL02 and TRL03 mandatory for boats with freezing capacity, records both live and frozen tails
Apr-1998	Regulations	Under FMN 48 (replaced FMN 34): • Minimum size limits amended - 80 mm carapace length, 100 mm tail length
1999	Traditional Inhabitant access, identification, definition	PZJA agrees that children of “amnesty” Papua New Guineans be considered Traditional Inhabitants, following the 1989 decision to include “amnesty” people within the definition of Traditional Inhabitants.
July-December 1999	Single jurisdiction, licensing, community licences, TIB licensing	Islander representatives propose a series of principles to underlie community licensing, consistent with the previously proposed system.
Apr-2000	Single jurisdiction, licensing, community licences, TIB licensing	Following a meeting between the PZJA and Islander representatives, the Traditional Inhabitant Boat (TIB) licence is introduced for a one year trial period.
Nov-2001	Regulations	Under FMN 58 (replaced FMN 38, 42, 44, 48): • Introduction of fishery closure from 1 Oct-30 Nov (revoking previous prohibition on taking TRL using hookah between 1 Oct-30 Nov). Exemption from closure but bag limits apply - 3 without a boat, 3 with 1 person in a boat, 6 with more than 1 person in a boat

Time period	Topic/Keywords	Description
		• Introduction of prohibition on taking or carrying of TRL while using, or in the possession of, hookah gear between 1 Oct-31 Jan • All other requirements remained unchanged - method restrictions, minimum size limits
2002	Legislation, TSRA, PZJA	*Torres Strait Fisheries Act 1984* is amended to make the Torres Strait Regional Authority Chairperson a member of the Protected Zone Joint Authority
Nov-2002	Latent effort, fishery participation	A 30% reduction in the number of tenders attached to each non-Traditional Inhabitant licence package was implemented, except where only 1 tender exists, in which case the tender will be entitled to continue working. This was done in order to reduce latent effort in the fishery and restrict expansion of effort by non-Traditional Inhabitant fishers. This arrangement was in place until 2011.
November 2002	Traditional Inhabitant access, Skehill report, management objectives	Skehill report – "A Fair Share of the Catch" – is delivered, evaluating Torres Strait fisheries and establishing an order of priority for their management. Recommends Traditional Inhabitants be given priority of access to the TRL Fishery.
Dec-2002	Regulations	Under FMN 62: • Introduction of prohibition of processing or carrying TRL meat removed from the shell on a boat. Exemption provided for traditional fishing.
Dec-2003	Latent effort	Cap on Traditional Inhabitant licences for boats greater than 6 m with a TRL Fishery endorsement – in place until 2006
Late 2003	Logbooks	Torres Strait Seafood Buyers and Processors Docket Book (TDB01) implemented – voluntary
Jun-2003	Logbooks	Under the *Torres Strait Fisheries Logbook Instrument No. 1*: • Tropical Rock Lobster Logbook TRL04 implemented – mandatory for all non-Traditional Inhabitant operators
Jan-2005	Management arrangements	Moon-tide hookah closures (a periodic closure on the use of hookah gear three days either side of the full or new moon each month during between Februrary and September) introduced – first implemented in 2005 as a way to reduce fishing effort to levels recorded in 2002. In 2013 the closures were removed following a buy-out of non-Traditional Inhabitant licences however were reintroduced in 2014 following agreement from both the sectors, and continue to date

Time period	Topic/Keywords	Description
Jul-2005	Management plan	PZJA agreed to create a plan of management to implement a quota management system in the fishery.
July 2005	Allocation	PZJA agrees to transition to initial 50:50 sectoral split in the fishery, brought about by government funded buyout, with a later goal of a 70:30 split between Traditional Inhabitants and non-Traditional Inhabitants, funded by an “open market and self-funded tender process”.
2006	TAC	Notional total allowable catches implemented (notional as allocation had not yet been undertaken nor a management plan developed)
Mar-2006	Regulations	Under FMN 73 (replaced FMN 58, 62): • Introduction of fishery closure from 1-30 Nov (revoking previous fishery closure from 1 Oct-30 Nov). Exemption from closure for traditional fishing only but bag limits apply - 3 without a boat, 3 with 1 person in a boat, 6 with more than 1 person in a boat • Introduction of prohibition on carriage of diving equipment between 1900-0600 AEST. Exemption can be sought, but all diving equipment (face mask and fins) in possession of that person, or on board the boat, is stowed and secured during the prohibited hours. ES states that this was implemented in response to concerns that night diving may occur in the Fishery • All other requirements remained unchanged - method restrictions, prohibition of processing or carrying TRL meat, minimum size limits, hookah gear restrictions
April 2006	IAAP, allocation	PZJA agrees to create an Independent Allocation Advisory Panel (IAAP) to advise on the appropriate basis for the allocation of fishing concessions in the non-Traditional Inhabitant sector.
Sep-2006	Regulations	Under FMN 80 (replaced FMN 73): • Correction made to error in FMN 73 regarding the fishery closure, reinstated to 1 Oct-30 Nov. Exemption from closure for traditional fishing only but bag limits apply - 3 without a boat, 3 with 1 person in a boat, 6 with more than 1 person in a boat • All other requirements remained unchanged - method restrictions, prohibition of processing or carrying TRL meat, minimum size limits, hookah gear restrictions, prohibition on carriage of diving equipment between 1900-0600 AEST
Jun-2007	IAAP, allocation	PZJA agrees to final Independent Allocation Advisory Panel (IAAP) report and a sectoral catch share ratio of 35:65 between the Traditional Inhabitant and non-Traditional Inhabitant sectors as detailed in the ‘Report to stakeholders on the data used to establish the historical catch ratios of the Community and non-community sectors’

Time period	Topic/Keywords	Description
Apr-2008	Buyback, structural adjustment	Australian Government buy-back of non-Traditional Inhabitant licences. 13 primary licences and 29 associated tenders removed from the TRL Fishery. Based on the provisional allocations associated with the 'bought-out' licences the sectoral catch share between the Traditional Inhabitant and non-Traditional Inhabitant sectors changed to 53.5:46.5.
2008	Conversion factor	TRL tail to whole weight conversion ratio (2.677) implemented
2009	Harvest strategy	Interim Harvest Strategy implemented for the TRL Fishery in response to the planned transition to a quota management system, laying out the biological objectives for the fishery and how this could be achieved.
Mar-2010	Environment	Torres Strait coral bleaching event
Aug-2011	Regulations	Under FMI 9 (replaced FMN 80): • Application of arrangements extended to PNG Treaty endorsed operators • All other requirements remained unchanged – method restrictions, prohibition of processing or carrying TRL meat, minimum size limits, hookah gear restrictions, prohibition on carriage of diving equipment between 1900-0600 AEST, fishery closure. FMI 9 was intended to amend an administrative oversight that had excluded cross-endorsed fishers from the provisions of FMN 80.
Apr-2012	Buyback, structural adjustment	Based on a further buy-out of one licence (1 primary and 1 tender) the sectoral catch share between the Traditional Inhabitant and non-Traditional Inhabitant sectors changed to 56.2:43.8
7-Aug-2013	Native title, sea claim	The High Court hands down decision regarding Torres Strait Sea Claim Part A. The decision overturned the Full Federal Court decision from March 2012 and found that the native title rights in the sea claim area include the right to take fish for commercial or trading purposes. This was found to be a non-exclusive right, and native title holders are still required to hold the appropriate licences and abide by the relevant laws and regulations.
2014	Fishery participation, Traditional Inhabitant access, 100% ownership	The Protected Zone Joint Authority acknowledges and supports the aspiration of Torres Strait Communities to own 100% of access to commercial Fisheries in the Australian area of the Torres Strait Protected Zone

Time period	Topic/Keywords	Description
May-2014	Native title	Malu Lamar (Torres Strait Islander) Corporation is appointed as the Registered Native Title Body Corporate for the Sea Claim Area Part A.
Mar-2016	Environment	Torres Strait coral bleaching and sea cage mortality event
Oct-2016 to Oct-2017	Buyback, structural adjustment	Based on a further buy-out of three licences (3 primaries and 7 tenders) the sectoral catch share between the Traditional Inhabitant and non-Traditional Inhabitant sectors changed to 66.17:33.83
Jul-2017	Vessel monitoring	Vessel monitoring system (VMS) implemented – mandatory for primary boat and/or operating with a Carrier Boat License (Class A, B, or C). Vessels operating for freight shipping are exempt from installing VMS. Exemptions may also be provided for carrier vessels that are six meters or less in length.
Dec-2017	Logbooks	Torres Strait Fisheries Catch Disposal Record (TDB02) implemented – mandatory for all Torres Strait licence holders
10-Apr-2018	Management arrangements	Following a low Recommended Biological Catch, additional moon-tide hookah closures introduced covering all new and full moon periods for the remainder of the 2017-18 fishing season, in order to slow down fishing effort and provide the TIB sector with the longest possible fishing season, avoiding an early closure of the fishery.
27-Apr-2018	Management arrangements, hookah	Prohibition on the carriage and use of hookah gear for the remainder of the 2017-18 fishing season.
29-Jun-2018	Management arrangements, hookah	Federal Court of Australia order to revoke prohibition on the carriage and use of hookah gear – reverted to additional moon-tide hookah closures.
20-Jul-2018	Regulations	Under the TRL Management Instrument 2018 (replaced FMI 9): • Traditional fishing bag limits removed. Noted that PZJA does not have jurisdiction in relation to traditional fishing conducted by Traditional Inhabitants • Introduction of capacity to close the TRL Fishery early to commercial fishing, when the total allowable catch is reached • Introduction of capacity to prohibit the use of hookah gear (i.e. moon-tide hookah closures) during the hookah season (1 Feb-30 Sep)

Time period	Topic/Keywords	Description
		• All other requirements remained unchanged – method restrictions, prohibition of processing or carrying TRL meat, minimum size limits, hookah gear restrictions, prohibition on carriage of diving equipment between 1900-0600 AEST, fishery closure
31-Jul-2018	Management arrangements	TRL Fishery closed for the remainder of the 2017-18 fishing season due to total allowable catch being reached.
1-Dec-2018	Management plan	*Torres Strait Fisheries (Quotas for Tropical Rock Lobster (Kaiar)) Management Plan 2018* commenced
1-Dec-2018	Regulations	Under the TRL Management Instrument 2018 (amendment to Jul-2018 Instrument): • Ability to close the TRL Fishery early to commercial fishing revoked • Implementation of a split of the total allowable catch for the TRL Fishery between the Traditional Inhabitant (66.17% of the total allowable catch) and non-Traditional Inhabitant sectors – applied from 1 Dec 2017-30 Sep 2018 only • Introduction of capacity to close of the TRL Fishery to the Traditional Inhabitant sector once their part of the total allowable catch is reached – applied from 1 Dec 2017-30 Sep 2018 only • Provide for individual transferrable quota arrangements to be established for the non-Traditional Inhabitant sector via licence conditions – applied from 1 Dec 2017-30 Sep 2018 only • Provide for the operation of the proposed Management Plan should the quota allocation process be finalised before the start of the 2019-20 fishing season • All other requirements remained unchanged – method restrictions, prohibition of processing or carrying TRL meat, minimum size limits, hookah gear restrictions, prohibition on carriage of diving equipment between 1900-0600 AEST, fishery closure, moon-tide hookah closures
16-Sep-2019	Management plan, allocation	Quota units allocated under the Management Plan: • 662,016 quota units to the Torres Strait Regional Authority (TSRA) comprising: 562,000 to hold for the benefit of the traditional inhabitant sector; and 100,016 for the TVH licences it holds • 337,981 quota units to the remaining TVH principal licence holders
19-Nov-2019	Harvest strategy	PZJA adopts final Harvest Strategy for the TRL Fishery
1-Dec-2019	Management plan, management arrangements	TRL Fishery commences operation under a quota management system as per the Management Plan

Time period	Topic/Keywords	Description
Early 2020	Markets, price, export	• Live export market into China closed temporarily prior to 2020 Chinese New Year. • Prices in the fishery were down significantly, similar to lowest prices on record in 2002-03. • TVH boats in Torres Strait and QLD East Coast were forced to stop fishing. • Whole frozen product only purchased at reject prices. • COVID-19 impacts affect flights and freight routes from Australia to Asian markets
~ October 2020	Markets, export, Cadmium	China began to increase inspection levels and testing of cadmium in Australian live lobster at the point of entry in major Chinese ports, causing considerable delays while inspection and testing was being undertaken. This resulted in high mortality rates of lobster product (not Torres Strait product).
November 2020	Markets, export	China formally notified the DAWE of two instances of non-compliance of lobster shipments with detections of cadmium above the maximum levels set by the Chinese Government.
December 2020	Markets, export	China banned the import of Australian lobster product

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
PRELIMINARIES Out-of-session correspondence	Agenda Item 1.5 For NOTING

RECOMMENDATIONS

1. That the RAG **NOTE** the correspondence sent out-of-session since the last TRLRAG meetings held on 16 December 2020 (TRLRAG 30) and 12 October 2021 (TRLRAG 31).

BACKGROUND

2. The following correspondence was circulated out-of-session since the last TRLRAG meetings held on 16 December 2020 (TRLRAG 30) and 12 October 2021 (TRLRAG 31). Copies of this correspondence can be requested at any time from the TRLRAG Executive Officer.

Date	Item
11 January 2021	AFMA circulated the draft meeting record from TRLRAG 30 (held on 16 December 2020) for member comments. Comments closed on 25 January 2021.
19 January 2021	AFMA sent a reminder to provide comments on the draft meeting record for TRLRAG 30.
27 January 2021	AFMA circulated the final TRLRAG 30 meeting record to members.
21 June 2021	AFMA emailed RAG members with a number of fishery updates relating to: a. The start of season TAC for 2021-22; b. Seeking comment on the CSIRO non-technical summary on the kaiar pre-season surveys; c. The June 2021 TRL Catch Watch report; and d. An update on next RAG meetings
12 August 2021	AFMA emailed RAG members seeking availability for TRLRAG 31 videoconference meeting on 7 October 2021 to discuss two key business items: a. Data inputs into the empirical Harvest Control Rule; and b. Research priorities for the TRL Fishery
17 August 2021	AFMA emailed all TRL RAG and Working Group members advising of a traditional inhabitant tender boat driver opportunity for the pre-season survey.
18 August 2021	Due to date clashes with Hand Collectables Resource Assessment Group, AFMA sought availability from RAG members for a videoconference on 12 October 2021, instead of 7 October 2021.

8 September 2021	AFMA circulated a Microsoft Teams meeting invite for TRLRAG 31 videoconference on 12 October 2021, with a draft agenda.
29 September 2021	AFMA circulated the final meeting papers for TRLRAG 31
16 November 2021	AFMA circulated the draft TRLRAG 31 meeting record to members for comment. No comments were received.
16 November 2021	AFMA circulated a draft agenda for TRLRAG 32 and confirmed that the meeting was to be held on Wednesday 15 December in Cairns. AFMA also sought member availability for the meeting, either in person or virtually. AFMA also circulated a draft scope for a future TRL research project to be funded through the TSSAC that covered fishery independent surveys, stock assessment, harvest control rule and RBC work.
23 November 2021	AFMA circulated a link to RAG members to view a pre-recorded video presentation from Dr Leo Dutra (CSIRO) on the outcomes of a recently funded desktop study “Climate variability and change relevant to key fisheries resources in the Torres Strait – a scoping study”. Members were able to provide comments on the project outcomes until 7 December 2021.
25 November 2021	AFMA advised of a change of venue for TRLRAG 32, from Hilton Doubletree to The Sebel, Cairns Harbourlights.
30 November 2021	AFMA circulated the final TRLRAG 31 meeting record to members and made the record available on the PZJA website.
2 December 2021	AFMA circulated the meeting papers for TRLRAG 32.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 16 December 2021
UPDATES FROM MEMBERS Industry & Scientific members	Agenda Item 2.1 For NOTING

RECOMMENDATIONS

1. That the RAG **NOTE** updates provided by industry and scientific members.

BACKGROUND

2. Verbal reports are sought from industry and scientific members under this item, with particular emphasis on COVID-19 related, market and export impacts to the previous fishing season and the start of the 2021-22 season.
3. It is important that the RAG develops a common understanding of any strategic issues, including economic, fishing and research trends relevant to the management the TRL Fishery. This includes within adjacent jurisdictions. This ensures that where relevant, the RAG is able to have regard for these strategic issues and trends.
4. RAG members are asked to provide any updates on trends and opportunities in markets, processing and value adding. Industry is asked to contribute advice on economic and market trends where possible. Scientific members are asked to contribute advice on any broader strategic research projects or issues that may be of interest to the Torres Strait in future.
5. At the last meeting of the RAG (TRLRAG 31), the RAG noted updates provided by industry members and observers regarding the performance of the TRL Fishery during the 2020-21 season, in particular that:
    a. Cray movement in the eastern islands has been slow with very little live cray activity. Issues with the community freezer coupled with unfavourable weather has had an impact on all fisheries in the Eastern communities.
    b. An inner island fisher echoed similar sentiments stating that there has not been a lot of movement of cray and fishing this season has been slow, though not from a lack of fishing effort from his boat.
    c. Fishers are not fishing differently compared to previous seasons, and effort is considered to be higher, but if there are no crays on the ground, there are no dinghies out fishing.
    d. Fuel prices and high overhead costs have had an impact on fishing effort.
    e. Between COVID-19 impacts last season, the ban on Australian lobster product into China and subsequent uncertainty of markets, there has been a considerable negative sentiment across the TRL industry, in both the Torres Strait and the East Coast.
    f. Several TIB dinghy fishers pulled out of the fishery early on in the season and sought out alternative employment. Low fishing effort early on in the season (February in particular) is thought to be attributed to impacts on prices and partly low lobster abundance. Industry members agreed that abundance on the ground reflected the 2020 pre-season survey results.

g. Lack of industry enthusiasm, lower prices and COVID-19 lockdowns all contributed to the TVH sector having limited diver availability resulting in one TVH boat (*Reality III*) not working for most of the season as there was only enough crew/divers to run the *Cape Grafton*. This is largely considered to be why the TVH catches were down this season.

h. The East Coast TRL Fishery experienced similar challenges, with prices and diver availability, though the TAC was around 74% caught which is an improvement on the previous two seasons.

i. The start of the 2020-21 season saw very low Cairns prices (approximately $37/kg, normally around $80-$85/kg). December 2020 production was reportedly half the amount of the next lowest production year in the past five years. January 2021 production did not improve much though the prices increased to around $41/kg (normally $40-$50 higher). February saw more industry operators out fishing and prices increased to $47/kg, with March prices even higher.

j. TRL production increased from April through to August, particularly in the TIB sector, and by September prices had returned back to 'almost normal'. Initially in the season, TRL markets included Hong Kong, Taiwan and domestic. Prices in mainland China increased substantially without the usual availability of Western Australian spiny lobster and South Australian rock lobster, which had positive flow on effects for tropical rock lobsters from other tropical areas (e.g. Vietnam lobsters were $30-$40 higher than ever before). As a result, most Australian tropical rock lobster in the 2020-21 season was sold to south east Asian markets including Thailand, Malaysia and Vietnam.

k. There has not been any live TRL Papua New Guinea (PNG) product available since the start of the pandemic. Only frozen tailed product is being purchased via sea freight.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
UPDATES FROM MEMBERS Government agencies	Agenda Item 2.2 For NOTING

RECOMMENDATIONS

1. That the RAG:
    a. **NOTE** update provided by the Australian Fisheries Management Authority (AFMA) below;
    b. **NOTE** the Communique from the Queensland Tropical Rock Lobster Working Group's meeting on 20 August 2021 provided under **Attachment 2.2a** and any additional verbal updates provided by Queensland Department of Agriculture and Fisheries (QDAF); and
    c. **NOTE** verbal updates provided by the Torres Strait Regional Authority (TSRA).

KEY ISSUES

Wildlife Trade Operation (WTO) Approval under the EPBC Act 1999

2. The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) requires the Australian Government to assess the environmental performance of all commercial fisheries, including those in the Torres Strait, and promote ecologically sustainable fisheries management. Approval under the EPBC Act is necessary for fisheries to be able to legally export commercially wild caught seafood from Australia. Such approvals may be subject to conditions applicable to the responsible management authority and fishers.
3. The Torres Strait TRL Fishery was first accredited as an approved Wildlife Trade Operation (WTO) in November 2004 for a period of three years and was subsequently reassessed and re-approved in 2007, 2011, 2014, 2017 and 2020.
4. The fishery was last assessed in 2020 and, as of 4 December 2020, was declared by the Delegate for the Minister of the Environment, as an approved WTO under the EPBC Act until 4 December November 2023 subject to several conditions being addressed during the period of the approval. The advice from the Delegate to AFMA on the WTO approval and the conditions imposed on the Torres Strait TRL Fishery is provided as **Attachment 2.2b**.
5. **Table 1** provides a summary of progress against each condition and recommendation in the 12 months since the fishery was last approved.

Table 1. Summary of progress against WTO conditions and recommendations for the Torres Strait TRL Fishery.

WTO Conditions for the Tropical Rock Lobster Fishery	Progress as of October 2021
Condition 1: The Torres Strait Protected Zone Joint Authority must ensure that operation of the Torres Strait Tropical Rock Lobster Fishery is carried out in accordance with	**On track** The Torres Strait Tropical Rock Lobster fishery continues to be managed in accordance with management

WTO Conditions for the Tropical Rock Lobster Fishery	Progress as of October 2021
management arrangements defined in the *Torres Strait Fisheries Act 1984*, *Torres Strait Fisheries Regulations 1985*, licence conditions and the Torres Strait Tropical Rock Lobster Fishery Harvest Strategy (2019).	arrangements in force under the *Torres Strait Fisheries Act 1984.*
Condition 2: The Torres Strait Protected Zone Joint Authority must inform the Department of Agriculture, Water and the Environment of any intended material changes to the Torres Strait Tropical Rock Lobster Fishery management arrangements that may affect the assessment against which *Environment Protection and Biodiversity Conservation Act 1999* decisions are made.	**On track:** There have been no material changes to management arrangements for the Fishery. As a result AFMA, on behalf of the PZJA, has not been required to inform the Department.
Condition 3: The Torres Strait Protected Zone Joint Authority must inform the Department of Agriculture, Water and the Environment of any intended changes to fisheries legislation that may affect the legislative instruments relevant to this approval.	**On track:** AFMA, on behalf of the PZJA, provided the Department an update on proposed legislative amendments on 26 October 2021.
Condition 4: The Torres Strait Protected Zone Joint Authority must provide reports to the Department of Agriculture, Water and the Environment annually as per Appendix B of the *Guidelines for the Ecologically Sustainable Management of Fisheries - 2nd Edition*.	**On track:** This report meets this requirement.
Recommendation 1: The Australian Fisheries Management Authority to continue to work with the Department of Agriculture, Water and the Environment and the Protected Zone Joint Authority to implement changes to the *Torres Strait Fisheries Act 1984* to allow data reporting requirements to apply to all fishing sectors in the fishery. Data collection requirements for target species are to include: • The total quantity of each species removed from the fishery, including any catch discarded prior to landing to an authorised fish receiver; an • catch and effort data, including location of all commercial fishing activity.	AFMA is continuing the work with DAWE to progress amendments to the *Torres Strait Fisheries Act 1984* to create provisions that would require all fishing sectors in the TRL fishery to undertake logbook reporting. DAWE in consultation with AFMA is finalising drafting instructions for the amendments and sourcing legislative drafting resources from the Office of Parliamentary Counsel. It is expected that an exposure draft of the amendments will be prepared by the end of December 2021, which will then require PZJA approval and subsequent approval from the Prime Minister to be released for consultation. Following this, opportunities to comment on the proposed amendments will be provided to fishers, their communities, Native Title bodies and the general public. This will include a round of community visits in during

WTO Conditions for the Tropical Rock Lobster Fishery	Progress as of October 2021
Progress and outcomes of this recommendation to be included in annual reports required under condition 4.	March - April 2022 where AFMA expects to be consulting with stakeholders on the legislative amendments and other fishery matters. Following the public consultation period, it is expected that Parliament will be able to consider the amendments in the Winter 2022 Parliamentary sittings.

ABARES fishery status report

6. 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 stock and the economic status of fisheries managed, or jointly managed by the Australian Government (Commonwealth fisheries).
7. The ABARES Fishery Status Report 2021 (covering the performance of fisheries in 2020) was released in October 2021. The reports assess all key commercial species from Commonwealth managed fisheries and examines the broader impact of fisheries on the environment, including on non-target species.
8. In summary, the TRL Fishery has been assessed for the 2020 period as outlined below.
9. ABARES fishery status reports can be accessed on the ABARES website at:

https://www.awe.gov.au/abares/research-topics/fisheries/fishery-status-reports

TABLE 17.1 Status of the Torres Strait Tropical Rock Lobster Fishery

Biological status					
Stock	2019		2020		Comments
	Fishing mortality	Biomass	Fishing mortality	Biomass	
Tropical rock lobster (*Panulirus ornatus*)					Spawning stock biomass in 2019 was above the biomass target reference point. Fishing mortality in the 2019–20 fishing season was less than the recommended biological catch.

Economic status

Favourable GVP in the past decade has been driven by high prices and demand from the Chinese market. While catch remained steady in 2019–20, the impacts of COVID-19 led to reduced demand and unit export returns for rock lobster, leading to a fall in GVP.

Note: **GVP** Gross value of production.

Fishing mortality	Not subject to overfishing	Subject to overfishing	Uncertain
Biomass	Not overfished	Overfished	Uncertain

Electronic Catch Disposal Records

1. AFMA has launched electronic Catch Disposal Records (eCDRs) as part of the mandatory Fish Receiver System. This will provide Torres Strait fish receivers with an optional fast and easy way to electronically report landed catch information to AFMA.

2. Using eCDRs can mean less paperwork and no need to post or email paper CDR records to AFMA. Fish receivers will benefit from electronically submitting their CDRs directly to AFMA in real time. Fishers also benefit by receiving a notification via SMS or email from AFMA when fish receiver submits an eCDR of the catch landed. The system is simple and can be accessed via computer, mobile phones or tablets.

3. While the Fish Receiver System remains a mandatory licence condition, using electronic CDRs is voluntary. Fishers are still able to use the original paper system.

Queensland Fisheries Tropical Rock Lobster Fishery Working Group Communique 20 August 2021

The reappointed Tropical Rock Lobster Fishery working group met for the fifth time online on the 20th August 2021.

The working group discussed the previous meetings actions items/ noted the progress of the meeting action items.

Fisheries Queensland provided a general update on the Sustainable Fisheries Strategy (the Strategy) and recent regulation changes that impact the fishery.

Members were invited to provide a general update from their respective sectors. Australian Fisheries Management Authority (AFMA) noted that catches are low in the Torres Strait fishery. The cause is currently unclear and will be considered at a future AFMA meeting. Commercial Industry members gave an update that the trade disruptions with China has had a significant impact on the TRL industry. The industry has now managed to find alternative markets, but pricing remains depressed. The recreational member noted that recreational fishers were concerned about making sure catch limits and rules were based on science. Many recreational fishers have ongoing concerns about current boat and possession limits and requested clarification about the rationale about some rules.

The working group noted the recently released harvest strategy and the current status of the Wildlife Trade Operations approval for the fishery which is in place until 28th August 2025. As part of future meetings, we will continue our understanding of the harvest strategy.

Fisheries Queensland provided an update on the upcoming stock assessment due for completion in early 2022. The initial stock assessment will apply to the commercial fishing area only. The working group are keen to expand the stock assessment for the whole of Queensland. As part of the stock assessment process, we will look at what recreational fishing data is available. AFMA and Fisheries Queensland have agreed to work together on the stock assessments, given TRL is a single biological population.

Fisheries Queensland provided an update on compliance within the industry, noting good compliance generally.

Fisheries Queensland provided an update on the new standardised commercial fishing reporting requirements that will commence on 1 September 2021. Working group members asked questions regarding the reporting process, including pre-trip notices, logbook, prior reporting and weights notice completion timeframes, accurate weights and certified scales, and landing location requirements.

The working group noted an update on the new commercial fishing smartphone application (the app – QLD eCatch). The app will cover a range of fisheries and is designed to encompass the new reporting requirements. Fisheries Queensland will organise meetings with TRL fishers once released and ahead of the next fishing season to train and support user uptake.

Fisheries Queensland presented the methodology and outcomes from the BDO social and economic indicators report for commercial and charter fisheries, and noted that an interactive dashboard is available on the department's website. The working group noted that BDO have been contracted to continue this project as well as work focused on providing comparable social and economic information from the recreational sector

alongside the commercial and charter sectors. The working group was encouraged to contact BDO with any queries and to provide Fisheries Queensland with contacts of groups that may be interested in developing projects for social and economic values and opportunities in Aboriginal and Torres Strait Islander communities.

The next working group meeting is tentatively scheduled for early December 2021.

The Tropical Rock Lobster Fishery Working Group members are: Fisheries Queensland (Chair – Mark Doohan (apology), Kimberly Foster, Samantha Miller, Jenny Keys, Tony Loader (QBFP)), commercial fishing (Brett Arlidge, Ean White, Steven Lloyd, science (Fay Helidoniotis, Fisheries Queensland), Aboriginal and Torres Strait Islander Peoples Representative (Jacob Matysek) and Australian Fisheries Management Authority (Selina Stoute).

Australian Government
Department of Agriculture, Water and the Environment

Ref: 002068366

Mr Wez Norris
Chief Executive Officer
Australian Fisheries Management Authority
GPO Box 7051
CANBERRA ACT 2610

Dear Mr Norris

I am writing to you as Delegate of the Minister for the Environment in relation to the reassessment of the Torres Strait Tropical Rock Lobster Fishery (the fishery) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In October the Australian Fisheries Management Authority applied for export approval for the fishery under the EPBC Act on behalf of the Protected Zone Joint Authority.

The application has been assessed and I have declared the fishery an approved wildlife trade operation under Part 13A of the EPBC Act until 4 December 2023.

The Part 13A declaration includes conditions that were agreed by officials from both departments as areas requiring ongoing attention. These are set out at Attachment 1.

The existing Part 13 accreditation will remain in place based on the previous assessment of the fishery's management arrangements designed to minimise interactions with species listed under the EPBC Act.

Please note that any person whose interests are affected by this decision may make an application to the Department for the reasons for the decision and may apply to the Administrative Appeals Tribunal to have this decision reviewed. I have enclosed further information on these processes at Attachment 2.

Yours sincerely

Laura Timmins
Delegate of the Minister for the Environment

4 December 2020

Part 13A conditions on the approved wildlife trade operation declaration for the Torres Strait Tropical Rock Lobster Fishery – December 2020

1. The Torres Strait Protected Zone Joint Authority must ensure that operation of the Torres Strait Tropical Rock Lobster Fishery is carried out in accordance with management arrangements defined in the *Torres Strait Fisheries Act 1984*, Torres Strait Fisheries Regulations 1985, licence conditions and the Torres Strait Tropical Rock Lobster Fishery Harvest Strategy (2019).
2. The Torres Strait Protected Zone Joint Authority must inform the Department of the Environment and Energy of any intended material changes to the Torres Strait Tropical Rock Lobster Fishery management arrangements that may affect the assessment against which *Environment Protection and Biodiversity Conservation Act 1999* decisions are made.
3. The Torres Strait Protected Zone Joint Authority must inform the Department of Agriculture, Water and the Environment of any intended changes to fisheries legislation that may affect the legislative instruments relevant to this approval.
4. The Torres Strait Protected Zone Joint Authority must provide reports to the Department of Agriculture, Water and the Environment annually as per Appendix B of the *Guidelines for the Ecologically Sustainable Management of Fisheries - 2nd Edition*.

Recommendation on the approved wildlife trade operation declaration for the Torres Strait Tropical Rock Lobster Fishery – December 2020

1. The Australian Fisheries Management Authority to continue to work with the Department of Agriculture, Water and the Environment and the Protected Zone Joint Authority to implement changes to the *Torres Strait Fisheries Act 1984* to allow data reporting requirements to apply to all fishing sectors in the fishery.

   Data collection requirements for target species are to include:

   - the total quantity of each species removed from the fishery, including any catch discarded prior to landing to an authorised fish receiver; and
   - catch and effort data, including location of all commercial fishing activity.

   Progress and outcomes of this recommendation to be included in annual reports required under condition 4.

Notification of Reviewable Decisions and Rights of Review[1]

There is a right of review to the Administrative Appeals Tribunal (AAT) in relation to certain decisions/declarations made by the Minister, the Minister's delegate or the Secretary under Part 13A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Section 303GJ(1) of the EPBC Act provides that applications may be made to the AAT for the review of the following decisions:

(a) to issue or refuse a permit; or

(b) to specify, vary or revoke a condition of a permit; or

(c) to impose a further condition of a permit; or

(d) to transfer or refuse to transfer a permit; or

(e) to suspend or cancel a permit; or

(f) to issue or refuse a certificate under subsection 303CC(5); or

(g) of the Secretary under a determination in force under section 303EU; or

(h) to make or refuse a declaration under section 303FN, 303FO or 303FP; or

(i) to vary or revoke a declaration under section 303FN, 303FO or 303FP.

If you are dissatisfied with a decision of a type listed above you may:

- by notice, provided in writing, request that the Minister or the Minister's delegate give you a statement in writing setting out the reasons for the decision as per section 28 of the *Administrative Appeals Tribunal Act 1975*. The Minister, or Minister's delegate may refuse to give you a statement of reasons if your application is made more than 28 days after the day on which you received this notice.
- apply to the AAT for independent merits review of the decision. The AAT undertakes *de novo* merits review. This means they take a fresh look at the facts, law and policy relating to the decision and arrive at their own decision. They decide if the decision should stay the same or be changed. They are independent of the Department.

Application for review of a decision must be made to the AAT within **28 days** after the day on which you have received the reviewable decision. However an extension of time for lodging an application may be granted by the AAT under certain circumstances. Please visit the AAT's website at http://www.aat.gov.au/ or telephone 1800 228 333 for further information. The role of the AAT is to provide a review mechanism that is fair, just, economical, informal and quick.

Applications & Costs

Applications to the AAT are made by lodging an Application Form (Form 1). This can be found on the AAT's website at http://www.aat.gov.au/.

There are no strict timelines in which the AAT must review the decision, however the first conference between the parties will usually be held within 6 to 10 weeks of the application being lodged. The time frame for review of certain decisions can be expedited in some circumstances.

[1] In accordance with the *Administrative Appeals Tribunal Act 1975* Code of Practice for Notification of Reviewable Decisions and Rights of Review

The cost of lodging an application for review is $952 (as of 1 July 2020) (GST inclusive). You may be eligible to pay a reduced fee of $100.00 if

- you are receiving legal aid for your application;
- you hold a health care card, a Commonwealth seniors health card or any other card issued by the Department of Social Services or the Department of Veteran's Affairs that entitles the holder to Commonwealth health concessions;
- you are in prison or lawfully detained in a public institution;
- you are under 18 years of age; or
- you are receiving youth allowance, Austudy or ABSTUDY.

You may also be eligible for a reduced fee if you can demonstrate to the AAT that paying the full fee would cause you financial hardship. Further information can be found on the AAT's website. Additionally, you can access information about legal assistance at https://www.ag.gov.au/LegalSystem/Legalaidprogrammes/Commonwealthlegalfinancialassistance/Documents/LegalFinancialAssistanceInformationSheet.pdf.

If you pay a standard application fee, most of it will be refunded if the case is resolved in your favour. The refund amount is the difference between the fee you paid and $100. So, if you paid $920, you get back $820 and if you pay $952, you get back $852. There is no refund if you paid the lower application fee for certain taxation decisions or the reduced fee of $100.

Contact Details

Further information or enquiries relating to the decision should be directed to:

The Director
Wildlife Trade Assessments Section
Department of Agriculture, Water and the Environment
GPO Box 858
Canberra ACT 2601
Telephone: +61 (0) 2 6274 1917
Email: sustainablefisheries@environment.gov.au

Alternatively you may contact the AAT at their Principal Registry or the Deputy Registrar, Administrative Appeals Tribunal in your Capital City or Territory.

Administrative Appeals Tribunal
Street address: Level 6, 83 Clarence Street, Sydney
Mailing address: GPO Box 9955, Sydney, NSW 2001
T: 1800 228 333 and (02) 9276 5000
F: (02) 9276 5599
E: generalreviews@aat.gov.au
W: http://www.aat.gov.au

Freedom of Information Request

You may make an application under the *Freedom of Information Act 1982* (FOI Act) to access documents. Further information can be found at http://www.environment.gov.au/foi/index.html. Please contact the Freedom of Information Contact Officer at foi@environment.gov.au for more information.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
UPDATES FROM MEMBERS PNG National Fisheries Authority	Agenda Item 2.3 updated For NOTING

RECOMMENDATIONS

1. That the RAG **NOTE** the updates to be provided by the PNG National Fisheries Authority (NFA).

KEY ISSUES

2. AFMA and NFA continue to work collaboratively to meet obligations under the Treaty. The COVID 19 pandemic has however impacted the extent of bilateral engagement and the ability to support cross endorsement. Bilateral engagement since 2020 necessarily has focused on agreeing seasonal catch sharing arrangements. Based on COVID 19 risks, Australia could not support cross-endorsement of PNG boats to fish in Australian waters in 2020 or 2021.
3. In cooperation with the Department of Foreign Affairs and Trade (DFAT), the TIMs and NFA, AFMA aims to convene a fisheries bilateral in the new year to ensure consideration of a broader range of matters. AFMA is looking forward to working with NFA regarding the issue of catches of protected zone stocks that take place in areas that are “outside but near” of the Protected Zone, exploring opportunities for PNG logbook data to be shared for the purposes of assessing the fishery and opportunities for research collaboration. The latter being particularly timely given AFMA will shortly be calling for funding applications to undertake fishery independent surveys, stock assessment work for the TRL Fishery, including Recommended Biological Catch calculations.
4. Under the Treaty where a stock substantially belongs to the Protected Zone but extends into an area outside but near it, the part of the stock found in that area can be declared "areas outside but near" the Protected Zone for the purposes of managing that fishery. Consistent with the Treaty, Australia accounts for catches taken in these areas against Australia’s catch apportionment.
5. AFMA has invited to our NFA colleagues to provide an update on the following if available:
    a) AFMA understand that some PNG fishers have started to use an electric spike to take TRL. For the purposes of using fishery dependent data to assess the stock it would be relevant to monitor the use of different methods and changes if any, in catch rates compared to existing methods.
    b) Several months ago video footage was circulating in the public showing a prawn trawler hauling a significant catch of TRL. AFMA has shared the footage with NFA for their information.

BACKGROUND

6. AFMA has a standing invite for officials from the PNG National Fisheries Authority (NFA) to attend all PZJA advisory committee meetings. If in attendance, NFA officials will provide an update on the PNG TRL fishery at the meeting.
7. Over 9-10 September 2021 the Torres Strait Treaty Traditional Inhabitants Meeting (TIM) and Joint Advisory Committee (JAC) meetings were held. Reports for each meeting are attached (**Attachments 2.3a** and **2.3b**).
8. Relevantly both meetings discussed matters around the Daru MOU and New City proposal (see paragraph 12 of the TIMs report and paragraph 20 of the JAC report). Both meetings emphasised the need to be included in any consultations on these and other such proposals.

REPORT FROM THE 2021

TORRES STRAIT TREATY TRADITIONAL INHABITANTS MEETING

Virtual, 9 September 2021

1. The Traditional Inhabitants Meeting (TIM) was held virtually on 9 September 2021.
2. The TIM provides Traditional Inhabitants under the Torres Strait Treaty with a forum to discuss and exchange views on the implementation of the Treaty.
3. The meeting was co-chaired for Papua New Guinea (PNG) by Councillor Kebei Salee, Sigabadaru and Councillor Getano Lui (Jnr), Iama (Yam) Island. A list of meeting attendees is at Attachment A.
4. The TIM welcomed the update from the Papua New Guinea (PNG) Immigration and Citizenship Authority (ICA) and Australian Torres Strait Treaty Liaison Officer that Traditional Visits under the Treaty have been put on hold due to the COVID-19 pandemic and border closures. The TIM agreed to defer several of the outstanding recommendations made at the 2019 TIM on Traditional Visits and cross-border activities to the 2022 TIM meeting.
5. The TIM noted the importance of a permanent PNG Department of Foreign Affairs and International Trade (DFAIT) Border Liaison Officer (BLO) on Daru Island to assist with managing the shared border during the COVID-19 pandemic and welcomed advice that the position would be filled in the first quarter of 2022. The TIM noted advice that DFAIT's Peter Mirino would continue as DFAIT's lead from Port Moresby, working closely with Hendrick Naimo from PNG ICA who is implementing BLO functions on-the-ground on Daru Island.
6. The TIM acknowledged the ongoing suspension of Traditional Visits and traditional activities due to international border closures enacted in response to the global COVID-19 pandemic at the beginning of 2020 by local government (the Torres Strait Island Regional Council), and by both the Papua New Guinea and Australian Governments. The TIM acknowledged the unprecedented impact that the COVID-19 pandemic has had on the Treaty and noted that there will likely be implications for the Treaty's implementation going forward.
7. The TIM acknowledged the ongoing risks of COVID-19 transmission to communities on both sides of the border and agreed that all Traditional Visits and traditional activities should remain on hold for the foreseeable future. Australian Traditional Inhabitants emphasised the need to protect the lives of vulnerable Torres Strait communities, and underscored that Traditional Visits will need to be reviewed once border restrictions are eased, at an appropriate time in the future, to ensure that residual COVID-19 risks and other community-level impacts are managed. The TIM noted that Australia and PNG will undertake separate discussions around future border and Traditional Visit management and approaches regarding incoming Traditional Visits to their respective jurisdictions.
8. The TIM acknowledged continuing unauthorised border crossings by PNG Treaty Village constituents seeking medical care on Australia's Saibai and Boigu Islands during the international border closures. The TIM affirmed that the health and safety of their communities is paramount and that such border movements should not occur.
9. The TIM noted the importance of COVID-19 vaccinations to protect communities from COVID-19. The TIM agreed to request an update at the JAC on COVID-19 vaccinations in the Treaty Villages and Torres Strait communities. Australian Traditional Inhabitants did not support a proposal from PNG Traditional Inhabitants that fully vaccinated PNG Treaty Village constituents be allowed to undertake Traditional Visits into Australia's Torres Strait Islands, but committed to continuing dialogue in regards to the border closures.
10. PNG Traditional Inhabitants highlighted the need for adequate medical care for PNG Treaty Villages, particularly for emergencies such as snake bites. Noting strong concerns from Australian Traditional

Inhabitants that any border crossings for medical purposes will raise the risk of COVID-19 transmission into their communities, the Australian Government strongly encouraged PNG Treaty Villages constituents to seek medical care at Mabudawan Health Centre (MHC), which is located in the PNG Treaty Village of Mabaduwan. The TIM agreed to seek an update on MHC (including its staffing) at the JAC, and requested that PNG and Australia ensure that it remains fully operational and appropriately staffed.

11. PNG Traditional Inhabitants thanked the Australian Government for its development assistance in the South Fly region, noting the range of areas of support. The TIM noted advice from Australian Traditional Inhabitants that any Australian-supported development initiatives in Western Province's South Fly district must be delivered through PNG channels and not Australia's Torres Strait Islands, to minimise the impacts on their communities and already-limited infrastructure and resources as well as ongoing COVID-19 risks.
12. PNG Traditional Inhabitants noted that they have not been provided information or consulted on the recent Daru Fisheries Memorandum of Understanding, Daru New City Proposal, or similar infrastructure proposals. The TIM noted advice from DFAIT that they were seeking further information across government on the proposals and will report back to the JAC. The TIM stressed the importance of being consulted on these and other proposals, in line with the spirit of the Treaty. The TIM affirmed their concerns around the potentially detrimental effects that such proposals could have on the environment, sustainability of resources in the region and livelihoods, particularly the overfishing of marine resources. The TIM agreed to seek an update on these proposals from the relevant agencies at the JAC. Australian Traditional Inhabitants confirmed that they do not support a review of the Treaty, in reference to a public Australian petition on the same subject.

Signed on 9 September 2021 virtually in Port Moresby and Canberra

Councillor Kebei Salee
Co-Chair and Leader of the Papua New Guinea Traditional Inhabitant Delegation

Councillor Getano Lui Jnr
Co-Chair and Leader of the Australian Traditional Inhabitant Delegation

REPORT OF THE 28TH TORRES STRAIT TREATY JOINT ADVISORY COUNCIL MEETING

Virtual, 10 September 2021

1. The Joint Advisory Council (JAC) was held virtually on 10 September 2021.
2. The Forum was co-chaired for Papua New Guinea (PNG) by Mr Joseph Varo, Deputy Secretary, Department of Foreign Affairs and International Trade (DFAIT), and for Australia by Bassim Blazey, Assistant Secretary, PNG Branch, Australian Department of Foreign Affairs and Trade (DFAT).
3. In accordance with Article 19 of the *Torres Strait Treaty* (the Treaty), Council members comprised national, state, and provincial representatives, and Traditional Inhabitant representatives. The delegation list is at **Attachment A** and the JAC functions are set out in **Attachment B**.
4. This document will be transmitted to the Papua New Guinean and Australian Foreign Minister.

Treaty Implementation and management of Traditional Visits

5. The JAC welcomed reports from the Traditional Inhabitants Meeting (TIM) Co-chairs on 9 September 2021 (**Attachment C**) and acknowledged the importance of Traditional Inhabitant views.
6. The JAC noted concerns raised by PNG Traditional Inhabitants around the suspension of Traditional Visits and traditional activities due to international border closures enacted in response to the global COVID-19 pandemic at the beginning of 2020 by the Torres Strait Island Regional Council and both the Papua New Guinea and Australian Governments.
7. The JAC noted concerns raised by Australian Traditional Inhabitants around the ongoing COVID-19 risks to their communities and need for continued border closures, as well as the need for adjustments to Traditional Visits once borders reopen to ensure residual COVID-19 risks and other community-level impacts are managed. Australian Government agencies including DFAT and Australian Border Force (ABF) committed to working further on this out-of-session with Australian Traditional Inhabitants.
8. The JAC noted the importance of a permanent DFAIT BLO on Daru Island to assist with managing borders during the COVID-19 pandemic and welcomed advice that the position would be filled in the first quarter of 2022. Traditional inhabitants noted that the BLO position has been vacant since 2019. The JAC noted advice that the DFAIT BLO would continue to lead from Port Moresby in the interim period, working closely with the PNG Immigration and Citizenship Authority BLO on-the-ground in Daru.
9. The TIM noted establishment of a new Western Provincial Administration (WPA) Border Liaison Officer (BLO) position to assist with provincial management of borders. It was agreed that DFAIT will provide advice to DFAT out-of-session on responsibilities and ways of working with DFAIT, PNG Immigration and Citizenship Authority and the WPA BLO.
10. The JAC noted agreement at the 28th PNG–Australia Ministerial Forum on the need for early consultation on any development proposals in or near to the Torres Strait Protected Zone that could impact on the interests of either country, particularly Traditional Inhabitants. The JAC requested that this includes consideration of such proposals by the JAC and Traditional Inhabitants.

Health and Development Assistance

11. The JAC noted updates on the COVID-19 situation in PNG and Australia, particularly the new and highly infectious Delta variant, and recent outbreaks across Western Province's North, Middle and South Fly Districts and across several states and territories in Australia.
12. The JAC noted agreement at the 28th PNG-Australia Ministerial Forum that COVID-19 continues to pose a serious threat and health advice and vaccinations will underpin decisions to reopen borders.
13. The JAC agreed that vaccination provided the best protection against COVID-19 and welcomed an update on vaccination efforts in the South Fly and Torres Strait. Vaccination levels across both the Torres Strait and South Fly regions need to be increased considerably to be able to consider reopening the shared Western Province-Torres Strait border.
14. The JAC noted that the Health Issues Committee meeting will be held on 12 November 2021 and an update on discussions will be provided at the 29th JAC meeting in 2022.
15. The JAC noted that, as part of Australia's commitment to deepen engagement in PNG priority regions under the Comprehensive Strategic and Economic Partnership (CSEP), Australia is progressing a *Western Province Strategy* in collaboration with the Fly River Provincial Administration to shape Australia's long-term engagement and assist PNG communities to resiliently manage and maximise their own resources. This was articulated in a Memorandum of Understanding (MoU) between the WPA and the Australian High Commissioner to PNG [signed May 2021] which outlines a range of joint development initiatives across Western Province.
16. The JAC noted advice from Australian Traditional Inhabitants that any Australian-supported initiatives in Western Province must be delivered through PNG and not Australia's Torres Strait Islands, to minimise the impacts on their communities and already-limited infrastructure and resources.
17. The JAC welcomed a detailed report on the functioning and staffing of the Mabudawan Health Centre noting that it was fully resourced as a Level Three health facility.

Environment and Fisheries

18. The JAC noted that the PNG Conservation and Environment Protection Authority and Australian Department of Agriculture, Water and Environment are working to determine with stakeholders a suitable time for EMC 28 (likely March 2022) and that updates from EMC 27 are being sought.
19. The JAC noted that the PNG National Fisheries Authority (NFA) and Australian Fisheries Management Authority (AFMA) will progress the Fisheries Bilateral Meeting in 2022.
20. The JAC raised concerns around the risk of overfishing of the fisheries resources in the Torres Strait, emphasising the need for early consultation with AFMA and Traditional Inhabitants. The JAC noted an update on the proposed development of a major fisheries and industrial development on Daru Island (that there was no evidence of any progress on these two initiatives) and acknowledged the concerns of Traditional Inhabitants on both sides regarding risks to the environment and sustainable fisheries. The JAC further noted that any consultations on new development initiatives that will have implications for the implementation of the Treaty, either in or adjacent to the Torres Strait Protected Zone, including but not limited to fisheries developments in the region, should include the JAC.

Customs and Cross Border Law Enforcement

21. The JAC thanked Traditional Inhabitants for their support during the border closures but noted some PNG Traditional Inhabitants [860 passenger arrivals including 181 PNG nationals accessing health services on Australia's Torres Strait Islands since March 2020] have continued to travel to Australia's Saibai and Boigu Islands for health care. The JAC agreed that the borders are to remain closed for the foreseeable future, including for the purposes of seeking medical care in Australia.
22. The JAC noted that PNG Traditional Inhabitants must access health care in PNG, including at the fully operational Mabudawan Health Centre, to protect communities on both sides against cross-border COVID-19 transmission. The Western Province Government committed to discussing further with the Western Provincial Health Authority and development partners such as Australia to ensure MHC is fully staffed, trained and equipped.
23. The JAC emphasised the need to prevent and disrupt transnational crimes such as people smuggling and drug and firearms trafficking and encouraged relevant PNG and Australian border and law enforcement agencies to increase collaboration on managing the shared Western Province-Torres Strait border during the COVID-19 pandemic. The JAC agreed for Joint Cross-Border Patrols to recommence, in a COVID-safe manner, to deter illegal activities and movements. JAC welcome PNG Narcotics Bureau to be part of Law Enforcement Agency along the common borders of PNG including at Torres Strait Protected Zone.
24. The JAC welcomed advice that the Community Safety and Security Facility on Saibai Island is operational (official launch scheduled for 2022). The facility will assist Australia uphold the COVID-19 border closures, manage Treaty Traditional Visits and activities in the long-term and provide community safety and security services to Torres Strait communities.

Biosecurity

25. The JAC noted the reports from the PNG National Agriculture, Quarantine and Inspections Authority (NAQIA) and Australian Department of Agriculture, Water and the Environment (DAWE).
26. Australia and PNG, through DAWE and NAQIA, continue to collaborate to help manage biosecurity risks for the benefit of both countries notwithstanding recent restrictions arising from COVID-19 response measures.
27. Australia confirmed that Traditional Inhabitants in the Torres Strait Protected Zone continued to display high levels of compliance with applicable biosecurity regulations during the period since the last JAC meeting.
28. Australia provided advice regarding continued investments in improved biosecurity surveillance and regulation systems across northern Australia including in Torres Strait. Recent initiatives have included: additional measures to regulate the northward movement of biosecurity threat species from Mainland Australia to Torres Strait and further north; additional investment in biosecurity officer resources in Torres Strait; and dissemination of improved products promoting awareness and compliance with applicable biosecurity regulations for cross border movements (north and south) between PNG and the Torres Strait Protected Zone.

Maritime Safety

29. The JAC noted the report from Australian Maritime Safety Authority (AMSA) on maritime safety activities and acknowledged the ongoing cooperation between PNG NMSA and Torres Strait communities to further enhance ship safety, marine pollution prevention and response and search and rescue in the region. The PNG National Maritime Safety Authority (NMSA) will provide an update at the next JAC.

Other Business

30. The JAC noted the proposed initiatives on a quota allocation of workers from the Treaty Villages in Australia's labour mobility programs, as well as a Teacher Practice Program, and agreed to discuss these items at the next JAC meeting.
31. The JAC noted advice from Australian Traditional Inhabitant Co-Chair of his interest in seeking a change of the name of Torres Strait to Zenadth Kes, clarifying that this would not affect the formal name of the Torres Strait Treaty.

Date and Venue of Next Meeting

32. The JAC agreed that the 29th JAC meeting will be hosted by Australia in 2022.

33. Agencies agreed to progress matters out of session, in accordance with the outcomes of the JAC meeting, and report on progress at the 29th JAC meeting.

Signed virtually on 10 September 2021 in Port Moresby and Canberra

Mr Joseph Varo
Co-Chair and Leader of the Papua New Guinea Delegation

Mr Bassim Blazey
Co-Chair and Leader of the Australian Delegation

ATTACHMENT A – DELEGATION LIST

PNG Traditional Inhabitants (Treaty Councillors of South Fly Fore Coast Kiwai RLLG)

PAPUA NEW GUINEA DELEGATION		
Department	**Representative**	**Title**
Department of Foreign Affairs and International Trade (DFAIT)	Joseph Varo (JAC Co-Chair)	Deputy Secretary
Department of Health	Ken Wai	Deputy Secretary
Department of Prime Minister and National Executive Council (PMNEC)	Tony Kaib	Director General – Security Coordination
Department of Prime Minister and National Executive Council (PMNEC)	Barbarinue Bagli (Ms)	
Department of National Planning	Martin Pomat	Assistant Secretary
Department of Provincial and Local Level Government	Jacqueline Winuan	
Department of Provincial and Local Level Government	Philo Karabau	
PNG Customs	Nazila Yalambing	
PNG Immigration and Citizenship Authority	Winis Map	
NAQIA	Michael Areke	
Department of Health	Catherina Poko	National Coordinator – Vaccination Program
DFAIT	Peter Mirino	Director, PNG-Solomon Islands Border, Border and Security Division
Western Provincial Administration (WPA)	Robert Aphonse	Provincial Administrator
WPA	Wilfred Gaso	Deputy Provincial Administrator
WPA	Elias Anden	Coordinator National Function Agency
WPA	Rupert Tabua	Deputy Provincial Administrator Resources Development
WPA	Gelam Mark	Border Liaison Officer
WPA	Shirley Kebei	Admin Officer
WPA/ Fore Coast Kiwai Local Level Government	Duobe Amura	Manager, Fore Coast Kiwai Local Level Government (FCKLLG)

South Fly District Administration (SFD)	Tawa Gebia	District Administrator
Royal PNG Constabulary (RPNGC, Daru)	Ewai Segi	Incoming Provincial Police Commander
PNG Defence Force (Daru)	Vincent Wriken	Chief Warrant Officer
PNG Immigration and Citizenship Authority (ICA, Daru)	Henrick Naimo	Manager
Department of Provincial and Local Level Government Affairs (DPLLGA, Daru)	Robin Bazu	Border Admin Officer
Fore Coast Kiwai Local Level Government	Epesi Dabu	Project Officer
Traditional Inhabitant Representatives		
Sigabadaru	Kebei Salee	TIM Co-chair, Councillor for Sigabadaru
Ture Ture	Abua Roy	Councillor for Ture Ture
Sui	Murray Dimia	Councillor for Sui
Parama	Jimmy Walter	Councillor for Parama
Katatai	Tibau Kaware	Councillor for Katatai
Kadawa	Biza Gera	Councillor for Kadawa
Mabudawan	Ma'a Sampson Uku	Councillor for Mabudawan
Kori (a)	Gregory Nabaka	Councillor for Kori (a)
Old Mawatta	Butium Koidawane	Councillor for Old Mawatta
Buzi/Ber	Banu Namai	Councillor for Buzi/Ber
Mari/Tais	Bill Menai	Councillor for Mari/Tais
Bula/Jarai	Bize Goi Menai	Councillor for Bula/Jarai

AUSTRALIAN DELEGATION		
Department	**Representative**	**Title**
Department of Foreign Affairs and Trade (DFAT)	Bassim Blazey (JAC Co-Chair)	Assistant Secretary, PNG Branch
Australian High Commission to PNG (AHC), DFAT	Geoff King	Counsellor (Subnational Development)
AHC, DFAT	Lara Andrews	Counsellor (Health)
AHC, AFP	Susan Smith	A/Superintendent PNG
AHC, Home Affairs	Andrew Edgar	Counsellor
DFAT	Johanna Stratton	A/Director, PNG Political and Torres Strait Section
DFAT	Jacqueline Herbert	Torres Strait Treaty Liaison Officer
DFAT	Annie Douglas	Policy Officer, PNG Branch
AHC, DFAT	Katherine Parkinson	First Secretary (Political)
AHC, DFAT	Emeline Cammack	First Secretary (Health Security)
AHC, DFAT	Amanda Young	First Secretary (Subnational Development)
Australian Border Force	Michael Talbot	A/Superintendent, OVERARCH
Australian Federal Police	Rees Folpp	A/Superintendent, Northern Command
Australian Fisheries Management Authority (AFMA)	Selina Stoute	Manager, Torres Strait Fisheries
AFMA	John Jones	Compliance Manager, Torres Strait Fisheries
Department of Agriculture, Water and the Environment (DAWE)	Wayne See Kee	Assistant Secretary, Biosecurity Operations Division (BOD)
DAWE	Murray Korff	Director, BOD
Department of Health (DoH)	Hayley Benson (HIC Co-chair)	Assistant Director, Blood Borne Viruses, Sexually Transmissible Infections & Torres Strait Health Section
DoH	Murimi Njora (HIC Co-Chair)	Assistant Director, Blood Borne Viruses, Sexually Transmissible Infections & Torres

		Strait Health Section
Department of Home Affairs	Nedra Kelaart	A/Director, PNG Section
Department of Premier and Cabinet (QLD)	Andrew Burke	Intergovernmental Relations
Department of Prime Minister & Cabinet (PM&C)	Kristian Nilsson	Advisor, International Division
PM&C	Rachel Kolek	Advisor, National Security Division
Department of Seniors, Disability Services and Aboriginal and Torres Strait Islander Partnership (QLD)	Danny Morseu	Regional Manager
National Indigenous Australians Agency (NIAA)	Nadja Mack	Director, Land Policy and Environment Branch
NIAA	Shay Simpson	Advisor, Land Policy and Environment Branch
Queensland Health	Marlow Coates	Executive Director, Torres and Cape Hospital and Health Service
Traditional Inhabitant Representatives		
Torres Strait Island Regional Council (TSIRC)	Getano Lui	TIM Co-chair and Councillor for Iama Island
TSIRC	Aven Noah	Councillor for Mer (Murray) Island
TSIRC	Conwell Tabuai	Councillor for Saibai Island
TSIRC	Torenzo Elisala	Councillor for Dauan Island

ATTACHMENT B – JAC FUNCTIONS (EXCERPT FROM THE TORRES STRAIT TREATY)

Article 19

Torres Strait Joint Advisory Council

1. The Parties shall jointly establish and maintain an advisory and consultative body which shall be known as the Torres Strait Joint Advisory Council (called in this Article "the Advisory Council").

2. The functions of the Advisory Council shall be-

(a) to seek solutions to problems arising at the local level and not resolved pursuant to Article 18 of this Treaty;

(b) to consider and to make recommendations to the Parties on any developments or proposals which might affect the protection of the traditional way of life and livelihood of the traditional inhabitants, their free movement, performance of traditional activities and exercise of traditional customary rights as provided for in this Treaty; and

(c) to review from time to time as necessary, and to report and to make recommendations to the Parties on, any matters relevant to the effective implementation of this Treaty, including the provisions relating to the protection and preservation of the marine environment, and fauna and flora, in and in the vicinity of the Protected Zone.

3. The Advisory Council shall not have or assume responsibilities for management or administration. These responsibilities shall, within the respective areas of jurisdiction of each Party, continue to lie with the relevant national, State, Provincial and local authorities.

4. In the exercise of its functions, the Advisory Council shall ensure that the traditional inhabitants are consulted, that they are given full and timely opportunity to comment on matters of concern to them and that their views are conveyed to the Parties in any reports and recommendations made by the Advisory Council to the Parties.

5. The Advisory Council shall transmit its reports and recommendations to the Foreign Ministers of the Parties. After consideration by appropriate authorities of the Parties, consultations may be arranged with a view to the resolution of matters to which the Advisory Council has invited attention.

6. Unless otherwise agreed by the Parties, the Advisory Council shall consist of eighteen members, that is nine members from each Party who shall include-

(a) at least two national representatives;

(b) at least one member representing the Government of Queensland in the case of Australia and one representing the Fly River Provincial Government in the case of Papua New Guinea; and

(c) at least three members representing the traditional inhabitants,

with each Party being free to decide from time to time from which of the aforementioned categories any other of its members will be drawn.

7. The Advisory Council shall meet when necessary at the request of either Party. Consecutive meetings of the Advisory Council shall be chaired alternately by a representative of Australia and a representative of Papua New Guinea. Meetings shall be held alternately in Australia and Papua New Guinea or as may from time to time be otherwise arranged.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
UPDATES FROM MEMBERS Native Title	Agenda Item 2.4 For NOTING

RECOMMENDATIONS

1. That the RAG **NOTE** any updates on Native Title matters from members, including representatives of Malu Lamar (Torres Strait Islanders) Corporation RNTBC (Malu Lamar).

BACKGROUND

2. AFMA has a standing invite for a representative from Malu Lamar to attend all PZJA advisory committee meetings.
3. On 7 August 2013 the High Court of Australia confirmed coexisting Native Title rights, including commercial fishing, in the claimed area (covering most of the Torres Strait Protected Zone). This decision gives judicial authority for Traditional Owners to access and take the resources of the sea for all purposes. Native Title rights in relation to commercial fishing must be exercisable in accordance with the *Torres Strait Fisheries Act 1984*.
4. Traditional Owners and Native Title representative bodies have an important role in managing Torres Strait fisheries. It is important therefore that the RAG keep informed on any relevant Native Title issues arising.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
CATCH AND EFFORT ANALYSES FOR THE 2020-21 FISHING SEASON	Agenda Item 3 For discussion and advice

RECOMMENDATIONS

1. That the RAG:
    a. **NOTE** the reported landed catch for the Australian Torres Strait Tropical Rock Lobster Fishery (TRL Fishery) (**Attachment 3a**).
    b. **NOTE** that an update on available data from the PNG TRL Fishery is expected to be provided by the PNG National Fisheries Authority (NFA) before or at the meeting (**Attachment 3b**).
    c. **DISCUSS** and **PROVIDE ADVICE** on the catch, effort and catch per unit effort (CPUE) data analyses for the Australian TRL Fishery for the 2020-21 fishing season undertaken and presented by CSIRO (**Attachments 3d – 3g**).

KEY ISSUES

Australian TRL Fishery catch

2. The Australian TRL Fishery fishing season runs from 1 December through to 30 September the following year. There is a prohibition on the use of hookah gear from 1 December through to 31 January the following year and periodically each month throughout the remainder of the season.
3. The reported landed catch for the Australian TRL Fishery for the 2020-21 fishing season is 237,510.44 kilograms (237.5 tonnes). All reported catches are from inside the Torres Strait Protected Zone (TSPZ) and Australia's declared outside but near area.
4. This equates to 56.43 per cent of Australia's 420,862.5 kilogram (420.86 tonnes) total allowable catch (TAC) for the 2020-21 fishing season. This catch data is sourced from the Torres Strait Fisheries Catch Disposal Record (TDB02) and covers the Traditional Inhabitant Boat (TIB) and Transferable Vessel Holder (TVH) sectors.
5. The TIB sector caught 121,587.08 kilograms (121.6 tonnes) of TRL which equates to 43.64 per cent of the TIB TAC and the TVH sector caught 115,923.36 kilograms (115.92 tones) of TRL which equates to 85.48% of the TVH TAC.
6. A summary of the reported landed catch for the Australian TRL Fishery is provided at **Attachment 3a.**

PNG TRL Fishery catch

7. The PNG TRL Fishery fishing season runs from 1 January through to 31 December each year. There is a prohibition on the use of hookah gear in the waters of Western Province and Torres Strait from 1 December through to 31 March the following year.
8. An update on available data from the PNG TRL Fishery is expected to be provided by the PNG National Fisheries Authority (NFA) by or at the meeting (**Attachment 3b**).

9. The TAC for the PNG TRL Fishery in 2021 is 93.525 kilograms. Due to COVID-19 restrictions, PNG boats were unable to catch their 109.1 tonne catch allocation in Australian waters this season.
10. An infographic showing the final catch sharing agreement between Australia and PNG is shown at **Attachment 3c**.

Total reported commercial catch for the TRL stock

11. The total reported commercial catch for the TRL stock is:

Area	Total (tonnes)	TAC (tonnes)
Australian TRL Fishery	237.5	420.9
PNG TRL Fishery - catches inside the TSPZ as at 31 August 2021	TBA	93.52
PNG TRL Fishery - catches outside the TSPZ as at 31 August 2021	TBA	
PNG catch allocation within Australian waters	0	109.1
Total	**TBC**	**623.52**

Catch and catch per unit effort (CPUE) data analyses

12. The annual data summary to be presented by CSIRO under this agenda item reviews the nominal and standardised catch per unit effort (CPUE) from the TIB and TVH sectors, as well as total catch from all sectors, the size-frequency information provided from a sub-sample of commercially caught TRL and the fishery-independent survey indices of 0+ and 1+ age lobsters. The data summary is used as an indicator to identify if catches correspond to the RBC, and to monitor CPUE (section 2.9 of the TRL Harvest Strategy).
13. The RAG is asked to consider the following catch and CPUE analyses CSIRO has prepared for the 2020-21 fishing season and provide advice as appropriate:
    a. *TS TRL Data summary paper* (**Attachment 3d**);
    b. *TS TRL Effort summary paper* (**Attachment 3e**)
    c. *TIB CPUE analysis paper* (**Attachment 3f**);
    d. *TVH CPUE analysis paper* (**Attachment 3g**).
14. These analyses will be presented by CSIRO at the meeting. The total catch data and standardised CPUE indices for the TVH and TIB sectors are key inputs to the empirical harvest control rule (eHCR) and integrated stock assessment.
15. Further analyses of the November 2021 pre-season survey data will be presented under **Agenda Item 4**.

Table 1. Reported landed catch (kilograms whole weight) of Tropical Rock Lobster (TRL) for the Australian Torres Strait TRL Fishery by month and sector for the 2020-21 fishing season.
Source: Torres Strait Fisheries Catch Disposal Record (TDB02) as at 25 November 2021.

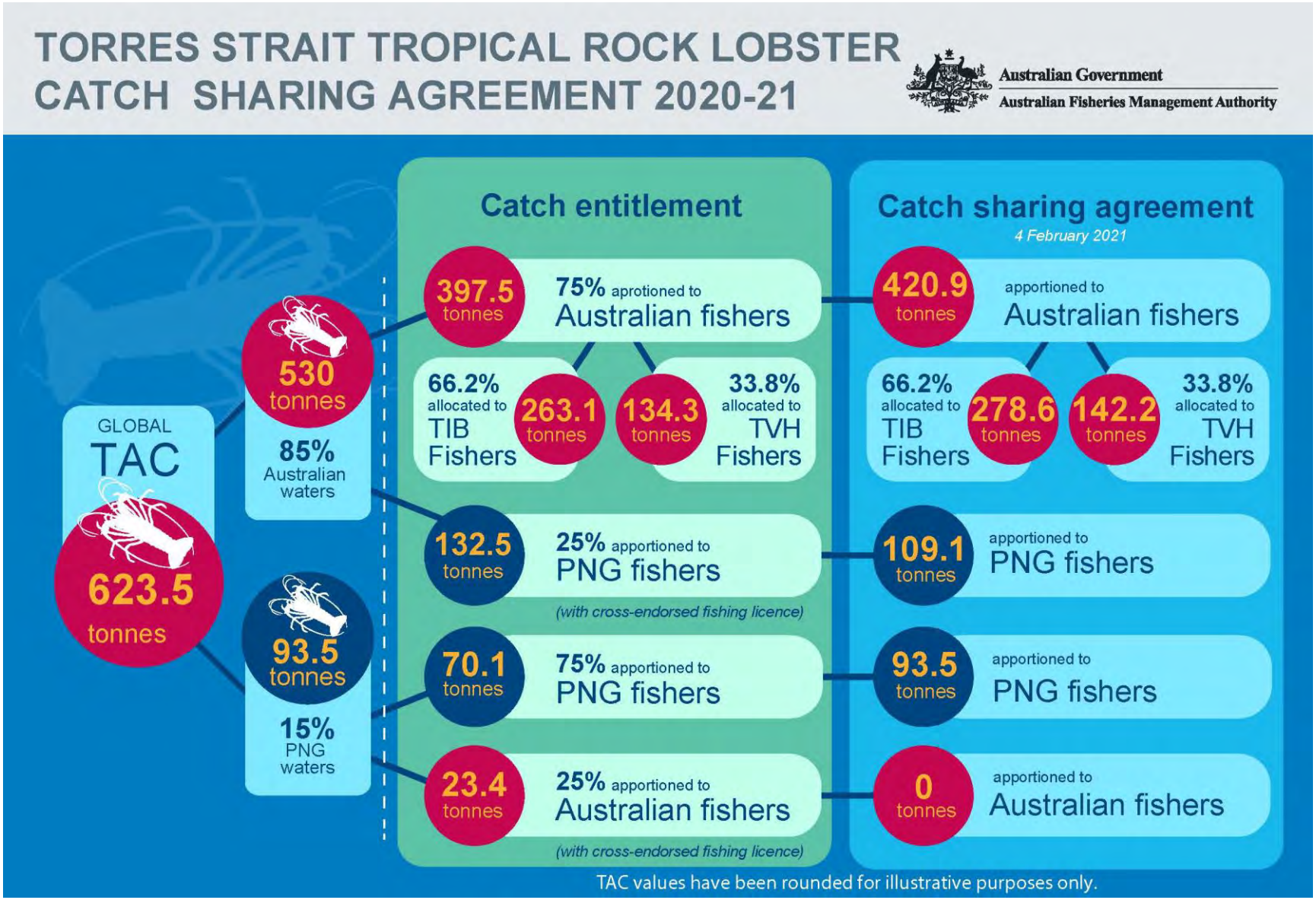
Month	Traditional Inhabitant Boat (TIB) sector	Transferable Vessel Holder (TVH) sector	Total (kg)
Dec-20	7,786.13	15,460.78	45,132.31
Jan-21	6,231.99		
Feb-21	15,653.41		
Mar-21	20,172.84	14,580.05	34,752.89
Apr-21	15,801.32	17,106.75	32,908.07
May-21	12,285.90	10,879.26	23,165.16
Jun-21	15,004.57	18,578.34	33,582.91
Jul-21	12,398.63	15,730.88	28,129.51
Aug-21	9,212.02	14,018.13	23,230.15
Sep-21	7,040.27	9.569.18	16,609.45
Total reported catch (kg)	**121,587.08**	**115,923.36**	**237,510.45**
TAC (kg)	**278,618.54**	**142,243.95**	**420,862.5**
Reported catch as a per cent of the TAC*	**43.64 %**	**81.50 %**	**56.43 %**

[#] In accordance with AFMA's Information Disclosure policy (*Fisheries Management Paper 12*), catches by month have been aggregated for December 2020 through to February 2021, as less than 5 boats operated in the Transferable Vessel Holder (TVH) sector..

PNG Jurisdiction of the TSPZ: Jan - Nov 2021				
Month (2020)	**Tail weight (kg)**	**Tail wt converted to whole wt (C. factor 2.677)**	**Whole weight (kg)**	**Total Catch (kg)**
JANUARY	1,167.08	3,124.27	986.22	4,110.49
FEBRUARY	1,277.72	3,420.46	1468.8	4,889.26
MARCH	1,027.28	2,750.03	1922.35	4,672.38
APRIL	793.05	2,122.99	1628.61	3,751.60
MAY	660.72	1,768.75	1881.6	3,650.35
JUNE	1,088.62	2,914.24	2627.05	5,541.29
JULY	957.12	2,562.21	1601.17	4,163.38
AUGUST	732.50	1,960.90	1343.41	3,304.31
SEPTEMBER	630.09	1,686.75	451.7	2,138.45
OCTOBER	1,035.97	2,773.29	886.57	3,659.86
NOVEMBER	175.56	469.97		469.97
TOTAL	**9,545.71**	**25,553.87**	**14,797.48**	**40,351.35**

PNG Waters outside of TSPZ: Jan - Nov 2021				
Month (2018)	**Tail weight (kg)**	**Tail wt converted to whole wt (C. factor 2.677)**	**Whole weight (kg)**	**Total Catch (kg)**
JANUARY	1,271.55	3,403.94	627.79	4,031.73
FEBRUARY	488.96	1,308.95	391.54	1,700.49
MARCH	661.13	1,769.85	746.00	2,515.85
APRIL	783.06	2,096.25	761.59	2,857.84
MAY	790.73	2,116.78	1,203.27	3,320.05
JUNE	876.53	2,346.47	1,396.57	3,743.04
JULY	570.10	1,526.16	584.05	2,110.21
AUGUST	436.90	1,169.58	230.17	1,399.75
SEPTEMBER	172.58	462.00	113.14	575.14
OCTOBER	1,846.71	4,943.64	622.54	5,566.18
NOVEMBER	-	-	-	-
TOTAL	**7,898.25**	**21,143.62**	**6,676.66**	**27,820.28**

PNG Catch Total: Jan - Nov 2021				
Month (2020)	**Tail weight (kg)**	**Tail wt converted to whole wt (C. factor 2.677)**	**Whole weight (kg)**	**Total Catch (kg)**
JANUARY	2,438.63	6,528.21	1,614.01	8,142.22
FEBRUARY	1,766.68	4,729.40	1,860.34	6,589.74
MARCH	1,688.41	4,519.87	2,668.35	7,188.22
APRIL	1,576.11	4,219.25	2,390.20	6,609.45
MAY	1,451.45	3,885.53	3,084.87	6,970.40
JUNE	1,965.15	5,260.71	4,023.62	9,284.33
JULY	1,527.22	4,088.37	2,185.22	6,273.59
AUGUST	1,169.40	3,130.48	1,573.58	4,704.06
SEPTEMBER	802.67	2,148.75	564.84	2,713.59
OCTOBER	2882.68	7,716.93	1509.11	9,226.04
NOVEMBER	175.56	469.97		469.97
TOTAL	**17,443.96**	**46,697.48**	**21,474.14**	**68,171.62**


TORRES STRAIT TROPICAL ROCK LOBSTER
CATCH SHARING AGREEMENT 2020-21
Australian Government
Australian Fisheries Management Authority
GLOBAL TAC
623.5 tonnes
530 tonnes
85% Australian waters
93.5 tonnes
15% PNG waters
Catch entitlement
397.5 tonnes
75% aprotioned to Australian fishers
66.2% allocated to TIB Fishers
263.1 tonnes
134.3 tonnes
33.8% allocated to TVH Fishers
132.5 tonnes
25% apportioned to PNG fishers
(with cross-endorsed fishing licence)
70.1 tonnes
75% apportioned to PNG fishers
23.4 tonnes
25% apportioned to Australian fishers
(with cross-endorsed fishing licence)
Catch sharing agreement
4 February 2021
420.9 tonnes
apportioned to Australian fishers
66.2% allocated to TIB Fishers
278.6 tonnes
142.2 tonnes
33.8% allocated to TVH Fishers
109.1 tonnes
apportioned to PNG fishers
93.5 tonnes
apportioned to PNG fishers
0 tonnes
apportioned to Australian fishers
TAC values have been rounded for illustrative purposes only.

Torres Strait Rock Lobster Fishery – Summary of the Catch and Effort Data for the TIB and TVH Sectors

Robert Campbell, Steven Edgar, Eva Plaganyi, Laura Blamey, Nicole Murphy, Leo Dutra

CSIRO Oceans and Atmosphere

December 2021

1. Introduction

This paper provides a summary of the catch and effort data pertaining to the Torres Strait Rock Lobster (TSRL) fishery during the 2021 fishing season. (Note, a fishing season begins on 1-December in a given year and extends through to 30-September the following year).

2. Data

TIB-Sector

The Torres Strait Seafood Buyers and Processors Docket Book (TDB01), until recently, was used in the TIB sector of the Torres Strait rock lobster fishery to record the catch sold by fishers (known as sellers on the Docket-Book) at the end of a fishing trip. It was replaced on 1 December 2017 by the mandatory Torres Strait Catch Disposal Record (TDB02) and an electronic version of this CDR was introduced to the fishery in 2021. As well as information related to the fish receiver, these docket-books also record information related to the fisher (name, boat symbol, etc), the sector of the fishery that the fisher operated (e.g. TIB or TVH) and the process state of the catch (e.g. whole, live or tailed). Additional information related to fishing effort (e.g. days fished, number of fishers) together with the area fished and methods used is currently only optional.

Completion of the TDB01 docket-book had only been voluntary and in several fishing seasons (2013-2016) the catch data for the TIB sector was supplemented with aggregate catch data obtained directly from several processors. The introduction of the compulsory TDB02 has rectified this past issue. Hopefully, the TDB02 docket-book has also rectified previous issues which were associated with the use of the TDB01 docket-book such as the double recording of catches (see Campbell and Pease 2017). The introduction of the compulsory TDB02 docket-book should, have also increased the reporting levels of the TIB catch.

Data related to the TDB02 CDR docket-book for the 2021 season was obtained from AFMA on 26 October with an update received on 12-November. Eight duplicate records for the TIB-sector were identified and removed. For the data summaries presented in this paper for the TIB sector, all data before December 2017 is based on data from the TBD01 docket-book while all data since December 2017 is taken from the TDB02 docket-book data received in October. The TDB01 docket-book data may be incomplete to some extent for the last few months up until November 2017; however the TDB02 data for all seasons is considered to be complete.

TVH-Sector

Together with the catch landed by the TIB-sector of the TSRL fishery, the new Torres Strait Catch Disposal Record (TDB02), introduced in the TSRL fishery at the start of November 2017, also records the catch landed by the TVH-sector. However, unlike for the TIB-sector,

catch and effort data related to the TVH sector also continues to be recorded in the Torres Strait Tropical Rock Lobster Fishery Daily Fishing Log (TRL04).

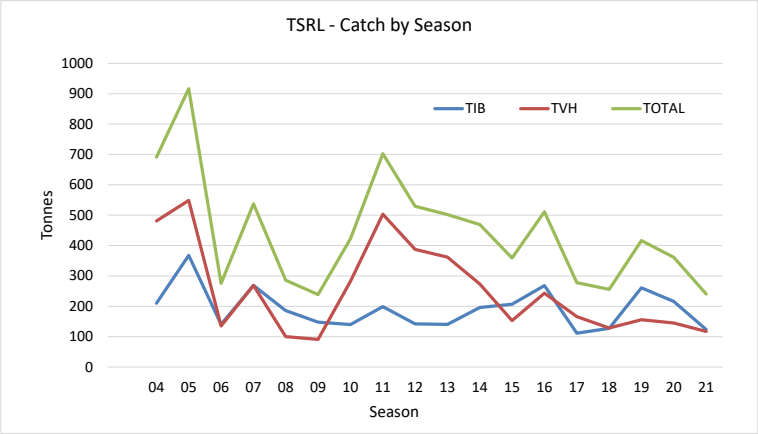
Data related to the TRL04 docket-book for the 2021 season was obtained from AFMA on 3 November 2021. For the data summaries presented in this paper for the TVH sector all data is based on information recorded in the TRL04 logbook. As with the TDB01 docket-book, the TRL04 logbook data may also be incomplete to some extent up until November 2017, while the TRL04 data since then is considered to be complete. Note, one record in the TDB02 data for 2021 was re-assigned to the TVH sector as the vessel was a TVH vessel.

3. Catch by Season

A comparison of the estimated total catch by sector for the seasons 2004 to 2021 is shown in Figure 1. Note, unlike the other data summaries presented in this paper, the TIB catch shown in this figure is based on the CDR data received on 12-November 2021. As the TVH catch is recorded in both the TRL04 logbook and the TDB02 CDR, two estimates for the 2021 season are provided for this sector. The small difference noted in the estimated TVH catch from these two logbooks is likely due to the fact that TRL04 weights are often estimated compared to more accurate weighing on land recorded on the CDR. Some differences in these catch estimates may also be due to differences in the times that AFMA receive and enter data from the two logbooks during the season.

Figure 1. Time-series of total catch by fishing season (December-November) and sector since 2004. TIB data is based on TDB01 docket-book and TDB02 CDR data, while TVH data is based on TRL04 logbook data.

SEASON	SEASON	TIB	TVH	TOTAL
04	2004	210.4	481.0	691.4
05	2005	367.6	549.0	916.6
06	2006	140.5	135.4	275.8
07	2007	268.7	268.6	537.3
08	2008	185.7	100.4	286.1
09	2009	147.8	91.1	238.9
10	2010	140.0	282.6	422.7
11	2011	199.1	503.5	702.6
12	2012	142.4	387.3	529.7
13	2013	140.3	361.7	502.0
14	2014	196.0	273.2	469.2
15	2015	206.7	152.7	359.4
16	2016	268.4	243.0	511.4
17	2017	111.5	166.3	277.8
18	2018	127.4	128.3	255.7
19	2019	260.6	155.9	416.5
20	2020	216.2	145.1	361.3
21	2021	123.2	117.1	240.3



NB. TVH (2021) =116.275 based on CDR

The reported catch by month for each sector of the TSRL for the 2004-2021 fishing seasons is shown in Table 1. The catch for the TVH sector is based on information reported in the TRL04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, for the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion, *P*, of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). These relate to the aggregate catches reported by several processors on a seasonal

Table 1. Catch by month (kilograms) for (a) the TIB sector, (b) the TVH sector and (c) the total TSRL fishery for the 2004-2021 fishing seasons. Note, the catch by month for the TVH is based on information reported in the TRL04 logbook, while the catches for the TIB sector are based on information reported in the TBD01 docket-book and TDB02 CDR. Furthermore, for the TIB sector the catch by month for the 2013-2016 fishing seasons is an estimate as the catch month is not known for a substantive portion *P* of the total catch in these seasons (*P*=39%, 34%, 33%, 55% respectively). For these seasons the catch within each month was estimated by raising the known catch in each month by the factor *R= 1/(1-P)*.

(a) TIB (From TBD01 and TDB02 logbooks

TIB	SEASON	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
04	2004		15,542	24,309	35,574	17,737	30,356	28,516	26,449	18,976	12,873	24	25	210,381
05	2005	21,648	15,098	50,625	58,221	47,575	56,758	43,061	34,474	23,682	16,088	314	71	367,615
06	2006	12,507	9,447	24,018	26,814	19,091	18,380	9,814	9,910	7,672	2,747	0	51	140,451
07	2007	19,002	24,941	24,716	62,040	29,185	33,759	29,025	23,193	13,907	8,920	0	0	268,688
08	2008	10,435	13,461	31,237	36,127	24,110	16,711	14,805	23,516	9,277	5,969	18	0	185,666
09	2009	9,716	13,273	20,547	23,103	23,733	15,647	13,242	15,393	7,811	4,819	529	0	147,813
10	2010	5,764	6,198	21,259	15,829	14,995	12,180	16,348	19,073	17,001	9,782	1,610	0	140,039
11	2011	6,929	18,215	30,141	49,767	20,400	23,990	18,686	18,856	8,858	3,218	0	0	199,060
12	2012	9,036	13,403	19,028	24,718	19,606	9,689	22,874	11,194	10,836	1,996	0	0	142,380
13	2013	4,961	1,371	15,940	13,421	20,778	18,606	16,324	18,656	14,425	15,837	0	0	140,320
14	2014	9,921	13,339	18,379	38,920	28,385	25,455	16,908	17,455	17,388	9,639	187	0	195,974
15	2015	20,518	9,495	31,813	21,672	27,456	17,212	45,680	13,204	11,819	7,512	283	0	206,664
16	2016	13,845	15,604	52,833	36,406	23,176	34,192	33,687	25,025	22,438	10,821	220	168	268,415
17	2017	5,147	8,290	23,339	15,831	11,697	14,959	7,476	9,730	10,803	4,075	155	0	111,502
18	2018	15,097	13,127	20,991	19,198	17,206	10,137	10,839	20,820	0	0	0	0	127,415
19	2019	23,938	14,695	19,137	52,219	37,781	31,716	28,345	24,476	18,923	9,382	0	4	260,616
20	2020	25,863	13,609	21,755	30,220	30,965	24,215	25,816	18,073	17,036	8,421	201	15	216,189
21	2021	7,548	6,155	15,653	20,084	15,449	12,286	15,005	11,973	8,385	5,244	387	0	118,169

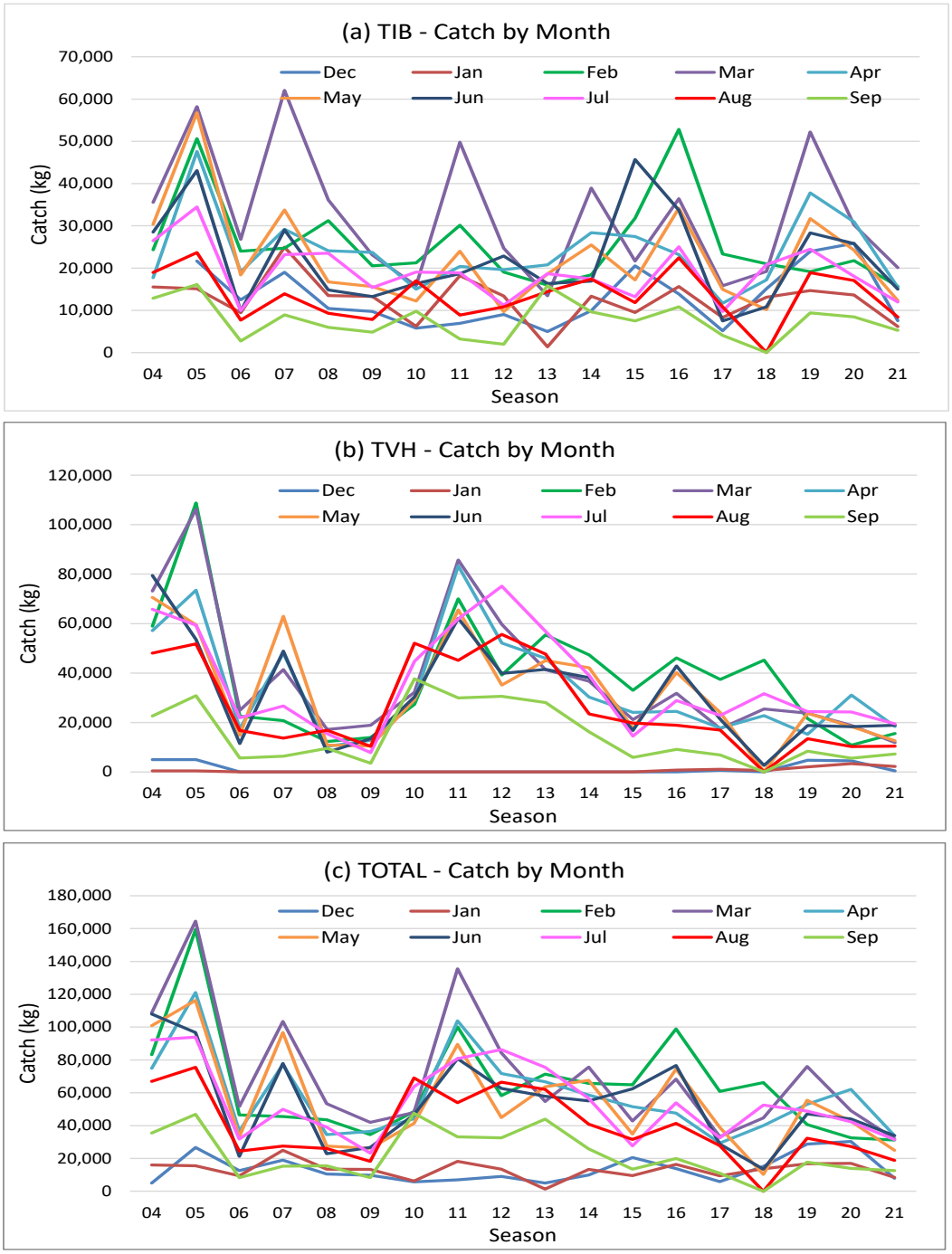
(b) TVH (From TRL04 logbook)

TVH	SEASON	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
04	2004	4,949	452	58,965	73,130	57,142	70,551	79,438	65,766	48,014	22,625	0	0	481,032
05	2005	4,984	398	108,739	106,276	73,510	59,475	53,618	59,361	51,795	30,814	0	0	548,970
06	2006	25	0	22,512	24,860	17,491	14,798	11,490	21,865	16,756	5,589	0	0	135,386
07	2007	0	0	20,768	41,389	47,980	62,941	48,836	26,689	13,655	6,368	0	0	268,626
08	2008	0	0	12,285	17,166	10,334	10,809	7,997	15,482	16,819	9,545	0	0	100,437
09	2009	0	0	13,905	18,881	12,748	10,479	13,408	7,824	10,350	3,470	0	0	91,065
10	2010	0	0	27,311	32,164	29,226	29,192	30,315	44,734	52,026	37,670	0	0	282,638
11	2011	0	0	69,994	85,730	83,334	65,515	62,084	61,867	45,097	29,913	0	0	503,534
12	2012	0	0	39,228	59,636	52,147	35,159	39,807	75,134	55,625	30,563	0	0	387,299
13	2013	0	0	55,428	41,275	45,929	45,030	41,502	56,818	47,621	28,058	0	0	361,661
14	2014	0	0	47,338	36,706	30,230	42,088	38,160	39,061	23,418	16,185	0	0	273,186
15	2015	0	0	32,992	21,166	24,051	17,623	16,745	14,460	19,782	5,891	0	0	152,710
16	2016	0	750	46,101	31,830	24,474	40,200	42,871	28,854	18,851	9,079	0	0	243,010
17	2017	690	1,051	37,432	17,478	17,701	23,982	21,268	22,839	16,955	6,875	0	0	166,271
18	2018	0	565	45,187	25,440	22,791	101	2,628	31,612	0	0	0	0	128,324
19	2019	4,739	2,075	21,522	23,722	15,219	23,742	18,777	24,361	13,426	8,341	0	0	155,924
20	2020	4,482	3,320	10,827	18,822	31,075	18,300	18,274	24,236	10,253	5,520	0	0	145,109
21	2021	430	2,235	15,527	11,839	18,407	12,611	18,856	19,447	10,444	7,278	0	0	117,074

(c) TOTAL

TOTAL	SEASON	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
04	2004	4,949	15,994	83,274	108,704	74,879	100,907	107,954	92,215	66,990	35,498	24	25	691,413
05	2005	26,632	15,496	159,364	164,497	121,085	116,233	96,679	93,835	75,477	46,902	314	71	916,585
06	2006	12,532	9,447	46,530	51,674	36,582	33,178	21,304	31,775	24,428	8,336	0	51	275,837
07	2007	19,002	24,941	45,484	103,429	77,165	96,700	77,861	49,882	27,562	15,288	0	0	537,314
08	2008	10,435	13,461	43,522	53,293	34,444	27,520	22,802	38,998	26,096	15,514	18	0	286,103
09	2009	9,716	13,273	34,452	41,984	36,481	26,126	26,650	23,217	18,161	8,289	529	0	238,878
10	2010	5,764	6,198	48,570	47,993	44,221	41,372	46,663	63,807	69,027	47,452	1,610	0	422,677
11	2011	6,929	18,215	100,135	135,497	103,734	89,505	80,770	80,723	53,955	33,131	0	0	702,594
12	2012	9,036	13,403	58,256	84,354	71,753	44,848	62,681	86,328	66,461	32,559	0	0	529,679
13	2013	4,961	1,371	71,368	54,696	66,707	63,636	57,826	75,474	62,046	43,895	0	0	501,981
14	2014	9,921	13,339	65,717	75,626	58,615	67,543	55,068	56,516	40,806	25,824	187	0	469,160
15	2015	20,518	9,495	64,805	42,838	51,507	34,835	62,425	27,664	31,601	13,403	283	0	359,374
16	2016	13,845	16,354	98,934	68,236	47,650	74,392	76,558	53,879	41,289	19,900	220	168	511,425
17	2017	5,837	9,341	60,771	33,309	29,398	38,941	28,744	32,569	27,758	10,950	155	0	277,773
18	2018	15,097	13,692	66,178	44,638	39,997	10,238	13,467	52,432	0	0	0	0	255,739
19	2019	28,677	16,770	40,659	75,941	53,000	55,458	47,122	48,837	32,349	17,723	0	4	416,540
20	2020	30,345	16,929	32,582	49,042	62,040	42,515	44,090	42,309	27,289	13,941	201	15	361,298
21	2021	7,978	8,390	31,180	31,923	33,856	24,897	33,861	31,420	18,829	12,522	387	0	235,243

Figure 2. Time-series of catch by month for the eight months December-to-July for (a) the TIB sector, (b) the TVH sector and (c) the total TSRL fishery. Note, refer to caption on Table 1 for how aggregate catches for some seasons were distributed across month.



basis to account for missing docket-book records. For these seasons the catch within each month was estimated by raising the known catch in each month by the factor $R= 1/(1-P)$. This assumes that the distribution of the catches by month in the aggregate catch data is the same as the distribution within the docket-book recorded catches.

Based on the catch-by-month estimates provided in Table 1, the time-series of catch by month for the ten months December-to- September is shown in Figure 2 for each sector of the TSRL over the seasons 2004-2021.

4. TIB Sector Summary

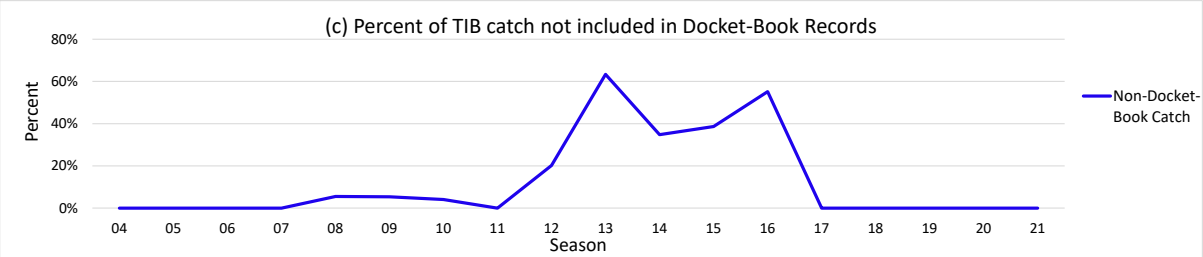
Several summaries by season of the catch and effort data for the TIB-sector are provided here. These summaries are mainly based on analysis the 61,963 catch and effort records aggregated at the Seller Record-Number level of the TBD01 or TDB02 docket-books. For the effort and catch-rates shown in the following figures the records were filtered as follows to remove missing data or possible data outliers (and data entry errors):

Where effort (days fished) was not recorded:	9,244 records	(15.09%)
Where effort (days fished) greater than 9 days:	116 records	(0.19%)
Where catch was zero or not recorded:	37 records	(0.06%)
Where catch was less than 1kg:	20 records	(0.03%)
Where catch was greater than 500kg:	300 records	(0.49%)

After removing these data records, the data used to determine effort and catch rates was based on 51,726 records, or 84.42% of all records.

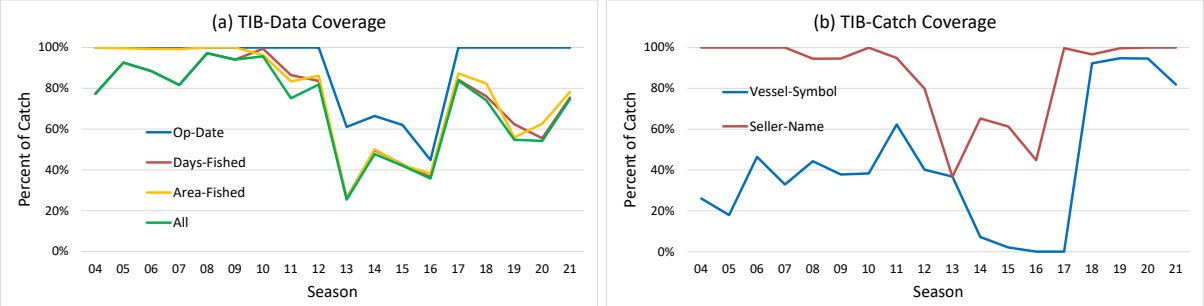
As these data summaries are based only on the catch and effort data recorded in the TBD01 or TDB02 docket-books, the information included in these summaries does not include the aggregate data provided by processors between 2013 and 2016 or the small amount of TIB related data recorded in the TRL04 logbook between 2008 and 2015. The percentage of the total TIB catch each season not included in the Docket-book data is shown in Figure 3. Given this situation, the reader is therefore requested to be mindful that the data shown in the following figures is not representative of all TIB-operations for some seasons.

Figure 3. Percentage of total TIB catch each season not included in the Docket-book data.



Further to the absence of data mentioned above, not all the data fields on either the TBD01 or TDB02 docket-books are complete due to the voluntary nature of the provision of some of the information (notably related to effort) on both books, and the incompleteness of these data fields creates problems in providing a complete analysis of the information for the TIB sector. An indication of availability of information is shown in Figure 4, which provides the annual percentage of the total TIB catch associated with records where various data fields are non-null. The data fields are, (i) Trip operation-date, (ii) Number of days fished, (iii) Area fished, (iv) Vessel-symbol and (v) Seller-name.

Figure 4. Time-series of the percent of the total seasonal TIB catch associated with data records where various data fields are non-null. (a) Trip operation-date, number of days fished, area fished and all three together, and (b) vessel-symbol and seller-name.



The 21 areas used to record the spatial location of catch taken in the TIB sector are shown in Figure 5 and listed in Table 2(a). The total number of data records associated with each area for the 2004-2021 seasons is also shown. For the purpose of the following analyses, several areas where the data coverage was low were combined. A revised listing of area codes and names based on aggregating some areas is shown in Table 2(b). These are the areas and names referred to in the following figures. Note that some concerns were expressed at the RAG meeting held in May 2018 that the area-fished recorded on docket-books may not coincide with the area where the actual fishing took place (it may instead coincide where the lobsters were sold). As such, the reader is reminded that the area-fished associated with catches in the TIB-

Figure 5. Map of the TIB fishing areas described in the analysis.

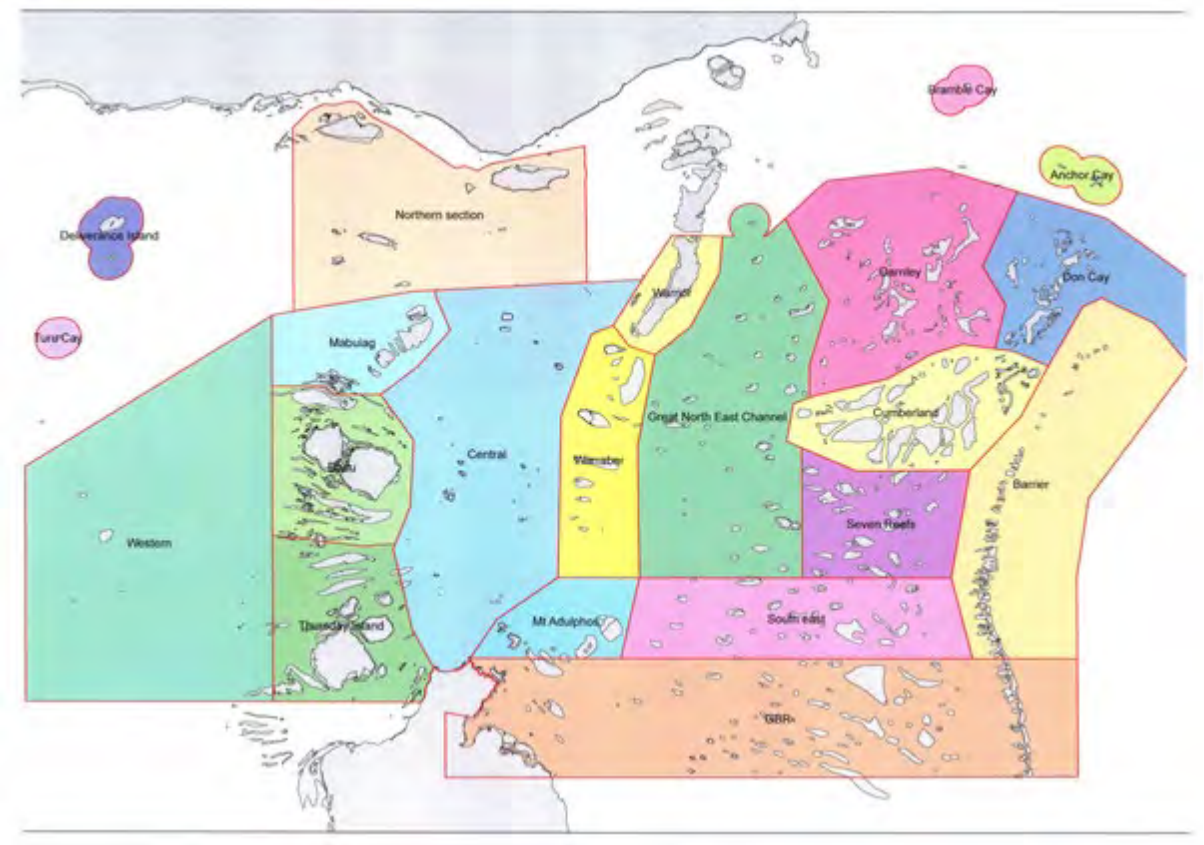


Table 2. (a) List of the TIB-area codes and names used in the TIB fishery together with the total number of data records associated with each area. A revised listing of TIB-area codes and names based on aggregating areas with few data records is shown in (b).

(a) List of TIB Areas and number of Data records

Area-Name	Area	Area-Rev	N-Records	Catch
Unknown	0	0	7,272	806,966
Turu Cay	1	6	255	13,784
Deliverance Island	2	6	34	1,440
Northern Section	3	6	274	29,024
Bramble Cay	4	16	19	1,481
Anchor Cay	5	16	9	238
Western	6	6	21	1,078
Mabuiag	7	7	6,428	502,581
Badu	8	8	6,213	325,071
Thursday Island	9	9	25,594	949,773
Central	10	10	787	40,932
Warrior	11	11	3,671	216,901
Warraber	12	12	5,008	221,637
Mt Adolphus	13	13	828	71,717
Great NE Channel	14	14	2,886	138,499
South East	15	15	119	11,171
Darnley	16	16	1,465	53,545
Cumberland	17	17	858	49,962
Seven Reefs	18	15	8	475
Don Cay	19	16	6	189
Barrier	20	15	11	365
GBR	21	15	160	10,198
		Total	61,926	3,447,027

(b) Revised list of TIB Areas

Area-Name	Area-Rev	N-Records	Catch
Western	6	584	45,327
Mabuiag	7	6,428	502,581
Badu	8	6,213	325,071
Thursday Island	9	25,594	949,773
Central	10	787	40,932
Warrior	11	3,671	216,901
Warraber	12	5,008	221,637
Mt Adolphus	13	828	71,717
Great NE Channel	14	2,886	138,499
South East	15	298	22,208
Darnley	16	1,499	55,453
Cumberland	17	858	49,962
Unknown	0	7,272	806,966
	Total	61,926	3,447,027

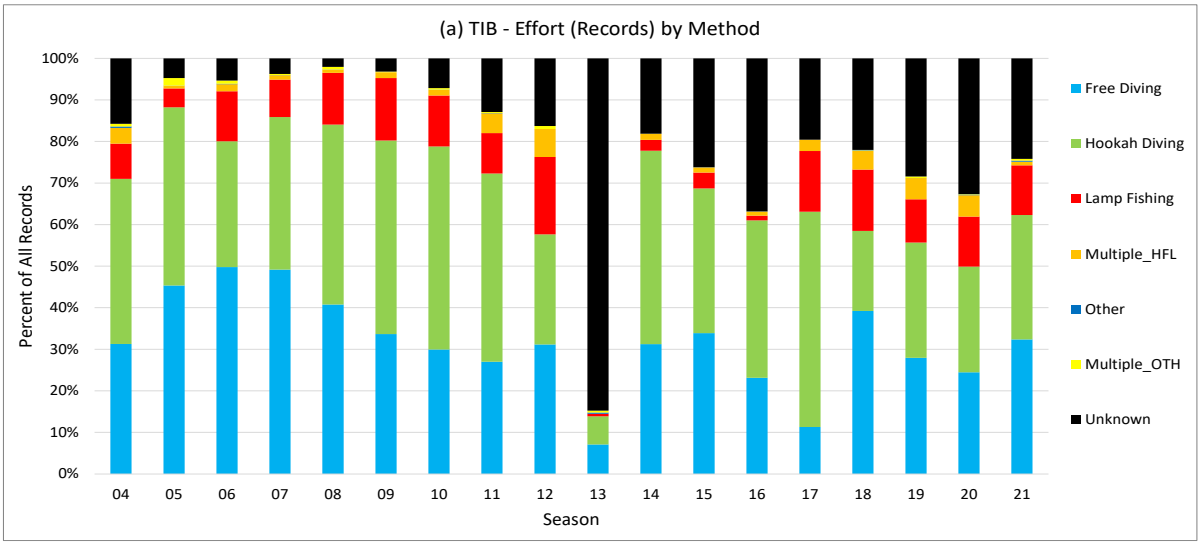
Table 3. List of the Seller-Homes used for summarising the TIB data together with the number of TIB records and associated catch in kilograms. Note, Seller-Homes with few records (generally less than 40) have been aggregated.

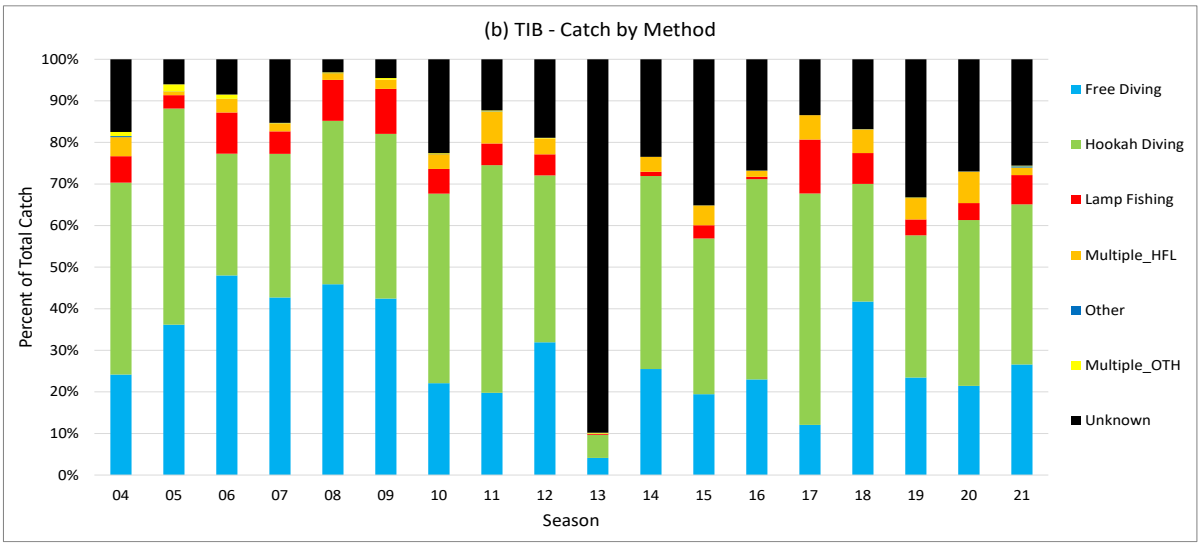
Seller-Home/Island	N-recs	%	Catch	%
WAIBEN (Thursday)	20,277	32.7%	1,388,686	40.3%
BADU (Mulgrave)	10,098	16.3%	630,009	18.3%
IAMA (Yam)	5,135	8.3%	243,681	7.1%
WARRABER (Sue)	6,590	10.6%	226,854	6.6%
NGURUPAI (Horn)	5,054	8.2%	163,090	4.7%
MASIG (Yorke)	2,561	4.1%	130,761	3.8%
MABUIAG (Jervis)	1,627	2.6%	115,079	3.3%
KIRRIRI (Hammond)	2,950	4.8%	88,000	2.6%
PORUMA (Coconut)	2,129	3.4%	84,755	2.5%
Erab & Ugar	227	0.4%	6,650	0.2%
MOA (Banks)	902	1.5%	49,789	1.4%
Muralag & Gealug	1,767	2.9%	112,234	3.3%
Cape Yorke	692	1.1%	39,053	1.1%
Northern_TS	262	0.4%	19,805	0.6%
Other	38	0.1%	3,983	0.1%
Unknown	1,617	2.6%	144,599	4.2%
	61,926	100.0%	3,447,028	100.0%

sector may not be correct. Due to this concern, the information on the address of sellers reported on the Docket-Books, in particular the island or town of the seller, was used to provide an alternative possible catch area. This alternative area is referred to as the Seller-Home and are listed in Table 3.

The data summaries for the TIB fishery are shown in Figures 6-12. The captions above each figure should hopefully provide sufficient information to help the reader adequately interpret each result.

Figure 6. Seasonal time-series of (a) number of Seller-records, (b) total catch, and (c) nominal CPUE (kilograms per day, records where effort between 1 and 9 days and catch between 1 and 500kg) for the TIB fleet for each method. Note, Multiple_HFL denotes records where Free-diving and/or Hookah and/or Lamp fishing were combined.





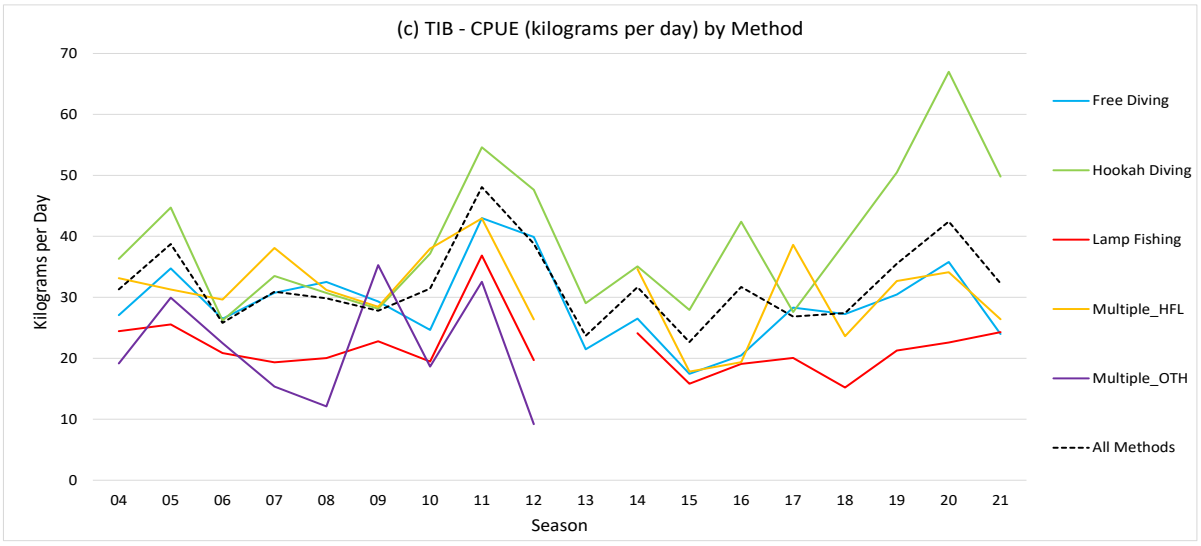
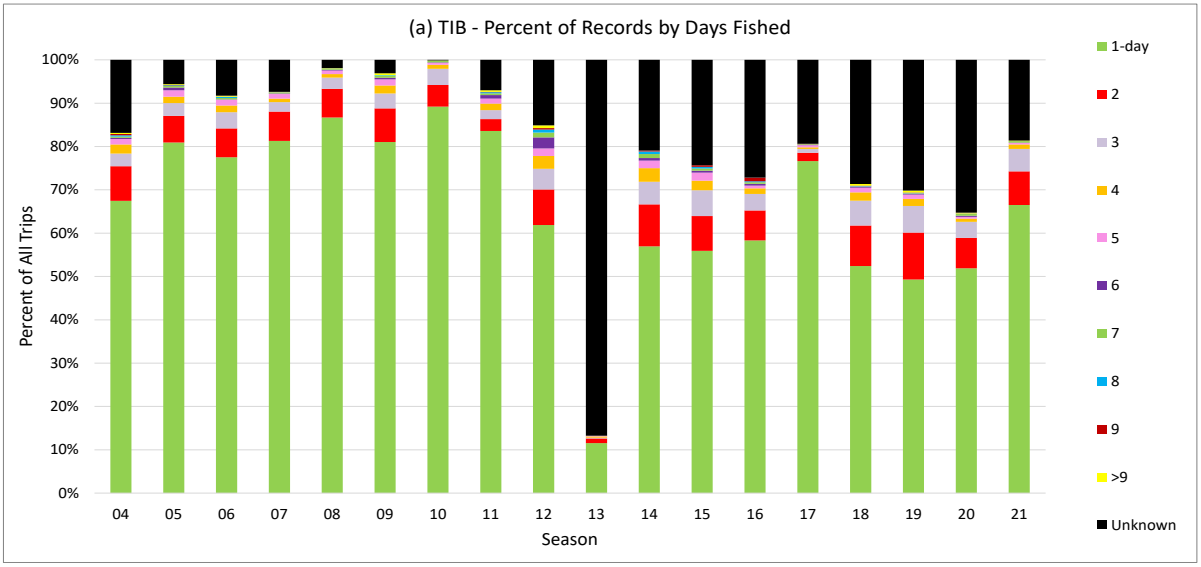
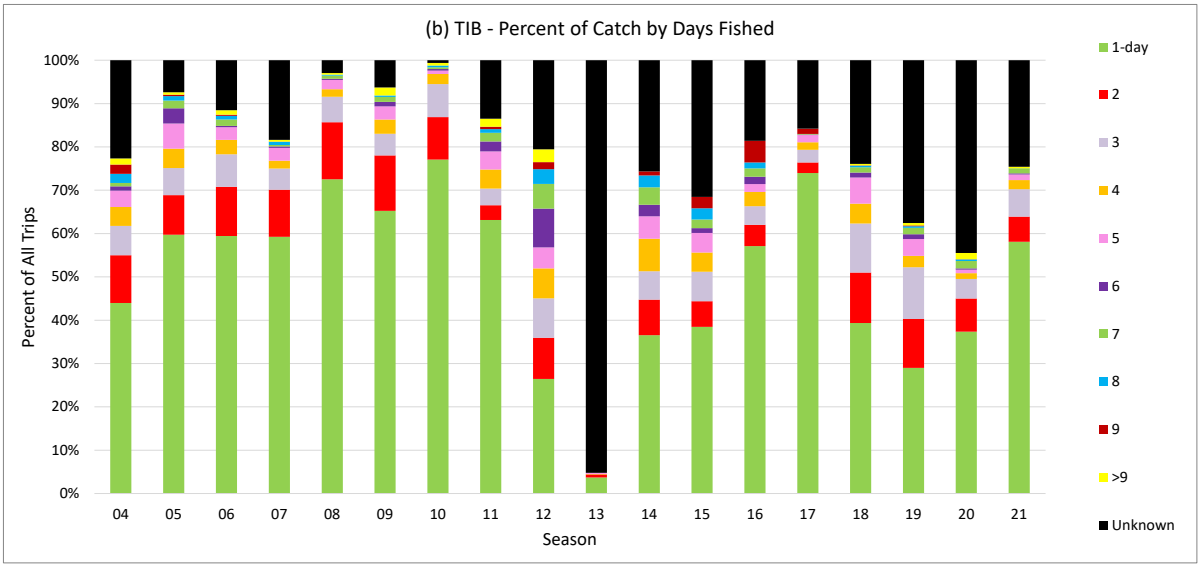


Figure 7. Percentage of (a) Seller-records, and (b) total catch, and (c) the percent of Docket-Book-records and associated total catch for which effort (days fished) is not recorded for each season stratified by the number of days fished.





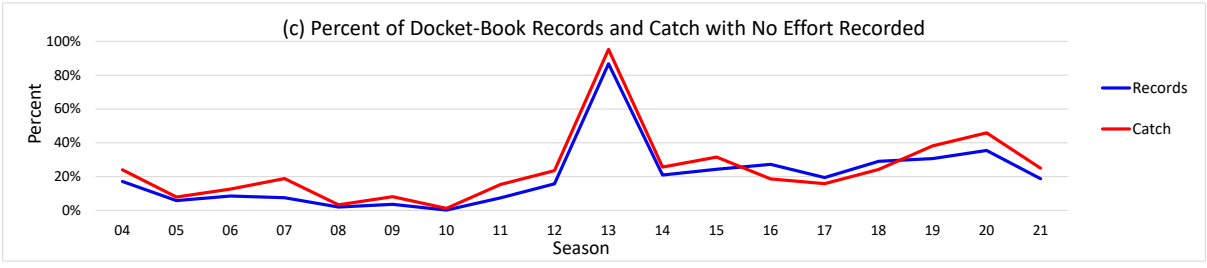
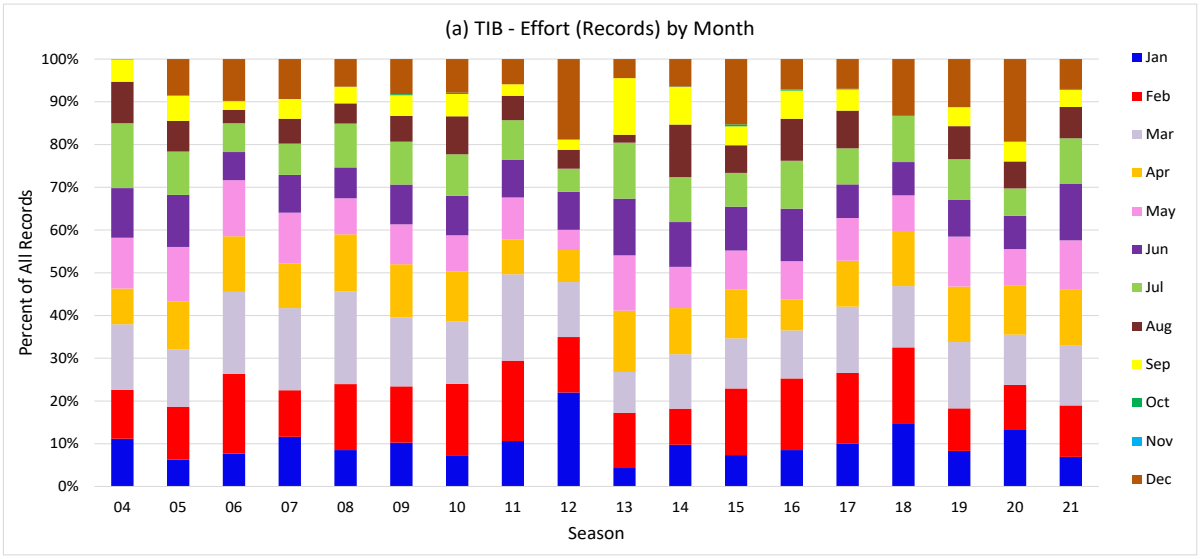
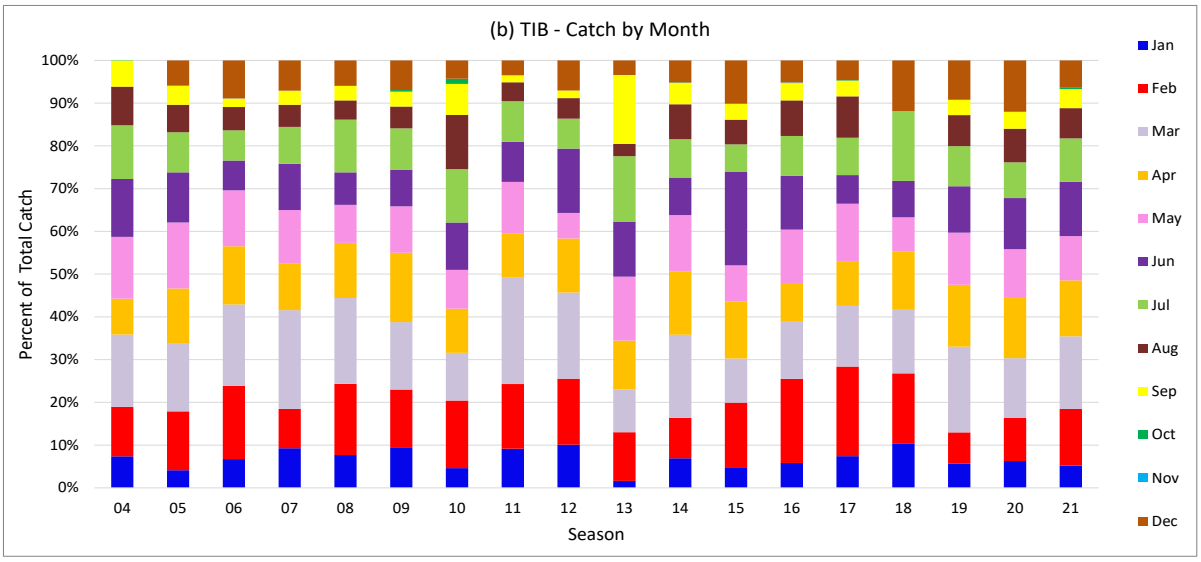


Figure 8. Seasonal time-series of (a) number of Seller-records, (b) total catch, and (c) nominal CPUE (kilograms per day, records where effort between 1 and 9 days and catch between 1 and 500kg) for the TIB fleet within each month.





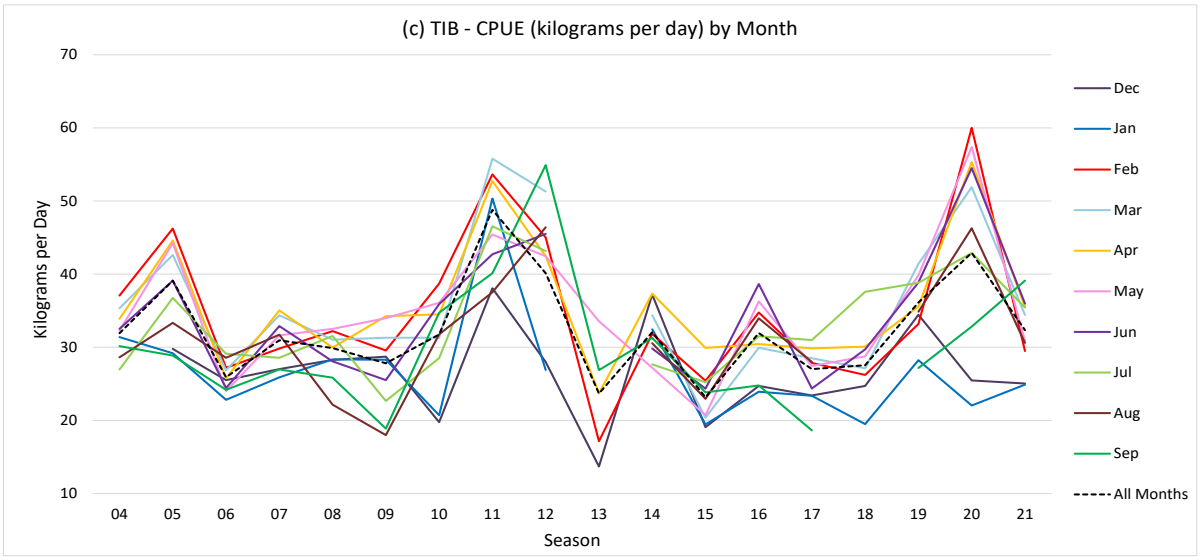


Figure 9. Seasonal time-series of (a) number of Seller-records, (b) the percent of Seller-records and total catch each season for which effort (days fished) is not recorded, and (c) total days fished (for records where effort between 1 and 9 days) for the TIB fleet within each Area.

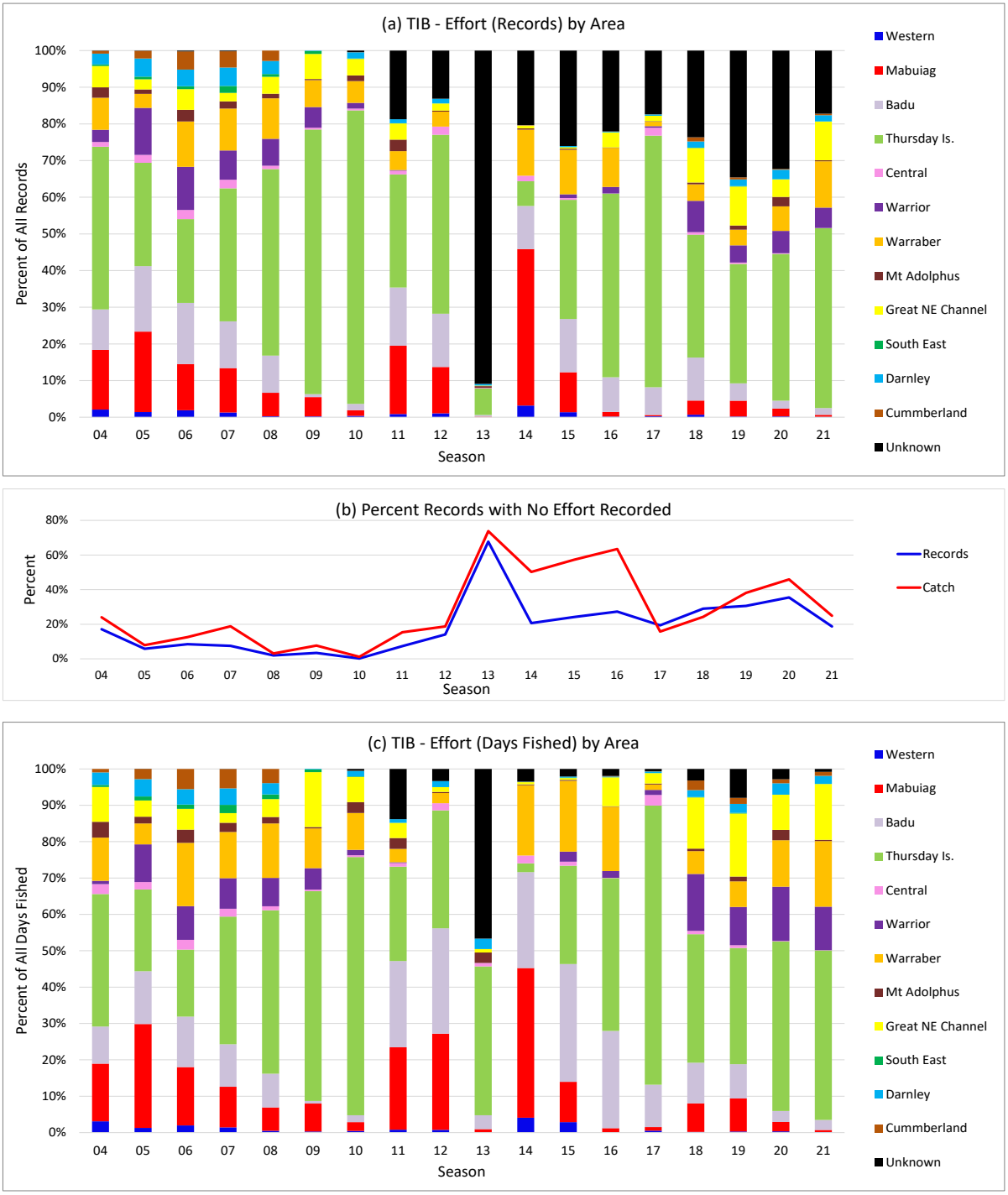
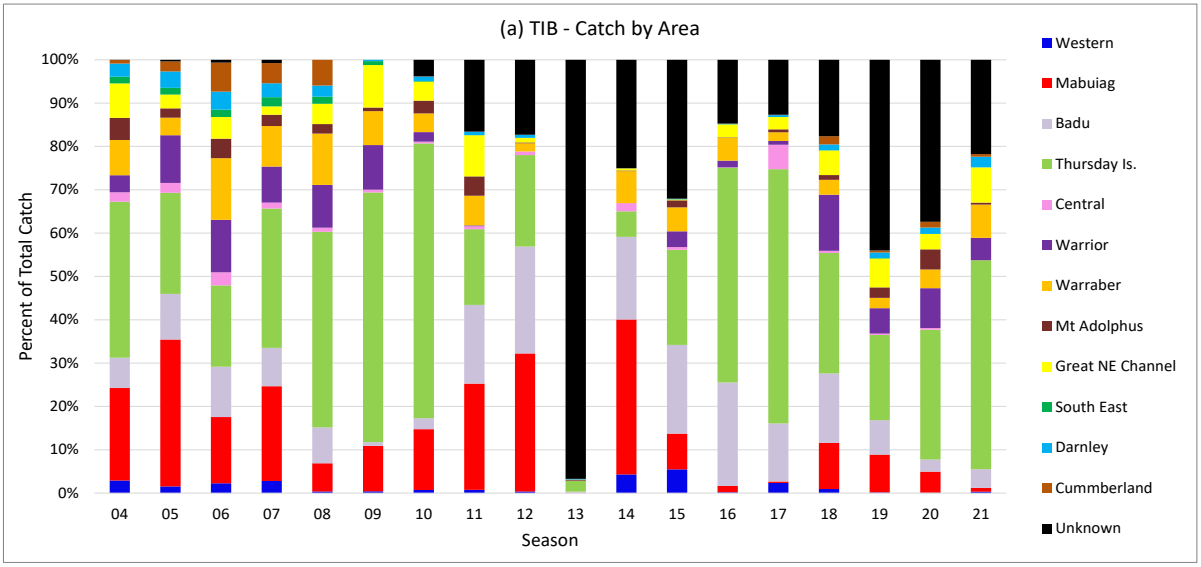
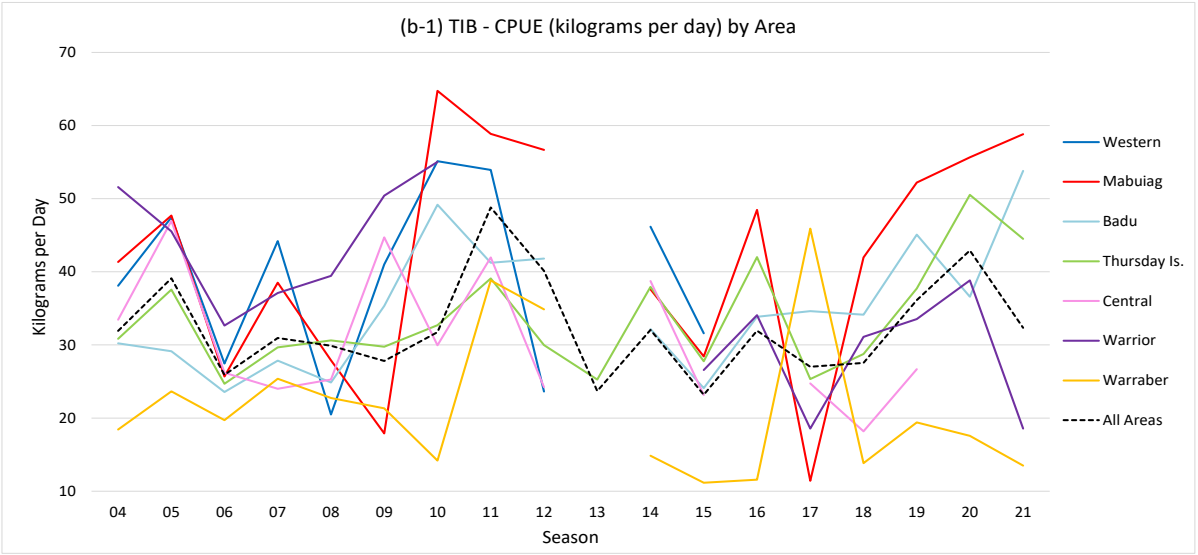


Figure 10. Seasonal time-series of (a) total catch, and (b) nominal CPUE (kilograms per day, records where effort between 1 and 9 days and catch between 1 and 500kg) for the TIB fleet within each Area.





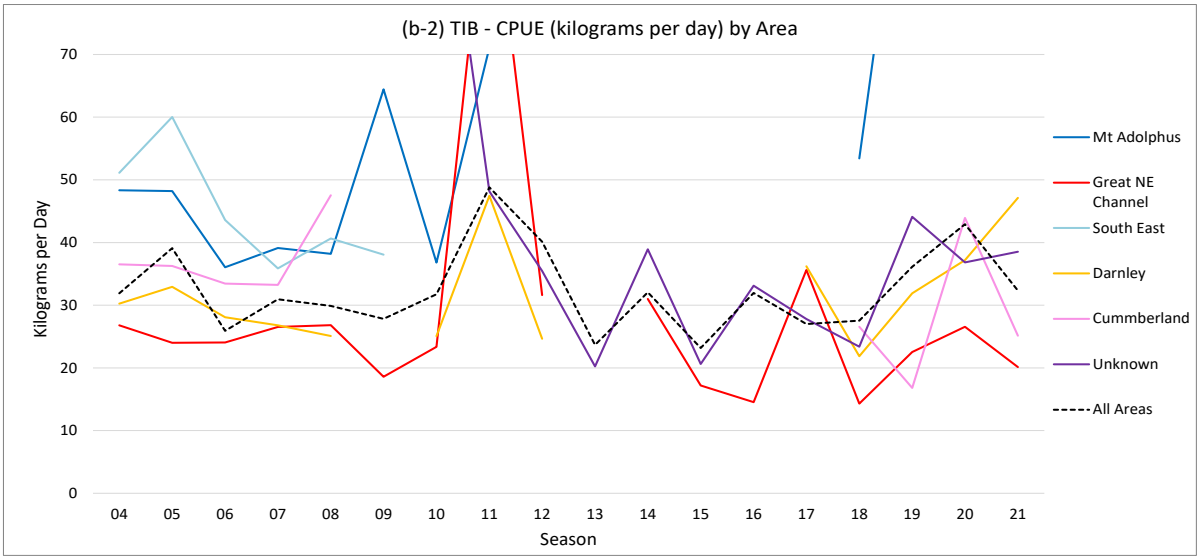
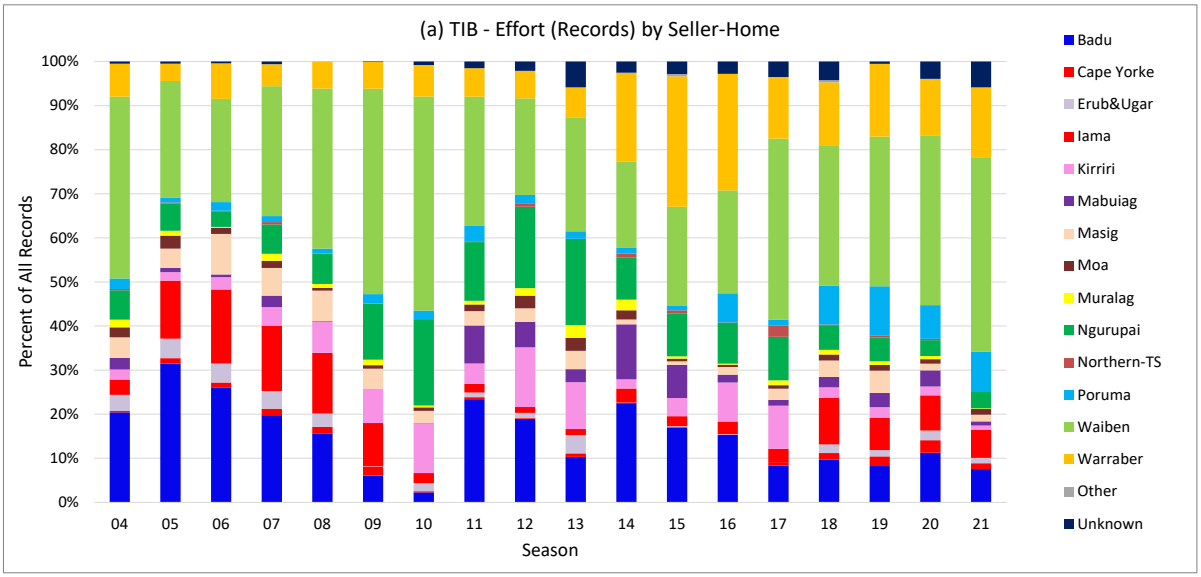
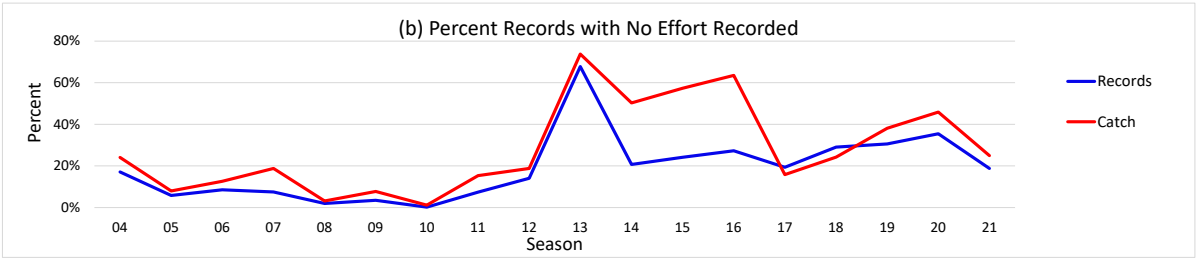


Figure 11. Seasonal time-series of (a) number of Seller-records, (b) the percent of Seller-records and total catch each season for which effort (days fished) is not recorded, and (c) total days fished (for records where effort between 1 and 9 days) for the TIB fleet within each Seller-Home.





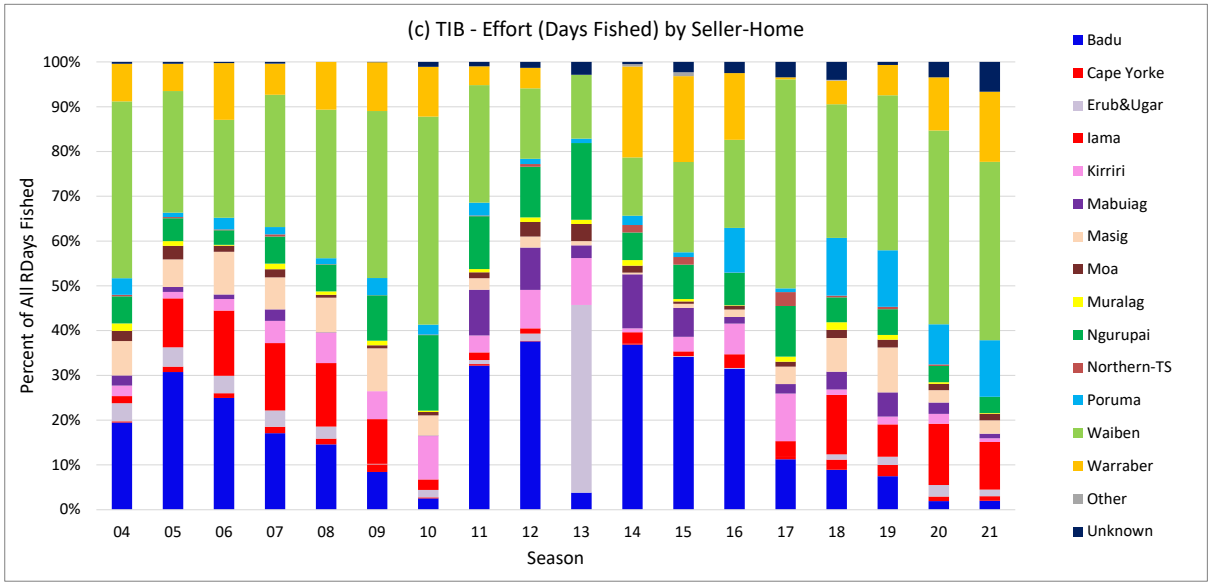
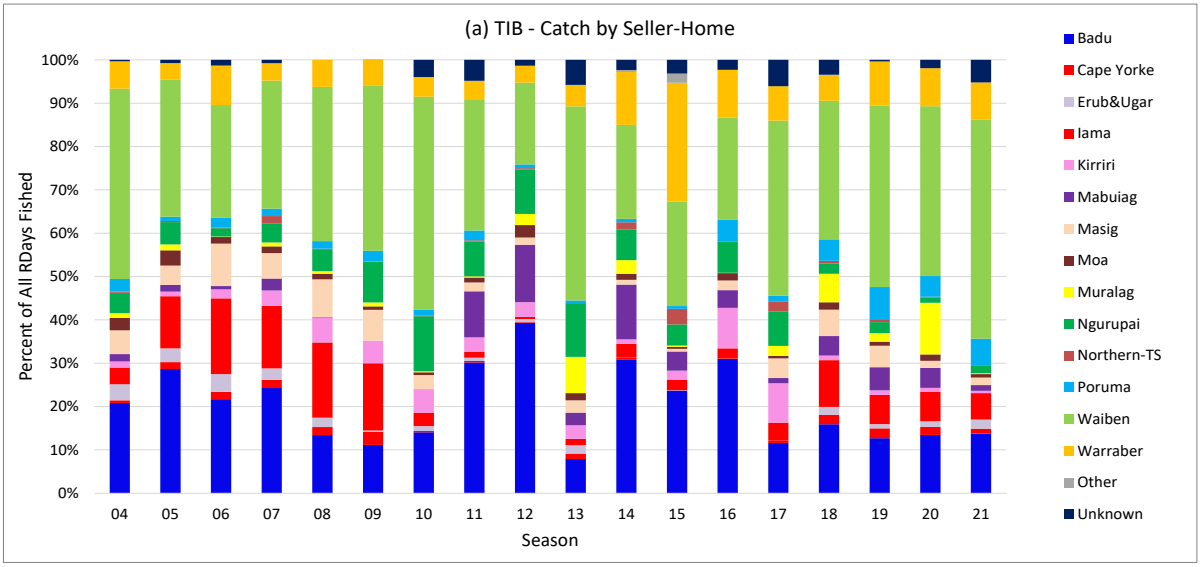
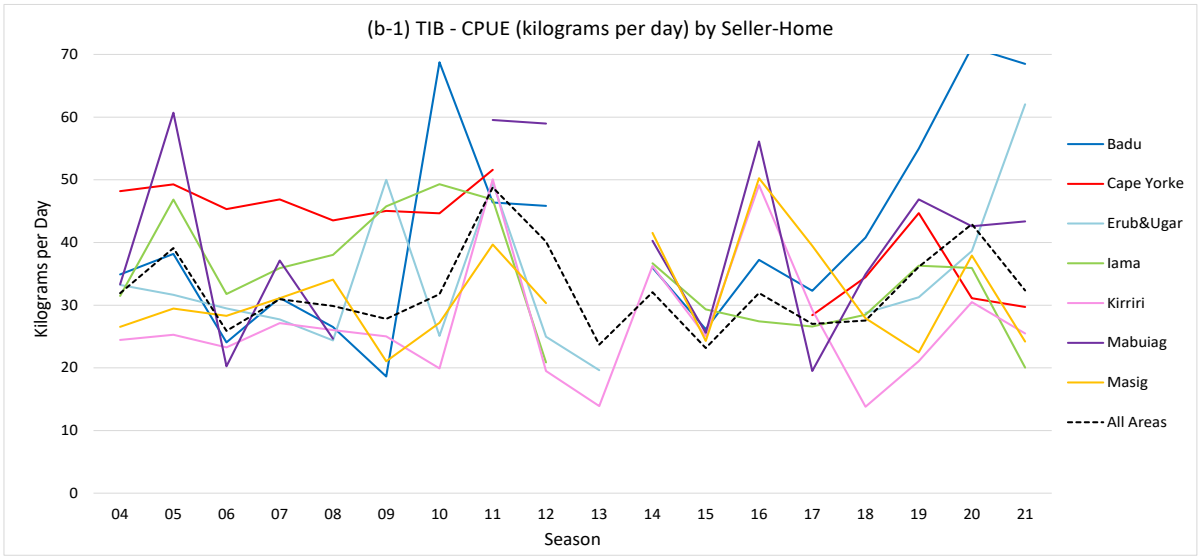
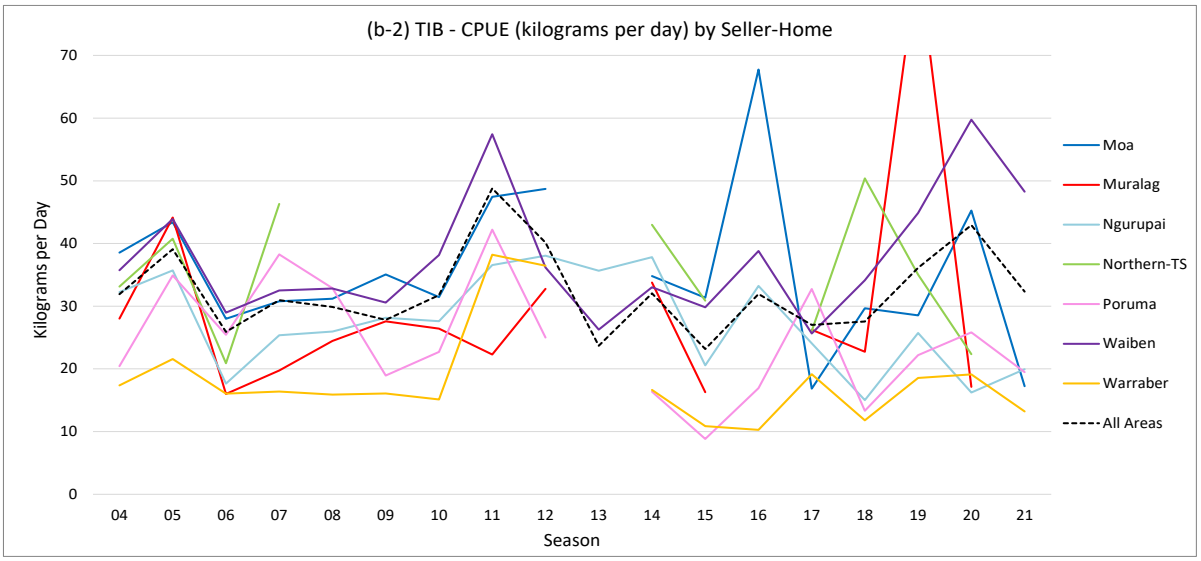


Figure 12. Seasonal time-series of (a) total catch, and (b) nominal CPUE (kilograms per day, records where effort between 1 and 9 days and catch between 1 and 500kg) for the TIB fleet within each Seller-Home.







TVH Sector Summary

As for the TIB-sector, several summaries for each season of the catch and effort data for the TVH-sector are provided here. These summaries are mainly based on analysis the 75,200 catch and effort data aggregated at the tender level. For the levels of effort and catch-rates shown in these figures the data were filtered as follows to remove missing data or possible data outliers (and data entry errors):

Where effort (hours fished) was not recorded:	13,793 records	(18.34%)
Where effort (hours fished) less than 0.5 hours:	7 records	(0.01%)
Where effort (hours fished) greater than 12 hours:	353 records	(0.47%)
Where catch was zero or not recorded:	923 records	(1.23%)
Where catch was less than 1kg:	14 records	(0.02%)
Where catch was greater than 500kg:	230 records	(0.31%)

After removing these data records, the data used to determine effort and catch rates was based on 59,982 records, or 79.76% of all records.

It can be noted that the TVH data do not have the same level of non-reporting of information associated with many of the data fields noted in the TIB-data (e.g. the fishing date is known for all catches in the TVH data).

The data summaries for the TVH fishery are shown in Figures 14-20. The captions above each Figure should hopefully provide sufficient information to help the reader adequately interpret each result. Note, the TRL04 logbook limits the reporting of catch and effort to a single location, generally the location where the primary boat is anchored and not the location where tenders are actually fishing (which can range as far as 20 nm from the primary boat).

Figure 14. Seasonal time-series of the percent of the total TVH catch stratified by (a) fishing method and (b) process form.

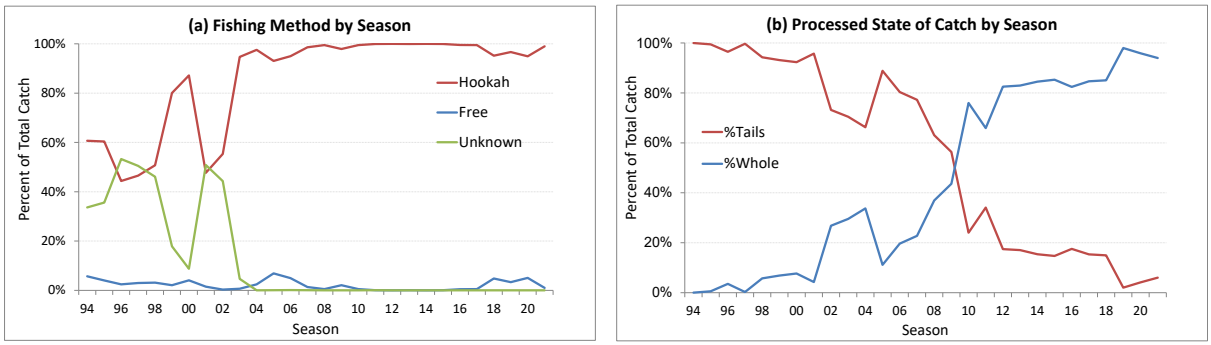


Figure 15. Map of the TVH fishing areas described in the analysis.

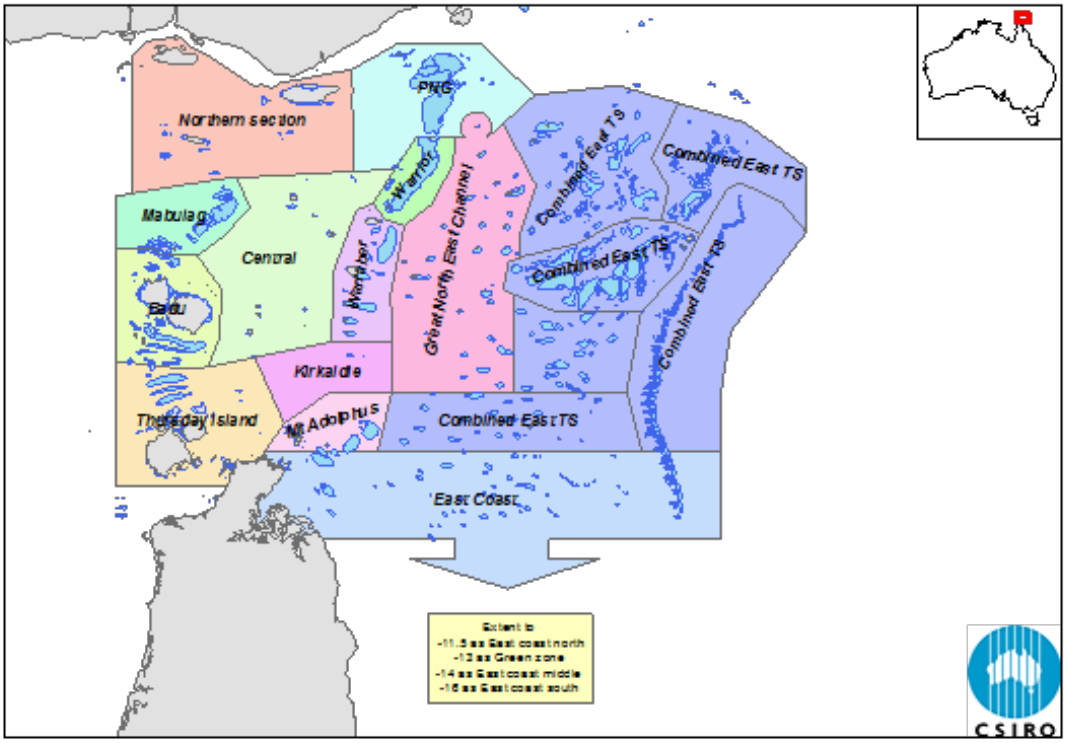
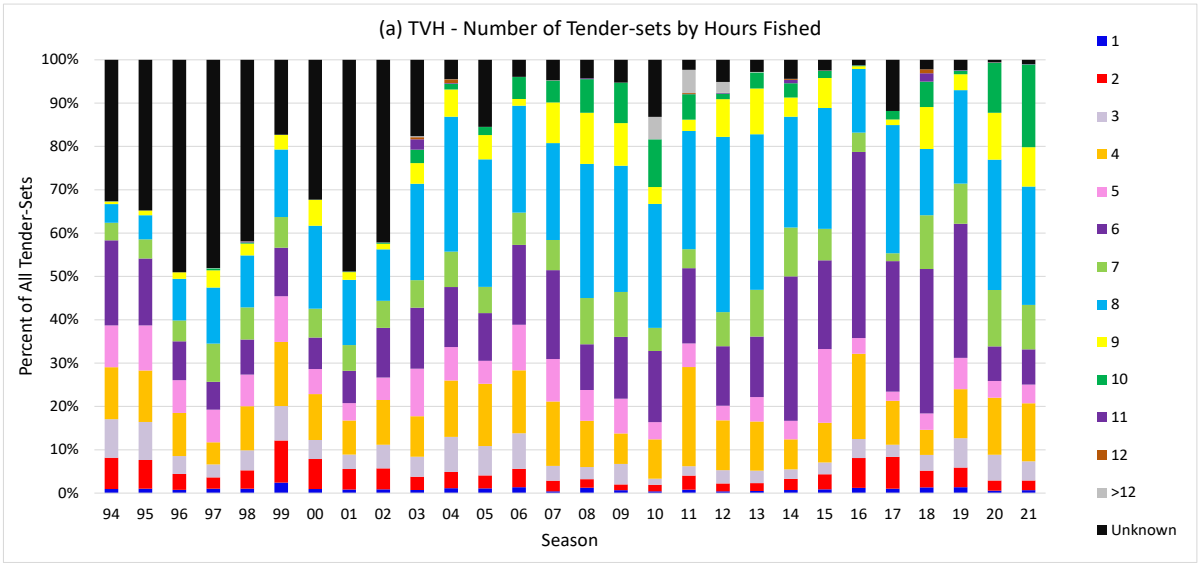
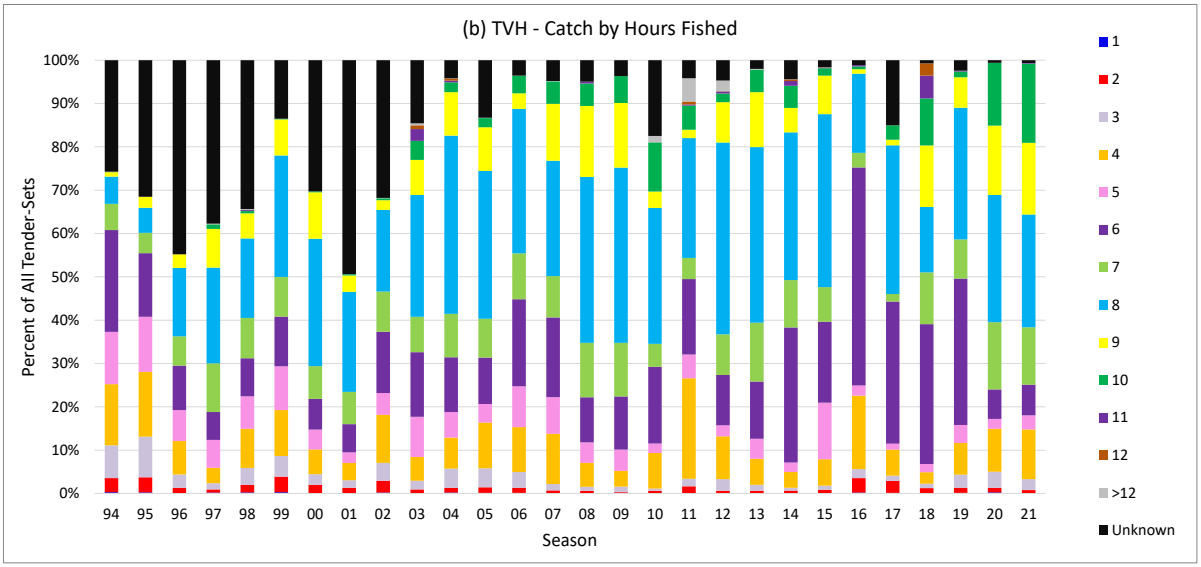


Figure 16. Percentage of (a) tender sets, and (b) total catch, and (c) the percent of tender sets and total catch for which effort (hours fished) is not recorded each season stratified by the number of hours fished.





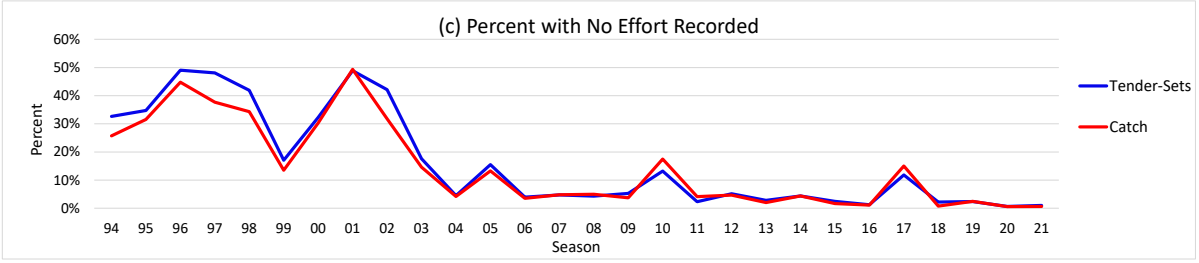
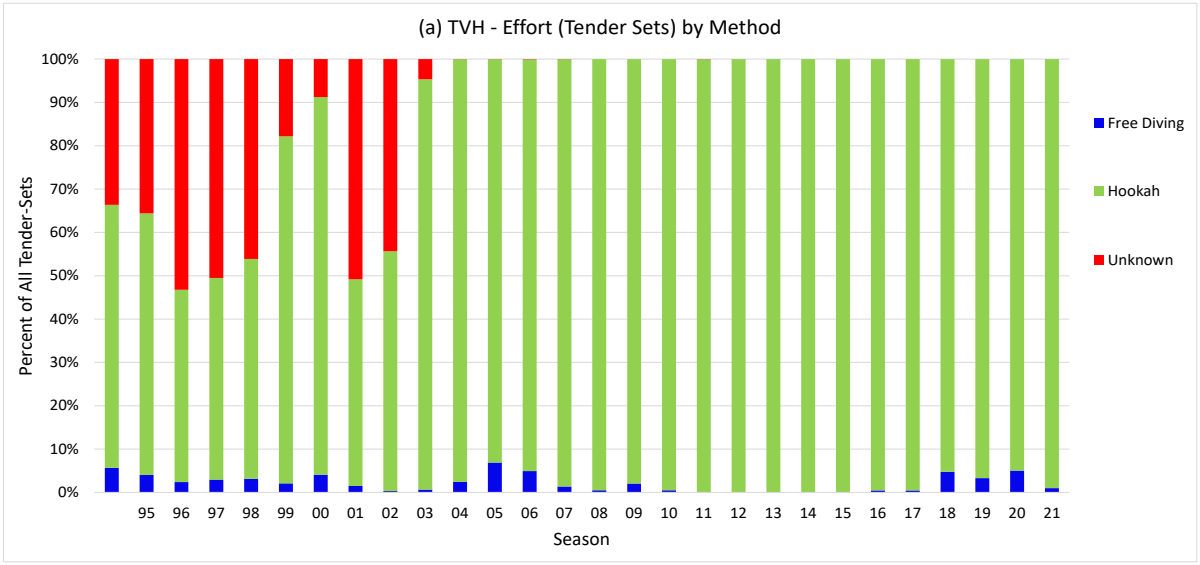
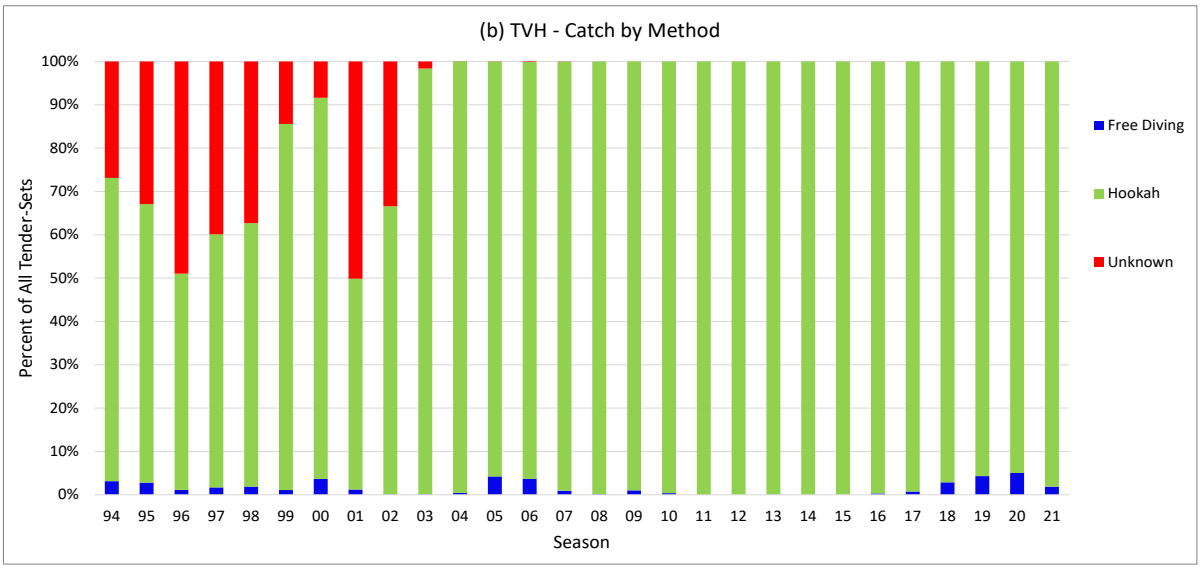


Figure 17. Seasonal time-series of (a) number of tender-sets, (b) total catch, and (c) nominal CPUE (kilograms per hour) for the TVH fleet for each method.





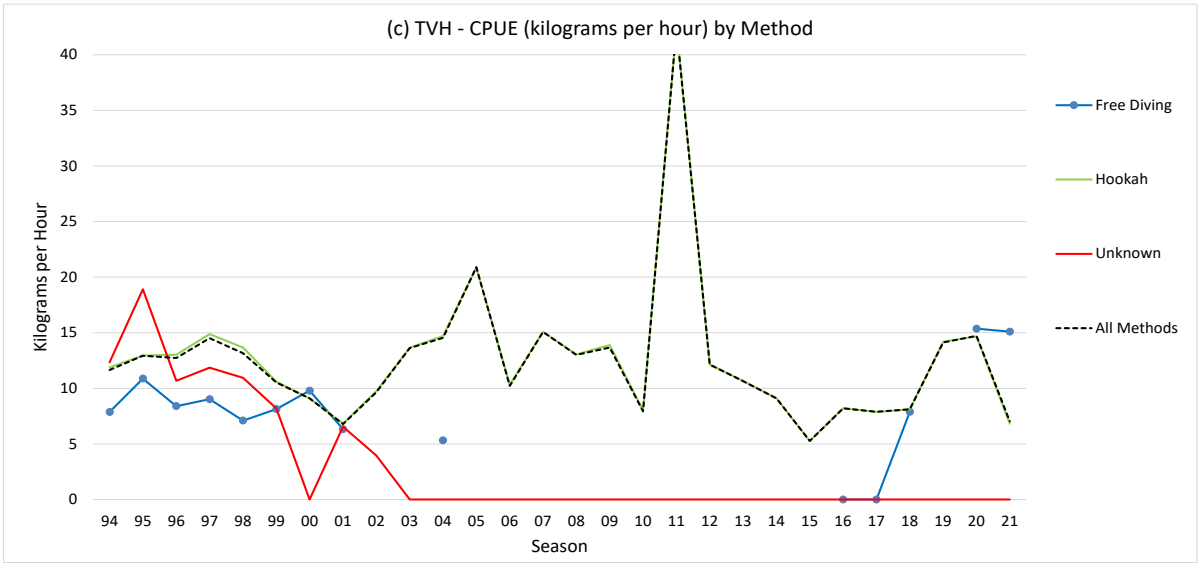
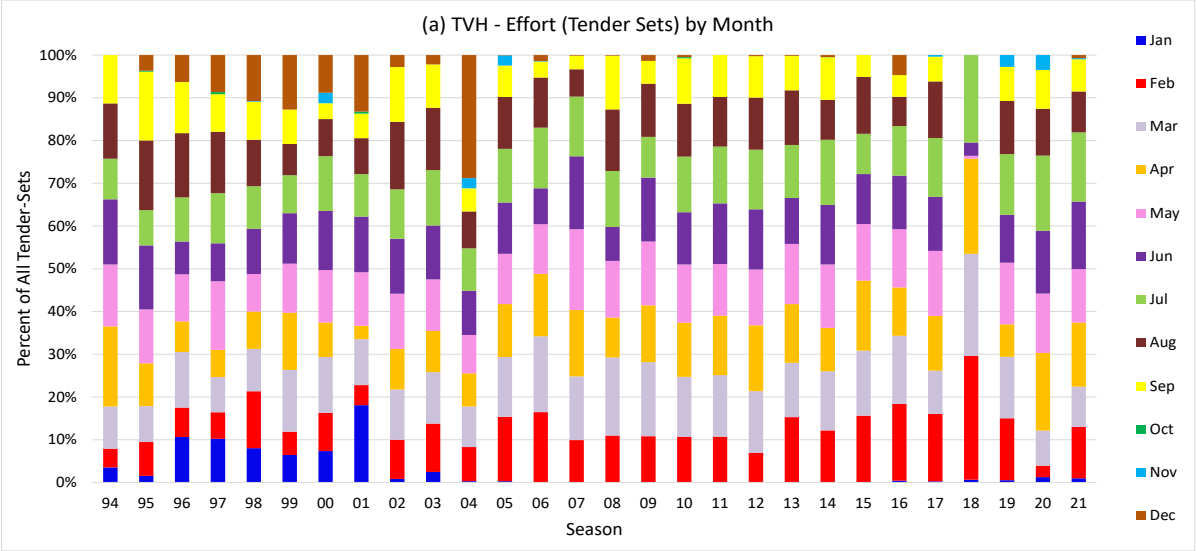
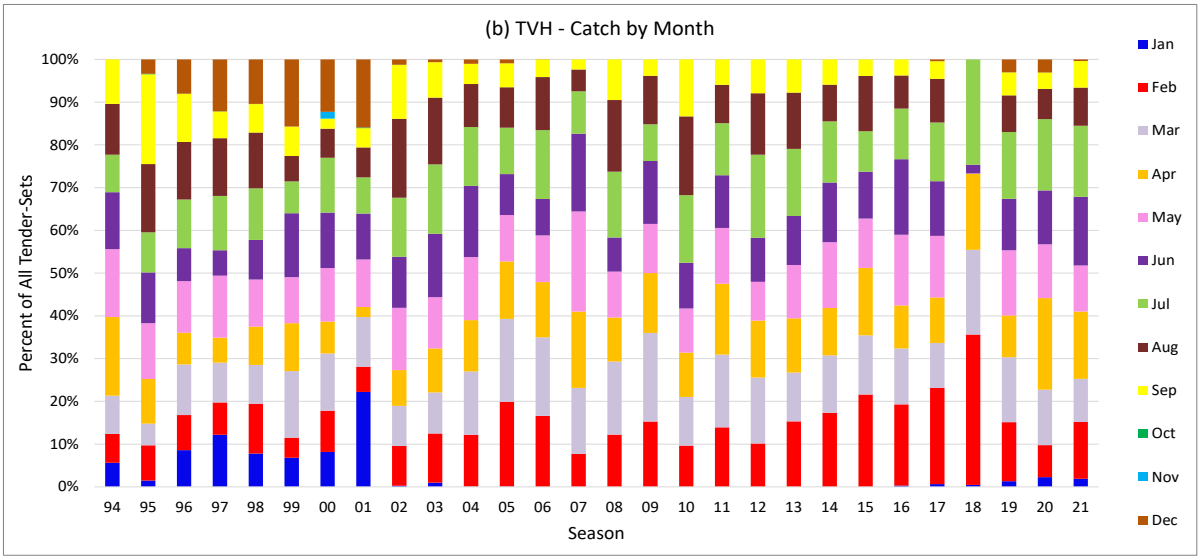


Figure 18. Seasonal time-series of (a) number of tender-sets, (b) total catch, and (c) nominal CPUE (kilograms per hour, based on records where effort between 0.5 and 12 hours and catch between 1 and 500kg) for the TVH fleet within each month.





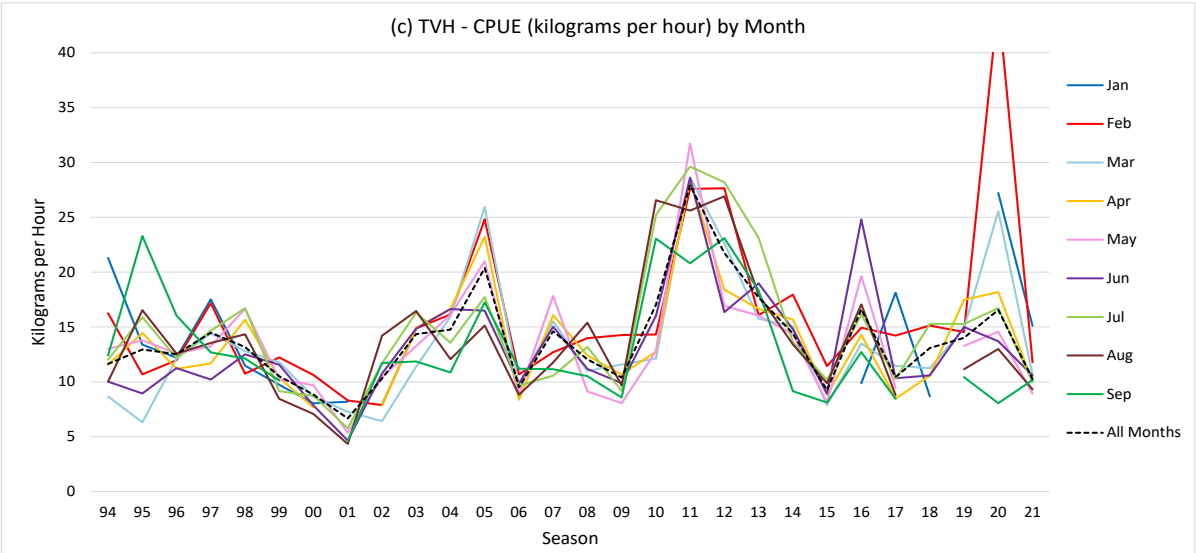


Figure 19. Seasonal time-series of (a) number of tender-sets, (b) the percent of tender sets and total TVH catch each season for which effort (hours fished) is not recorded, and (c) total hours fished (for sets where effort between 0.5 and 12 hours) for the TVH fleet within each Area.

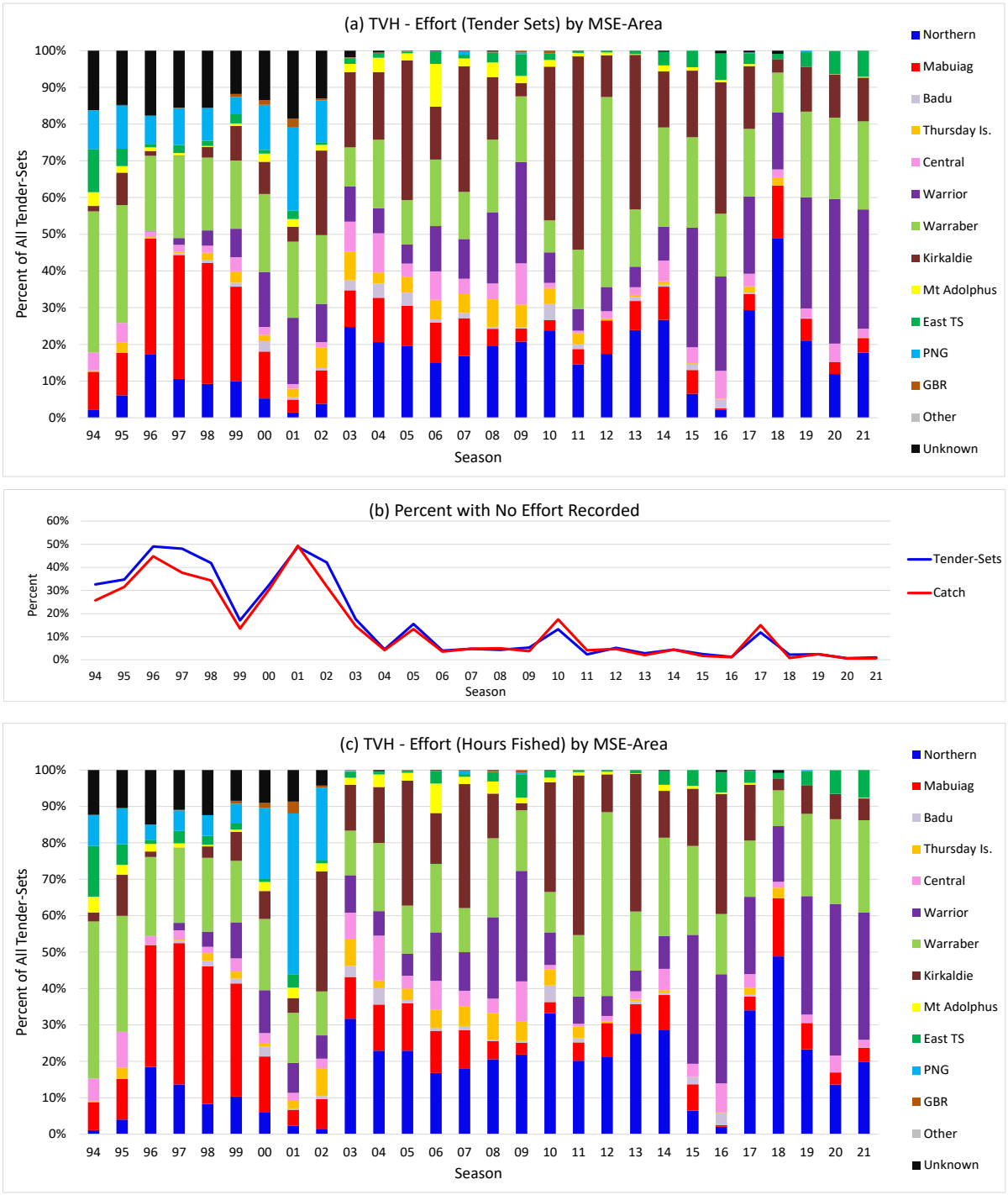
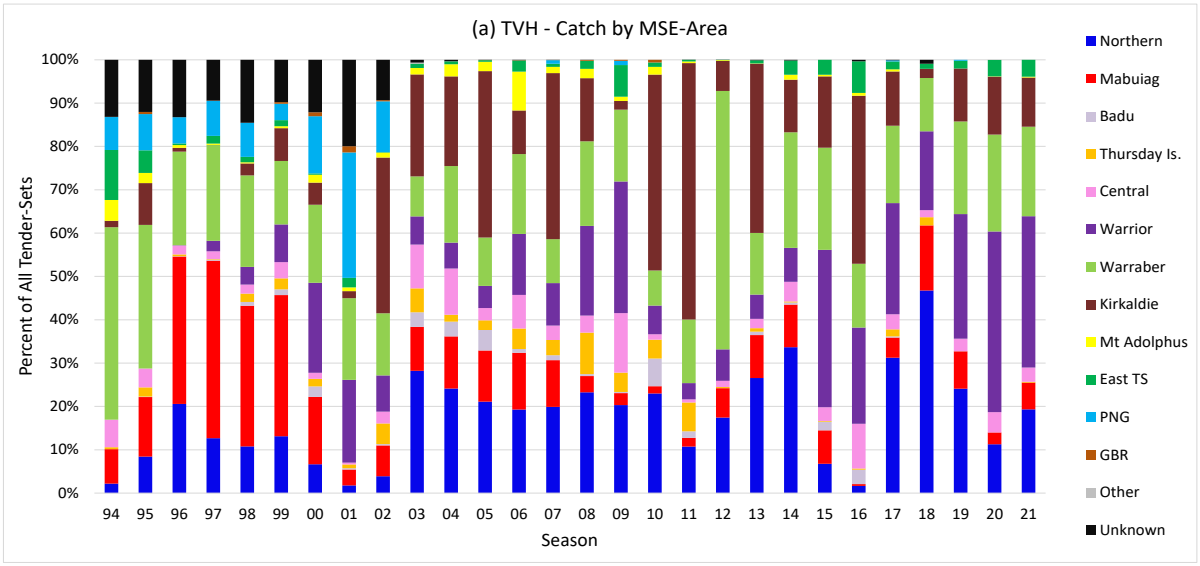
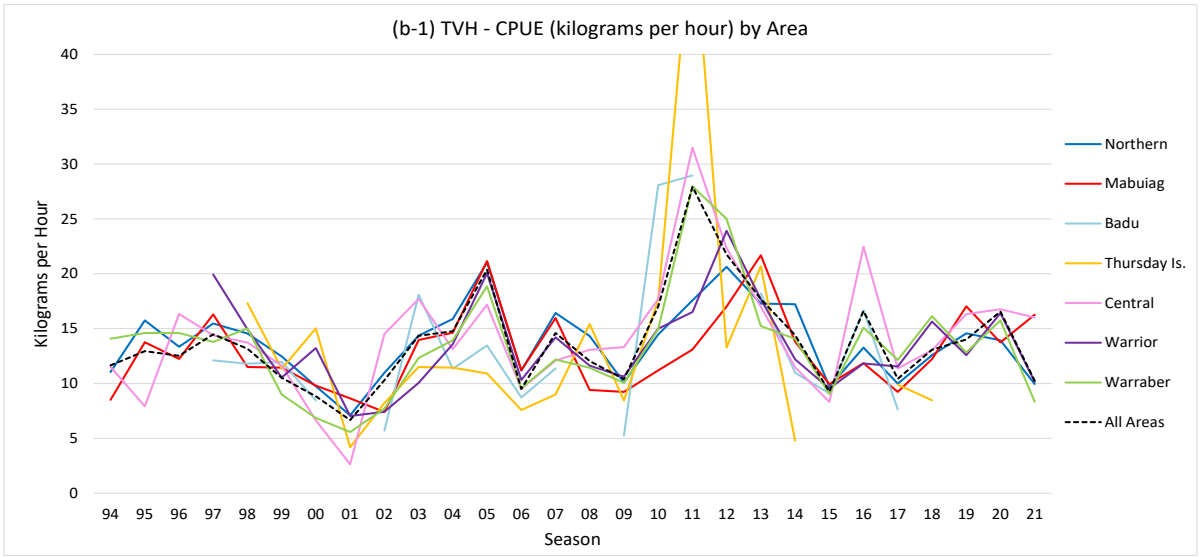
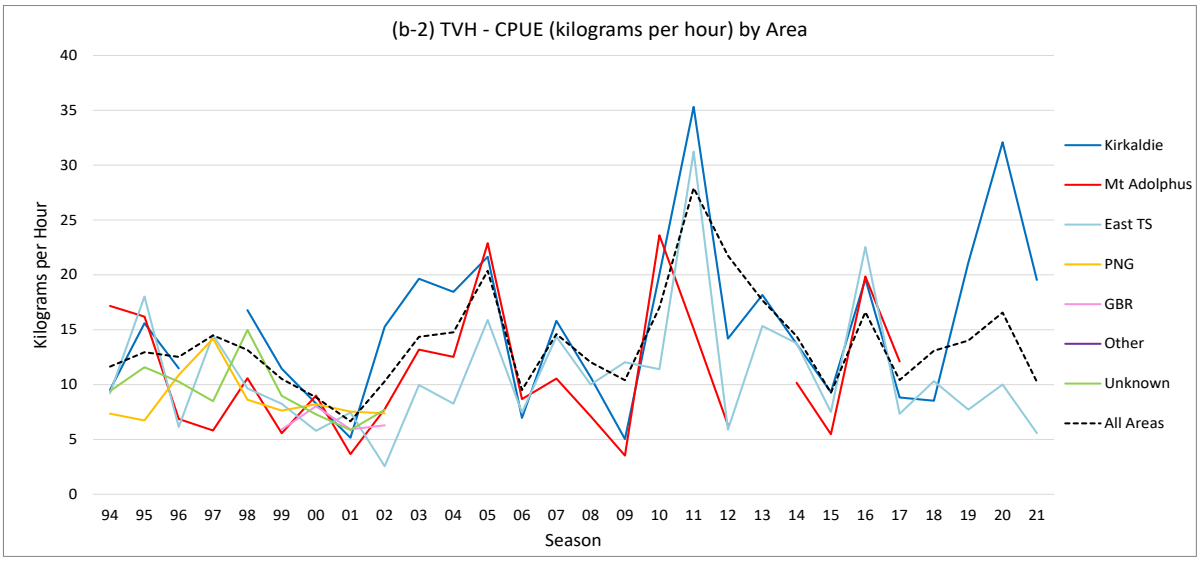


Figure 20. Seasonal time-series of (a) total catch, and (b) nominal CPUE (kilograms per hour, based on records where effort between 0.5 and 12 hours and catch between 1 and 500kg) for the TVH fleet within each Area.







References.

Campbell, R.A. (2017) Estimation of total annual effort in the Torres Strait Rock Lobster Fishery – 2017 Update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12- 13 December 2017, Cairns.

Campbell, R.A., Pease, D. 2017. Separating TIB, TVH and Processor catch records from Docket-Book Data. Report to AFMA – 2017 Update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12- 13 December 2017, Cairns.

Campbell, R.A. Plaganyi, E, Deng, R., 2017a. Use of TIB Docket-Book Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2017 update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12-13 December 2017, Cairns.

Campbell, R.A, Plaganyi, E., Deng, R., 2017b. Use of TVH Logbook Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2017 Update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12-13 December 2017, Cairns.

Campbell, R.A., Plaganyi, E., Deng, R., Tonks, M, Haywood, M. 2018. Torres Strait Rock Lobster Fishery – Summary of the Catch and Effort Data pertaining to the 2018 Fishing Season (Dec-17 to Apr-18). Information paper presented to the 23rd meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 15 May 2018, Cairns

Total Seasonal Effort and other Operational Characteristics in the Torres Strait Rock Lobster Fishery - 2021 Update

Robert Campbell, Steven Edgar, Eva Plaganyi, Laura Blamey, Nicole Murphy, Leo Dutra

December 2021

1. TVH Fishery

1.1 Data Summary

Catch and effort data for the TVH sector of the Torres Strait rock lobster fishery is recorded in the TRL04 Logbook. The structure of the data is shown in Figure 1. For each vessel-day there can be multiple shots (up to 4) with each shot consisting of several (up to 6) active tenders. Each tender has a catch recorded by diving method (hookah or free diving but sometimes not recorded) and the catch is recorded by processed form (whole or tailed but sometimes not recorded). The data was aggregated so that each data record refers to the catch and effort for a unique vessel-day, shot-number, tender and fishing method (to be referred to as a tender/method-set in this document). Between the 1994 and 2021 fishing seasons (where a season is from 1-December to 30-September the following year and is designated by the end year) there are a total of 75,273 tender/method-sets. The distribution of these records by season and month are given in Table 1. It is apparent that there has been little, if any, effort during October and January since 2006 season. The percent of total TVH catch each season caught by each fishing method, and the percent of the catch by processed state are shown in Figure 2.

Figure 1. Structure of the TVH data

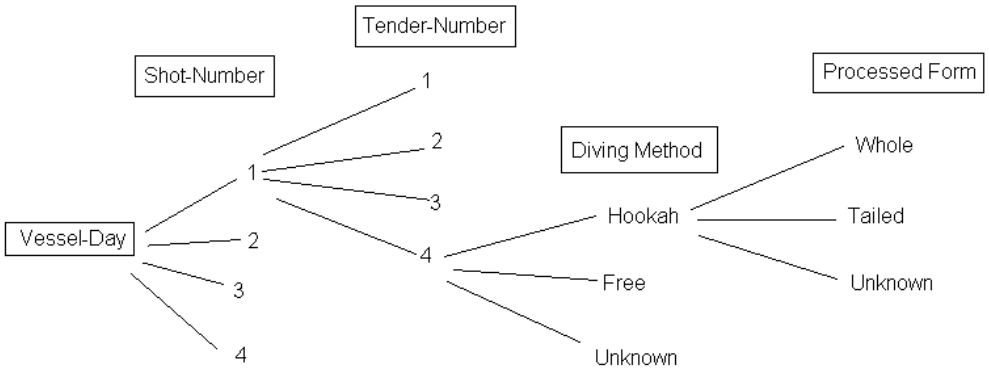


Figure 2. (a) The percent of total TVH catch each season caught by each fishing method, and (b) percent of total TVH catch each season by processed state.

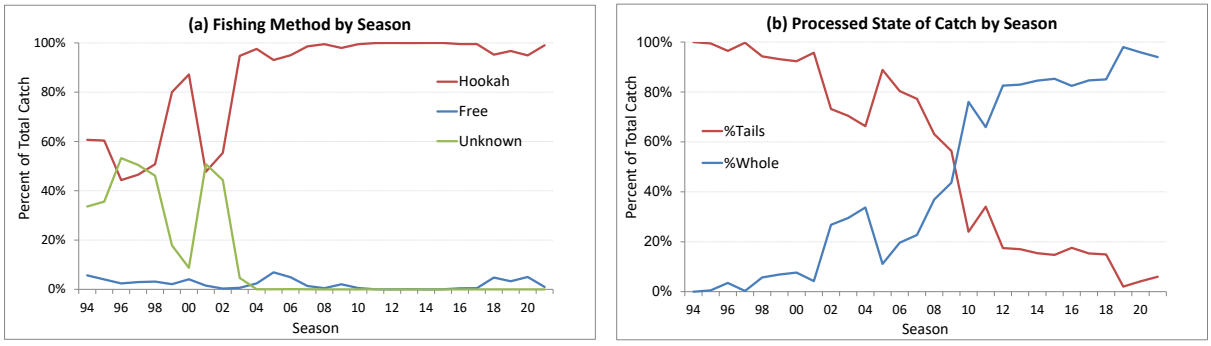


Table 1. Number of TVH tender/method-sets by season and month.

SEASON	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1994		84	105	236	448	347	364	227	310	270			2391
1995	54	23	116	123	147	185	220	121	239	238	3		1469
1996	220	366	237	447	247	378	264	356	517	411			3443
1997	324	383	232	307	239	599	333	438	538	328	18		3739
1998	598	445	739	551	485	487	587	553	603	493		9	5550
1999	231	117	98	262	242	208	214	161	132	146			1811
2000	235	196	240	349	215	328	370	342	232	99		66	2672
2001	274	375	97	223	65	259	270	206	174	119	9	1	2072
2002	87	26	285	365	295	401	400	360	492	398			3109
2003	89	100	461	488	393	490	518	527	596	413			4075
2004	176	24	587	697	571	662	761	729	633	395			5235
2005	106	13	662	615	543	519	527	552	533	323			4393
2006	4		410	437	361	286	207	349	289	92			2435
2007			288	427	446	542	489	402	184	91			2869
2008			133	222	113	161	96	159	175	152			1211
2009			148	227	174	201	200	125	163	70			1308
2010			255	333	302	324	292	309	294	253		6	2368
2011			286	384	371	322	380	354	310	261			2668
2012			166	344	368	311	336	333	291	231			2380
2013			461	383	414	424	324	374	385	243			3008
2014			357	404	297	433	408	445	274	291		1	2910
2015			419	408	441	355	313	253	357	137			2683
2016		12	500	444	315	379	349	323	191	141			2654
2017	9	7	397	254	322	383	318	346	333	146			2515
2018		10	436	360	335	10	47	308					1506
2019	54	10	277	275	145	275	214	272	237	152			1911
2020	44	16	34	104	230	176	186	223	139	115			1267
2021	4	16	196	154	245	204	258	265	156	123			1621
Total	2,509	2,223	8,622	9,823	8,769	9,649	9,245	9,412	8,777	6,131	30	83	75,273

Effort is recorded as “Hours-Fished” which records the duration of the fishing trip for each tender/method-set (i.e. the hours-fished is recorded by each tender separately for each method used). It remains unknown whether the effort recorded on the TRL04 logbook refers to time a tender is away from the mother-vessel or the actual diver time in the water. Indeed, different tenders/vessels may use different approaches.

Unfortunately, the fishing effort has not been completed for all tender/method-sets (c.f. Figure 3a), with the number of hours fished recorded for only 81.7% of all records, though this percentage varies between seasons (between a maximum of 49% in 1996 to a minimum of 0.6% in 2020). Since 2004 the percentage of records with unknown effort has generally been below five percent.

The distribution of hours fished for all tender/method-sets is shown in Figure 3b. The number of recorded hours fished was between 0.15 hours and 96 hours, though the majority were less than 12 hours. The mode of the recorded number of hours fished is seen to be 8 hours – however, whether this just corresponds to a standard “8-hour day’s work” or truly represents the number of hours fished remain uncertain. Recorded effort of four and six hours are also common. Of the 338 records where the hours fished was greater than 12, most (315) recorded 24 hours which was assumed to be a day’s fishing. All records where the hours-fished was greater than 12 hours were considered suspect due to possible recording errors and as such only those records where the hours-fished was 12 hours or less were included in the analysis. A further seven records where effort was less than 0.5 hours were also excluded.

To investigate whether the distribution of effort has changed over time, the distribution of hours fished for all tender/method-sets was calculated for each season and then the mean of these seasonal distributions was calculated for the following five season periods: 1994-1999, 2000-2004, 2005-2009, 2010-2014, 2015-2019. These mean distributions are shown in Figure 4 together with the seasonal distributions for the last two seasons (2020, 2021). There is an indication that the number of recorded hours fished has increased since the mid-1990s, with

Figure 3. (a) The total number of TVH catch records each season and the number of records for which the corresponding effort data is available (the percentage of records for which no effort is recorded is also shown on the right-hand axis), and (b) the distribution of effort ("hours fished") for all fishing operations between the 1994 and 2021 fishing seasons.

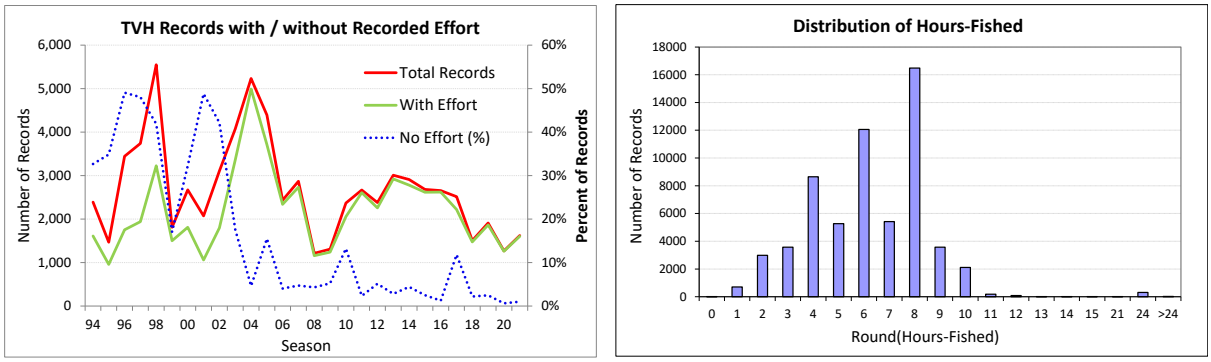
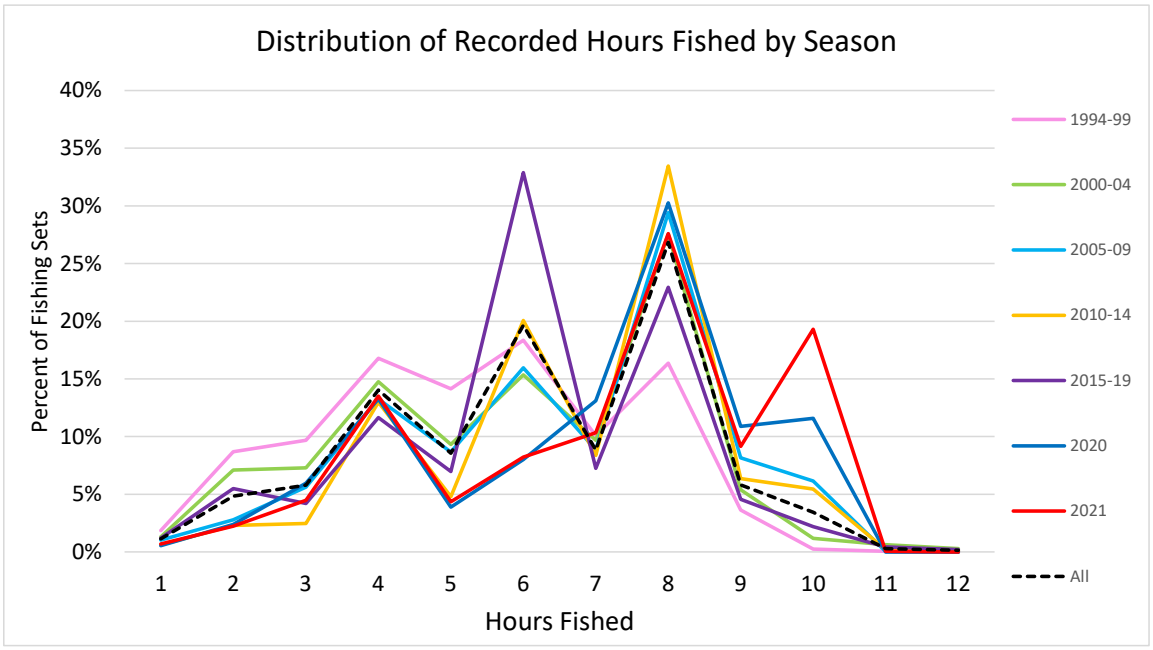


Figure 4. Mean distribution of effort ("hours fished") during various groups of fishing seasons.



the average effort increasing from 5.34 hours and 5.95 hours during the periods 1994-99 and 2000-04 respectively to 6.93 to 7.13 hours during 2020 and 2021 respectively. The average hours fished during the three additional periods between 2005 and 2019 was 6.48, 6.50 and 6.08 respectively.

1.2 Estimate of Seasonal Effort between 2004 to 2021

Given the above data preparation and filtering the following process was adopted for estimating the total effort each fishing season:

1. First, as the logbook requests that each tender record each method (free diving, hookah diving) used during a tender-set, with effort recorded separately for each method, the data was aggregated so that each tender-set record refers to the catch and effort for a unique vessel-day, shot-number and tender (to be known as a tender-set). The total effort for each tender-set was the sum of the effort for all methods. Between the 2004 and 2021 fishing seasons there are a total of 44,884 tender-sets Note, there were only 58 tender-sets where

more than one method and associated catches were recorded. For six of these tender-sets no effort was recorded for either method, while for eight tender-sets the effort was recorded for only one method. Due to the very small number of records (representing 0.03% of all tender-sets) where effort had not been fully recorded, this missing information was ignored in the following process.

2. Second, a seasonal listing of the number of tender-sets against the number of hours fished was prepared (c.f. Table 2a, Figure 5). Records listed against zero hours fished pertain to those where the effort was either not recorded or was outside the 0.5 to 12 hour band used. The percentage of such records varied between 0.99% for the 2021 season and 18.34% for the 2010 season. (and was 6.26% over all seasons). The total number of tender-sets for each season is also shown in this table.
3. Third, for those records where the hours-fished was recorded, the total number of hours fished for these tender-sets was totalled. This result is shown as the Total Hours in Table 2b.
4. Finally, to account for those records where the hours-fished was not recorded, the total calculated in the previous section was adjusted as follows:

$$Total\ Hours\ (Adj) = Total\ Hours * \frac{\sum_{i=0}^{12} NumberRecords_i}{\sum_{i=1}^{12} NumberRecords_i}$$

This assumes that the distribution of hours -fished for those records where effort was not recorded is similar to the distribution of hours-fished for those records where effort was recorded. Again, for each season this result is shown as the Total Hours -Adj in Table 2b.

The results of the above process are shown in Figure 6. Note that the final adjusted effort shown for each season (Total Hours-Adj) is only an estimate as it is difficult to know how accurate the recording of the effort at the tender/method level is in the logbook (noting the uncertainty previously mentioned as to what the recorded effort refers to: time away from the mother-vessel or time-in-the-water). Nevertheless, the trends in both the seasonal effort measured in hours fished or number of tender-sets are similar.

Figure 5. Estimates of TRL04 Logbook recorded and adjusted total number of hours fished and number of tender-sets for the TVH sector each fishing season.

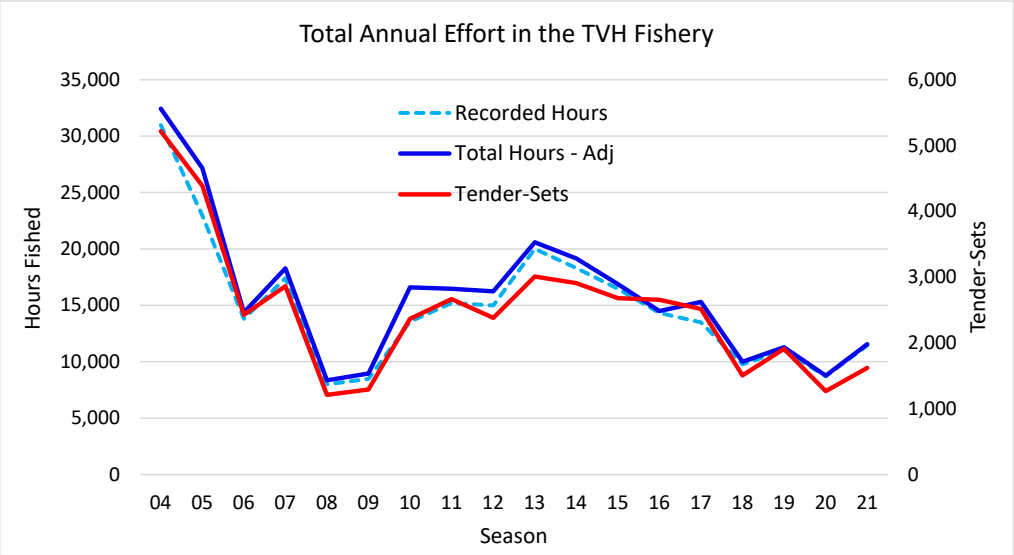


Table 2. Seasonal listing of (a) the number of TVH records against the number of hours fished – rounded to the nearest integer, and (b) unadjusted and adjusted total number of hours fished.

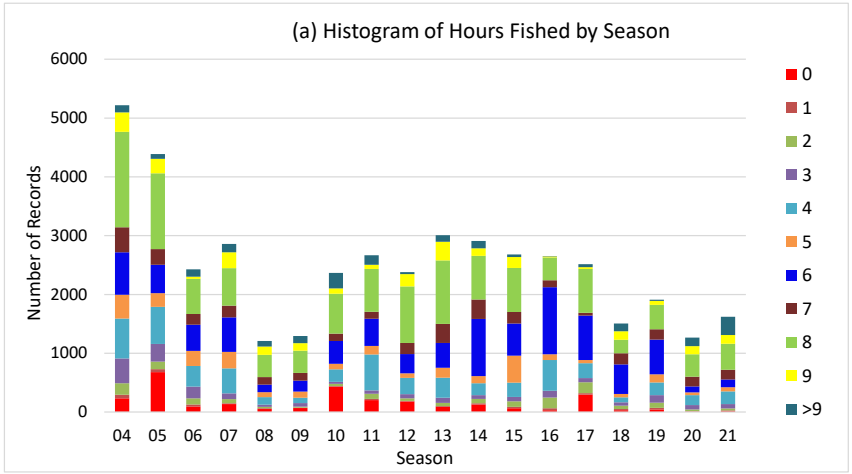
(a)

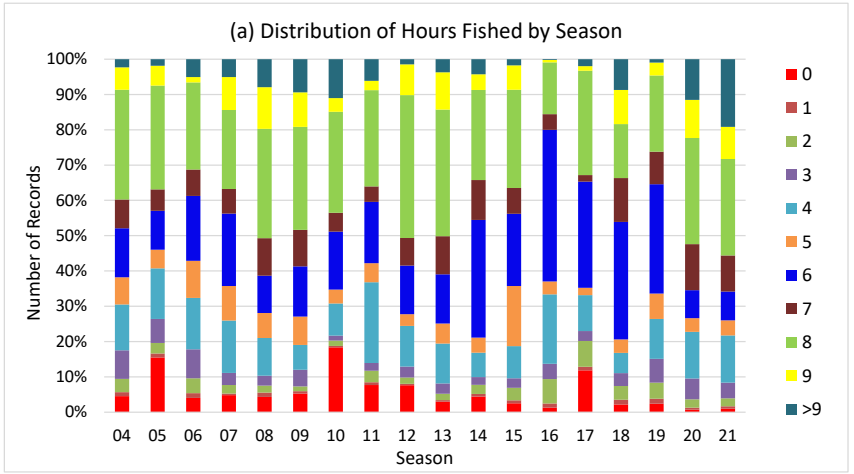
Hours-Fished	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Total
0	236	681	97	138	52	68	434	205	181	88	129	67	33	297	33	46	9	16	2,810
1	59	48	33	12	15	9	10	21	10	15	21	23	32	26	20	26	7	11	398
2	196	131	103	70	24	17	36	87	43	54	75	94	183	184	58	87	30	36	1,508
3	423	298	199	98	34	61	33	58	73	87	64	73	116	71	55	129	75	72	2,019
4	678	631	353	425	129	91	215	610	274	341	201	245	522	255	87	216	167	217	5,657
5	402	232	255	280	86	104	94	145	80	170	124	457	97	53	57	138	49	70	2,893
6	724	483	447	587	128	184	388	463	327	420	970	549	1140	757	502	591	101	132	8,893
7	426	266	181	199	129	134	126	117	187	324	329	195	118	46	187	177	165	166	3,472
8	1623	1291	599	640	375	377	677	728	963	1080	744	747	390	744	230	412	381	443	12,444
9	329	247	37	268	143	127	92	70	207	318	129	186	17	32	146	70	137	147	2,702
10	69	81	123	144	94	121	261	156	30	111	95	44	5	50	88	16	146	310	1,944
11	7	0	0	0	2	0	0	1	4	0	24	1	1	0	29	2	0	1	72
12	45	0	0	0	0	0	0	6	1	0	5	1	0	0	14	0	0	0	72
Total Tender-Sets	5,217	4,389	2,427	2,861	1,211	1,293	2,366	2,667	2,380	3,008	2,910	2,682	2,654	2,515	1,506	1,910	1,267	1,621	44,884
0.5 to 12 hours	4,981	3,708	2,330	2,723	1,159	1,225	1,932	2,462	2,199	2,920	2,781	2,615	2,621	2,218	1,473	1,864	1,258	1,605	42,074
% zero	4.52%	15.52%	4.00%	4.82%	4.29%	5.26%	18.34%	7.69%	7.61%	2.93%	4.43%	2.50%	1.24%	11.81%	2.19%	2.41%	0.71%	0.99%	6.26%

(b)

Total Hours	30,967	22,948	13,801	17,403	7,996	8,484	13,547	15,202	15,000	19,994	18,296	16,464	14,314	13,495	9,774	11,023	8,700	11,449	268,857
Total Hours - Adj	32,434	27,163	14,376	18,285	8,355	8,955	16,590	16,468	16,235	20,597	19,145	16,886	14,494	15,302	9,993	11,295	8,762	11,563	286,896

Figure 5. Distribution of TVH tender-sets against the number of hours fished for each fishing season by (a) number and (b) by percentage.



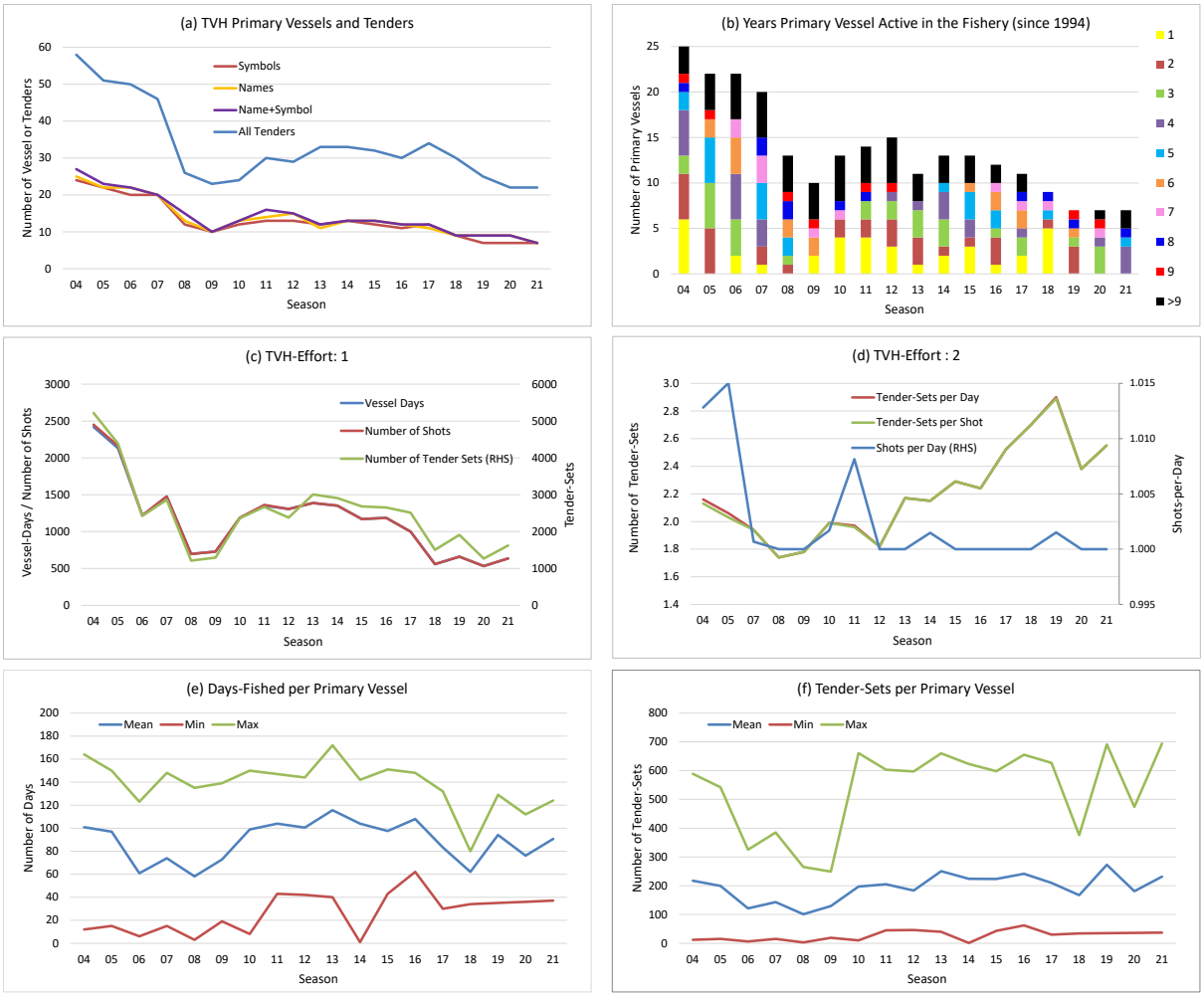


1.3 TVH Operational Characteristics

A range of other operational characteristics related to the TVH fishery are shown in Figure 7 for each season between 2004 and 2021. Note, unless otherwise stated each primary vessel has been distinguished by its vessel-symbol.

Figure 7. The following operational characteristics related to the TVH fishery are shown for each season between 2004 and 2021 (note, unless otherwise stated each primary vessel has been distinguished by its vessel-symbol):

a) Number of primary vessels (distinguished by either symbol, name or combination of both) and all tenders operating each season;
b) Histogram of the number of years that primary vessels (distinguished by vessel-name) have been active in the fishery between 1994 and 2021;
c) Total number of vessel-days, number of shots, and number of tender-sets per season;
d) Mean number of shots per day, tender-sets per day and tender-sets per shot;
e) Mean, minimum and maximum number of days fished per primary vessel;
f) Mean, minimum and maximum number of tender-sets fished per primary vessel;



2. TIB Fishery

2.1 Docket-book Coverage

The Buyers and Processors Docket-Book (TDB01) was used in the TIB sector of the Torres Strait rock lobster fishery up until the end of the 2017 fishing season while a new TDB02 Docket-Book (acting as the primary Catch-Disposal-Record, CDR, for the fishery) was introduced at the start of the 2018 fishing season in December 2017 and an electronic version of this logbook was introduced to the fishery in 2021. Both the TDB01 and TDB02 docket-books record the catch sold by fishers (known as sellers on the docket-book) at the end of a fishing trip. However, unlike the logbook for the TVH sector of fishery, which requires catch and effort data to be recorded for individual fishing operations related to each vessel tender, both the TDB01 and TDB02 docket-books require only aggregate catch and effort data to be recorded at the end of each trip. In particular, these docket-books record the transaction date, the name of the seller together with details of the catch (in weight) and for the TDB01 Docket-Book the price obtained. Additional information can also be provided regarding the vessel, the number of crew, the number of days fished and the fishing methods used. This information therefore provides a measure of both the catch and effort for a given seller (or fisher) during a fishing trip.

However, there were several issues associated with the TDB01 docket-book system which create problems with using this data for estimating the total catch and effort in the TIB fishery. These issues include:

i. The completion of the TDB01 docket-book was only voluntary,
ii. The fact that catches recorded in this docket-book could also be reported elsewhere, including the TVH logbook,
iii. The fact that processors could also record catches in the docket-book, essentially creating duplicates.

Given the duplication of catch information from both the TVH sector and processors which occurs in the TBD01 docket-book data, several filters are applied to this data to remove these duplicates. Further to these issues, during some seasons several TIB boats only recorded their catch in the TVH-related logbook (TRL04) and these catch records need to be transferred to the TIB database. Finally, between 2013 and 2016 several processors reported aggregate seasonal catch data as these catches were not being recorded in the TDB01 Docket-Book. Each processor reported the catch for tailed and whole lobsters separately, so that for each season two data records (one each for whole and tailed weights) were added to the Docket-Book data for each processor to account for these additional catches.

Considerable effort has gone into understanding the nature of both the TDB01 Docket-Book and TRL04 Logbook data so as to identify the catch records that should be assigned to the TIB fishery. A full description of the approach and data-rules used to identify and remove these duplicate records from the Docket-Book data is described in Campbell and Pease (2017).

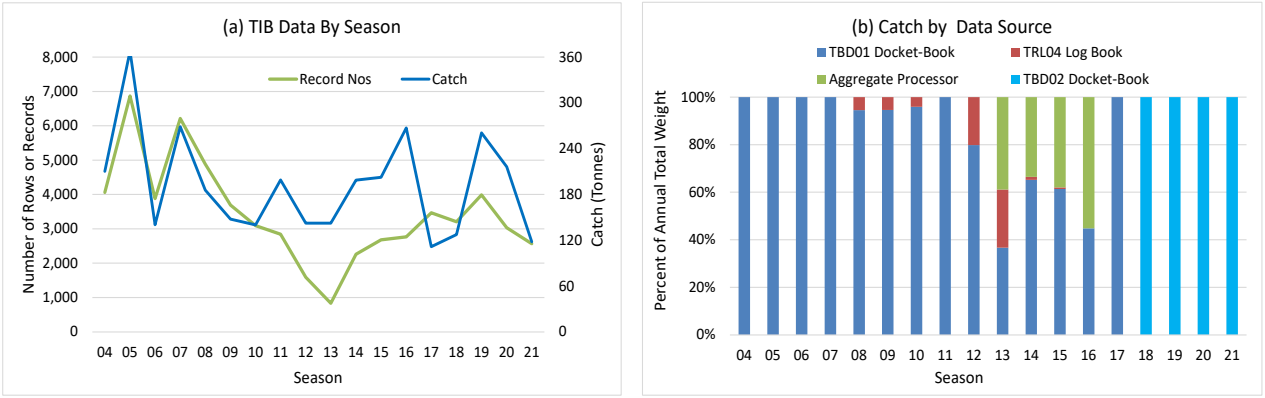
2.2 TIB Summary

A total of 61,926 Docket-Book and associated TVH and processor catch records have been attributed to the TIB fishery covering the seasons 2004 to 2021. A few Docket-Book records (37) having a zero catch of lobsters are not included in this total as it is assumed that other species may have been targeted on these trips.

Table 3. Number of distinct TIB Record Numbers by season and the related catch by data source. Note, PRC relates to the aggregate catch provided by several processors.

	N-Records				% Catch			
Season	TDB01	TDB02	TRL04	PRC	TDB01	TDB02	TRL04	PRC
2004	4,058	0	0	0	100.0%	0.0%	0.0%	0.0%
2005	6,867	0	0	0	100.0%	0.0%	0.0%	0.0%
2006	3,882	0	0	0	100.0%	0.0%	0.0%	0.0%
2007	6,212	0	0	0	100.0%	0.0%	0.0%	0.0%
2008	4,768	0	114	0	94.5%	0.0%	5.5%	0.0%
2009	3,596	0	95	0	94.6%	0.0%	5.4%	0.0%
2010	3,033	0	62	0	95.9%	0.0%	4.1%	0.0%
2011	2,845	0	0	0	100.0%	0.0%	0.0%	0.0%
2012	1,424	0	168	0	79.8%	0.0%	20.2%	0.0%
2013	649	0	183	2	36.7%	0.0%	24.5%	38.9%
2014	2,224	0	32	2	65.2%	0.0%	1.2%	33.5%
2015	2,652	0	25	2	61.4%	0.0%	0.7%	38.0%
2016	2,762	0	0	4	44.8%	0.0%	0.0%	55.2%
2017	3,469	0	0	0	100.0%	0.0%	0.0%	0.0%
2018	0	3,206	0	0	0.0%	100.0%	0.0%	0.0%
2019	0	3,990	0	0	0.0%	100.0%	0.0%	0.0%
2020	0	3,034	0	0	0.0%	100.0%	0.0%	0.0%
2021	0	2,566	0	0	0.0%	100.0%	0.0%	0.0%
	48,441	12,796	679	10				

Figure 6. Number of TIB data rows, distinct TIB Record Numbers, and associated catch (in tonnes) per fishing season.



2.3 Data Preparation

The catch and effort information recorded in each of the TDB01 and TDB02 Docket-Books is associated with a unique Record-No (i.e. the corresponding record number of the page on which the catch and effort data is recorded). While there are usually multiple catch records associated with a given Record-No (given that the catch is separately recorded by process form and perhaps grade), the structure of the docket-book would seem to indicate that there should be a unique Record-No for each vessel, date and seller-name. However, investigation of the data indicates that there are often multiple Record-Nos associated for a given vessel, date and seller-name. The reason for these multiple records remains unknown, but is likely to be due to mis-recording of the date (and possibly other data fields). Whatever the reason, for the following analysis it was assumed that the multiple records for some vessel, date and seller-names is due to the mis-reporting of the date, and that each Record-No indeed pertains to a separate trip for each seller.

Unlike the TVH data where the measure of effort is hours-fished, the measure of effort recorded in the Docket-Book data is coarser, being days-fished. Furthermore, and as noted above, it has been assumed that each Record-No relates to the catch and effort of a single fisher (or seller) during a given trip, i.e. it is assumed that the measure of effort (days fished) associated with each Record-No also pertains to the actual effort expended by that seller in obtaining the recorded catch.

For the TIB attributed catch not-recorded in the Docket-Book there is no corresponding effort information in days fished. However, the TRL04 Logbook allows for fishing effort to be recorded as the number of hours fished. For the 679 TRL04 Logbook records attributed to the TIB sector between 2004 and 2015 the hours fished varied between 1 and 11 with a mode at 6 hours (43% of records). If one considers these fishing efforts correspond to a single day's fishing then one could set the effort equal to one day for all these records. However, a comparison of the seasonal CPUE (kg/day) between these logbook records with the CPUE for records in the Docket-Book (where days-fished is also 1) indicates that the former are, on average, three times higher. This indicates that the nature of the operations for these larger TIB vessels is substantially different from those of the typical TIB vessel. For example, more than one tender is often associated with each catch Record for the larger vessels recording their catch on the TRL04 Logbook. As such, for the following analysis the effort for these Records was assumed to remain unknown. Similarly, the number of days fished to attribute to the aggregate seasonal catch data provided by the processors also remains unknown.

2.4 Estimate of Seasonal Effort

As with the TVH data, in order to account for the under-reporting of effort relating to all trips in the TIB database, the following process was adopted for estimating the total seasonal effort:

1. First, a seasonal listing of the number of 61,237 TIB Records included in the TDB01& TDB02 Docket-Books against the number of days fished was prepared (c.f. Table 4). Note: trips of duration greater than 2-3 days have been recorded and whether these are correct remains uncertain. The associated histogram of the number of days fished is shown in Figure 7.
2. Due to the voluntary nature of recording effort data, the number of days-fished per trip is not available for 9,244 data records. For the 52,707 records where the days-fished has been recorded the total number of days fished was calculated as follows:

Table 4. (a) Seasonal listing of the number of Docket-Book Records against the number of days fished. (b). Unadjusted and adjusted total number of days fished each season.

(a)

Days-Fished	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Total
0	685	387	321	458	92	112	4	200	215	563	466	647	751	672	919	1204	1070	478	9244
1	2744	5563	3012	5049	4248	3009	2770	2381	1049	258	1301	1512	1611	2659	1680	1968	1575	1706	44095
2	325	422	259	421	317	279	151	78	117	7	216	213	191	66	300	432	213	200	4207
3	119	204	145	137	123	124	113	59	68	1	116	159	105	31	184	245	112	133	2178
4	85	101	60	49	39	66	29	44	42	2	70	59	36	13	62	65	22	26	870
5	52	101	51	67	39	51	13	32	25	1	39	49	17	17	34	39	13	9	649
6	10	43	3	6	8	13	3	23	36	0	13	12	12	4	9	9	7	2	213
7	12	27	14	7	9	17	10	12	16	0	21	14	10	5	2	5	13	9	203
8	12	10	9	8	4	5	2	7	10	0	13	9	6	0	2	3	2	0	102
9	12	5	2	2	0	0	0	3	5	0	5	10	23	2	3	3	1	0	76
10	2	5	3	3	1	7	1	8	2	0	0	0	0	0	0	2	1	0	35
11	3	0	0	0	3	5	1	1	7	0	0	0	0	0	0	2	0	1	23
12	0	4	1	1	0	2	0	0	0	0	0	0	0	0	0	3	1	0	12
13	4	1	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	9
14	2	1	1	1	0	0	0	1	0	0	0	0	0	0	7	2	2	2	19
15	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	4
16	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Total Records	4,067	6,874	3,885	6,212	4,883	3,691	3,097	2,849	1,592	832	2,260	2,684	2,762	3,469	3,205	3,987	3,032	2,566	61,951

(b)

Total Days (D>0)	4,832	8,625	4,783	7,097	5,788	4,859	3,717	3,460	2,330	288	2,930	3,228	2,934	3,098	3,516	4,344	2,698	2,768	71,295
Total Catch (D>0)	162726	340524	124236	219368	180495	139055	139197	172191	119033	37350	98865	86498	97491	93901	96923	162642	119879	89099	2,479,473
Total Days - Adj1	6,247	9,311	5,407	8,693	5,954	5,165	3,739	4,000	2,787	672	3,915	4,691	3,604	3,679	4,622	6,961	4,866	3,671	87,984
Associated Catch	210,383	367,615	140,451	268,689	185,665	147,814	140,039	199,061	142,379	87,111	132,114	125,702	119,755	111,504	127,415	260,615	216,188	118,170	3,100,670
Total Catch	210,383	367,615	140,451	268,689	185,665	147,814	140,039	199,061	142,379	120,979	176,420	173,415	185,825	111,504	127,415	260,615	216,188	118,170	3,292,627
Total Days -Adj2	6,247	9,311	5,407	8,693	5,954	5,165	3,739	4,000	2,787	933	5,228	6,472	5,592	3,679	4,622	6,961	4,866	3,671	93,327

$$Total\ Days = \sum_{i=1}^{20} Number\_Records_i * Days\_Fished_i$$

For each season this result is shown as the Total Days in Table 5b.

3. To account for the 9,244 records where the days-fished had not been recorded, the total calculated in the previous section was pro-rated as follows:

$$Total\ Days\ (Adj1) = Total\ Days * \frac{\sum_{i=0}^{20} Number\_Records_i}{\sum_{i=1}^{20} Number\_Records_i}$$

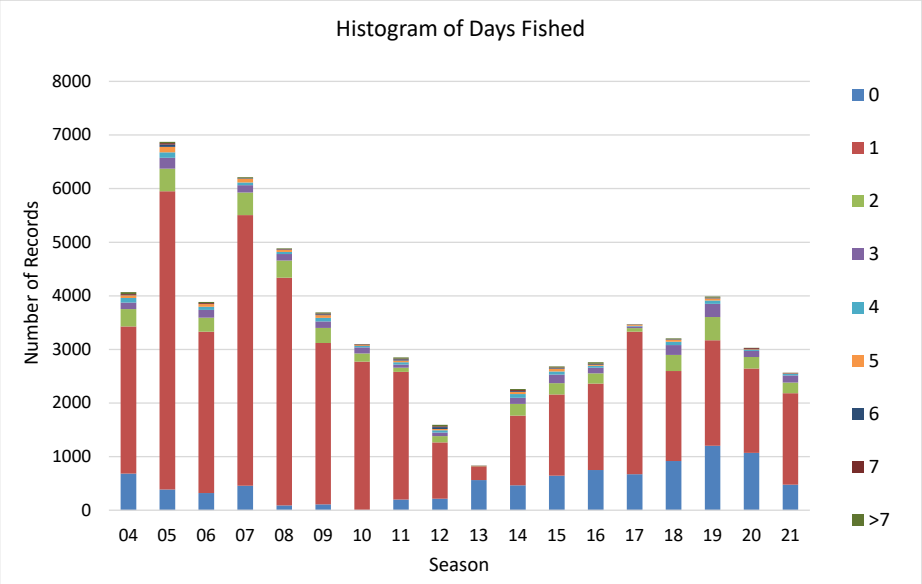
This assumes that the distribution of days-fished for those Docket-Book records where effort was not recorded is similar to the distribution of days-fished for those records where effort was recorded. Again, for each season this result is shown as the Total Days-Adj1 in Table 5b.

4. Finally, to account to the effort associated with those catches which had not been recorded in the TDB01 Docket-Book (i.e. those catches recorded in the TRL04 Logbook or provided in aggregate form for some seasons by processors), a final estimate of the total number of days fished each season was calculated as follows:

$$Total\ Days\ (Adj2) = Total\ Days(Adj1) * \frac{Total\ TIB\ Catch}{Effort\ Associated\ Catch}$$

where *Effort Associated Catch* relates to the total catch pertaining to the 55,617 Docket-Book records included in Step 1. Again, this assumes that for catches not recorded in the Docket-Book the relationship between catch and effort is similar to those catches recorded in the Docket-Book. The result is shown as the Total Days-Adj2 in Table 5b.

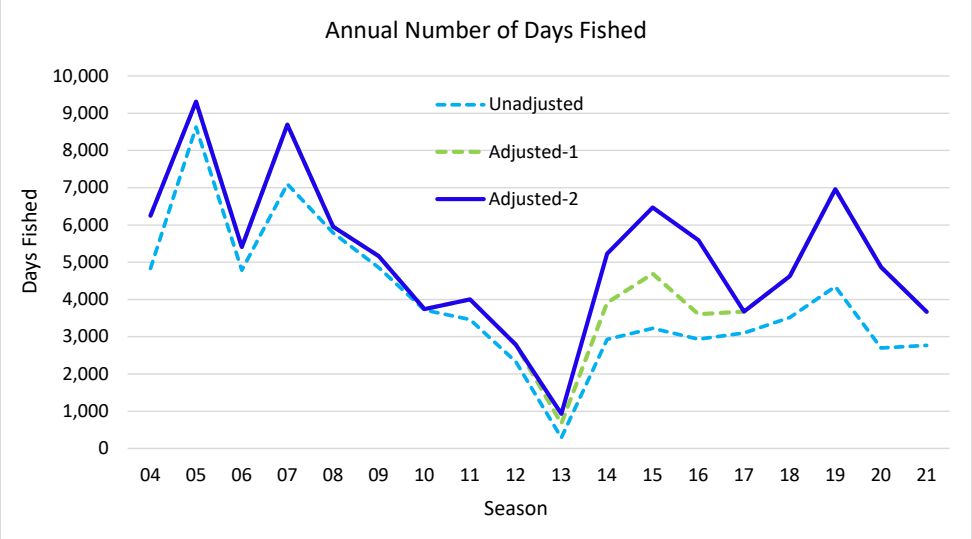
Figure 7. Histogram of the number of days fished for TIB related records each season.



The results of the above analyses are shown in Figure 8. Note that the final adjusted effort shown for each season (Total Days-Adj2) is only an estimate and it is difficult to know how accurate this estimate is for each season. For example, the relatively low effort estimate for 2013 is no doubt influenced by the small amount of data available for that season – only 269 Docket-Book records had effort recorded, while the high efforts estimated for the seasons 2014

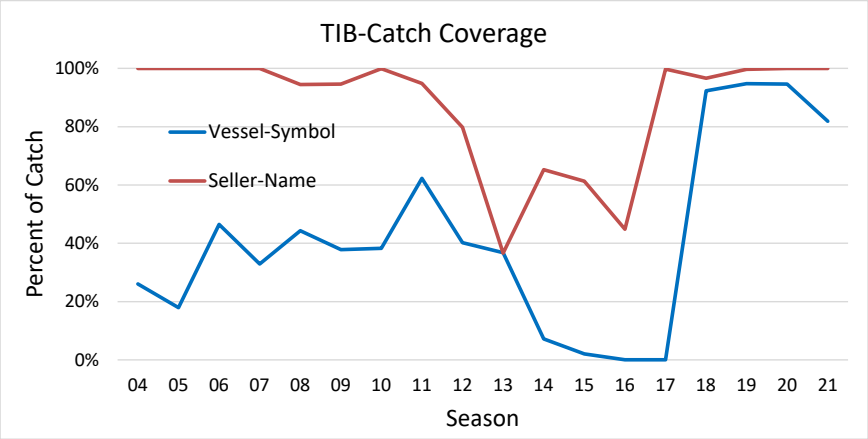
to 2016 are influenced by the high proportion (33 to 55%) of the catch provided in aggregate form (again for which no effort information was available). Finally, the time-series of seasonal effort is premised on the total TIB catch data being adequately captured by various formats (TDB01 & TDB02 Docket-books, TRL04 Logbook, processors) and if this data is not complete given the caveats on the data mentioned previously then this this will impact on the estimate of total effort for each season.

Figure 8. Estimates of unadjusted and adjusted total number of days fished each fishing season in the TIB sector.



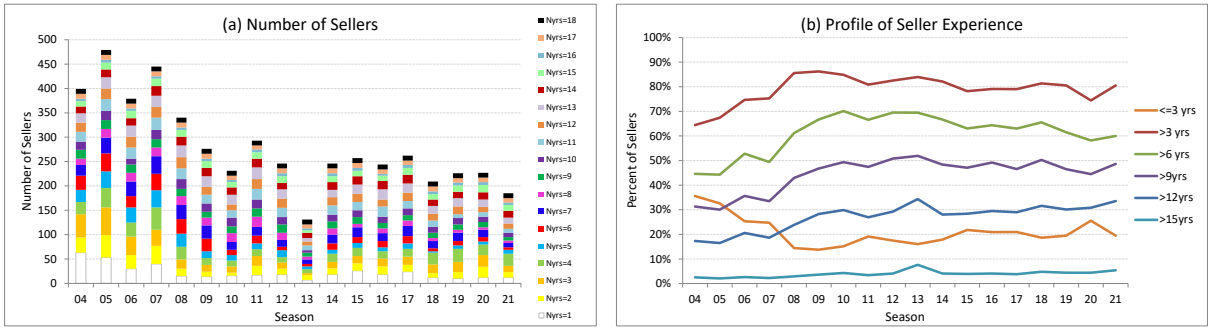
2.5 Seller Catch and Effort Profiles

Figure 9. Percentage of the total TIB catch each year for which either the Vessel-symbol or Seller-name were available.



The number of unique Seller-names listed in the TIB database, by season, is shown in Figure 10a. The number of Sellers varies between a maximum of 479 in 2005 and a minimum of 131 in 2013. However, the number of Sellers is likely to be higher, perhaps considerably, in those seasons where no Seller-names can be apportioned to substantial portion of the catch (such as between 2013 and 2016, c.f. Figure 9). The number of seasons that each Seller is listed in the TIB database between 2004 and 2021 was also ascertained to determine the experience of each Seller over this period. The profile of experience of all Sellers each season is shown in Figure 10a while the percentage of all Sellers each season with a given level of seasonal experience is shown in Figure 10b. This latter figure indicates that the percentage of Sellers each season with more than 6 seasons experience has varied from around 70% between 2010 and 2013 but has decreased in recent seasons to around 60%. Since 2011 around 20% of Sellers have had only three seasons or less experience.

Figure 10. (a) Number of unique Seller-names listed in the TIB database, by season, stratified by the number of seasons each Seller fished in the fishery between 2004 and 2021, and (b) seasonal profile of Seller experience.



The profile of the number of Sellers with a given level of seasonal experience in the TIB fishery between 2004 and 2021 is shown in Figure 11a. Also shown is the percentage of the total catch taken over this period by all Sellers with each level of seasonal experience. The 442 Sellers with only a single season of experience (37% of all Sellers) have combined caught 3.1% of the total catch between 2004 and 2021, while the 12 Sellers with 16 seasons of experience have combined caught 8.7% of this total catch. The highest percentage of the total catch (15.3%) has been caught by the 30 fishers with 12 seasons of experience.

For each Seller the average catch over all seasons fished was calculated. The minimum, mean and maximum of these catches for each level of fisher experience is shown in Figure 11b. The results indicate that the mean seasonal catch for Sellers increases with Seller experience, increasing from 188 kilograms for those Sellers with only one season of experience to 1200 kilograms for Sellers with 16 seasons of experience. There is also a general increase in the minimum seasonal catch with Seller experience. On the other hand, the maximum seasonal catch does not show any trend with Seller experience, though displays a high degree of variation (with the highest value greater than 8 tonnes).

Figure 11. (a) Profile of the number of Sellers having fished a given number of seasons in the TIB fishery between 2004 and 2021, together with the percentage of the total catch taken over this period by all Sellers with each level of experience, and (b) the mean, minimum and maximum of the average seasonal catch taken by Sellers for each level of experience.

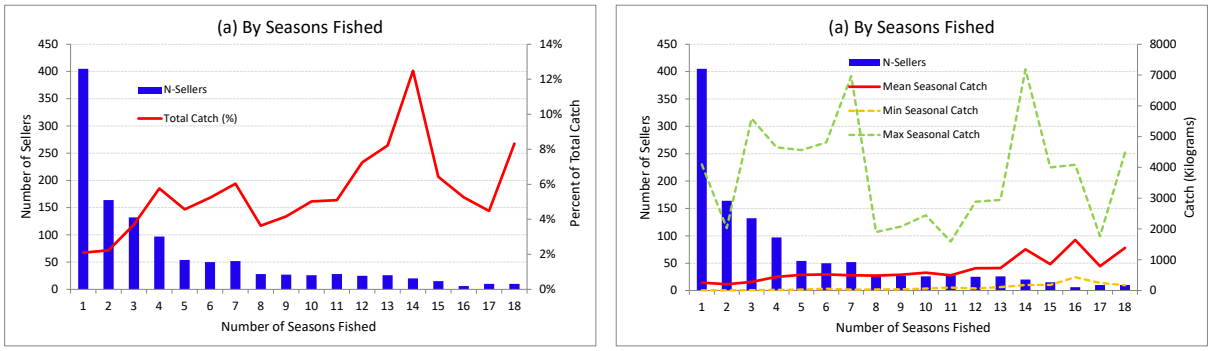
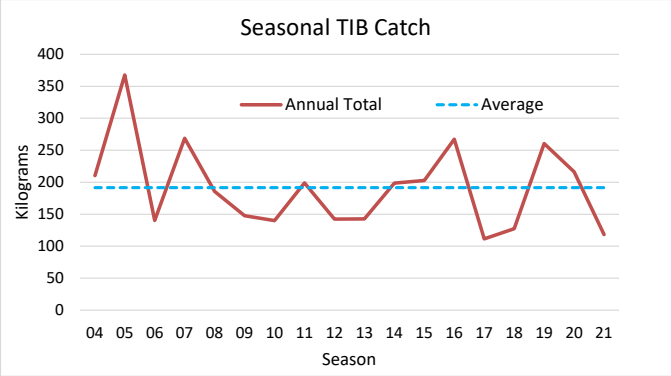
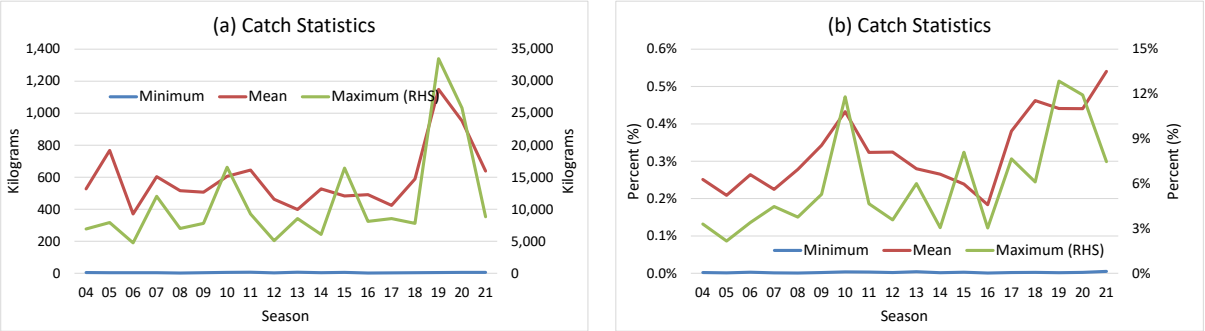


Figure 12. Total seasonal TIB catch between 2004 and 2021 together with the average seasonal catch over this period.



The total seasonal catch for the TIB sector between 2004 and 2021 is shown in Figure 12 together with the average catch taken over this period. The total TIB catch was below this long-term average between 2017 and 2018 (by 42% to 34% respectively) but increased substantially in 2019 to be 36% above the long-term average. The mean, minimum and maximum of the catches taken by all listed Sellers within each season is shown in Figure 13a, while the mean, minimum and maximum percentage of the total catch each season taken by Sellers is shown in Figure 13b. For all seasons the minimum reported catch taken by any Seller has been less than 7kg (varying between 1.34 kg to 6.67 kg), while the mean Seller catch varied between 371 kg in 2006 and 768 kg in 2005 before increasing substantially to 1,149 kg in 2019. However, the mean catch as a proportion of the total catch in each season does not shown this increase in 2019 (instead a small decrease from 0.46% in 2018 to 0.44%). The maximum catch taken by any Seller in a season varied between 4,673 kg in 2006 and 16,549 kg in 2010 before also

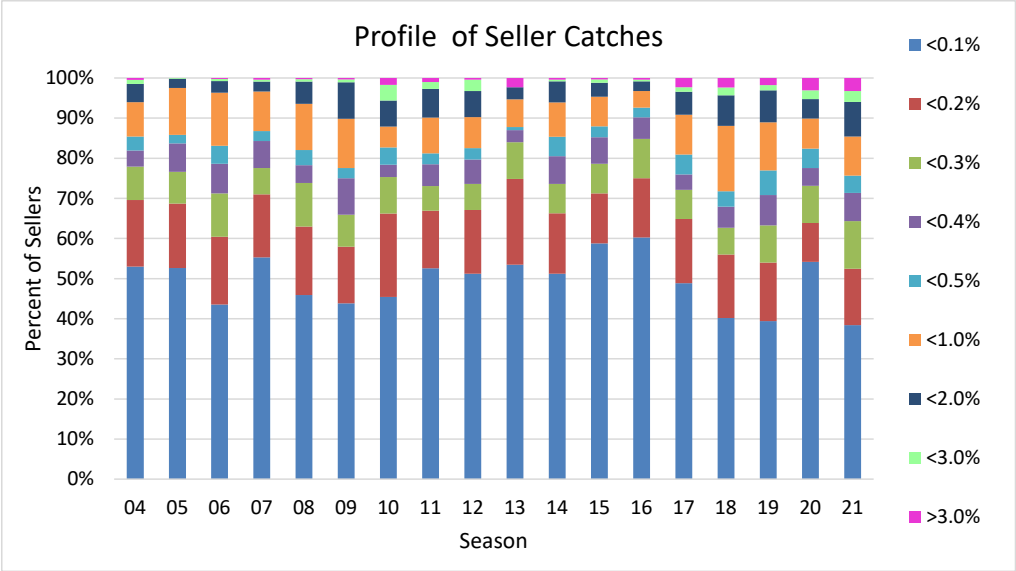
Figure 13. (a) The mean, minimum and maximum of the catch taken by all listed Sellers within each season, and (b) the mean, minimum and maximum percentage of the total catch each season taken by Sellers.



increasing substantially to 33,518 kg in 2019, but as a proportion of the total catch this maximum catch in 2019 is like that also observed in 2010 and 2020 (around 12%).

The seasonal profile of the percentage of Sellers with a catch that is within a given percentile bin of the total catch for that season is shown in Figure 14. The largest proportion of the total catch each season (varying between 38% in 2021 and 55% in 2007; average of 49% over all seasons) is seen to be taken by Sellers each of which have a catch that is less than 0.1% of the total catch. On the other hand, the percentage of Sellers each season with a catch greater than or equal to 3-percent of the total catch is very small, varying between zero in 2005 and 2.4% in 2018, but has been above 3% for the past two seasons.

Figure 14. Seasonal profile of the percentage of Sellers with a catch that is within a given percentile bin of the total catch for that season (note <0.2 mean a catch that is within 0.1% and 0.2% of the total seasonal catch, etc).



Finally, the catches taken by each Seller each season were categorised into the following three Catch-Types: 1) Catch < 50 kg

3) Catch > 1000 kg

and the profile of Catch-Types for each season is shown in Figure 15a. It is seen that in 2019 there was a substantial increase in the proportion of Sellers (31%) that had a catch greater than 1000 kg compared to recent years, and this proportion is greater than that previously reported in any season since 2004 (varying between 7.6% in 2013 and 25% in 2005). A unique Seller - Type was also determined for each of the 1,174 Sellers listed as a TIB fisher between 2014 and 2021 based on the average of the reported catches taken by each Seller across each all seasons.

Seller-Type
1) Average catch across all seasons fished < 50 kg
2) Average catch across all seasons fished between 50kg and 1000 kg
3) Average catch across all seasons fished > 1000 kg

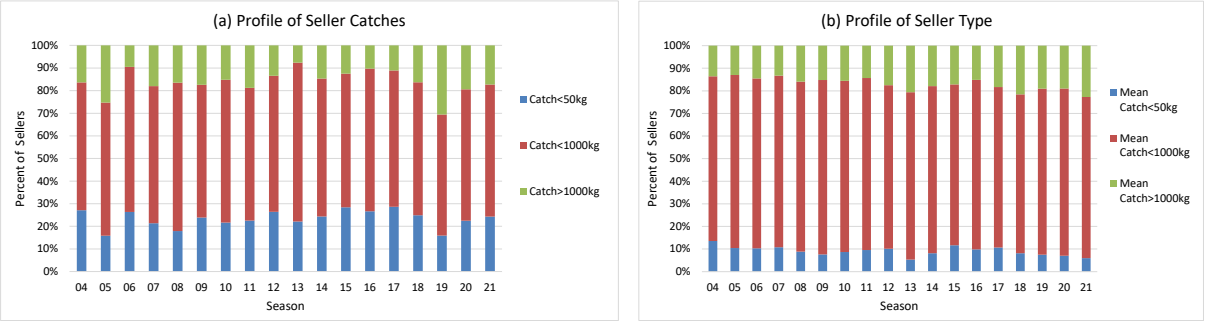
The number (and proportion) of all Sellers within each Seller-Type was:

Seller-Type		
	1) 310 (26.4%)	1) 268 (87% of all Type 1 Sellers)
	2) 769 (65.5%)	2) 304 (40% of all Type 2 Sellers)
	3) 95 (8.1%)	3) 19 (20% of all Type 3 Sellers)

The number of Sellers for which the Catch-Type was the same each season and hence equal to the Seller-Type is also shown in the second column of results above.

The profile of Seller-Types for each season is shown in Figure 15b. The proportion of Type 1 Sellers (average catch < 50 kg) displays a decreasing trend over period shown, varying between 13.6% in 2004 and 5.9% in 2021 and having an average of 9.1% over all 18 seasons. On the other hand, there is an increasing trend in the proportion of Type-3 Sellers (average catch >1000 kg) over the seasons, increasing from around 13% in 2004-05 to between 19% and 23% in the four most recent seasons (being highest in 2021).

Figure 15. The seasonal profile of the percentage of Sellers within each Seller-Type as defined in the text.



Campbell, R.A., Pease, D. 2017. Separating TIB, TVH and Processor catch records from Docket-Book Data. Report to AFMA – 2017 Update. Information paper to be presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12-13 December 2017, Cairns.

Appendix A. Seasonal Catch-Per-Unit-Effort

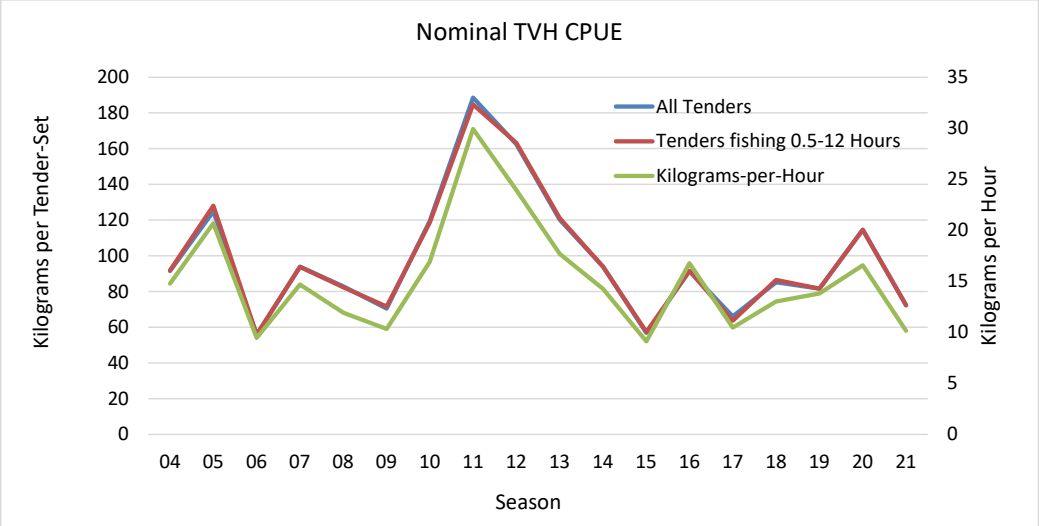
A. TVH Sector

Effort in the TVH-sector is recorded as hours fished by a tender during each set. As indicated in Table 2 the hours fished for the majority of tender sets (93.1%) are between 0.5 and 12 hours, while the hours fished is not recorded for 6.9% of tender sets. The effort recorded for the remainder of tender sets (<0.5 or >12 hours) is considered not reliable. The seasonal total number of tender sets, associated catch and corresponding catch-per-unit-effort (CPUE) for (a) all tender-sets and (b) those where effort is between 0.5 and 12 hours is listed in Table A1 while the CPUE for each of the data sets is displayed in Figure A1.

Table A1. (a) Seasonal total number of tender-sets, associated catch (kilograms) and corresponding CPUE (kilograms per tender-set) for all TVH tender sets, and (b) seasonal total number of tender-sets, associated hours fished and catch (kilograms) and corresponding CPUE (kilograms per tender-set) and kilograms per hour fished for TVH tender sets where effort is between 0.5 and 12 hours.

	(a) All Sets				(b) Sets fishing 0.5-12 Hours				
Season	N-sets	Hours	Catch	CPUE	N-sets	Hours	Catch	CPUE	Kg/hour
04	4,991	30967	457,481	91.7	4,991	30,967	457,481	91.7	14.8
05	3,711	22948	474,808	127.9	3,711	22,948	474,808	127.9	20.7
06	2,336	13801	130,471	55.9	2,336	13,801	130,471	55.9	9.5
07	2,731	17403	255,498	93.6	2,731	17,403	255,498	93.6	14.7
08	1,159	7996	95,452	82.4	1,159	7,996	95,452	82.4	11.9
09	1,240	8484	87,701	70.7	1,240	8,484	87,701	70.7	10.3
10	1,933	13547	229,055	118.5	1,933	13,547	229,055	118.5	16.9
11	2,463	15202	454,980	184.7	2,463	15,202	454,980	184.7	29.9
12	2,199	15000	359,004	163.3	2,199	15,000	359,004	163.3	23.9
13	2,920	19994	353,786	121.2	2,920	19,994	353,786	121.2	17.7
14	2,781	18296	261,091	93.9	2,781	18,296	261,091	93.9	14.3
15	2,615	16464	150,147	57.4	2,615	16,464	150,147	57.4	9.1
16	2,621	14314	240,229	91.7	2,621	14,314	240,229	91.7	16.8
17	2,218	13495	141,278	63.7	2,218	13,495	141,278	63.7	10.5
18	1,473	9774	127,373	86.5	1,473	9,774	127,373	86.5	13.0
19	1,864	11023	152,050	81.6	1,864	11,023	152,050	81.6	13.8

Figure A1. Seasonal CPUE (kilograms per tender-set and kilograms per hour) for (a) all TVH tender sets and (b) tender sets where effort is between 0.5 and 12 hours.



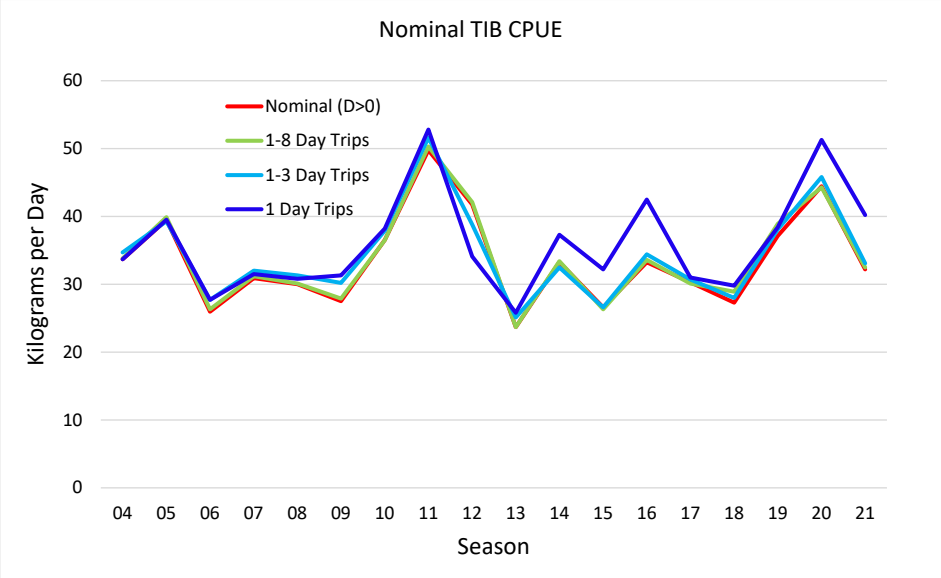
B. TIB Sector

Effort in the TIB-sector is recorded as the length of each fishing trip in days fished. As indicated in Table 5 fishing trips of up to 20 days have been recorded in the TIB docket-book, though the majority of trips (72%) are recorded as having a length of only one day. Whether or not the effort for trips having a long duration is recorded correctly remains unknown. The seasonal total number of days fished, associated catch and corresponding catch-per-unit-effort (CPUE) for trips having a duration of (a) 1-8 days, (b) 1-3 days and (c) 1 day only is listed in Table A2 while the CPUE (kilograms per day) for each of the data sets is displayed in Figure A2. For comparison, the CPUE associated with the Total Catch and estimated Total Days-Adj2 calculated for all TIB records in Table 5b is also displayed. Note, due to the low number of effort records for 2013 the high CPUE estimate for this season is considered unreliable.

Table A2. Seasonal total number of days fished, associated catch (kilograms) and corresponding catch-per-unit-effort (kilograms per day) for TIB trips having a duration of (a) 1-8 days, (b) 1-3 days and (c) 1 day only. The CPUE in the column All Data relates to that associated with the Total Catch and estimated Total Days-Adj2 calculated for all TIB records in Table 5b.

		Trips 1 to 8 days			Trips 1 to 3 days			Trips 1 day only			All Data	D>0
Season	Season	Days	Catch	CPUE	Days	Catch	CPUE	Days	Catch	CPUE	CPUE	CPUE
04	2004	4,591	155,271	33.8	3,751	129,980	34.7	2,744	92,517	33.7	33.7	33.7
05	2005	8,455	337,233	39.9	7,019	276,162	39.3	5,563	219,622	39.5	39.5	39.5
06	2006	4,648	122,434	26.3	3,965	109,958	27.7	3,012	83,462	27.7	26.0	26.0
07	2007	6,982	218,131	31.2	6,302	201,513	32.0	5,049	159,195	31.5	30.9	30.9
08	2008	5,631	169,638	30.1	5,137	160,656	31.3	4,134	127,222	30.8	30.0	30.0
09	2009	4,600	128,481	27.9	3,844	116,116	30.2	2,914	91,252	31.3	27.5	27.5
10	2010	3,634	132,711	36.5	3,349	126,976	37.9	2,708	103,563	38.2	36.5	36.5
11	2011	3,328	167,415	50.3	2,714	140,084	51.6	2,381	125,665	52.8	49.8	49.8
12	2012	2,020	85,060	42.1	1,319	51,204	38.8	881	30,068	34.1	41.8	41.8
13	2013	105	2,487	23.7	92	2,312	25.1	75	1,935	25.8	23.7	23.7
14	2014	2,853	95,207	33.4	2,049	66,514	32.5	1,269	47,380	37.3	33.3	33.3
15	2015	3,113	81,878	26.3	2,390	63,678	26.6	1,487	47,845	32.2	26.6	26.6
16	2016	2,727	91,493	33.6	2,308	79,433	34.4	1,611	68,389	42.5	33.2	33.2
17	2017	3,080	92,558	30.1	2,884	88,463	30.7	2,659	82,503	31.0	30.3	30.3
18	2018	3,334	96,397	28.9	2,832	79,400	28	1,680	50,132	29.8	27.3	27.3
19	2019	4,135	160,818	38.9	3,567	136,066	38.1	1,968	75,603	38.4	37.1	37.1
20	2020	2,639	116,846	44.3	2,337	107,065	45.8	1,575	80,740	51.3	44.4	44.4
21	2021	2,729	88,710	32.5	2,505	83,012	33.1	1,706	68,665	40.2	32.2	32.2

Figure A2. Seasonal CPUE (kilograms per day) for TIB trips having a duration of (a) 1-8 days, (b) 1-3 days and (c) 1 day only, together with the estimated CPUE for All Data records.



Use of TIB Docket-Book Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2021 Update

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CSIRO Oceans and Atmosphere

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1. Introduction

The Torres Strait Seafood Buyers and Processors Docket Book (TDB01), until recently, was used in the TIB sector of the Torres Strait rock lobster fishery to record the catch sold by fishers (known as sellers on the Docket-Book) at the end of a fishing trip. It was replaced on 1 December 2017 by the mandatory Torres Strait Catch Disposal Record TDB02 and an electronic version of this logbook was introduced to the fishery in 2021. However, unlike the Daily Fishing Log (TRL04) used in the TVH sector of fishery, which requires catch and effort data to be recorded for individual fishing operations related to each vessel tender, both the TDB01 and TDB02 Docket-Books require only aggregate catch and effort data to be recorded at the end of each trip. Nevertheless, both sets of catch and effort data recorded in each sector of the fishery have proven useful in constructing abundance indices for the fishery, and both are included in the Harvest Control Rule used to help determine an appropriate annual TAC. This document provides the latest update of the data and analyses undertaken for constructing the abundance index based on the Docket-Book data for the TIB sector (see Campbell *et al*, 2019).

2. Estimation of Total TIB Catch

A copy of both the TDB01 and TDB02 Docket-Books are shown in Appendix A. Each docket-book records the transaction date, the name of the seller, together with details of the catch (in weight). Additional information is also provided regarding the vessel, the number of crew, the number of days fished and the fishing methods used. This information therefore provides a measure of both the catch and effort for a given seller (or fisher) during a fishing trip and hence can be used to gain a measure of the catch rate (weight of lobsters caught per day fished) during that trip.

However, there were a number of issues with the TDB01 Docket-Book system which create problems with using these data for estimating the total catch and effort in the TIB fishery. These issues included:

i. The requirement that completion of this docket-book was only voluntary,
ii. The fact that catches recorded in this docket-book could also be reported elsewhere, including the TVH logbook,
iii. The fact that processors could also record catches in this docket-book, essentially creating duplicates.

Given the duplication of catch information from both the TVH sector and processors which occurred in the TDB01 docket-book data, several filters have been developed and applied to the data sourced from this docket-book in an attempt to identify and remove these duplicates. Further to these issues, several large TIB boats prior to 2016 only recorded their catch in the TVH-related logbook (TRL04) and these catch records need to be transferred to the TIB

database. This occurred because some TIB operators believed the TRL04 Logbook was mandatory, though they later became aware reporting for TIB is currently voluntary.

Finally, between 2013 and 2016 several processors reported aggregate annual catch data to AFMA as these catches were not being recorded in the TDB01 Docket-Book. Each processor reported the catch for tailed and whole lobsters separately, so that for each season two catch records were added to the TIB database for each processor to account for these additional catches.

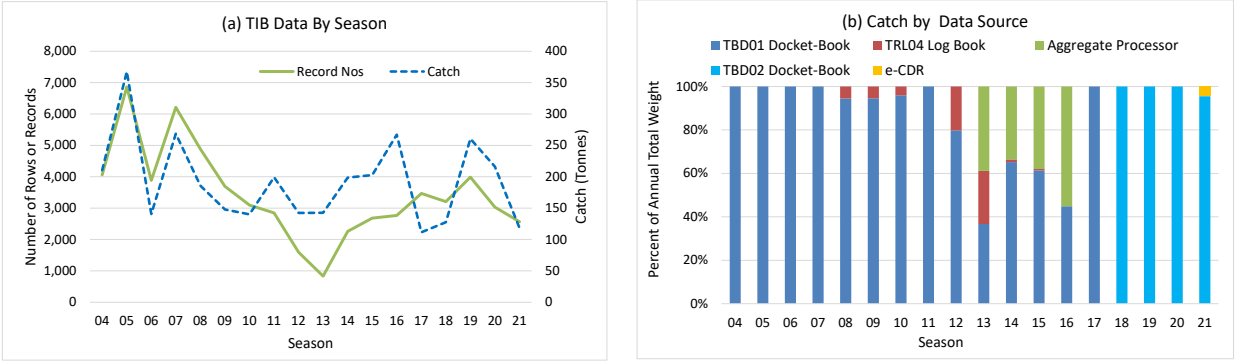
Considerable effort has gone into understanding the nature of both the TDB01 Docket-Book and TRL04 Logbook data so as to identify the catch records that should be assigned to the TIB sector of the fishery. A full description of the approach and data-rules used to identify and remove these duplicate records from the Docket-Book data is described in Campbell and Pease (2017). For the analyses described in this report, a total of 48,441 catch records have now been attributed to the TIB fishery covering the 2004 to 2017 seasons while an additional 12,796 TIB catch records have been sourced from the TBD02 docket-book (including the associated e-CDR) since the 2018 season. Note, several (54) Docket-Book records having a zero catch of lobsters are not included in these totals as it is assumed that other species may have been targeted on these trips. Also, catch record for the purpose of the data summarised in this report pertains to the catch and effort information provided on a single page in either the TDB01/TDB02 Docket-Books or TRL04 Logbook and for which a unique Record-Number (Record-No) is attributed. Within the TIB database there are usually multiple rows of catch information associated with each unique Record-No as the catch is separately recorded by process form and perhaps grade.

The number of catch records and the associated estimate of the total catch of rock lobsters in the TIB sector each season (starting 1-December), and by data source, is shown in Table 1 and Figure 1. Between 2004 and 2007 all catch was sourced from the TDB01 Docket-Book, and the number of catch records each season varied between 4,058 and 6,867. After this time, and between 2008 and 2015, a portion of the total catch attributed to the TIB sector each season was recorded in the TRL04 Logbook, and while the total related catch was usually small (<10 tonnes) this catch represented over 20% of the total TIB catch in both 2012 and 2013. Finally, between 2013 and 2016 a significant portion of the total TIB catch (between 33% in 2014 and 55% in 2016) was attributed to the aggregate catch data provided by several processors (as this catch was not recorded in the Docket-Book). Whether or not other catches were also not being recorded in the Docket-Book during these or in other seasons remains unknown. Finally, during the 2017 season all catches attributed to the TIB sector were recorded in the TDB01 Docket-Book, while with the introduction of the new TDB02 Docket-Book in December 2017 all catches during the 2018-to-2020 fishing season were recorded in this latter Docket-Book. While most catches continued to be recorded in the TDB02 Docket-Book during the 2021 fishing season, a small proportion (4.5%) was recorded in e-CDRs which were introduced for the first time this season (c.f. Figure 1b).

Table 1. Number of distinct TIB Record Nos by fishing season and the related catch by data source. Note, PRC relates to the aggregate catch provided by several processors.

	Records by Data Source					Total	Catch by Data Source					Total Catch
Season	TDB01	TDB02	e-CDR	TRL04	PRC	Records	TDB01	TDB02	e-CDR	TRL04	PRC	(kg)
2004	4,058	0	0	0	0	4,058	210,383	0	0	0	0	210,383
2005	6,867	0	0	0	0	6,867	367,615	0	0	0	0	367,615
2006	3,882	0	0	0	0	3,882	140,451	0	0	0	0	140,451
2007	6,212	0	0	0	0	6,212	268,689	0	0	0	0	268,689
2008	4,768	0	0	114	0	4,882	175,442	0	0	10,223	0	185,665
2009	3,596	0	0	95	0	3,691	139,850	0	0	7,964	0	147,814
2010	3,033	0	0	62	0	3,095	134,353	0	0	5,686	0	140,039
2011	2,845	0	0	0	0	2,845	199,061	0	0	0	0	199,061
2012	1,424	0	0	168	0	1,592	113,622	0	0	28,757	0	142,379
2013	649	0	0	183	2	834	52,249	0	0	34,862	55,411	142,522
2014	2,224	0	0	32	2	2,258	129,657	0	0	2,456	66,662	198,776
2015	2,652	0	0	25	2	2,679	124,369	0	0	1,333	76,904	202,606
2016	2,762	0	0	0	4	2,766	119,756	0	0	0	147,380	267,136
2017	3,469	0	0	0	0	3,469	111,504	0	0	0	0	111,504
2018	0	3,206	0	0	0	3,206	0	127,415	0	0	0	127,415
2019	0	3,990	0	0	0	3,990	0	260,615	0	0	0	260,615
2020	0	3,034	0	0	0	3,034	0	216,188	0	0	0	216,188
2021	0	2,445	121	0	0	2,566	0	112,880	5,289	0	0	118,170
Total	48,441	12,675	121	679	10	61,926	2,287,000	717,098	5,289	91,283	346,357	3,447,027

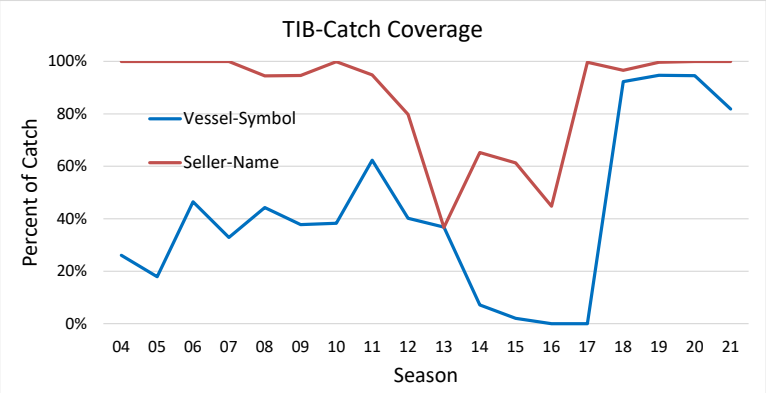
Figure 1. (a) Number of distinct TIB catch records and associated catch (in tonnes) by fishing season, and (b) the proportion of the annual TIB catch by data source.



3. The TIB Docket-Book Data

The number of distinct Vessel-symbols and Seller-names associated with the 61,931 Docket-Book records associated with a TIB catch since 2004 is 1,402 and 2,544 respectively. However, these numbers are inflated due to different spellings and mistakes often associated with a single Vessel-symbol or Seller-name. Attempts have been made to correct these symbols and names, and as a result the number of distinct Vessel-symbols and Seller-names has been reduced to 877 and 1,176 respectively. However, the percentage of all records (and total catch) without a Vessel-symbol remains high at 60% (and 60% respectively). On the other hand, only 1.3% of all records (and 13% of the total catch) have no associated Seller-name. The disconnect between the small number of data records with no Seller-name and the higher percentage of the catch is due to the fact that in some seasons a significant portion of the total TIB catch (between 33% in 2014 and 55% in 2016) was attributed to the aggregate catch data provided by several processors (as this catch was not recorded in the Docket-Book). This is clearly seen on Figure 2 which shows the percentage of the total TIB catch each year for which either the Vessel-name or Seller-name were available.

Figure 2. Percentage of the total TIB catch each year for which either the Vessel-symbol or Seller-name were available.



METHOD	N-recs	%	Catch	%
HOOKAH DIVING	23,622	38.1%	1,332,049	38.6%
FREE DIVING	21,325	34.4%	911,697	26.4%
UNKNOWN	9,243	14.9%	910,949	26.4%
LAMP FISHING	5,994	9.68%	167,170	4.85%
FREE DIVING-LAMP FISHING	764	1.23%	48,477	1.41%
FREE DIVING-HOOKAH DIVING	343	0.55%	36,861	1.07%
DIVING UNSPECIFIED	214	0.35%	15,897	0.46%
HANDLINING-FREE DIVING	141	0.23%	7,182	0.21%
FREE DIVING-HOOKAH DIVING-LAMP FISHING	35	0.06%	5,479	0.16%
HOOKAH DIVING-LAMP FISHING	42	0.068%	3,804	0.110%
TROLLING-FREE DIVING	44	0.071%	1,293	0.038%
HANDLINING	43	0.069%	1,230	0.036%
UNKNOWN-HOOKAH DIVING	18	0.029%	933	0.027%
FREE DIVING-UNKNOWN	12	0.019%	659	0.019%
HANDLINING-TROLLING-FREE DIVING	18	0.029%	561	0.016%
UNKNOWN-FREE DIVING	13	0.021%	419	0.012%
HOOKAH DIVING-LAMP FISHING-FREE DIVING	1	0.002%	381	0.011%
FREE DIVING-HANDLINING	12	0.019%	362	0.010%
Methods with less than 10 records	47	0.076%	1,627	0.047%
TOTAL	61,931	100%	3,447,027	100%

Figure 3. Spatial structure of the TIB data.

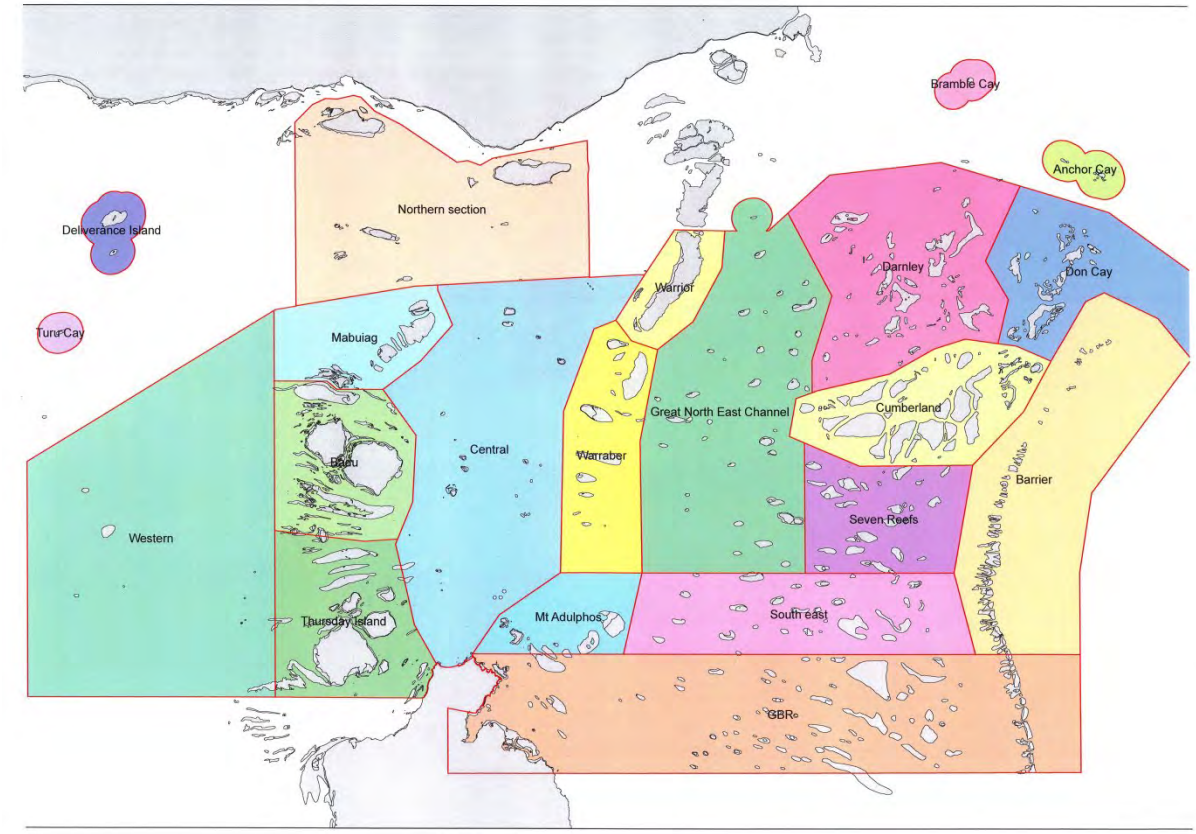


Table 3. Number of TIB records (and associated catch in kilograms) by the associated TIB-Area recorded on the Docket-Books. Note, TIB-Areas with few records (generally less than 30) have been aggregated.

Area	Area-Name	N-recs	%	Catch	%
9	Thursday Island	25,594	41.33%	949,773	27.55%
0	Unknown	7,272	11.74%	806,966	23.41%
7	Mabuiag	6,428	10.38%	502,581	14.58%
8	Badu	6,213	10.03%	325,071	9.43%
12	Warraber	5,008	8.09%	221,637	6.43%
11	Warrior	3,671	5.93%	216,901	6.29%
14	Great NE Channel	2,886	4.66%	138,499	4.02%
13	Mt Adolphus	828	1.3%	71,717	2.1%
16	Darnley	1,465	2.37%	53,545	1.55%
17	Cumberland	858	1.4%	49,962	1.4%
10	Central	787	1.27%	40,932	1.19%
3	Northern Section	274	0.44%	29,024	0.84%
1	Turu Cay	255	0.41%	13,784	0.40%
15	South East	119	0.19%	11,171	0.32%
21	GBR	160	0.26%	10,198	0.30%
99	Other Ares	108	0.17%	5,267	0.15%
Total		61,926	1	3,447,027	1

The frequency of the fishing methods associated with all Record Nos is shown in Table.2. Around 38.6% of the total catch is associated with hookah-diving, while free diving and lamp fishing are associated with 26% and 4.8% of the total catch respectively. A very small amount (0.05%) of the total catch is also associated with other methods (e.g. handlining, rod-and-reel) while around 3.6% of the total catch is associated with some combination of these six fishing methods. However, the catch method for around 15% of all catch records (and 26% of the total catch) remains unknown.

The distribution of all Record Nos (and catch) across each of the 21 TIB areas (shown in Figure 3) is given in Table 3. Around 41% of all TIB Records and around 27% of the catch are associated with fishing in the Thursday Island region, with another 15% and 9% of the total catch coming from the Mabuiag and Badu regions respectively. Eleven of the 21 regions each account for less than one percent of the total catch over all seasons (and only 2.0% in total).

Across all TIB Records the region fished remains unknown (i.e. not recorded) for 11.7% of all records and 23.4% of the total catch. However, as noted by TSRL-RAG23 in May 2018, the Area fished information recorded on the TDB02 docket-book during the 2018 season did not align with knowledge of the main catch regions that season. This discrepancy raised the likelihood that the Area fished information recorded on the TIB Docket-Book records may not be correct in many instances. One possible explanation offered was that it may relate to where the catch was sold instead of where the catch was made. This may account for the high proportion of the catch recorded in the Thursday Island area.

Instead of using the Area fished recorded on the Docket-Books as the location of the fishing operation for any trip, TSRL-RAG23 suggested using the vessel symbol (boat-mark) instead, as the first few letters of the vessel symbol usually relate to the island where the vessel is registered. It was reasoned that where the vessel is registered would likely correspond to the location of the fishing trip, as most TIB Sellers fish around their home island. For example, the vessel with symbol YKE999 refers to a vessel registered on Yorke Island. However, while the reporting of the vessel-symbol has been quite good (82-95%, c.f. Figure 2) on the new TDB02 Docket-Book during the past four seasons, as previously mentioned the reporting of the vessel on the previously used TDB01 Docket-Book was quite poor, being less than 10% between 2014 to 2017 and averaging only around 40% before 2014. This negates the use of vessel-symbol for the purposes of this analysis.

An alternative is to use information contained in the Seller-addresses reported on the Docket-Books, in particular the island or town of the Seller. The reasoning behind this approach was that the address of the Seller (in particular the island) would hopefully relate to the location of the fishing trip. Note, both a street address and a postal address are reported on the Docket-Book and in the following analysis the street address was used. As the Seller-address information was not available for the 2020 and 2021fising seasons, the following protocol was adopted:

i) First, a listing of the Seller-Address 2 and the Seller-Town fields reported in the TDB02 Docket-Book during the 2018 and 2019 fishing seasons were identified (c.f. Table 4).
ii) Second, the Seller-Home was set equal to the information recorded in the Seller-Address 2 field, and where this information was not reported the Seller-Home was set equal to the information recorded in the Seller-Town field.
iii) Third, after correcting for multiple spelling of the same location and identifying the island associated with town names, the final list of Seller-Homes and associated Seller-Island is shown in Table 5a.

Table 4. Listing of information related to the Seller address reported in the TDB02 Docket-Book during the 2018 and 2019 fishing seasons.

Seller Address 2	Seller-Town	Number
WARRABER ISLAND	VIA THURSDAY ISLAND	779
BADU ISLAND	VIA THURSDAY ISLAND	441
YORKE ISLAND	VIA THURSDAY ISLAND	284
YAM ISLAND	VIA THURSDAY ISLAND	245
MABUIAG ISLAND	VIA THURSDAY ISLAND	223
COCONUT ISLAND	VIA THURSDAY ISLAND	206
HAMMOND ISLAND	VIA THURSDAY ISLAND	177
TAMWOY	THURSDAY ISLAND	140
HORN ISLAND	VIA THURSDAY ISLAND	129
PORUMA ISLAND	VIA THURSDAY ISLAND	118
DARNLEY ISLAND	VIA THURSDAY ISLAND	93
ST PAULS COMMUNITY	MOA ISLAND	38
YORKE IS	VIA THURSDAY ISLAND	38
SAIBAI ISLAND	VIA THURSDAY ISLAND	33
MOA ISLAND	VIA THURSDAY ISLAND	29
ST PAULS COMMUNITY MOA I	VIA THURSDAY ISLAND	28
THE ESPLANADE	MURALAG ISLAND	23
ST PAULS	MOA ISLAND	18
PURUMA ISLAND	VIA THURSDAY ISLAND	17
TAMWOY TOWN	THURSDAY ISLAND	17
MALAYTOWN	BADU ISLAND	13
MURALUG BEACH	PRINCE OF WALES ISLAND	7
STEPHEN ISLAND	VIA THURSDAY ISLAND	6
YORK ISLAND	VIA THURSDAY ISLAND	6
ST PAULS COMMUNITY, MOA I	VIA THURSDAY ISLAND	4
MEIMALGAU YABU ST	MOA ISLAND	3
ST PAUL'S COMMUNITY	MOA ISLAND	3
BOIGU ISLAND	VIA THURSDAY ISLAND	1
DARNLEY ISLAND	DARNLEY ISLAND	1
MURRAY ISLAND	VIA THURSDAY ISLAND	1
NR	BADU ISLAND	362
NR	THURSDAY ISLAND	3464
NR	YAM ISLAND	425
NR	WARRABER ISLAND	420
NR	HORN ISLAND	399
NR	COCONUT ISLAND	253
NR	PORTSMITH	207
NR	PORUMA ISLAND	198
NR	NR	182
NR	BAMAGA	116
NR	VIA THURSDAY ISLAND	85
NR	YORKE ISLAND	84
NR	PRINCE OF WALES ISLAND	69
NR	HAMMOND ISLAND	66
NR	NEW MAPOON	59
NR	TRINITY PARK	50
NR	MABUIAG ISLAND	47
NR	IAMA ISLAND	24
NR	YORK ISLAND	21
NR	MANUNDA	14
NR	DARNLEY ISLAND	10
NR	STEPHEN ISLAND	8
NR	DAUAN ISLAND	6
NR	DARNLEY VILLAGE	5
NR	MORNINGSIDE	4
Total		9699

Table 5a. Final listing of Seller-Home and Seller-Island based on the information regarding Seller address in the TDB02 Docket-Book during the 2018 and 2019 fishing seasons.

Seller-Home	Seller-Home 2	Island	N-Recs	%-Total
THURSDAY ISLAND	Thursday	WAIBEN (Thursday)	3,621	37.3%
WARRABER ISLAND	Warraber	WARRABER (Sue)	1,207	12.4%
BADU ISLAND	Badu	BADU (Mulgrave)	816	8.4%
COCONUT ISLAND	Coconut	PORUMA (Coconut)	814	8.4%
YAM ISLAND	Iama	IAMA (Yam)	702	7.2%
HORN ISLAND	Horn	NGURUPAI (Horn)	528	5.4%
YORKE ISLAND	Yorke	MASIG (Yorke)	433	4.5%
MABUIAG ISLAND	Mabuiag	MABUIAG (Jervis)	308	3.2%
CAIRNS	Other islands	CAIRNS (Qld)	271	2.8%
HAMMOND ISLAND	Hammond	KIRRIRI (Hammond)	243	2.5%
UNKNOWN	Unknown	UNKNOWN	187	1.9%
BAMAGA	Cape York	BAMAGA (Cape York)	116	1.2%
DARNLEY ISLAND	Darnley	ERUB (Darnley)	109	1.1%
PRINCE OF WALES ISLAND	Prince of Wales	MURALAG (Prince of Wales)	99	1.0%
ST PAULS	Moa	MOA (Banks)	91	0.94%
NEW MAPOON	Cape York	NEW MAPOON (Cape York)	59	0.61%
SAIBAI ISLAND	Other islands	SAIBE (Saibai)	33	0.34%
MOA ISLAND	Moa	MOA (Banks)	32	0.33%
STEPHEN ISLAND	Other islands	UGAR (Stephen)	14	0.14%
DAUAN ISLAND	Other islands	DAUAN (Mt Cornwallis)	6	0.06%
BRISBANE	Other islands	BRISBANE (Qld)	4	0.04%
ERUB ISLAND	Darnley	ERUB (Darnley)	3	0.03%
MURRAY ISLAND	Other islands	MER (Murray)	2	0.02%
BOIGU ISLAND	Other islands	BOIGU (Talbot)	1	0.01%
Total			9,699	

Table 5b. Number of TIB records (and associated catch in kilograms) by Seller-Home/Island. Note, Seller-Islands with few records (generally less than 40) have been aggregated.

Seller-Home/Island	N-recs	%	Catch	%
WAIBEN (Thursday)	20,277	32.7%	1,388,686	40.3%
BADU (Mulgrave)	10,098	16.3%	630,009	18.3%
IAMA (Yam)	5,135	8.3%	243,681	7.1%
WARRABER (Sue)	6,590	10.6%	226,854	6.6%
NGURUPAI (Horn)	5,054	8.2%	163,090	4.7%
MASIG (Yorke)	2,561	4.1%	130,761	3.8%
MABUIAG (Jervis)	1,627	2.6%	115,079	3.3%
KIRRIRI (Hammond)	2,950	4.8%	88,000	2.6%
PORUMA (Coconut)	2,129	3.4%	84,755	2.5%
Erab & Ugar	227	0.4%	6,650	0.2%
MOA (Banks)	902	1.5%	49,789	1.4%
Muralag & Gealug	1,767	2.9%	112,234	3.3%
Cape Yorke	692	1.1%	39,053	1.1%
Northern_TS	262	0.4%	19,805	0.6%
Other	38	0.1%	3,983	0.1%
Unknown	1,617	2.6%	144,599	4.2%
	61,926	100.0%	3,447,028	100.0%

v) A similar process was also undertaken using the information recorded on the TDB01 Docket-Book.

vi) For the 2020 and 2021fishing seasons, the home/island(s) associated with each Seller during the previous two seasons (i.e. the 2018 and 2019 fishing seasons) was determined. Where this home/island was unique (and not unknown) for a given Seller, then this home/island was associated with that Seller during the 2020 and 2021fishing seasons.

vii) A similar approach was taken to associate an island with a Seller in previous seasons where the home/island remained unknown.

viii) Finally, where the number of records for a given Seller- Home/Island was small, the records for these home/islands were either combined or allocated to one of the regions defined as follows:

a. Northern Torres-Strait where home/ island in (Saibe, Boigu, Dauan)
b. Cape Yoke where home/island in (Bamaga, New Mapoon, Injinoo)
c. Other where home/island in (Cairns, Brisbane, Besi, Mer)

A listing of Seller-Home/Islands associated with all Docket-Book data is shown in Table 5b

Of interest is to examine the correspondence between the reported TIB-Area fished (as previously summarised in Table 3) and the location of the Seller-Home/Island. For this exercise, for each reported TIB-Area the percentage of records associated with each of the corresponding Seller- Homes was determined and the results are shown in Figure 4. For each TIB-Area, between 20% and 92% of the related records are associated with a single Seller-Home. For example, 92% of the records reported to be in the Cumberland Area are associated with the Masig Seller-Home, while 64% of the records reported to be in the Thursday Island Area are associated with the Waiben Seller- Home. For the Great North-Eastern Area, around 42% of records are associated with both the Masig and Poruma Seller-Homes. On the other hand, only 20% of the records related to the Western Area are associated with Northern-TS Seller- Home, while 17% are associated with the Waiben Seller- Home. This may indicate that in some instances the Seller-address may not necessarily be related to the place where fishing occurs.

Figure 4. For each reported Area the percentage of records associated with that Area is shown for each of the corresponding Seller-Islands (listed at the top of the figure).

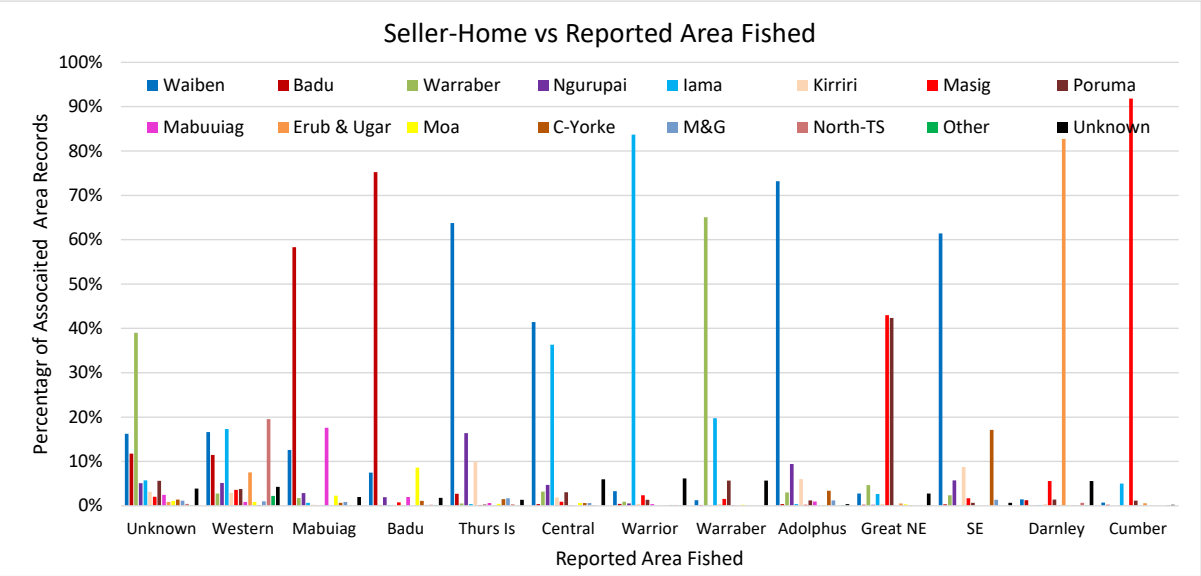


Table 6. Number of TIB records (and associated catch in kilograms) by (a) the number of days fished, and (b) the number of fishers as recorded on docket-books.

(a) Days-Fished

Days	N-recs	%	Catch	%
1	44,067	71.2%	1,647,041	47.8%
Unknown	9,251	14.9%	967,371	28.1%
2	4,201	6.8%	268,300	7.8%
3	2,178	3.5%	194,533	5.6%
4	870	1.4%	101,810	3.0%
5	649	1.0%	101,666	2.9%
6	213	0.3%	45,935	1.3%
7	203	0.3%	45,716	1.3%
8	102	0.2%	29,049	0.8%
9	76	0.1%	21,528	0.6%
10	35	0.1%	9,461	0.3%
>10	80	0.1%	14,612	0.4%
	61,925	100.0%	3,447,022	100.0%

(b) Number of Fishers

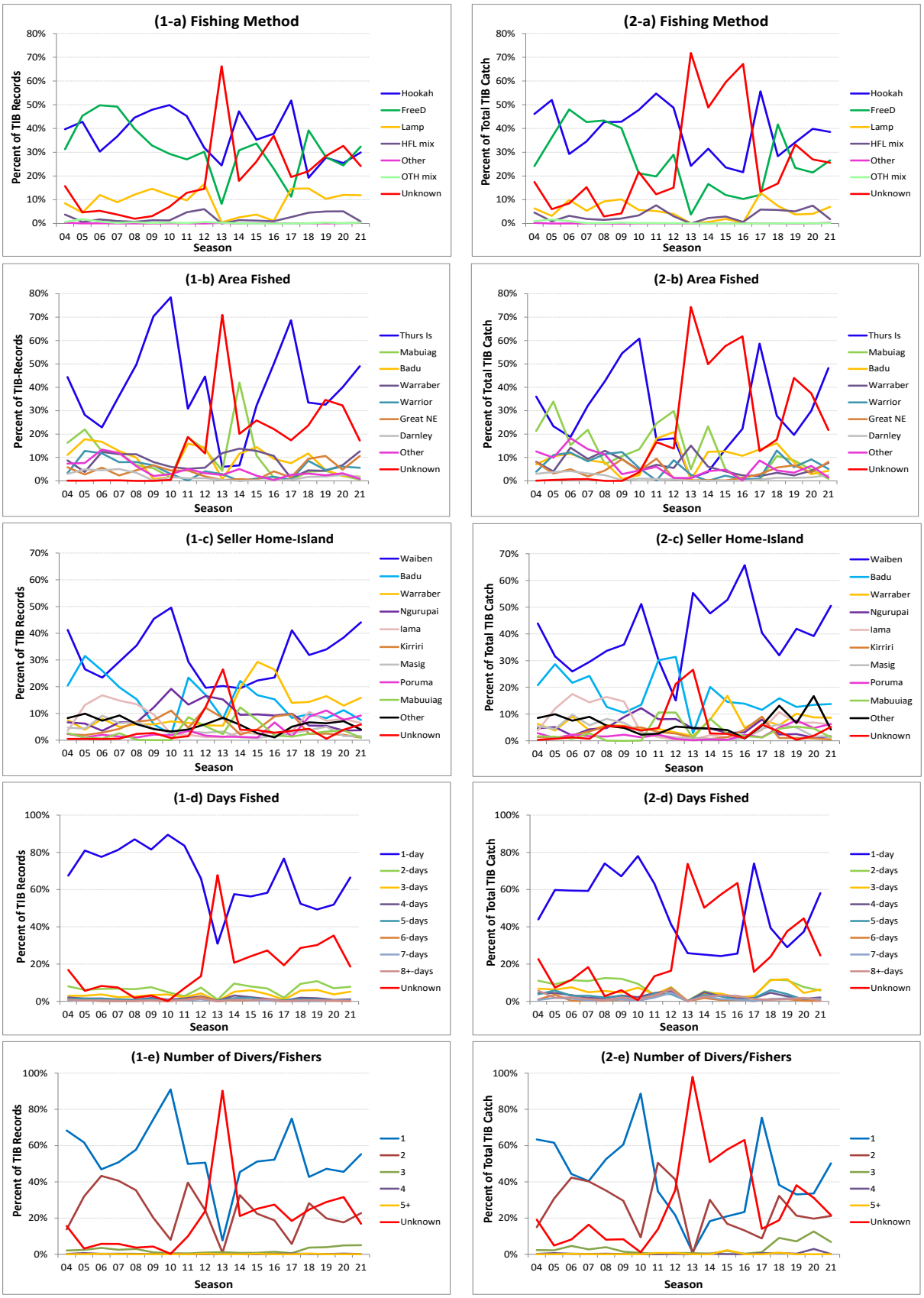
Fishers	N-recs	%	Catch	%
1	35,148	56.8%	1,435,539	41.6%
Unknown	9,070	14.6%	978,234	28.4%
2	16,056	25.9%	896,787	26.0%
3	1,436	2.3%	112,225	3.3%
4	160	0.3%	14,889	0.4%
>4	56	0.1%	9,353	0.3%
	61,926	100.0%	3,447,027	100.0%

A summary of the number of recorded days-fished associated with the TIB catch records is shown in Table 6a. Reported days fished varies between 1 and 93 days, though there are only 81 records (0.13% of all records) where the reported number of days-fished is greater than ten. It is most likely that there are data errors. On the other hand, a large majority of records report only one (71%), two (6.8%) or three (3.5%) days fished, in total accounting for around 96% of all records where this information is reported. The days-fished remains unknown (i.e. not recorded) for around 15% of these records (but for 28% of the total catch).

Finally, a summary of the number of divers/fishers recorded on the docket-books (and associated catch) is shown in Table 6b. Reported number of divers/fishers varies between 1 and 14, though there are only 56 records (0.09% of all records) where the reported number of divers/fishers is greater than four. Again, it is most likely that there are data errors. Most records report only one (57%), or two (26%) divers/fishers, in total accounting for around 97% of all records where this information is reported. The number of divers/fishers remains unknown for around 15% of all records (and 28% of the total catch). It remains uncertain as to relationship between the number of divers in the water at any one time and the number of divers/fishers reported on the Docket-Book. A sample of fish receivers undertaken by AFMA during November 2019 indicated that different approaches have been used in recording the number of divers/fishers. Two receivers indicated they record the total number of people in the boat, but one confirmed there is always at least one person in the boat (driving, not diving). Another receiver records the number of people doing the catching/diving, however if two is recorded, it was not clear if that is two people in the water at the same time or not. A third receiver indicated that they write down one less than the total number of people in the boat. As accurate information on fishing effort is of primary importance in the calculation of catch-rates, it is recommended that steps be undertaken to standardise the reporting of diver/fisher numbers reported in the TDB02 Docket-Book. This issue needs to be fully discussed, and an appropriate reporting approach identified, by the TRL-RAG Data Sub-Group.

The seasonal percentage of the both the number of TIB catch records and total TIB catch for the various levels (a) fishing method, (b) TIB-area fished, (c) Seller-home/island, (d) days fished and (e) number of divers/fishers are shown in Figure 5. The seasonal percent of unreported (unknown) levels for each data field are also shown. Between 2012 and 2016 there was a significant increase in the proportion of the seasonal catch for which the information relating to these variables remains unknown, and this lack of information impedes the ability

Figure 5. Seasonal percent of (1) number of TIB catch records and (2) total TIB catch for the various levels of: (a) fishing method, (b) area fished, (c) Seller home-island, (d) days fished and (e) number of divers/fishers.



to construct indices of resource abundance that represent the distribution of lobsters across the TIB fishery. While this situation has improved in recent seasons, nevertheless there is still room for improving the information recorded on the TDB02 Docket-Book. For example, during 2021 the Method was not reported for around 24% of records (down from 32% in 2020), Area fished was not reported for around 17% of records (down from 32% in 2020), the Days-fished was not reported for around 19% of records (down from 35% in 2020), and the Number of Divers/Fishers- was not reported for around 17% of records (down from 35% in 2020, cf. Figure 5). A comparison of Figures 5b and 5c indicates that an advantage of using the Seller-home as an indication of the location of the fishing trip is that the reporting of this field in the Docket-Book is more completed than for the Area fished.

4. Selection of data used for CPUE analysis

Each catch record in the TIB data is associated with a Record-No, and the structure of the Docket-Book would seem to indicate that there should be a unique Record-No for each vessel, date and seller-name. However, investigation of the data indicates that there are often multiple Record-Nos associated for a given vessel, date and seller-name. The reason for these multiple records remains unknown but may be due to incorrect recording of dates, etc. In order to identify an appropriate data structure for analysis, the following procedure was adopted to filter the data:

1. The TIB data was aggregated over vessel-symbol, date and seller-name. Where the vessel-symbol or seller-name was null these fields were set to 'Unknown'. Data was limited to the seasons 2004 to 2021 resulting in a total of 59,480 aggregate Vessel-Day-Seller records (hence-forth known as VDS records);
2. Only those VDS records having a unique Record-No were selected for analysis – accounting for 57,219 (96.2%) of the VDS records identified in the previous step. It was assumed that where the vessel or seller were unknown, that selection of only those GLM records having a unique Record-No limited the GLM records chosen to those associated with a single vessel and a single seller;
3. VDS records were also deleted where any of the number of fishers, the number of days fished, the number of methods, the area fished, and the Seller-Home were not unique or remained unknown (i.e. not recorded). Records associated with the TRL04 logbook or where the catch was zero were also deleted. This resulted in 47,768 VDS-records being retained.
4. Finally, VDS records were only retained where they satisfied the following criteria:
    a. the month was not October or November,
    b. the fishing method listed in Table 2 was either 'Hookah diving', 'Free diving', 'Lamp fishing' or some combination of these three methods (denoted 'Mixed'),
    c. the number of fishers was between 1 and 3,
    d. the number of days fished was between 1 and 9,
    e. the recorded catch weight was between 1kg and 500kg, Note, the distribution of catches is over-dispersed, with 0.54% of records having a catch greater than 500kg and 0.17% of records having a catch greater than 1000kg.

    The records for a few large vessels which were considered non-representative of the TIB fishing sector were also removed.
5. Finally, the records for the 2013 season were also deleted due to the small number of records for this season (72) compared to all other seasons (between 1,111 and 5,725). The small number for 2013 was because many of the fields on the TDB-01 Docket-Book that season were left blank.
6. This procedure resulted in 45,122 VDS records being selected for analysis.

Table 7. Number of GLM records within each season, month and quarter, Seller-Island, Area fished, days fished, fishing method, percent tails in the catch, and number of fishers and associated nominal catch rates.

Season	N-Recs	CPUE
2004	2898	32.2
2005	5459	38.9
2006	3216	25.7
2007	5248	31.0
2008	4300	30.1
2009	3211	27.9
2010	2628	30.7
2011	2157	49.1
2012	1018	40.7
2014	1556	31.8
2015	1719	23.0
2016	1496	31.6
2017	2436	26.6
2018	1970	28.2
2019	2407	37.2
2020	1674	45.9
2021	1719	33.6
Total	45,112	

Month	N-Recs	CPUE
1	4060	26.7
2	6194	35.0
3	7290	36.0
4	5342	36.2
5	4972	35.3
6	4371	33.5
7	4164	31.7
8	2995	30.1
9	2079	27.6
10		
11		
12	3645	26.7
Total	45,112	

Months 10 & 11 deleted

Area	N-Recs	CPUE
0	866	40.2
6	366	38.5
7	4920	41.4
8	5276	31.8
9	21647	33.0
10	642	31.3
11	2839	37.7
12	3554	19.4
13	698	53.1
14	2279	24.4
15	254	43.0
16	1021	33.0
17	750	35.3
Total	45,112	

Seller-Home	N-Recs	CPUE
Badu	7569	34.5
Cape Yorke	513	42.4
Erub & Ugar	880	33.6
Iama	4000	36.9
Kirriri	2157	26.6
Mabuiag	1194	43.4
Masig	2006	29.0
Moa	696	37.3
Muralag	446	31.6
Ngurupai	4061	28.4
Northern-TS	179	35.6
Other	20	46.8
Poruma	1451	22.2
Unknown	493	24.6
Waiben	16,728	37.9
Warraber	2,719	16.5
Total	45,112	

Method	N-Recs	CPUE
Free Diving	18346	29.7
Hookah	20641	38.6
Lamp Fishing	4999	21.3
Mixed	1126	33.0
Total	45,112	

Days	N-Recs	CPUE
1	37807	34.6
2	3633	31.8
3	1849	29.1
4	756	29.3
5	585	28.4
6	185	31.8
7	160	24.7
8	75	27.5
9	62	26.3
Total	45,112	

%-Tails	N-Recs	CPUE
<20%	16352	25.7
20-40%	3493	36.6
40-60%	2583	35.2
60-80%	2219	36.8
>80%	20465	37.5
Total	45,112	

Fishers	N-Recs	CPUE
1	30162	31.7
2	13797	34.5
3	1153	35.0
Total	45,112	

The decline in the number of selected VDS-Records since 2010 has been noted in previous analyses, with the average number of VDS -records per season decreasing from 3,851 between 2004 to 2010 to only 1,589 between 2011 and 2016. However, this situation improved between 2017 and 2019 when the average number of records has increased to 2,175 but has again decreased to average only 1,697 during the past two seasons. The mandatory use of the TDB02-Docket-Book is likely to have increase the reporting rate since 2018, but as noted earlier the voluntary reporting of the effort data is still limiting the amount of data available for catch rate analyses. COVID-restrictions have no doubt also impacted on the level of effort in the fishery during the past two seasons.

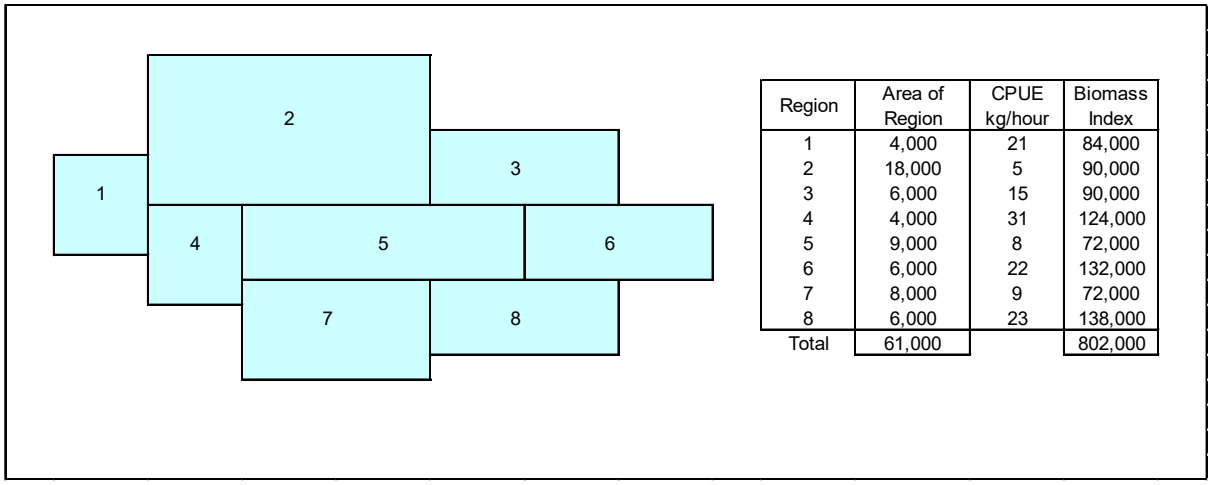
Unlike the TVH data where the measure of effort is hours-fished, the measure of effort for the TIB data is coarser, being days-fished. Furthermore, and as noted above, it has been assumed that each selected GLM record pertains to the catch and effort of a single fisher (or seller) during a given trip, i.e. it is assumed that the measure of effort (i.e. days fished) associated with each GLM record also pertains to the actual effort expended by that seller in obtaining the recorded catch. While the number of days fished for each Record-No in the GLM data is unique, there are instances nevertheless where for the same vessel, date and seller there are multiple Record-Nos where the number of days fished is different. Investigation of this issue undertaken with the AFMA data section indicated that the dates associated with these docket-book forms were most likely not correct (Campbell 2016a).

5. General Linear Model Analysis

i) Basic Idea of an Abundance Index

The analyses which are outlined in this section are undertaken with the aim of to developing an annual index of abundance of lobsters in the Torres Strait rock lobster fishery. The concept behind these analyses is explained here.

Figure 6. Hypothetical fishery used to calculate an abundance index.



Region	Area of Region	CPUE kg/hour	Biomass Index
1	4,000	21	84,000
2	18,000	5	90,000
3	6,000	15	90,000
4	4,000	31	124,000
5	9,000	8	72,000
6	6,000	22	132,000
7	8,000	9	72,000
8	6,000	23	138,000
Total	61,000		802,000

Catch (kgs) = q. Effort (hours fished) * Density of lobsters (lobsters per square meter)

The parameter q, known as the catchability coefficient, is a combined measure of the efficiency of the fishing gear and the fisher. From this equation it follows that:

$$\text{Density of lobsters (lobsters per square meter)} = \frac{\text{Catch (kgs)}}{\text{q. Effort (hours fished)}}$$

$$\Rightarrow \text{Density of lobsters (lobsters per square meter)} = \frac{\text{CPUE}}{\text{q}}$$

It is seen then that the catch-per-effort (CPUE) provides an indicator of the density of lobsters in the region fished (i.e. higher CPUE is an indicator of higher density, etc). If we assume that the density of lobsters is the same within a given region of spatial size A, then the number of lobsters in that region will be given by:

Number of lobsters = Density of lobsters (lobsters per square meter) * Area (square meters)

$$\Rightarrow \text{Number of lobsters, N} = \frac{\text{CPUE} * \text{Area}}{\text{q}}$$

So an estimate of the number of lobsters in a given region is given by knowing the CPUE, the area of the region and the catchability coefficient of the fisher. CPUE is provided from the catch and effort data for the fisher and the area of the region fished can be measured. However, q remains unknown.
If a given fisher (for which the catchability coefficient is q_o) fishes in region 1 (which has an area A1) and achieves an average catch rate of CPUE1, then an estimate of the number of lobsters in region 1 is:

$$\Rightarrow \text{Number of lobsters, N(1)} = \frac{\text{CPUE1} * \text{A1}}{\text{qo}}$$

An example how this equation can be used to provide an estimate of the abundance of lobsters in a hypothetical fishery is shown in Figure 6.

If the same fisher also fishes in all eight regions (using the same method and efficiency so that q_o remains constant across all fishing operations) then an estimate of the total abundance of lobsters across the entire fishery can be estimated by summing across all areas:

$$\text{Total abundance of lobsters} = \sum_{a=1}^{8} \frac{CPUE(a) * A(a)}{q_o}$$

where CPUE (a) and A(a) are the CPUE achieved and size of area *a* respectively. If we assume that a group of fishers (each with the same q) operates in each region simultaneously (so that the catch rates obtained in each region are not influenced by lobsters moving between regions over time), then the above equation provides an estimate the total abundance of lobsters at any given time (say t_o), i.e.

$$\text{Total abundance of lobsters } (t_o) = \sum_{a=1}^{8} \frac{CPUE(a, t_o) * A(a)}{q_o}$$

If the same group of fishers undertakes a similar set of fishing operations at another time, say t_1, then an estimate the total abundance of lobsters at this other time will be:

$$\text{Total abundance of lobsters } (t_1) = \sum_{a=1}^{8} \frac{CPUE(a, t_1) * A(a)}{q_o}$$

The abundance of lobsters at this time relative to the abundance at time t_o is then given by:

$$\text{Relative abundance at } t_1 \text{ relative to } t_o = \sum_{a=1}^{8} \frac{CPUE(a, t_1) * A(a)}{q_o} \Big/ \sum_{a=1}^{8} \frac{CPUE(a, t_o) * A(a)}{q_o}$$

$$= \frac{\sum_1^8 CPUE(a, t_1) * A(a)}{\sum_1^8 CPUE(a, t_0) * A(a)}$$

So, if a group of fishers each with the same ability (i.e. same q) could operate across the entire fishery at a sequence of different times, then one can use the above equation to obtain a relative index of abundance at each time. Indeed, this is the basis behind the concept of doing sequential surveys (such as the annual pre-season survey) using a standard set of fishing equipment.

If surveys such as described above were repeated each month during a fishing season, then one could take the average over all months to ascertain an estimate of average abundance during this season, i.e.

$$\text{Abundance of lobsters in season (S)} = \sum_{m=1}^{12}\sum_{a=1}^{8}\frac{CPUE(m,a,)*A(a)}{q_o}$$

And again, repeating this exercise each season would allow for the relative abundance in any season to be compared to the abundance in any other season, e.g.

$$\text{Abundance of lobsters in season}S_i \text{ relative to Season } S_o = \frac{\sum_{m=1}^{12}\sum_{a=1}^{8} CPUE(S_i,m,a)*A(a)}{\sum_{m=1}^{12}\sum_{a=1}^{8} CPUE(S_o,m,a)*A(a)}$$

Unfortunately, for the exercise of obtaining an annual abundance index using the catch and effort data recorded by the fishing fleet during an entire fishing season such a simple approach is not possible. Foremost is the fact that there are many operators and several fishing methods used, each having a different catchability coefficient. Also, there may be environmental factors that influence the distribution of lobsters and hence catch rates (e.g. phase of the moon, tides, etc). As such, the catch rate achieved by any individual fisher will depend on a range of factors. For example.,

Catch rate = CPUE(Season, Month, Area, Fisher ,Method, Environment)

The essence of the statistical analyses described in the following sections is to account for each of the factors which may influence the catch rates of lobsters at any particular time, location and for any given fishing method. For example, by comparing the different catch rates achieved by all fishers with all other factors held constant (i.e. same season, month, area, method, etc) the analysis can ascertain the relative efficiencies (q's) of each fisher. Similarly, by holding all other factors constant except for say method, the analysis can then ascertain the relative effect of each method on catch rates. In this manner, the relative influence of each level of all factors influencing catch rates can be determined. Finally, a "standard' fisher, method and environmental level can be chosen and the catch rates within each season, month and area relative to these standards then determined. Once done, the above equation can then be used to ascertain the relative abundance in any given season compared to any other season. The statistical methods used here for undertaking such analyses are known as Generalised Linear Models.

ii) GLM Models

As with the analysis of the TIB data in previous years, General Linear Models (GLM) were fitted to the TIB data selected in the previous section in order to standardise the CPUE to account for changes in the distribution of records across a number of effects. As mentioned previously, the measure of effort for the TIB data was taken to be days-fished. The catch rate associated with each GLM record was then defined to be the mean weight of lobsters caught per day-fished, i.e.

$$CPUE = \frac{Whole\ \ Weight\ of\ landed\ lobsters}{Number\ of\ days\ fished}$$

In order to investigate the influence of the various effects on the catch rate associated with each GLM data record, and to help account for the possible misreporting of the Area fished on Docket-Book records (as noted by TSRL-RAG23 in May 2018), the following models were fitted to the data records described in the previous section.

<u>Model-1: Main Effects Model</u>

To explore the impact of each main effect included in the GLM, the first set of analyses was based on the following model where no interactions between main effects were included:

CPUE = Intercept + Season + Month + Area-Fished + Fishing-Method
+ Proportion-landed as Tails
+ Southern Oscillation Index + Moon-Phase
/ distribution = gamma, link = log

= *I* + *S* + *M* + *SI* + + *F* + *P* + *SOI* + *Moon* / dist= gamma, link=log

where:

a) *Season* has 17 levels: 2004-2012, 2014-2021.
b) *Month* has 10 levels: December–to-September.
c) *Area-Fished* corresponds to the *Seller-Home* and has 13 levels as shown in Table 7 (the three levels Other, Northern-TS and Unknown were not used due to the small number of records for these areas).
d) *Fishing-Method* has 4 levels: (1) Hookah, (2) Free Diving, (3) Lamp Fishing, and (4) Mixed methods.
e) *Proportion*-Tails has 5 levels: (1) <20%, (2) 20-40%, (3) 40-60%, (4) 60-80%, and (5) ≥80%.
f) *SOI* is the monthly value of the Southern Oscillation Index.
g) *Moon-Phase* has 30 levels: the number of days after the last full moon.

The SAS GENMOD procedure was used to fit the model. All effects were fitted as categorical effects except for SOI which was fitted as a continuous cubic function. A log-gamma distribution was assumed for the distribution of CPUE values. With the non-inclusion of the three Seller-Home areas having a small number of records, the total number of records fitted to the model was 44,420. The annual index of abundance was determined using the method described in the next section

The simple structure of this Main Effects model is based on some simplifying assumptions. For example, it assumes that the influence of each level of a given main effect is the same across all other combinations of the other main effects. For example, the relative influence of each Month is assumed to be same across all Seasons and Areas, and similarly the relative influence of each Area is the same across all combinations of Month and Season. Whilst these assumptions may to some extent approximate reality, there may be instances where some assumptions are not fulfilled. For example, there appears to be a degree of inter-annual variation in the relative level of catch rates in different areas across different seasons. Such variation can be accounted for in the models described below.

For each of the main effects, a measure of the impact of each level on the modelled CPUE was obtained by taking the exponent of the estimated parameter for each level. The impact of each level was then compared to the impact of a reference level. For each main effect these reference levels were:

Month	March
Area-Fished	Waiben
Method	Hookah diving
Proportion-tails	>80%

Finally, the annual influence of each of the main effects on the resulting index of abundance was calculated using the method described in Bentley et al (2012).

As shown in Campbell (2004) a bias in the annual abundance index can result when there is an unequal number of observations within each spatial-temporal stratum used for calculating the abundance index. In order to overcome this problem a weighting of the observations needs to be incorporated when fitting the data to the GLM. Each observation was therefore weighted such that the sum of the weights for all observations in each of the *Season-Month-Area* strata was the same for all strata. Furthermore,

in order to account for the weighting given each observation in determination of the annual influence of each main effect, the sum of the weights for all observations within a given level was used instead of just the number of observations.

Interactions Models

A second set of analyses was undertaken to explore whether the inclusion of interactions between the main spatial-temporal effects improved the model fit to the data. Specifically, the following three models were examined:

Model-2: Int-1:

*CPUE = Intercept + Season +Month + Month*Area*
+Fishing-Method + Proportion-Tails + SOI + Moon
/ distribution = gamma, link = log

Model-3: Int-2:

*CPUE = Intercept + Season *Month +Season*Area + Month*Area*
+Fishing-Method + Proportion-Tails + SOI + Moon
/ distribution = gamma, link = log

Model-4: Int-3:

*CPUE = Intercept + Season *Month*Area*
+Fishing-Method + Proportion-Tails + SOI + Moon
/ distribution = gamma, link = log

where * indicates an interaction between the related effects. The inclusion in these interactions allows for the relative distribution of the resource between the different areas and months to be different between seasons.

iii) Derivation of Annual Index

Using the results from each GLM an annual abundance index was constructed based on the standardised CPUE. This follows the qualitative description provided previously.

For each model the standardised CPUE within each *Season-Month-Area* stratum was calculated as follows:

$$stdCPUE(season = s, month = m, area = a) = exp(I + f(S_s, M_m, A_a) + F_{ref} + P_{ref})$$

where $f(S_s, M_m, A_a)$ is the functional form of the parameters for *Season*, *Month* and *Area* as described in each of the four models above, and F_{ref}, and P_{ref} are the parameter values relating to each of the reference (standard) levels for *Fishing-Method* and *Proportion-Tails* effects included in the model. Note, due to the over-parameterization inherent in the GLM the values of F_h, and P_{ref} can be set to zero.

In total there are 2210 (=17 seasons x 10 months x 13 areas) *Season-Month-Area* strata. As the standardised-CPUE is taken as an index of the density of fish within each stratum, an index of the abundance of lobsters across the fishery in each season and month is given by:

$$Index(season = y, month = m) = \frac{1}{\sum_{a=1}^{NA} Area_a} \sum_{a=1}^{NA} Area_a . stdCPUE(s, m, a)$$

where $Area_a$ is the spatial size of each of the *NA Area* effects included in the GLM. Finally, an index of abundance for each season can be obtained by taking the average of the *NM* monthly indices in each season.

$$Index(season = s) = \frac{1}{NM}\sum_{m=1}^{NM}\left[\frac{1}{\sum_{a=1}^{NA} Area_a}\sum_{a=1}^{NA} Area_a.stdCPUE(s,m,a)\right]$$

Finally, a relative annual abundance index, B_s, was calculated such that the mean index over all seasons equals 1, i.e.

$$B_s = \frac{Index(season = s)}{\frac{1}{NS}\sum_{i=1}^{NS} Index(season = i)}$$

The derivation of the annual index as described above is also dependent upon having an estimate of the size of each area fished. In this instance as the *Area* effect included in the GLM relates to the Home/Island of the fisher (seller), then the area fished would correspond to the total area of lobster habitat around each Seller-Home. However, as there are no known estimates of the size of these areas, as an approximation the size of all areas around each Seller-Home was assumed to be the same (and set equal to 1). It can be noted that for those models which do not included an interaction with the *Season* effect (i.e. the main effects and Int-1 models), the relative abundance index, B_s, reduces to the simpler form:

$$B_s = \frac{exp(S_s)}{\frac{1}{NS}\sum_{i=1}^{NS} exp(S_i)}$$

where S_i , $i=1, NS$ are the parameters estimates relating to the *NS Season* effects included in the model. In these situations the abundance is independent of the relative size of each *Area* effect included in the analysis model.

The derivation of the annual index as described above is also dependent upon having an estimate of the stdCPUE in each *Season-Month-Area* stratum. However, catch and effort data are not available for all strata and for some models this prevents the estimation of the value of stdCPUE for some strata. For example, there are four *Season*Month* strata and eighteen *Season*Area* strata for which there are no fishing operations in the TIB data. The number of strata for which there are no data was also increased given the pre-analysis filtering of the data described previously. For the Main-Effects model these missing observations do not cause a problem, as the estimated stdCPUE in each *Season-Month-Area* stratum is just a linear combination of the values of the main effects, i.e.

$$f(S_s, M_m, A_a) = Season(s) + Month(m) + Area(a)$$

The value of stdCPUE could also be estimated for all strata in the Int-1 model as there are observations available for all eighty *Month*Area* strata. However, for the Int-2 and Int-3 models the value of stdCPUE could not be estimated for all strata. Where this occurred, the value of stdCPUE was back-filled using the corresponding value for that stratum from one of the previous models where this value could be estimated. In this way, a value of stdCPUE could be ascertained for all strata.

iv) Inclusion of Seller

Together with the four models described above, a second set of analyses was also undertaken where the Seller-Name (*Seller*) was also fitted as an additional effect to each of the models. To ensure that there was sufficient data for parameter estimation of each *Seller* effect only those sellers which had fished for three or more seasons and for which there were 30 or more data records were included in the analyses. This left a total of 38,901 records for 297 distinct Sellers. The Seller with the largest number of records was used as the reference Seller.

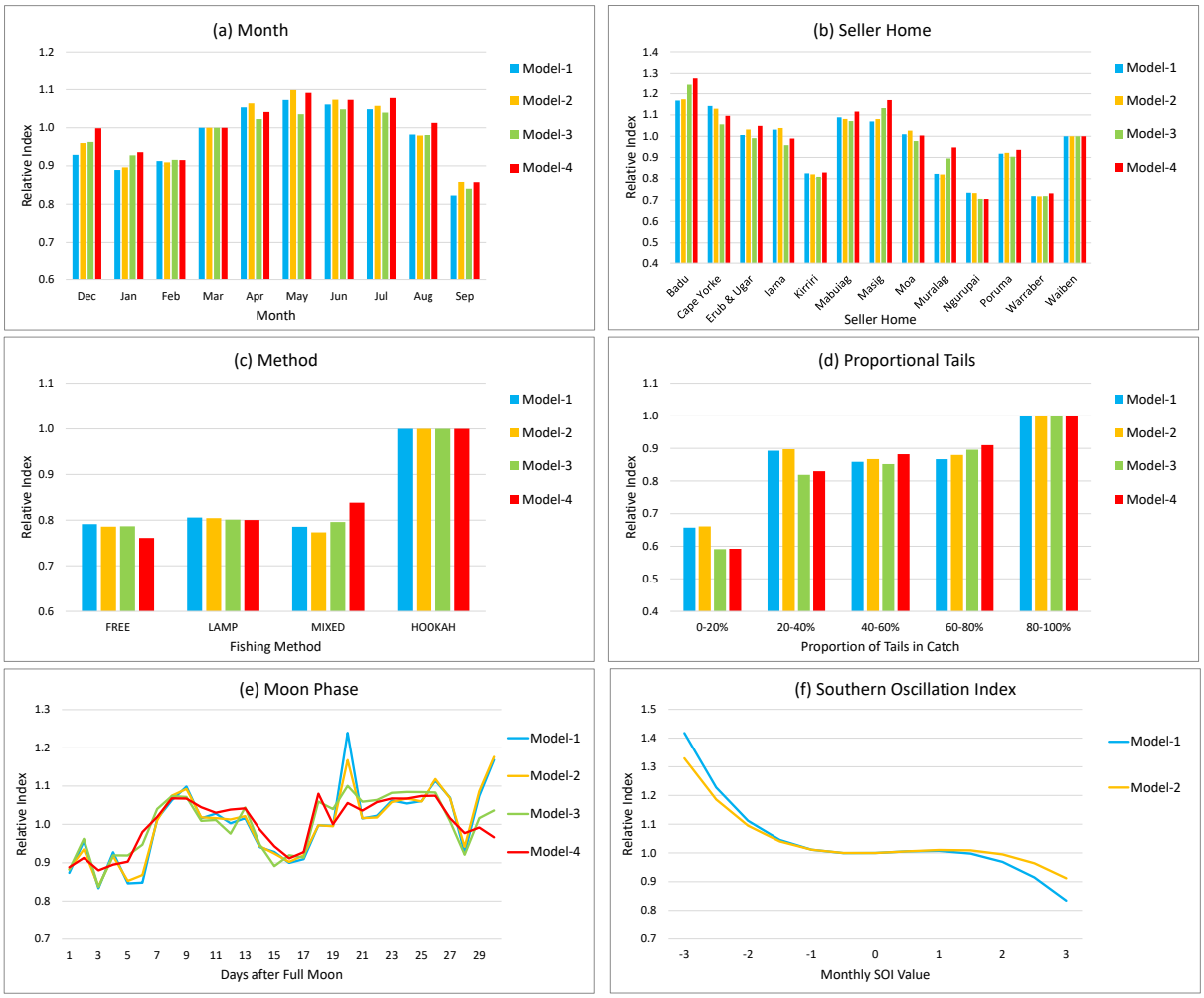
6. Results and Abundance Indices

i) Standardising Effects – No Seller Effect

Statistics for the Type-3 contrasts computed for each fitted effect indicated that each effect was highly significant. A comparison of relative influence of each level of the *Month*, *Seller-Island*, *Method*, *Proportion-Tails*, *SOI and Moon-Phase* effects for each model is shown in Figure 7. For each effect the values have been scaled so that the influence of each effect is relative to a selected reference level.

Relative catch rates between the eight months included in the model are seen to be reasonably consistent across the four models. Catch rates during December to February are generally lower than the average over all months, though rates in December are estimated to be higher than during January and February (which are around 9% lower than during the reference month, March). Across all models catch rates generally increase from February to May, when rates are on average around 7.5% higher than during March. Catch rates remain relatively high during July before declining during August and reaching a seasonal low during September (~15% less than March).

Figure 7. Comparison of relative influence of each level of the Month, Area, Method, Percent-Tails, SOI and Moon-Phase effects for the four GLMs where Seller-effect is not included. Note, for each effect the values have been scaled so that the influence of each effect is relative to that of the last level of each effect (i.e. Month=March, Area=Waiben, Method= Hookah, %-Tails= '>80%', and Moon-Phase=Mean over all phases).



Relative catch rates between the 13 areas (Seller-Homes) included in the GLM are again seen to reasonably consistent across the four models. Across all models and areas catch rates are estimated to be highest in Badu (on average 21% higher than in the reference area, Waiben) followed by Cape Yorke, Mabuiag and Masig where catch rates are on average around 9-11% higher than in Waiben. Catch rates are estimated to be lowest (around 28% lower than Waiben) around Ngurupai and Warraber,

The relative catch rates of each fishing method also show reasonable consistency across all models. Catch rates for free-diving, lamp fishing and mixed methods are estimated to be similar, being on average 20-22% below the reference method, Hookah fishing.

Finally, despite relative catch rates being estimated to be somewhat higher for Models 1 and 2 when tails make up less than 40% of the total catch., in general the pattern of catch rates across all models is similar, with the relative catch rates generally increasing as the *Proportion-Tails* increases in the catch. On average, catch rates in sets where tails make up only 0-20% of the
total catch are 37% lower than sets included in the reference level, 80-100% tails). This difference diminishes for the other levels (20-80% tails) where the estimated catch rates vary between 18-10% lower than the reference level (>80% tails).

Of the two environmental effects, the influence of the Moon-Phase on catch rates, shown in Figure 7e, displays an interesting bi-modal distribution across the days between successive full moons. Catch rates are lowest during days near a full moon and also low around a new moon, while catch rates are highest mid-way between these two phases (i.e. around the first and last quarters). During these latter periods estimated catch rates are up to 35% higher than at the time of a full moon (but vary by around 23% for Model 4). A similar pattern across moon-phases was also seen in the analysis of the TVH data.

The influence of the SOI on catch rates, shown in Figure 7f, indicate that high negative values of the SOI (i.e. strong El Nino conditions) tend to marginally increase catch rates while the influence of high positive values of the SOI (i.e. strong La Nina conditions) decrease catch rates. This result is different from that found when analysing the TVH data. However, there is a high level of uncertainty associated with these results as over the 175 months between January 2004 and October 2021 there have been only 3 months where the mean monthly value of the SOI has been less than -20, and 6 months where this value has been greater than 20, and between these values the influence of the SOI is seen to be relatively small.

ii) Annual Abundance Indices – No Seller Effect

The seasonal abundance indices based on each of the four GLM models discussed in the previous section are listed and displayed in Table 8 and Figure 8 respectively. Relative to the nominal index, each of the standardised indices displays a number of substantive shifts, generally being lower than the nominal index over the first half of the time-series and higher than the nominal index during the second half (i.e. since 2014). The reasons for these changes can be investigated using the seasonal influence of each main effect which is shown in Figure 9 for the Main-effects model. The influence on the seasonal index is seen to be greatest for the *Proportion-Tails* effect, and the decreasing trend observed over time is correlated with the shift from the catch being predominantly tails to now being predominantly whole lobsters (c.f. Figure 10a), with the latter process type decreasing catch rates (c.f. Figure 7d).

The influence in the four other main effects included in the model is small over each season. The small influence of the Method effect over time is likely due to the observation that, despite some differences

between seasons, there is no overall trend in the proportion of sets using each method during most seasons. The small positive influence of the method effect between 2014 and 2016 appears to be due to the lower proportion of lamp fishing sets and the higher proportion of hookah sets during that period (cf. Figure 10b). The small negative influence of the method effect after that time is also likely due to the decrease in the proportion of hookah sets. The lack of influence for the moon effect is likely since the proportion of fishing sets around the phases of the moon is also likely to have remained substantially similar over the seasons. On the other hand, the lack of influence for the month and area effects between seasons is due to the fact that the observations in the analysis were weighted so that the weighted number of observations in each Season-Month-Area stratum was effectively the same. Removing this strata weighting (as shown in Figure 9b) indicates that the area effect does have a small influence between seasons, no doubt due to the seasonal shifts of lobster abundance between areas and the ability of the fishing effort to follow these shifts.

Several criteria for assessing the goodness-of-fit for each of the GLM models are shown in Table 9. For each criterion (where smaller is better) there is a general improvement in the fit between each successive model implying that the model which includes the 3-way *Season*Month*Area* interaction generally provides the best fit to the data (though Model-3 was considered to have the best fit based on the often-used BIC-criteria). The full 3-way interaction model has considerably greatly flexibility in accounting for inter-annual changes in the distribution of the resource across the different months and areas in comparison to the Main-Effects model which assumes that these distributions are the same for all seasons. However, the number of parameters (1796) estimated in the full interaction model is considerably greater than the number of parameters (76) estimated in the Main-Effects model. A consequence of the increase in the number of parameters is that the number of observations on which some of the parameters rely to be estimated can be small (or in some instances zero). A small number of observations increases the likelihood that the corresponding parameter is poorly estimated. The number of strata where a value from a previous model was used to estimate a value of stdCPUE for those Season-Month-Area for which there were no observations is also shown (being 5% and 20% for Models 3 and 4 respectively). Despite these issues, the resulting annual indices were found to be similar between the different models.

Table 8. Relative abundance indices for the TIB fishery based standardised annual CPUE estimated using GLMs with no Seller-effect included. Note, each index is scaled so that the mean of the index over all seasons is equal to 1.

Season	Nominal	Main-Effects	Int - M*A	Int - S*M+S*A+M*A	Int - S*M*A
2004	0.970	0.849	0.847	0.781	0.775
2005	1.178	0.971	0.983	0.899	0.892
2006	0.776	0.723	0.735	0.688	0.687
2007	0.939	0.838	0.852	0.775	0.762
2008	0.911	0.748	0.761	0.731	0.728
2009	0.841	0.896	0.905	0.906	0.906
2010	0.927	0.963	0.959	0.977	0.984
2011	1.480	1.344	1.341	1.362	1.360
2012	1.211	1.108	1.101	1.043	1.051
2013					
2014	0.940	0.954	0.969	0.994	1.004
2015	0.688	0.805	0.794	0.734	0.737
2016	0.944	1.101	1.082	1.061	1.065
2017	0.801	0.959	0.962	0.954	0.948
2018	0.844	0.883	0.883	0.916	0.916
2019	1.125	1.300	1.262	1.341	1.338
2020	1.400	1.422	1.431	1.461	1.459
2021	1.024	1.137	1.133	1.378	1.387

Figure 8. Relative indices of resource availability based on the four GLMs not including a Seller-effect fitted to the catch and effort data for the TIB fishery.

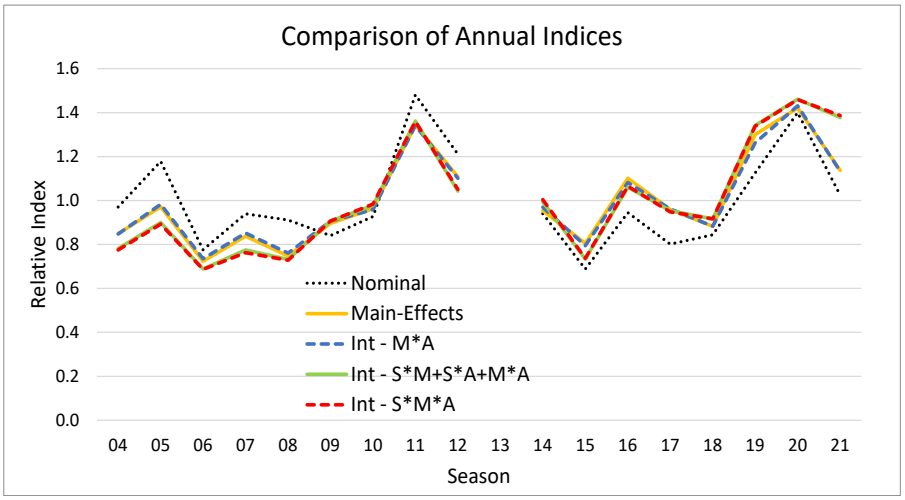


Figure 9. Seasonal influence of the fixed effects fitted to the Main-Effects model. Results are shown for models where the observations in each *Season*Month*Area* stratum are either (a) weighted or (b) not weighted.

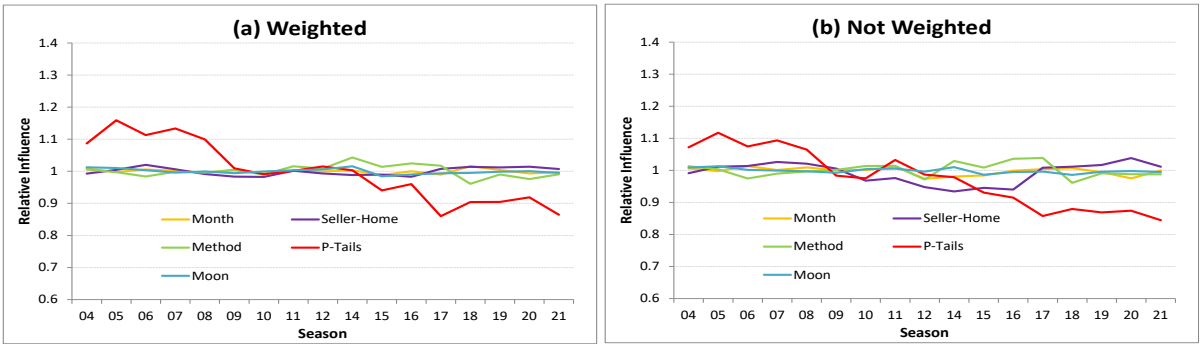


Figure 10. Percent of total annual catch (whole weight) by processed form.

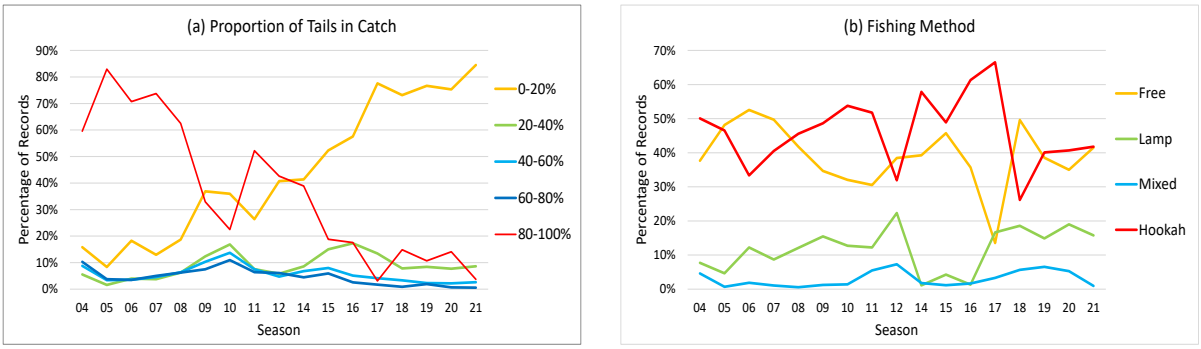


Table 9. (a) Criteria for assessing the goodness-of-fit of each GLM not including the Seller-effect. The model displaying the best fit using either the AIC or BIC goodness-of-fit criteria is shown by the shading, and (b) the number of *Season*Month*Area* strata for which the value was back-filled using a previous model.

(a)

Criteria	Main-Effects	Model-2	Model-3	Model-4
N-records	44,420	44,420	44,420	44,420
N-parameters	76	184	507	1796
Deviance	23,399	22,801	18,665	14,322
Pearson Chi-Square	33,668	30,416	22,725	15,611
Log Likelihood	-215,232	-214,544	-209,293	-202,499
AICC (smaller is better)	430,619	429,460	419,604	408,594
BIC (smaller is better)	431,298	431,078	424,033	424,239

(b)

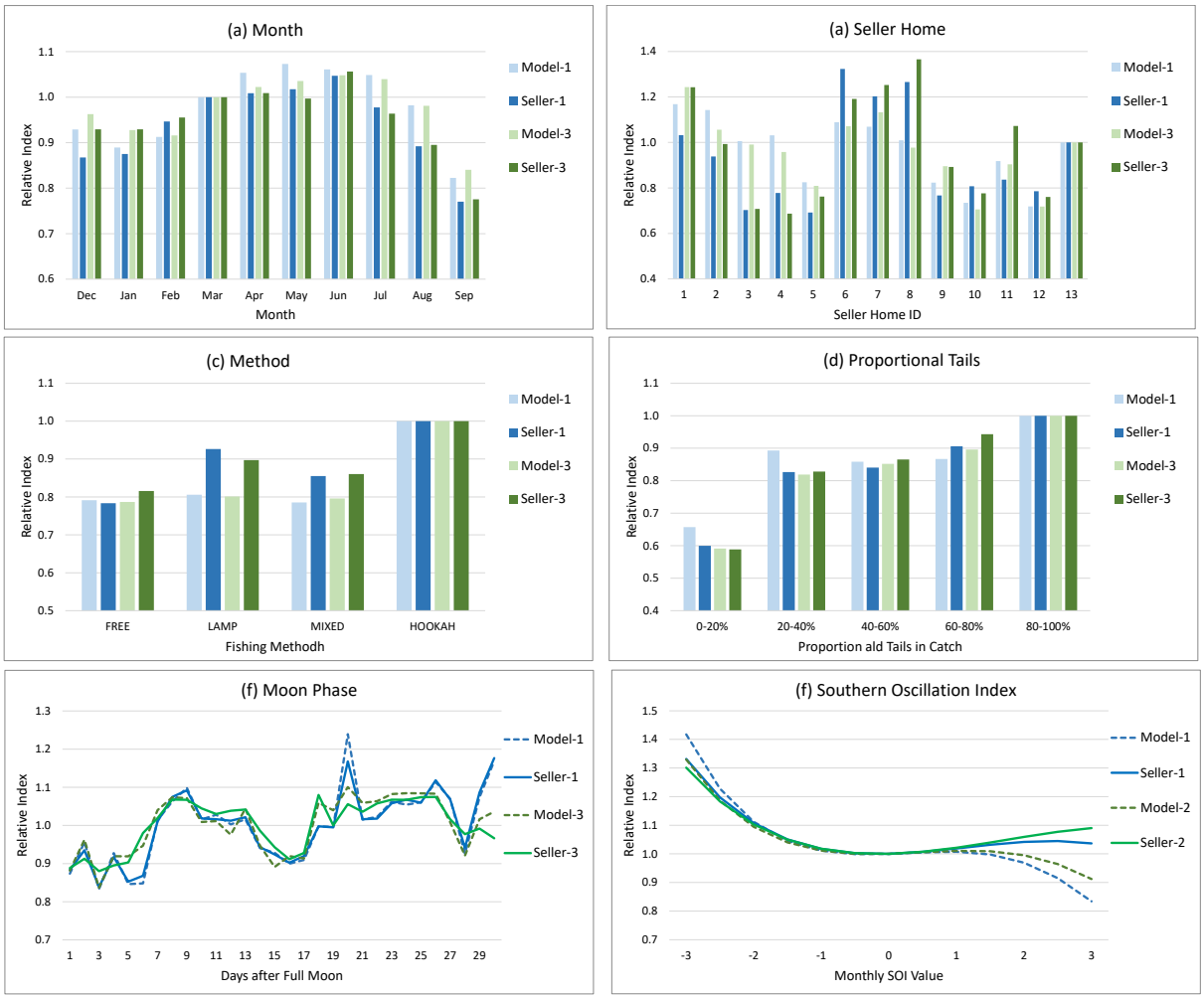
N-Strata	2210	2,210	2,210	2,210
N-Back-filled	0	0	109	449
%-Back-filled	0%	0%	5%	20%

iii) Standardising Effects – With Seller Effect

As with the previous four models, which did not include the Seller-effect, statistics for the Type-3 contrasts computed for each fitted effect for the four models which did include the Seller-effect also indicated that each effect was highly significant. A comparison of relative influence of each level of the *Month, Seller-Island, Method, Proportion-Tails, SOI and Moon-Phase* effects for the two GLMs where Seller-effect is not included (Model-1 and Model-3) and the two corresponding GLMS where the Seller-effect is included (Seller-1 and Seller-3) is shown in Figure 11. For each effect the values have been scaled so that the influence of each effect is relative to a selected reference level.

For each main effect, while there is some variation in the relative effect for each level, the overall pattern of relative effects is similar between those models with and without the Seller-effect included. For example, there is a general increase in catch rates from December to June and then a considerable decline in catch rates through to September, and again there is a general increase in catch rates with an increase in the proportion of tails in the catch. The influence of the two environmental effects is also seen to be similar. However, there are some differences between the two types of models for the different methods. The models including the Seller-effect estimate higher relative catch rates for lamp fishing (and to some extent for the mixed methods) in comparison to the models without the Seller-effect.

Figure 11. Comparison of relative influence of each level of the Month, Area, Method, Percent-Tails, SOI and Moon-Phase effects for the two GLMs where Seller-effect is not included (Model-1 and Model-3) and the two corresponding GLMS where the Seller -effect is included (Seller-1 and Seller-3). Note, for each effect the values have been scaled so that the influence of each effect is relative to that of the last level of each effect (i.e. Month=March, Area=Waiben., Method= Hookah, %-Tails= '>80%', and Moon-Phase=Mean over all phases).



iv) Annual Abundance Indices – With Seller Effect

The seasonal abundance indices based on each of the four GLM models including a Seller-effect are listed and displayed in Table 10 and Figure 12 respectively. As with the previous set of indices shown in Figure 8, the seasonal trend for four indices is again seen to be very similar. Furthermore, as before the value of the index is higher in 2021 for Model-3 and Model-4 than for the other two models. However, for the same underlying GLM a comparison of the annual index based on the model which does not include a Seller-effect and that which does indicates some substantial differences in seasonal trends (c.f. Figure 13). For the two models shown, the seasonal index based on GLM including the Seller-effect is considerably flatter than the index based on the model not including the Seller-effect. The former is generally higher before 2010 and lower since 2017, though this difference is quite appreciable over the last three seasons since 2019. The reason for this difference can again be investigated using the seasonal influence of each main effect which is shown in Figure 14 for the Main-effects model. The influence of the main effects is similar to that observed previously in the models with no Seller-effect (c.f.

Table 10. Relative indices of seasonal resource availability for the TIB fishery based standardised annual CPUE estimated using GLMs with the Seller-effect included. Note, each index is scaled so that the mean of the index over all seasons is equal to 1.

Season	Nominal	Main-Effects	Int - M*A	Int - S*M+S*A+M*A	Int - S*M*A
2004	0.982	0.924	0.929	0.881	0.855
2005	1.168	1.046	1.054	0.997	1.025
2006	0.779	0.769	0.782	0.757	0.755
2007	0.936	0.885	0.901	0.854	0.880
2008	0.910	0.841	0.846	0.852	0.866
2009	0.832	0.975	0.974	1.004	1.052
2010	0.938	1.000	1.006	0.971	0.985
2011	1.451	1.348	1.336	1.373	1.428
2012	1.183	1.163	1.170	1.132	1.141
2013					
2014	0.912	0.988	0.986	1.023	0.978
2015	0.685	0.860	0.847	0.801	0.776
2016	0.934	1.044	1.027	1.068	1.035
2017	0.804	0.918	0.928	0.911	0.910
2018	0.839	0.865	0.866	0.860	0.847
2019	1.173	1.118	1.108	1.142	1.141
2020	1.430	1.234	1.226	1.229	1.212
2021	1.044	1.024	1.015	1.144	1.116

Figure 12. Comparison of the relative indices of seasonal resource availability for the TIB fishery based on the four GLMs including a Seller-effect fitted to the catch and effort data.

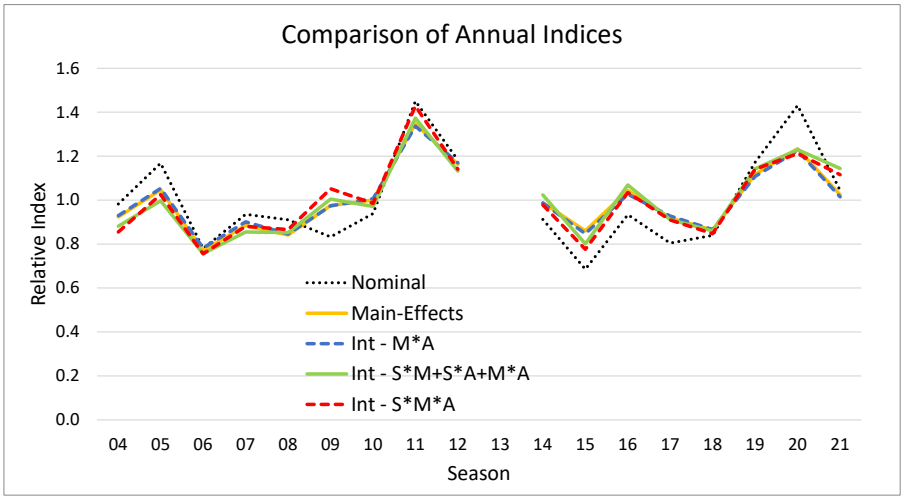
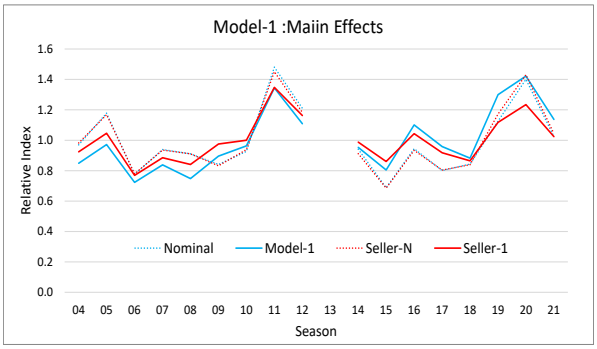


Figure 13. Comparison of the annual index of resource availability based on the GLMs which do not include a Seller-effect (Model-1 and Model-3) and GLMs which do include a Seller-effect (Seller-1 and Seller-3). Note, Seller-N is the nominal index for these latter models.



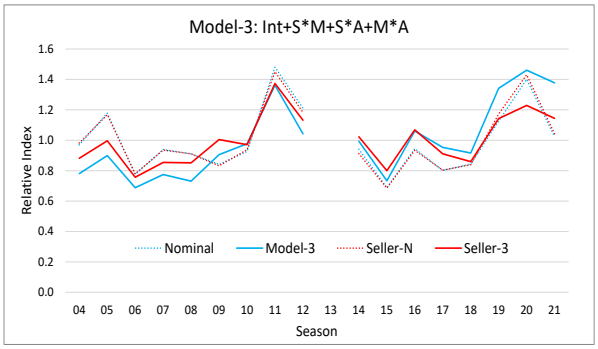


Figure 14. Seasonal influence of the fixed effects fitted to the Main-Effects model. Results are shown for models where the observations in each *Season*Month*Area* strata are either (a) weighted or (b) not weighted.

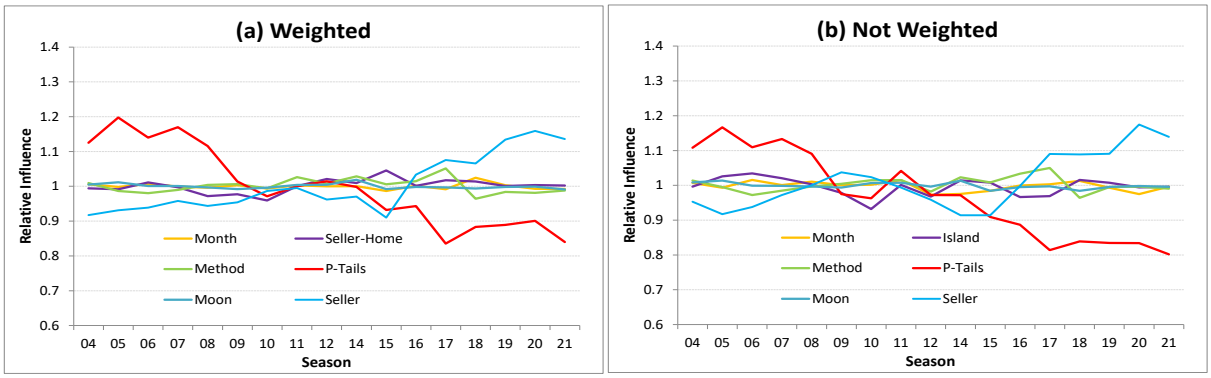


Figure 9) but the relative influence of the Seller-effect in this second set of GLMs is seen to be substantial. The negative influence before 2010 helps explain the higher value of the Seller-based index during this period and the positive influence since 2017 also explains the lower value of this index since that season. This general trend in the influence of the Seller-effect can possibility be explained by a general increase in the skill or efficiency of the Sellers in the fishery over time. Accounting for this increase results in a flatter abundance index over the period analysed.

Table 11. (a) Criteria for assessing the goodness-of-fit of each GLM. The model displaying the best fit using either the AIC or BIC goodness-of-fit criteria is shown by the shading, and (b) the number of *Season*Month*Area* strata for which the value was back-filled using a previous model.

(a)

Criteria	Main-Effects	Model-2	Model-3	Model-4
N-records	38,901	38,901	38,901	38,901
N-parameters	371	479	800	2020
Deviance	16,076	15,591	13,715	10,360
Pearson Chi-Square	20,286	19,031	16,052	10,965
Log Likelihood	-183,996	-183,301	-180,417	-174,219
AICC (smaller is better)	368,739	367,565	362,437	352,482
BIC (smaller is better)	371,935	371,686	369,310	369,808

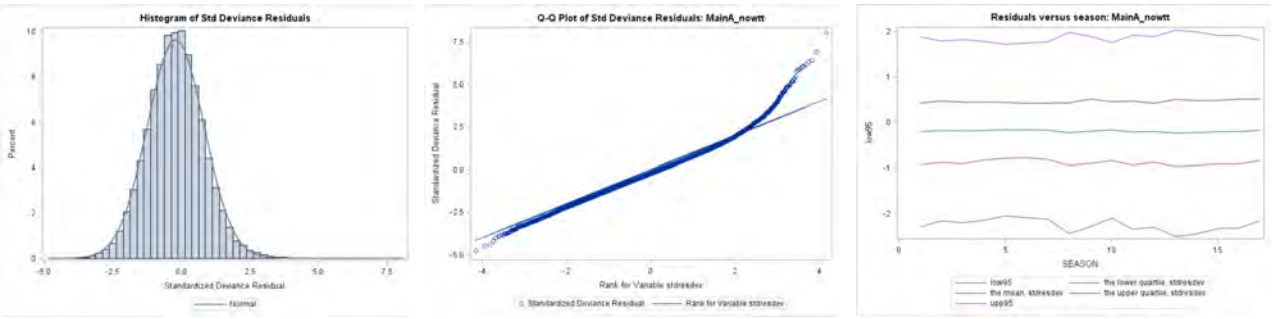
(b)

N-Strata	2210	2,210	2,210	2,210
N-Back-filled	0	0	129	520
%-Back-filled	0%	0%	6%	24%

As for the previous set of models, several criteria for assessing the goodness-of-fit for each of the GLM models including the Seller-effect are shown in Table 11. Again, there is a general improvement in the fit between each successive model implying that the model which includes the 3-way *Season*Month*Area* interaction generally provides the best fit to the data, though again Model-3 is considered to have the best fit based on the often-used BIC-criteria. The number of parameters in these models is greater due to the addition of the 297 Sellers, and again around 24% of the stdCPUE in each *Season*Month*Area* stratum have been back-filled in Model-4.

Finally, several plots displaying the distribution of the residuals fitted to the full interaction model (Model-4) are shown in Figure 15 and indicate a relatively good fit of the model to the data. However, the lack of linearity in the right side of the Q-Q plot indicates that the assumption of a log-gamma distribution is not satisfied for all observations, most likely related to the over-dispersion of the distribution of catches (i.e. a few observations with very large catches).

Figure 15. Analysis of residuals for Model 4 with the Seller-effect included.



7. Sensitivity Runs

The following additional sets of model runs were performed to investigate the sensitivity of the model results to changes in i) how effort was modelled, ii) deletion of catch outliers, and iii) data preparation.

i) Changes to Data

The following two sets of sensitivities were undertaken based on the following changes to the data fitted to each model:

Changes to Effort

The TIB docket-book requests that Sellers (fishers) record the following two measures of effort on the Docket-Book:

1: Number of days fished 2: Number of fishers

The total measure of fishing effort can then be calculated as:

Effort = Days-fished * Number of fishers

As noted previously, the number of fishers recorded on Docket-Books has varied between 1 and 14 but only records where the number of fishers was less than 4 were included in the data for analysis. The distribution of fisher number by season for this data is shown in Figure 15. However, there is ambiguity about the number of fishers recorded on the Docket-Books. For example, if there are two people in the boat but only one diver in the water at any one time then the number of fishers should be 1, but perhaps 2 are recorded on the Docket-Book. For all the TIB indices calculate in the previous sections it has been assumed that the number of fishers was 1 for all data records. Here, two additional sensitivities were run where Effort = Days fished * Number of fishers and:

E-1: Number of fishers, N = Number recorded in Docket-book

Changes to Maximum catch

As noted in the data preparation section, to remove the influence of possible outliers in the data all records where the catch was greater than 500kg per set were not included in the data fitted to the GLMs. Here, two additional sensitivities were run where the maximum catch was reduced:

C-1 : Remove records where the total catch weight was greater than 300 kg.

C-2: Remove records where the total catch weight was greater than 200 kg.

Changes to Effort and Maximum Catch

Finally, we investigate the influence of combining the above changes as follows:

EC-1 : Combine E-1 and C-1.

EC-2: Combine E-2 and C-2.

Figure 15. Distribution of the number of fishers recorded in Docket-Books by season for the data fitted to the GLMs described in the text.

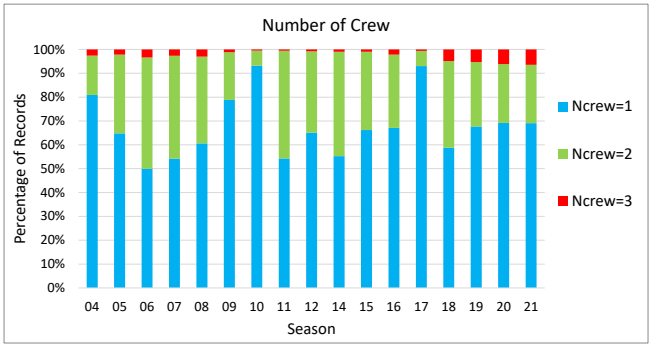
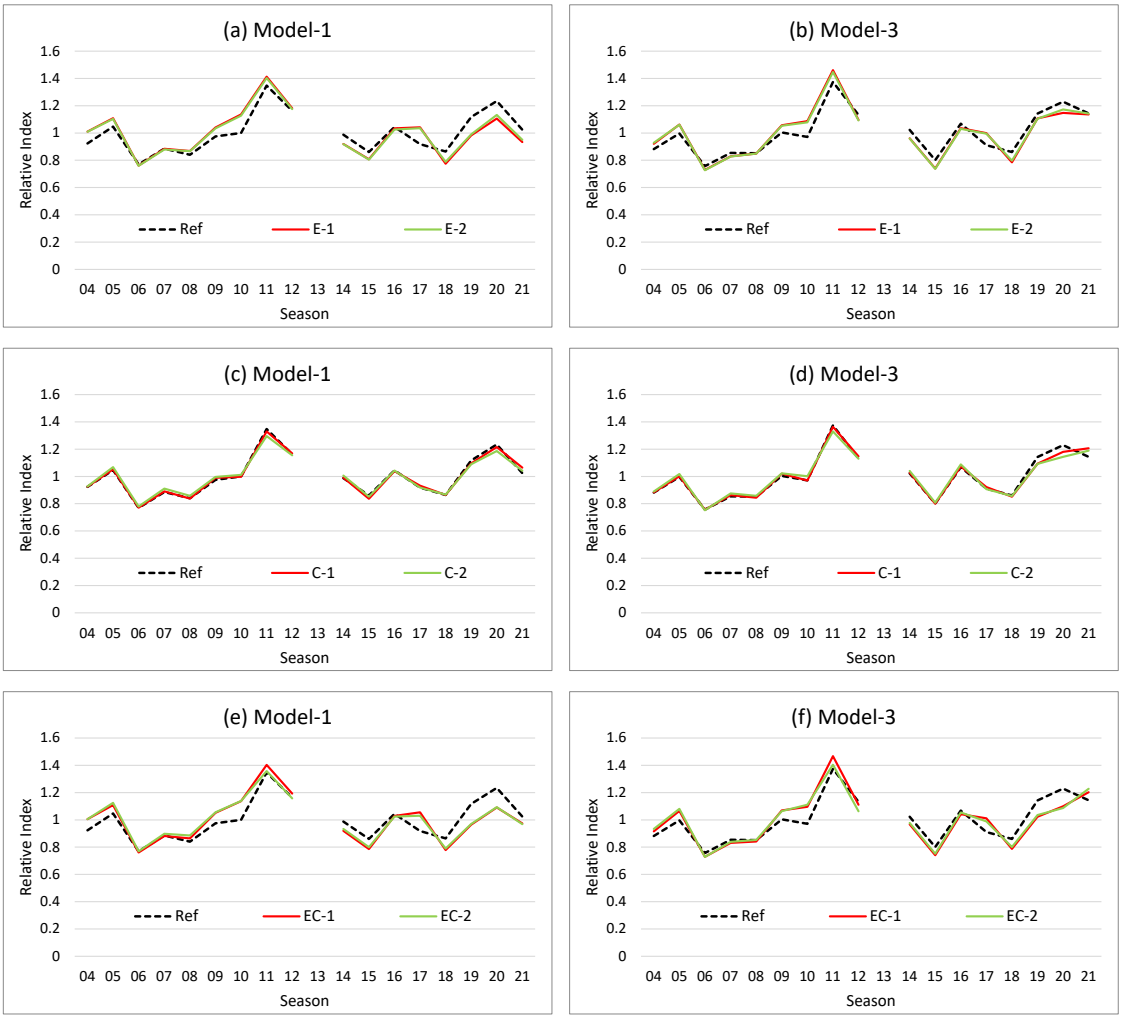


Figure 16. Comparison of annual indices based on changes to the effort and maximum catch fitted to each GLM. Results are based on fitting Model-1 and Model-3 to the GLM with the Seller-effect included. The reference index (Ref) for each model is that shown in Figure 12.



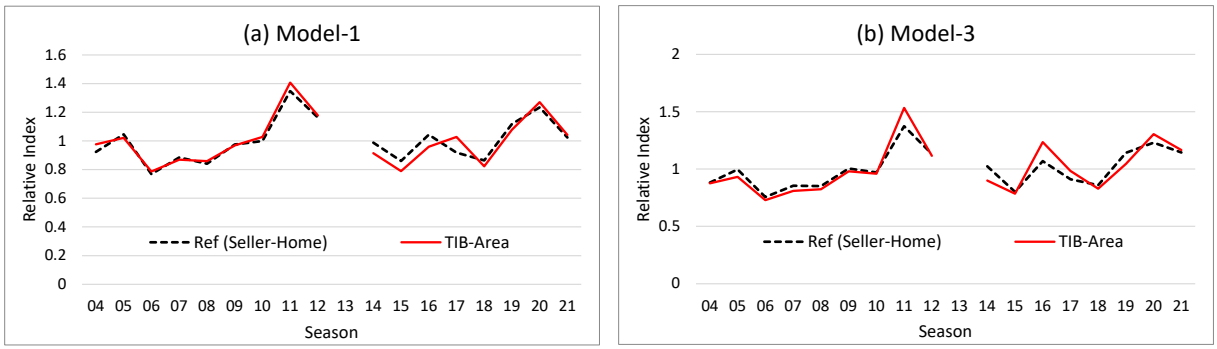
A comparison of the resulting indices with the previous Seller index based on the previously used assumptions are shown in Figure 16. The inclusion of the Number of Crew in the definition of effort results in some changes from the reference index, particularly in the latter seasons for Model-1, though the indices are similar for the two sensitivities. These changes can be correlated with seasonal changes in the proportion of records with different levels of the number of crew. Changing the maximum level of catch in the data fitted to the GLMS is seen to have little influence on the resulting annual index (c.f. Figures 16c,d), though the index for Model-3 in 2021 is higher than that for the reference model.

The changes in the indices when both changes to the data are combined are similar to those seen in the effort changes alone, though the index for Model-3 between 2018 and 20120 is lower than any of the other indices but again shows a continued increase in 2021 compared to the reference index.

ii) Changes to Area-Fished

Instead of the *Seller-Island* term, the *Area*-Effect included in the model was based on the TIB-Area as recorded on the Docket-Books (as has used in the analyses presented in years before 2019). The Areas-effect was limited to the 12 areas listed in Table 7. After removing records where the TIB-Area was not recorded, the remaining 38,288 data records were fitted to the reference GLM with Seller-effect included. Comparison of the annual index based on fitting either the Seller-Home or TIB-Area as the Area-effect in the GLM is shown in Figure 17. Whilst there are some differences in the value of the index in some seasons, the overall trend over the entire period is similar for the two models.

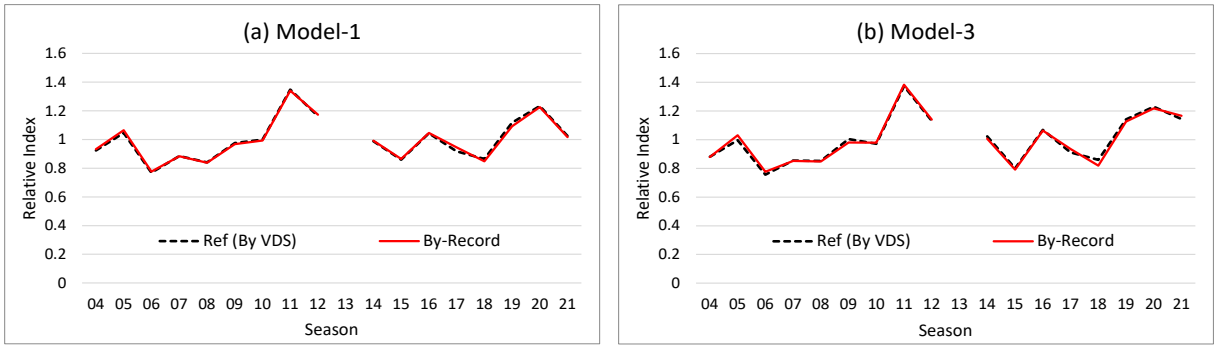
Figure 17. Comparison of annual indices based on changes to Area-effect fitted to each GLM. Results are based on fitting Model-1 and Model-3 to the GLM with the Seller-effect included. The reference index (Ref) for each model is that shown in Figure 12.



iii)Changes to Level of Data Aggregation

As discussed previously when preparing the data for analysis (c.f. Section 4), catch observations associated with multiple Record-No for a given vessel, date and seller-name were excluded. As an alternative, a second data set was prepared where instead of aggregating the data at the VDS level, the data was aggregated at the level of the Record-No. After the same level of filtering as before, 42,134 data records were fitted to the GLM models with the Seller-effect included. Comparison of the annual indices based on both data sets is shown in Figure 18 and indicates that the index is insensitive to these differences in data aggregation.

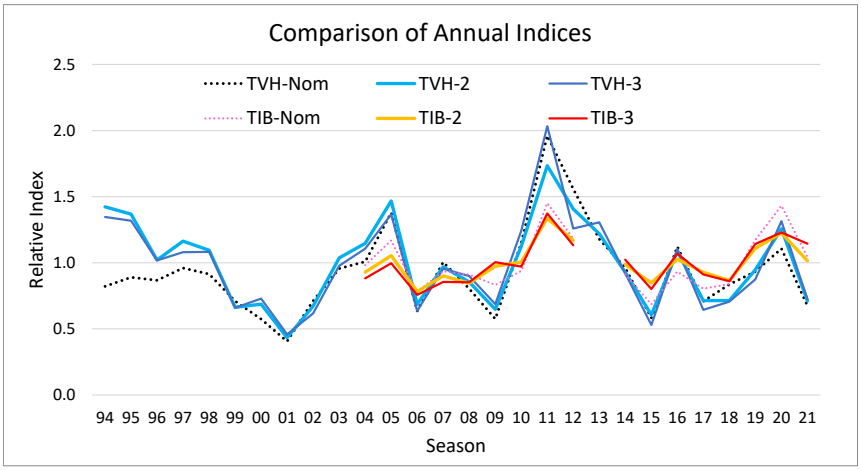
Figure 18. Comparison of annual indices based on data aggregated at the VDS or Record-No level. Results are based on fitting Model-1 and Model-3 to the GLM with the Seller-effect included.



8. Comparison with TVH indices

A comparison of the TIB abundance indices based on the Model-2 and Model-3 GLMs fitted with a Seller -Effect included with the corresponding indices based on the same models fitted to the catch and effort data from the TVH fishery is shown in Figure 18. A number of differences are seen between each set of indices. In particular, the standardised TIB indices each display a considerably flatter trend over time than the TVH indices. Despite this, the peaks and troughs in each of the TIB and TVH indices generally coincide. For example, local maximum occurs for the 2005, 2011, 2016 and 2020 seasons while local minimum occur for the 2006, 2015 and 2018 seasons. However, the local minimum observed in the TVH indices in 2009 is not observed in the TIB index. As both the TIB and TVH fisheries are fishing the same resource, the similar trends observed in these results should not be unexpected. The reasons for the flatter trend in the TIB indices remain uncertain and warrants further investigation but may be due to the nature of the data collected from this fishery, in particular the courser scale measure of effort collected from the TIB fishery (day) in comparison to that collected in the TVH fishery (hours). Also, the spatial extent of the fishing in the TIB fishery may be different, as the generally smaller boats used in this sector of the fishery are likely not able to cover the same extensive fishing grounds away for the islands as occurs in the TVH sector. Some form of hyper-stability in catch rates in the TIB-sector also cannot be ruled out.

Figure 18. Comparison of the selected TIB and TVH resource indices. All indices are scaled so the average over the seasons 2004-2012 and 2014-2021 is equal to one.



9. Concluding Remarks

For the Torres Strait rock lobster fishery there are currently two sources of catch and effort data, those for the TVH and TIB sectors. The TRL04 Logbook data from the TVH sector is believed to provide a relatively complete and good source of catch and effort data for this sector (e.g. Campbell et al, 2018). Improvements in compliance to ensure that all fields in the Logbook are completed (e.g. area fished and hours fished) would improve the utility of these data. Also, a better recording of the locations of the fishing effort (i.e. at the tender level) would also improve the accuracy of the data for standardising catch rates. On the other hand, the data for the TIB sector is less complete and the measure of effort (days fished) is less accurate and incomplete in many instances. There also remains problems with the way in which the area-fished in the TIB is recorded, and what is the correlation between what is recorded and where the fishing actually occurs. However, given the potential for this sector to grow in importance in future years there is a need to assess the utility of these data to provide a useful index of resource abundance.

The results presented above indicate that while the TIB-based indices have the potential to capture the major trends stock abundance, they likely lack the detail required to track finer inter-annual trends in abundance. There are several reasons for this outcome. In particular, the measures of catch and effort in the TIB data are coarser (trip-based) compared to the tender-hours based data for the TVH data. Indeed, for the TIB data it remains unknown how many hours per trip fishing actually occurred and whether there are differences between the different sellers and trends over the years. Also of concern is the likely lack of accuracy of the data related to the Area fished being recorded in the docket books, as this is likely to be highly influential variable in helping to account for the annual variability in catch rates across the fishery. Whether or not the use of the Seller-address can help overcome this issue needs further investigation and discussion at the TRL-RAG.

Finally, it has been noted that many of the voluntary fields in the TDB02 Docket-Book relating to fishing effort have not completed in recent seasons, and while improvements in supplying this information have been noted in some seasons it was disappointing to observe a continued and substantial level of non-reporting of this information in recent seasons (c.f. Figure 5). While the recording of several data fields (e.g. Fisher Name, Fisher Type, Boat Symbol, and catch details) are mandatory on the TDB02 form, it is also essential that the other fields in the voluntary sector of the form (e.g. detailing fishing effort and methods) are completed if the required information is to be available for standardising the TIB catch and effort data. As with the TVH data, continued effort needs to be placed on ensuring the completeness and accuracy of these data if they are to be used on a continuing basis. Toward this end, Torres Strait TRL_RAG Data Sub-Group has commenced a process to review the data collected and the data requirements in the fishery for both assessment and management purposes (Anon, 2019) and this process needs to continue.

References

Anon. 2019. Report of the Torres Strait Tropical Rock Lobster Resource Assessment Group (TRLRAG) Data Sub-Group Meeting 1, held 18 June 2019, Cairns.

Campbell, R.A., 2016a. Data issues pertaining to the Torres Strait rock lobster fishery – discussions with AFMA. Information paper presented to the 18th meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 2-3 August 2016, Thursday Island.

Campbell, R.A., 2016b. Separating TIB, TVH and Processor catch records from Docket-Book Data. Report to AFMA.

Campbell, R.A, Dennis, D., Plaganyi, E., Deng, R., 2017. Use of TIB Logbook Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2017 Update. Information paper presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12-13 December 2017, Cairns.

Campbell, R.A., Pease, D. 2017. Separating TIB, TVH and Processor catch records from Docket-Book Data. Report to AFMA – 2017 Update. Information paper to be presented to the 21st meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 12-13 December 2017, Cairns.

Campbell, R.A, Plaganyi, E., Deng, R., 2018. Use of TIB Logbook Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2018 Update. Information paper presented to the 24th meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 18-19 October 2018, Cairns.

Appendix A (i). The old Buyers and Processors Docket Book (TDB01) used in the TIB sector of the Torres Strait rock lobster fishery before the introduction of the TDB02 Docker Book in December 2017 (shown in Appendix A (ii)).

Torres Strait Seafood Buyers and Processors Docket Book

RECIPIENT CREATED TAX INVOICE

FOR Name:.....

Address:.....

.....

A.B.N.:.....Lic. No. .....

Seller:				**Book No.**	**Page No.**
Seller's ABN:		Seller's Licence No.			
Seller's Address:			Date:		

Fishing effort and boat details – Traditional Inhabitant Boat (TIB) only

Boat symbol:		No. of divers/fishers:	
Days fishing:		Area fished: From map (write no. of area most fished)	

Methods used: (tick box, use more than one if needed)
☐ Hookah (MDH) ☐ Handline (LHL) ☐ Drop line (LDR)
☐ Free dive (MDF) ☐ Rod and reel (LRR) ☐ Other–specify
☐ Lamp fishing (MLF) ☐ Troll (LTL)

Non Traditional Inhabitant Boat (TIB) fishers & buyers of PNG & east coast product only

Region Fished: (tick box) ☐ Torres Strait ☐ East Coast Queensland ☐ Papua New Guinea

Has the seller recorded their catches elsewhere?: (tick box)
☐ YES (please indicate) → ☐ TRL04 Logbook ☐ TSF01 Logbook ☐ Other →
☐ No

Details of catch being sold

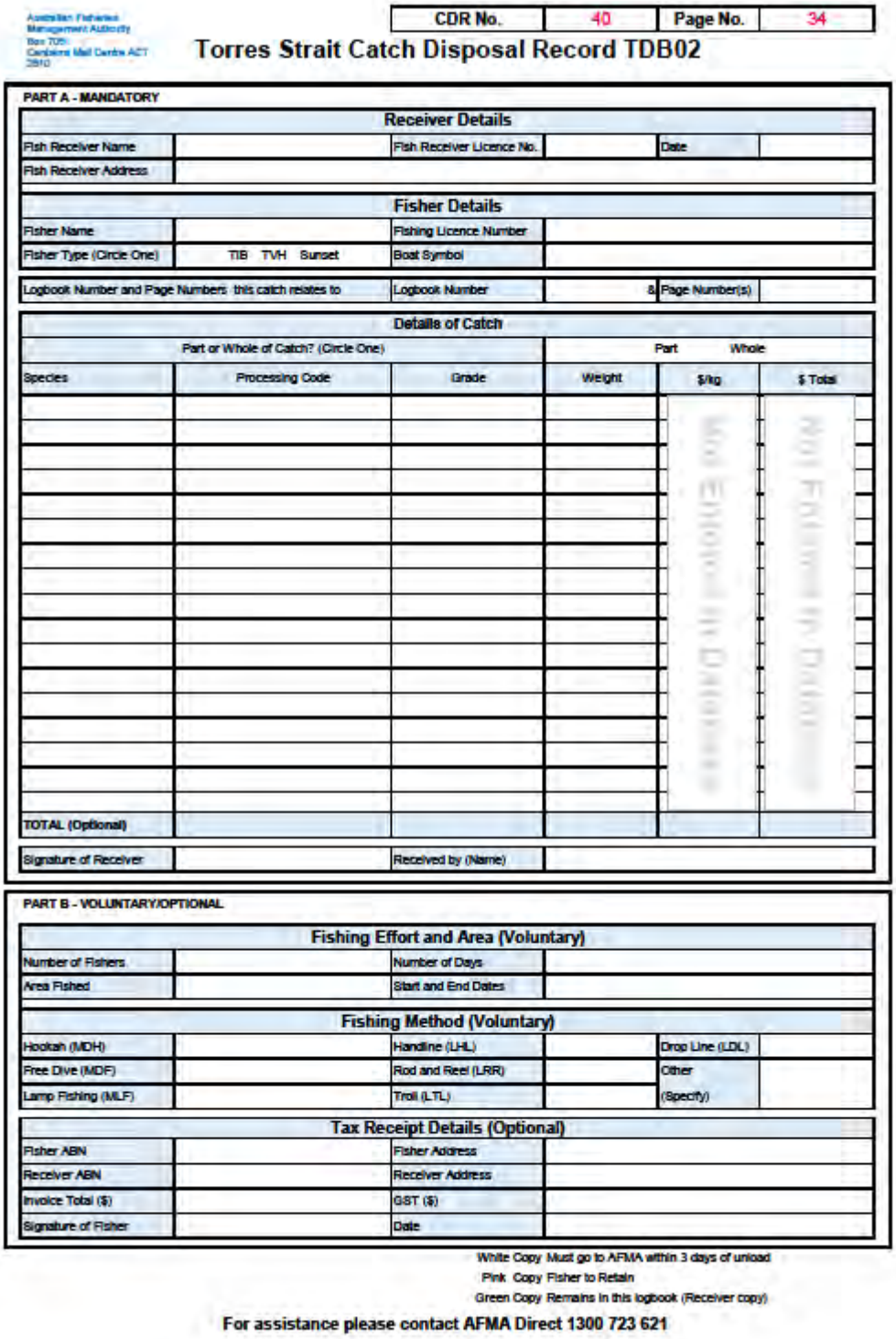
Species	Processing Code	Grade	Kg	$/Kg	$/Kg	Amount
				SEEN BY AFMA (OPTIONAL)	NOT SEEN BY AFMA	NOT SEEN BY AFMA
Completed by:					Subtotal	
Signature:					GST	
Payment received:					**TOTAL**	

Australian Fisheries Management Authority
PO Box 376
Thursday Island QLD 4875

For assistance
Phone: (07) 4069 1990
Fax: (07) 4069 1277

WHITE COPY: **Fisher** (seller)
YELLOW COPY: **AFMA**
PINK COPY: **Buyer** (you)

Appendix A (ii). The new mandatory Torres Strait Catch Disposal Record (TDB02) used in the Torres Strait rock lobster fishery since the start of the 2017/18 fishing season.



Australian Fisheries Management Authority
Box 7051
Canberra Mail Centre ACT 2610

CDR No.	40	Page No.	34

Torres Strait Catch Disposal Record TDB02

PART A - MANDATORY

Receiver Details					
Fish Receiver Name		Fish Receiver Licence No.		Date	
Fish Receiver Address					

Fisher Details			
Fisher Name		Fishing Licence Number	
Fisher Type (Circle One)	TIB TVH Sunset	Boat Symbol	

Logbook Number and Page Numbers this catch relates to	Logbook Number	&	Page Number(s)

Details of Catch

Part or Whole of Catch? (Circle One) — Part Whole

Species	Processing Code	Grade	Weight	$/kg	$ Total
TOTAL (Optional)					

Signature of Receiver		Received by (Name)	

PART B - VOLUNTARY/OPTIONAL

Fishing Effort and Area (Voluntary)			
Number of Fishers		Number of Days	
Area Fished		Start and End Dates	

Fishing Method (Voluntary)					
Hookah (MDH)		Handline (LHL)		Drop Line (LDL)	
Free Dive (MDF)		Rod and Reel (LRR)		Other	
Lamp Fishing (MLF)		Troll (LTL)		(Specify)	

Tax Receipt Details (Optional)			
Fisher ABN		Fisher Address	
Receiver ABN		Receiver Address	
Invoice Total ($)		GST ($)	
Signature of Fisher		Date	

White Copy Must go to AFMA within 3 days of unload
Pink Copy Fisher to Retain
Green Copy Remains in this logbook (Receiver copy)

For assistance please contact AFMA Direct 1300 723 621

Use of TVH Logbook Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2021 Update

Robert Campbell, Steven Edgar, Eva Plaganyi, Laura Blamey, Nicole Murphy, Leo Dutra

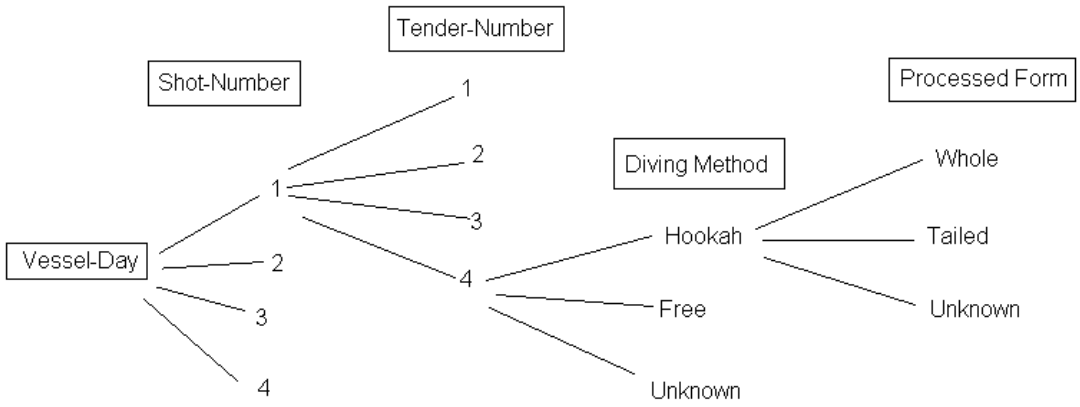
CSIRO Oceans and Atmosphere

December 2021

1. TVH Data

The Torres Strait Tropical Rock Lobster Fishery Daily Fishing Log (TRL04) is used to record the catches taken in the TVH sector of the Torres Strait rock lobster fishery. Logbook data obtained from AFMA consists of 106,556 individual catch records for the TVH rock-lobster fishery for the 28 seasons between 1994 and 2021. The structure of the data is shown in Figure 1. For each vessel-day there can be multiple shots (up to 4) with each shot consisting of several tenders. Each tender has a catch recorded by diving method (hookah or free diving, but sometimes not recorded and labelled as unknown in the following) and the catch is recorded by processed form (whole or tailed; but sometimes not recorded and labelled as unknown in the following). The data was aggregated so that each record refers to the catch for a unique vessel-day, shot, tender and diving method. This gave 75,273 records.

Figure 1. Structure of the TVH data



The distribution of these 75,273 catch records by season and month, diving method, processed state of catch and Management Strategy Evaluation (MSE) area used for the TVH-fishery are given in Tables 1-3. There was little if any effort recorded during October and November, and since 2006 there has been little or no effort in the months December and January. As such the analyses undertaken were limited to the eight months between February and September. Similarly, the analyses were also limited to those records with a known MSE-area (i.e. areas designated A0 and A99 were excluded). MSE-areas 201 and 202 were combined (to provide a better data coverage and is designated as area 110) while areas 301 (Western) and 401 (GBR) were also excluded.

In the past CPUE has been recorded as the catch-per-tender-set. However, as there can be multiple shots-per-day the duration of a tender-set can obviously vary and each tender-set cannot be assumed to be equivalent to a tender-day. The catch data also contains a field “Hours-Fished” which records the duration of the fishing trip for each tender-set and this was deemed to be a better measure of tender effort than assuming each tender-set is equivalent to a day’s effort. However, unfortunately this field

Table 1. Number of TVH catch records by fishing season and month.

SEASON	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL
1994		84	105	236	448	347	364	227	310	270			2391
1995	54	23	116	123	147	185	220	121	239	238	3		1469
1996	220	366	237	447	247	378	264	356	517	411			3443
1997	324	383	232	307	239	599	333	438	538	328	18		3739
1998	598	445	739	551	485	487	587	553	603	493		9	5550
1999	231	117	98	262	242	208	214	161	132	146			1811
2000	235	196	240	349	215	328	370	342	232	99		66	2672
2001	274	375	97	223	65	259	270	206	174	119	9	1	2072
2002	87	26	285	365	295	401	400	360	492	398			3109
2003	89	100	461	488	393	490	518	527	596	413			4075
2004	176	24	587	697	571	662	761	729	633	395			5235
2005	106	13	662	615	543	519	527	552	533	323			4393
2006	4		410	437	361	286	207	349	289	92			2435
2007			288	427	446	542	489	402	184	91			2869
2008			133	222	113	161	96	159	175	152			1211
2009			148	227	174	201	200	125	163	70			1308
2010			255	333	302	324	292	309	294	253		6	2368
2011			286	384	371	322	380	354	310	261			2668
2012			166	344	368	311	336	333	291	231			2380
2013			461	383	414	424	324	374	385	243			3008
2014			357	404	297	433	408	445	274	291		1	2910
2015			419	408	441	355	313	253	357	137			2683
2016		12	500	444	315	379	349	323	191	141			2654
2017	9	7	397	254	322	383	318	346	333	146			2515
2018		10	436	360	335	10	47	308					1506
2019	54	10	277	275	145	275	214	272	237	152			1911
2020	44	16	34	104	230	176	186	223	139	115			1267
2021	4	16	196	154	245	204	258	265	156	123			1621
Total	2,509	2,223	8,622	9,823	8,769	9,649	9,245	9,412	8,777	6,131	30	83	75,273

Table 2. Seasonal number of TVH catch records by diving method and TVH catch by processed state.

	Number of Vessel by -			Diving Method			Total	Catch by Processed State (kg)			Total		
SEASON	Name	Symbol	Both[#]	Hookah	Free	Unknown	Records	Tails	Whole	Unknown	Catch	%Tails	%Whole
1994	10	10	10	1,451	136	804	2,391	120,061	0	0	120,061	100.0%	0.0%
1995	12	12	12	887	59	523	1,469	86,549	473	0	87,022	99.5%	0.5%
1996	19	19	19	1,527	83	1,833	3,443	203,446	7,426	0	210,872	96.5%	3.5%
1997	21	20	21	1,740	111	1,888	3,739	270,686	755	8	271,449	99.7%	0.3%
1998	23	22	23	2,817	174	2,559	5,550	331,261	20,108	0	351,369	94.3%	5.7%
1999	14	14	14	1,450	38	323	1,811	87,143	6,420	0	93,563	93.1%	6.9%
2000	15	15	15	2,329	109	234	2,672	122,209	10,165	0	132,374	92.3%	7.7%
2001	18	18	18	988	31	1,053	2,072	76,513	3,398	0	79,911	95.7%	4.3%
2002	17	17	17	1,721	10	1,378	3,109	107,700	39,474	0	147,174	73.2%	26.8%
2003	20	20	20	3,860	26	189	4,075	252,835	105,964	0	358,799	70.5%	29.5%
2004	25	24	27	5,107	127	1	5,235	316,477	161,074	0	477,552	66.3%	33.7%
2005	22	22	23	4,088	303	2	4,393	486,865	61,065	0	547,930	88.9%	11.1%
2006	22	20	22	2,313	120	2	2,435	108,795	26,591	0	135,387	80.4%	19.6%
2007	20	20	20	2,829	39	1	2,869	207,511	61,115	0	268,626	77.2%	22.8%
2008	13	12	15	1,205	6	0	1,211	63,378	37,060	0	100,438	63.1%	36.9%
2009	10	10	10	1,281	27	0	1,308	51,330	39,726	10	91,066	56.4%	43.6%
2010	13	12	13	2,356	12	0	2,368	67,854	214,783	0	282,638	24.0%	76.0%
2011	14	13	16	2,666	1	1	2,668	171,404	331,531	0	502,934	34.1%	65.9%
2012	15	13	15	2,380	0	0	2,380	67,514	319,130	2	386,646	17.5%	82.5%
2013	11	12	12	3,006	2	0	3,008	61,631	300,030	0	361,661	17.0%	83.0%
2014	13	13	13	2,910	0	0	2,910	42,105	230,961	120	273,186	15.4%	84.5%
2015	13	12	13	2,682	1	0	2,683	22,479	130,231	0	152,709	14.7%	85.3%
2016	12	11	12	2,642	12	0	2,654	42,674	200,336	0	243,010	17.6%	82.4%
2017	11	12	12	2,503	12	0	2,515	25,505	140,766	0	166,270	15.3%	84.7%
2018	7	7	7	1,434	72	0	1,506	19,159	109,142	22	128,323	14.9%	85.1%
2019	7	7	7	1,848	63	0	1,911	3,162	152,762	0	155,923	2.0%	98.0%
2020	7	7	7	1,203	64	0	1,267	5,978	139,130	0	145,108	4.1%	95.9%
2021	7	7	7	1,605	16	0	1,621	7,035	110,039	0	117,074	6.0%	94.0%
Total				62,828	1,654	10,791	75,273	3,429,259	2,959,655	162	6,389,075	53.7%	46.3%

Table 3. Number of TVH catch records by fishing season and Management Strategy Evaluation (MSE) areas used for the TVH-fishery.

	Northern	Mabuiag	Badu	Thurs Is.	Central	Warrior	Warraber	Kirkaldie	Adolphus	East TS	East TS	PNG	East Coast	Western	NR	
SEASON	A101	A102	A103	A104	A105	A106	A107	A108	A109	A201	A202	A301	A401	A0	A-99	TOTAL
1994	51	249		10	116		918	36	89	106	176	252	1		387	2391
1995	90	170	2	40	77		471	132	26	36	33	171	4		217	1469
1996	592	1087	2	13	53	5	703	48	34	1	32	264			609	3443
1997	395	1263	17	14	72	70	838	4	24	49	33	375	3	1	581	3739
1998	512	1827	52	106	106	230	1101	160	16	34	43	497		2	864	5550
1999	180	467	20	56	69	141	336	171	12	13	32	85	15		214	1811
2000	141	341	75	47	57	401	567	234	60	8	19	328	33		361	2672
2001	30	73	13	49	26	374	429	84	44	3	44	473	46		384	2072
2002	119	284	18	176	44	323	582	718	48		17	359	16		405	3109
2003	1011	405	112	315	334	390	434	832	95	7	49	8	4	4	75	4075
2004	1076	632	206	159	559	357	975	961	209	15	51	1	8		26	5235
2005	858	481	159	194	156	231	527	1671	84	3	18		6	2	3	4393
2006	362	268	20	131	187	301	440	351	285	34	48		4		4	2435
2007	483	293	42	146	120	311	367	980	62	6	28	26	2		3	2869
2008	236	58	6	91	52	235	240	206	48	2	31		3		3	1211
2009	268	46	5	80	145	365	231	47	26	23	59	6	7			1308
2010	564	67	103	103	33	197	206	992	43	12	32		14		2	2368
2011	389	111	34	82	17	158	430	1406	25		14				2	2668
2012	414	217		14	46	157	1231	271	18	6	5				1	2380
2013	718	239	34	16	63	168	469	1267	6	6	21				1	3008
2014	777	263	15	27	165	268	786	445	47	14	93				10	2910
2015	176	173	45	5	117	874	661	486	25		121					2683
2016	57	12	62	7	202	681	454	950	18	131	60				20	2654
2017	738	111	9	43	86	529	463	430	15		74	5			12	2515
2018	735	218		34	32	233	164	55			22				13	1506
2019	402	115	3		50	578	446	233			76	8				1911
2020	151	42			63	499	281	149	1		80			1		1267
2021	288	64		2	39	527	389	193	4	12	103					1621
Total	11,813	9,576	1,054	1,960	3,086	8,603	15,139	13,512	1,364	521	1,414	2,858	166	10	4,197	75,273

Figure 2. The total number of TVH catch records each fishing season and the number of records for which the corresponding effort data is available. The percentage of records for which no effort is recorded is also shown (right hand axis).

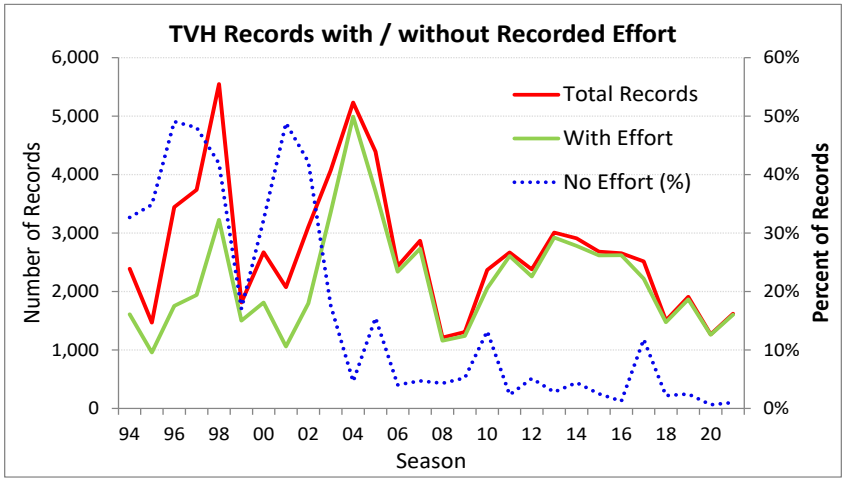
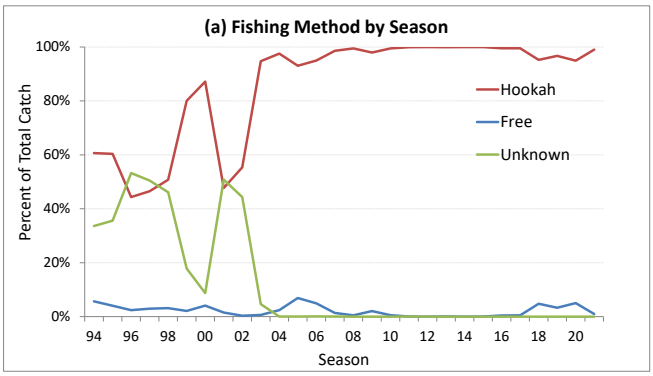


Figure 3. The percent of total TVH catch each fishing season (a) caught by each fishing method, and (b) landed as Tails or Whole weight.



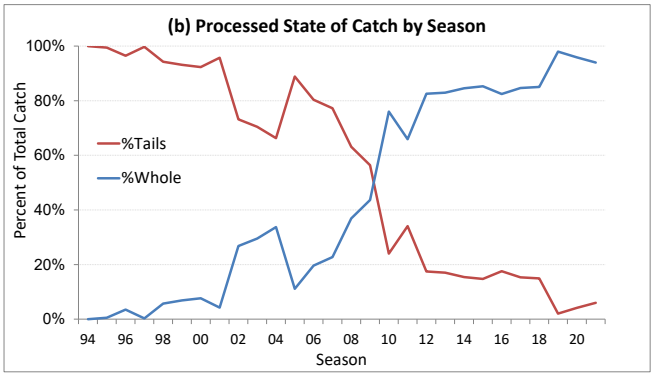
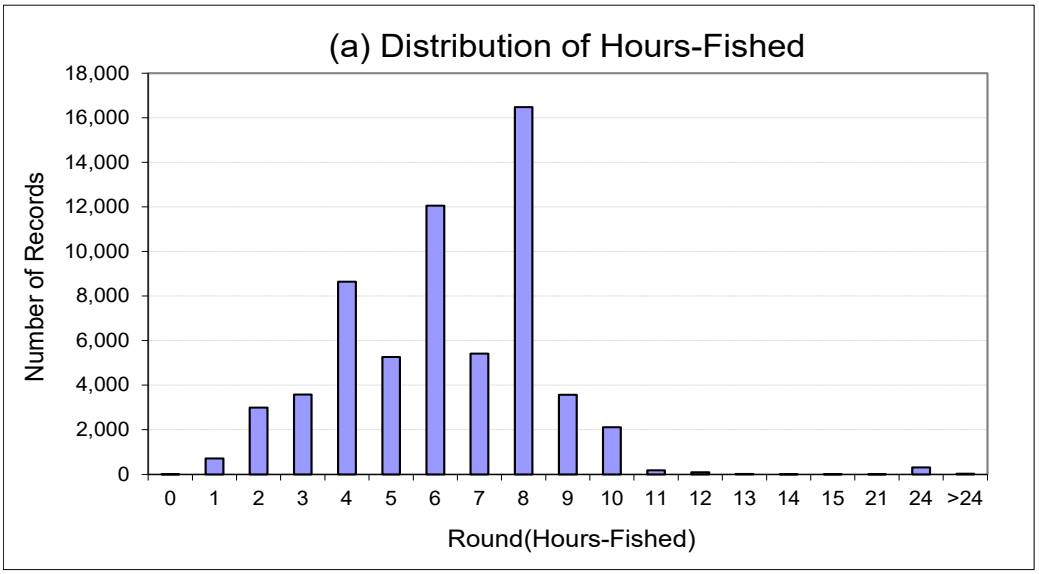
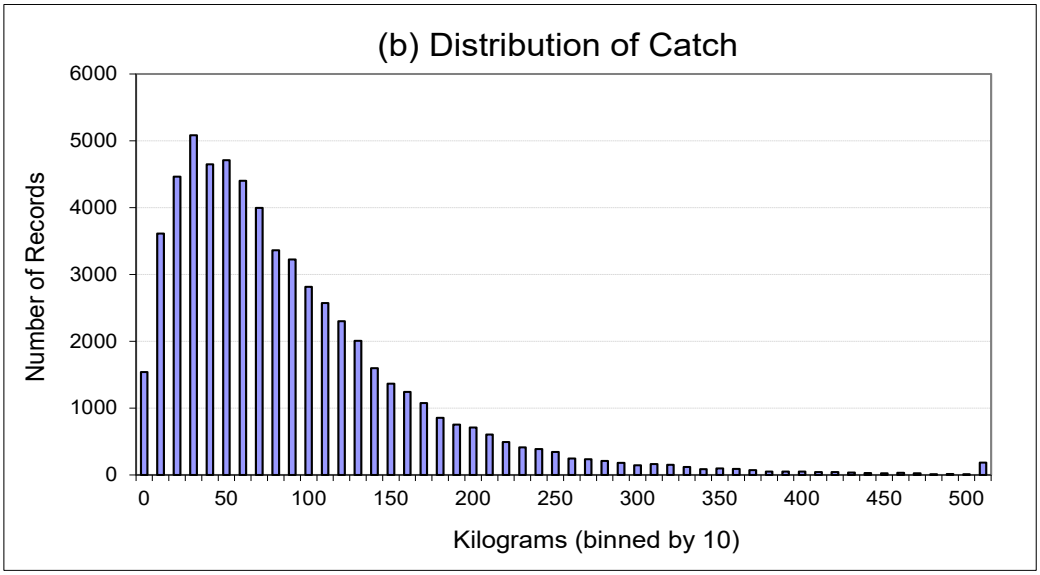


Figure 4. Distribution of (a) effort, (b) catch and (c) nominal CPUE for the 56,534 records for which effort was recorded on TVH logbooks.





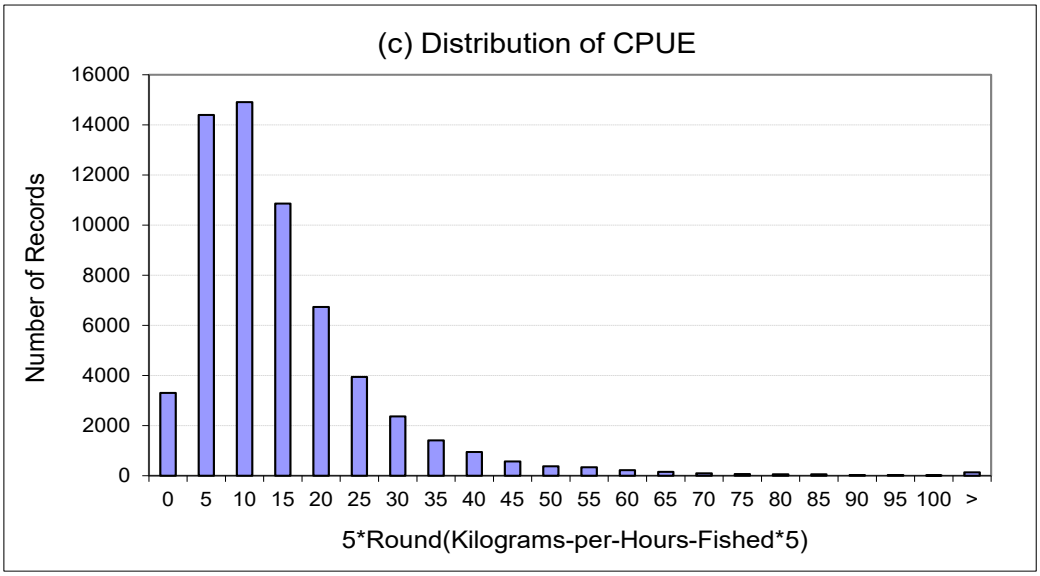
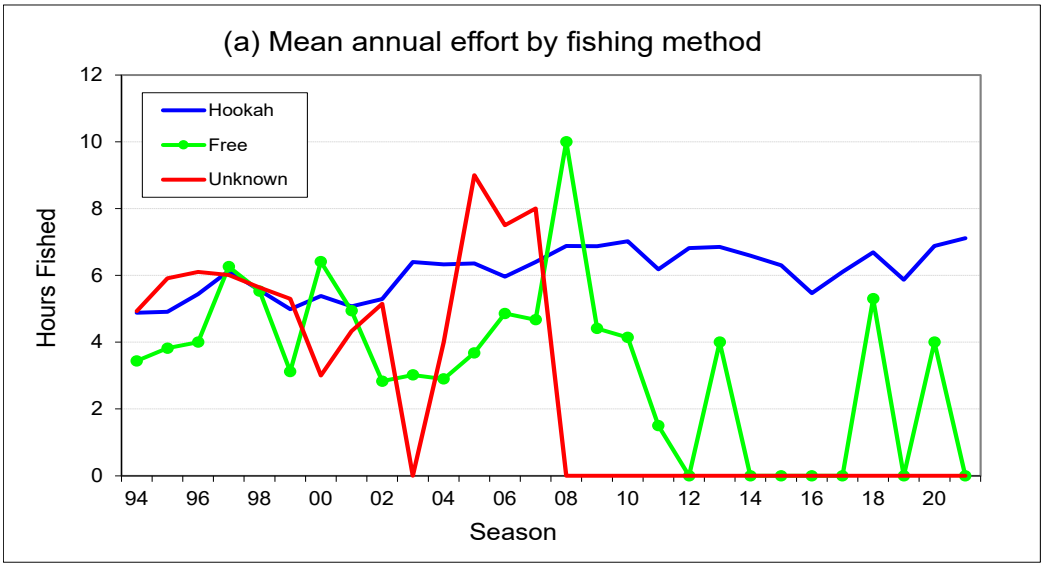
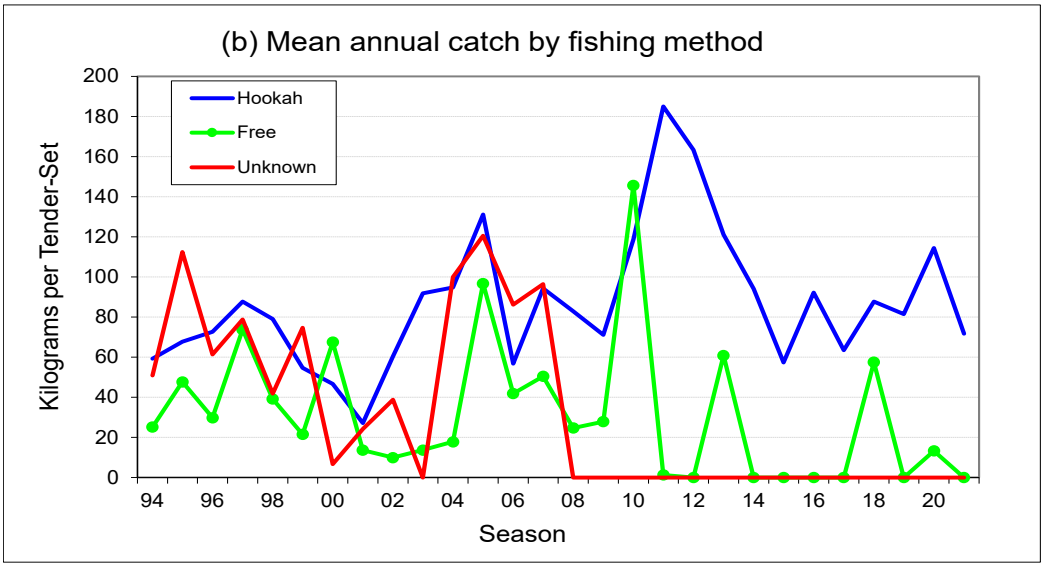
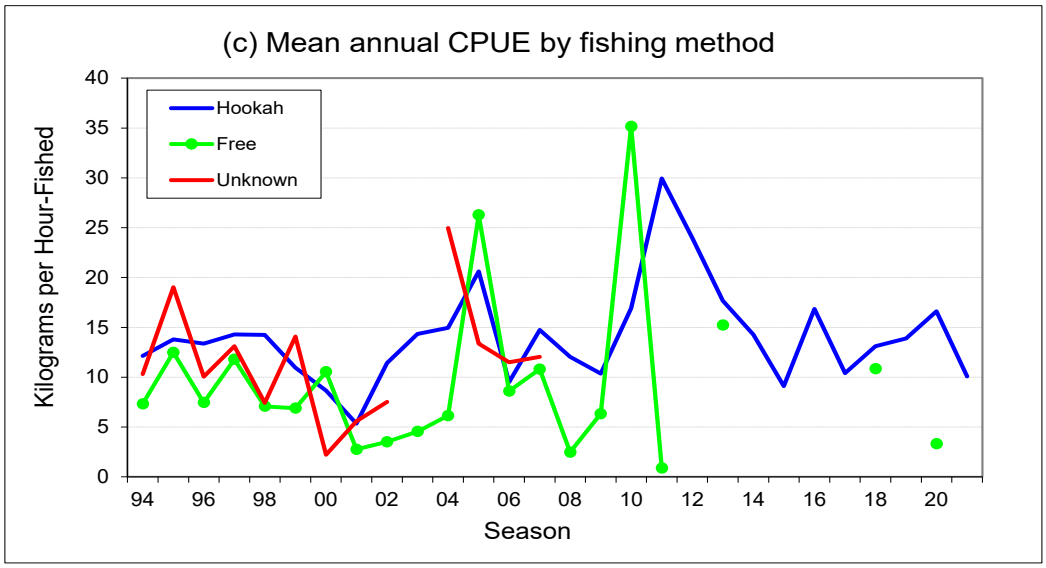


Figure 5. Mean (a) effort, (b) catch and (c) CPUE by fishing method and fishing season for the 51,643 unique vessel-day, shot, tender and diving method records for which this effort was between 0 and 12 hours and areas and months restricted as described in the text.







has not been completed for all tender-sets, with the number of hours fished recorded for only 61,473 (81.7%) of the 75,273 records. (Note, the proportion of records where the effort was not recorded averaged 32% between 1994 and 2005 but has been less than 5% for most seasons since 2006; but was 13% in 2010 and again increased to 11.8% in 2017; it was 0.6% in 2020 and 1.0% in 2021. c.f. Figure 2). The distribution of hours fished for these records is shown in Figure 4. The number of recorded hours fished is between 0.15 hours and 96 hours, though the majority (99.4%) were for 12 hours or less. The mode of the recorded number of hours fished is seen to be 8 hours – however, whether this just corresponds to a standard "8-hour day's work" or truly represents the number of hours fished remain uncertain. Recorded effort of four and six hours are also common. Of the 354 records where the hours fished was greater than 12, most (315) recorded 24 hours which was assumed to be a day's fishing. All records where the recorded hours-fished was greater than 12 hours were considered suspect and as such only those records where the hours-fished was 12 hours or less were included in the analysis. A further 37 records where effort was less than 0.5 hours were also excluded.

After applying each of the following filters to the data:

- Exclude MSE-areas 0, 301, 401 and -99
- Exclude Months (Jan, Oct, Nov, Dec)
- Exclude Hours-Fished less than 0.5 hour and greater than 12 hours

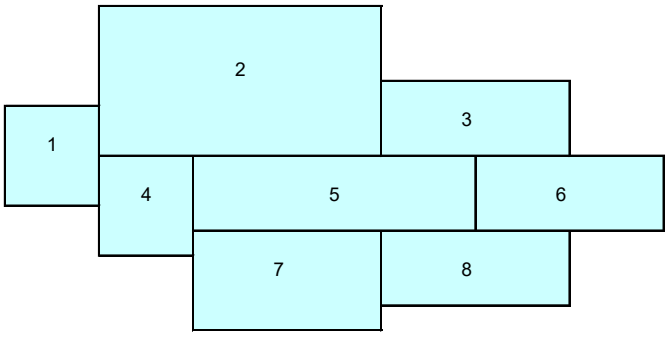
the number records included in the data for further analysis was reduced to 54,923. The mean (a) effort, (b) catch and (c) CPUE by fishing method and season for these records are shown in Figure 5.

2. GLM Analysis

i) Basic Idea of an Abundance Index

The analyses which are outlined in this section are undertaken with the aim of to developing an annual index of abundance of lobsters in the Torres Strait rock lobster fishery. The concept behind these analyses is explained here.

Figure 6. Hypothetical fishery used to calculate an abundance index.



Region	Area of Region	CPUE kg/hour	Biomass Index
1	4,000	21	84,000
2	18,000	5	90,000
3	6,000	15	90,000
4	4,000	31	124,000
5	9,000	8	72,000
6	6,000	22	132,000
7	8,000	9	72,000
8	6,000	23	138,000
Total	61,000		802,000

Consider a hypothetical fishery shown in Figure 6. The spatial extent of this fishery is divided into eight regions and each region has a different spatial size. This mimics the TVH regions in the TSRL fishery. For a diver fishing in any region then for a given amount of fishing effort (e.g. hours fished) then the resulting catch will (on average) be given by the following formula:

Catch (kgs) = q. Effort (hours fished) * Density of lobsters (lobsters per square meter)

The parameter *q*, known as the catchability coefficient, is a combined measure of the efficiency of the fishing gear and the fisher. From this equation it follows that:

$$\text{Density of lobsters (lobsters per square meter)} = \frac{\text{Catch (kgs)}}{\text{q. Effort (hours fished)}}$$

$$\Rightarrow \text{Density of lobsters (lobsters per square meter)} = \frac{\text{CPUE}}{\text{q}}$$

It is seen then that the catch-per-effort (CPUE) provides an indicator of the density of lobsters in the region fished (i.e. higher CPUE is an indicator of higher density, etc). If we assume that the density of lobsters is the same within a given region of spatial size A, then the number of lobsters in that region will be given by:

Number of lobsters = Density of lobsters (lobsters per square meter) * Area (square meters)

$$\Rightarrow \text{Number of lobsters, N} = \frac{\text{CPUE} * \text{Area}}{\text{q}}$$

So an estimate of the number of lobsters in a given region is given by knowing the CPUE, the area of the region and the catchability coefficient of the fisher. CPUE is provided from the catch and effort data for the fisher and the area of the region fished can be measured. However, q remains unknown.
If a given fisher (for which the catchability coefficient is q_o) fishes in region 1 (which has an area A1) and achieves an average catch rate of CPUE1, then an estimate of the number of lobsters in region 1 is:

$$\Rightarrow \text{Number of lobsters, N(1)} = \frac{\text{CPUE1} * \text{A1}}{\text{qo}}$$

An example how this equation can be used to provide an estimate of the abundance of lobsters in a hypothetical fishery is shown in Figure 6.

If the same fisher also fishes in all eight regions (using the same method and efficiency so that q_o remains constant across all fishing operations) then an estimate of the total abundance of lobsters across the entire fishery can be estimated by summing across all areas:

$$\text{Total abundance of lobsters} = \sum_{a=1}^{8} \frac{CPUE(a) * A(a)}{q_o}$$

where CPUE (a) and A(a) are the CPUE achieved and size of area *a* respectively. If we assume that a group of fishers (each with the same q) operates in each region simultaneously (so that the catch rates obtained in each region are not influenced by lobsters moving between regions over time), then the above equation provides an estimate the total abundance of lobsters at any given time (say t_o), i.e.

$$\text{Total abundance of lobsters } (t_o) = \sum_{a=1}^{8} \frac{CPUE(a, t_o) * A(a)}{q_o}$$

If the same group of fishers undertakes a similar set of fishing operations at another time, say t_1, then an estimate the total abundance of lobsters at this other time will be:

$$\text{Total abundance of lobsters } (t_1) = \sum_{a=1}^{8} \frac{CPUE(a, t_1) * A(a)}{q_o}$$

The abundance of lobsters at this time relative to the abundance at time t_o is then given by:

$$\text{Relative abundance at } t_1 \text{ relative to } t_o = \sum_{a=1}^{8} \frac{CPUE(a,t_1) * A(a)}{q_o} \Big/ \sum_{a=1}^{8} \frac{CPUE(a,t_o) * A(a)}{q_o}$$

$$= \frac{\sum_1^8 CPUE(a,t_1) * A(a)}{\sum_1^8 CPUE(a,t_0) * A(a)}$$

So, if a group of fishers each with the same fishing efficiency (i.e. same q) could operate across the entire fishery at a sequence of different times, then one can use the above equation to obtain a relative index of abundance at each time. Indeed, this is the basis behind the concept of doing sequential surveys (such as the annual pre-season survey) using a standard set of fishing equipment.

If surveys such as described above were repeated each month during a fishing season, then one could take the average over all months to ascertain an estimate of average abundance during this season, i.e.

$$\text{Abundance of lobsters in season (S)} = \sum_{m=1}^{12} \sum_{a=1}^{8} \frac{CPUE(m,a,) * A(a)}{q_o}$$

And again, repeating this exercise each season would allow for the relative abundance in any season to be compared to the abundance in any other season, e.g.

$$\text{Abundance of lobsters in season} S_i \text{ relative to Season } S_o = \frac{\sum_{m=1}^{12} \sum_{a=1}^{8} CPUE(S_i,m,a) * A(a)}{\sum_{m=1}^{12} \sum_{a=1}^{8} CPUE(S_o,m,a) * A(a)}$$

Unfortunately, for the exercise of obtaining an annual abundance index using the catch and effort data recorded by the fishing fleet during an entire fishing season such a simple approach is not possible. Foremost is the fact that there are many operators and several fishing methods used, each having a different catchability coefficient. Also, there may be environmental factors that influence the distribution of lobsters and hence catch rates (e.g. phase of the moon, tides, etc). As such, the catch rate achieved by any individual fisher will depend on a range of factors. For example.,

Catch rate = CPUE(Season, Month, Area, Fisher ,Method, Environment)

The essence of the statistical analyses described in the following sections is to account for each of the factors which may influence the catch rates of lobsters at any particular time, location and for any given fishing method. For example, by comparing the different catch rates achieved by all fishers with all other factors held constant (i.e. same season, month, area, method, etc) the analysis can ascertain the relative efficiencies (q's) of each fisher. Similarly, by holding all other factors constant except for say method, the analysis can then ascertain the relative effect of each method on catch rates. In this manner, the relative influence of each level of all factors influencing catch rates can be determined. Finally, a "standard' fisher, method and environmental level can be chosen and the catch rates within each season, month and area relative to these standards then determined. Once done, the above equation can then be used to ascertain the relative abundance in any given season compared to any other season. The statistical methods used here for undertaking such analyses are known as Generalised Linear Models.

ii) Data Preparation

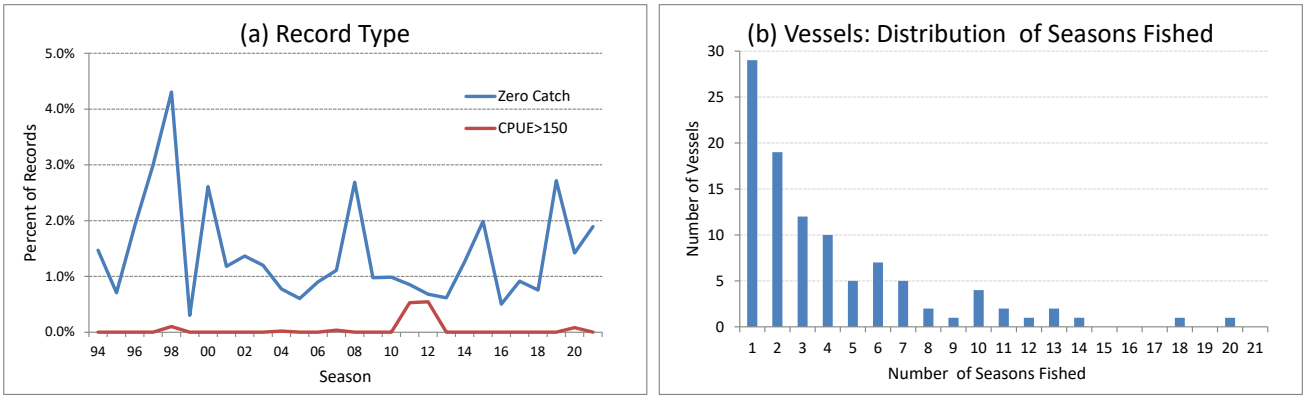
Of the 54,923 records selected above for analysis it was noted that there was a small percentage of records (714 or 1.3%) where the catch was zero. The inclusion of such records in the GLM analyses can cause problems. The percentage of such records each season is shown in Figure 7a and varies from a high of 4.31% in 1998 to a low of 0.30% in 1999 (it was 1.89% in 2021). Nevertheless, apart from the five seasons when this percent was greater than 2% there does not appear to be a trend in the percentage of zero catches in the data over time. As such, and as recommended for the analyses

undertaken previously, these zero catch records were excluded from the analyses. Note, to retain the zero-catch records in the analysis a two-stage analysis of the data can be undertaken where one first models the probability of obtaining a positive catch following by a separate analysis where one models the size of the positive catch. The results of each analysis can then be combined to obtain the required standardised CPUE index. Such an approach was not considered appropriate for these data due to the small percentage of zero-catch records in the data.

Further inspection of the data also indicated several records having a very high CPUE (kilograms of catch per hour fished) value and which could be considered outliers in the data, possibly due to errors in either the recording of the catch or effort. To exclude these possibilities the 30 records (0.05% of all records) having a CPUE>150 kgs/hour were deleted from the data (cf. Figure 7a).

Finally, due to the observation that Vessel-Names and Vessel-Symbols are not always matched (likely due to the switching of licences between vessels) a combination of Vessel-Name and Vessel-Symbol was adopted to identify vessels in the data. Of the 102 vessels identified in this manner, only the data pertaining to the 51 vessels which had fished for 3 or more seasons and for which there were 50 or more data records were included in the final data set selected for analysis (c.f. Figure 7b. Note all seven active vessels were selected for 2021). Combined with the other two filters described previously the total number of records remaining in the data for analysis was 50,923.

Figure 7. (a) Percentage of records in the data, by fishing season, where either the catch is zero, or the CPUE>150 kg/hour, and (b) histogram of the number of vessels (distinguished by vessel symbol) by the number of seasons they have fished in the fishery.



The number of *Area-Month* strata fished each season and the number of vessels fishing each season in the data selected for inclusion in the GLM analyses is shown in Figure 8 while a bubble plot displaying the number of observations for each vessel each season in the data selected for analysis is shown in Figure 9. A summary of the number of observations and nominal CPUE (kilograms per hour) within each *Season*Area*, *Season*Month* and *Area*Month* strata is provided in the Appendix.

Figure 8. (a) Number of *Area-Month* strata fished each season and (b) the number of vessels fishing each season in the data selected for inclusion in the GLM analyses.

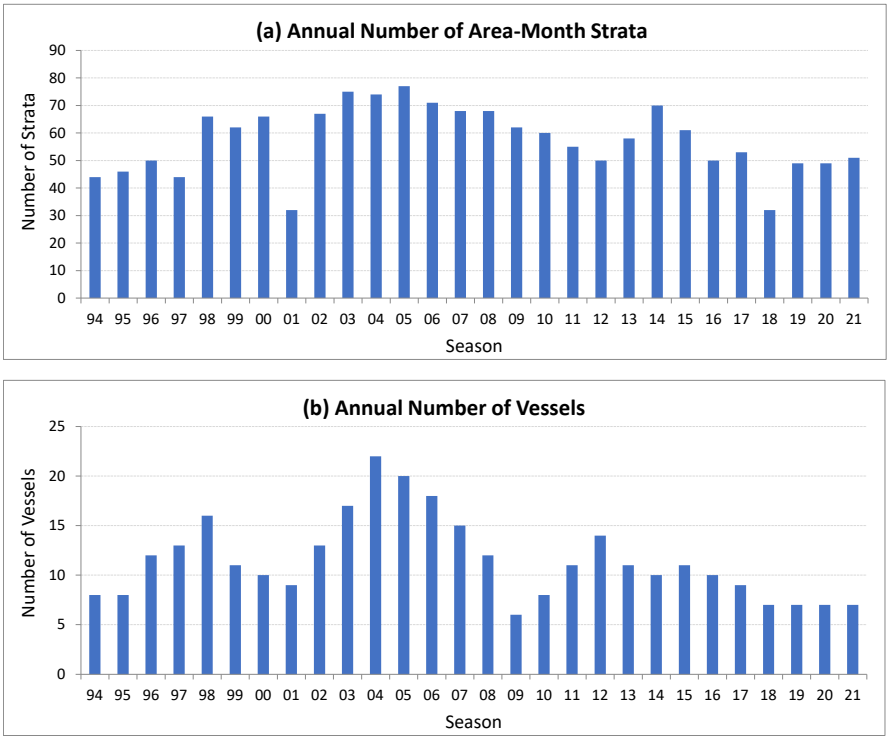
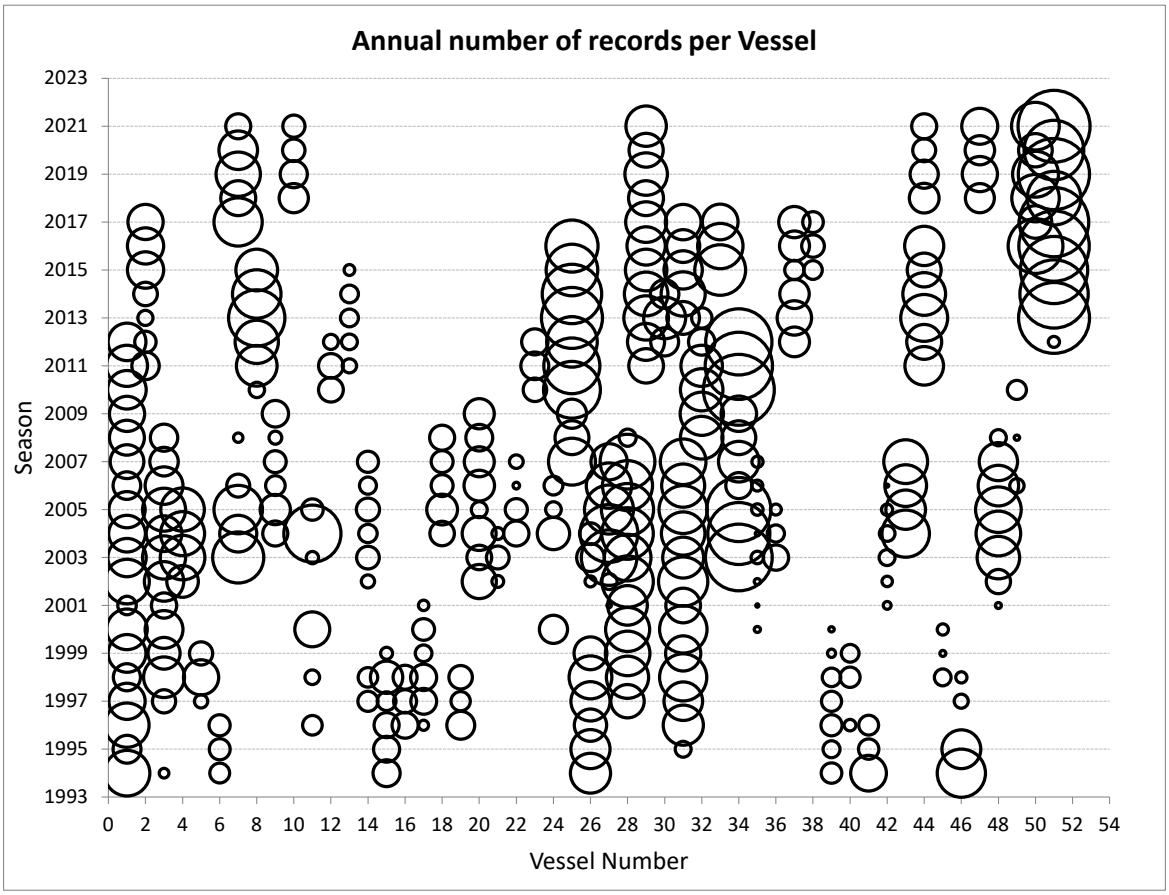


Figure 9. Bubble plot displaying the number of observations for each vessel each fishing season in the data selected for inclusion in the GLM analyses.



iii) GLM Models

As with the analyses of the TVH data in previous years, General Linear Models (GLMs) were adopted for analysing the data to obtain a standardised index of stock abundance in each season.

Model-1: Main Effects Model

To explore the impact of each main effect included in the GLM, the first set of analyses was based on the following model where no interactions between main effects were included:

CPUE = Intercept + Season + Month +Area + Vessel +Fishing-Method
+ Proportion of Catch Landed as Tails
+ Southern Oscillation Index + Moon-Phase
/ distribution = gamma, link = log

where:

a) *Season* has 28 levels: 1994-2021 (see below)
b) *Month* has 8 levels: February–to-September.
c) *Area* has 10 levels as shown in Table 3.
d) *Vessel* has 51 levels as shown in Figure9.
e) *Fishing-Method* has 3 levels: (1) Hookah, (2) Free Diving, (3) Unknown
f) *Proportion*-Tails has 5 levels: (1) <20%, (2) 20-40%, (3) 40-60%, (4) 60-80%, and (5) ≥80%
g) *SOI* is the monthly value of the Southern Oscillation Index
h) *Moon-Phase* has 30 levels: the number of days after the last full moon.

The SAS GENMOD procedure was used to fit the model. All effects were fitted as categorical effects except for SOI which was fitted as a continuous cubic function. A log-gamma distribution was assumed for the distribution of CPUE values. The annual index of abundance was determined using the method described in the next section

The simple structure of this Main Effects model is based on some simplifying assumptions. For example, it assumes that the influence of each level of a given main effect is the same across all other combinations of the other main effects. For example, the relative influence of each Month is assumed to be same across all Seasons and Areas, and similarly the relative influence of each Area is the same across all combinations of Month and Season. Whilst these assumptions may to some extent approximate reality, there may be instances where some assumptions are not fulfilled. For example, there appears to be a degree of inter-annual variation in the relative level of catch rates in different areas across different seasons. Such variation can be accounted for in the models described below.

For each of the main effects, a measure of the impact of each level on the modelled CPUE was obtained by taking the exponent of the estimated parameter for each level. The impact of each level was then compared to the impact of a reference level. For each main effect these reference levels were:

Month	September
Area	A110, Eastern Torres Strait
Method	Hookah diving
Vessel	Vessel with the largest number of records
Proportion-tails	>80%

Finally, the annual influence of each of the main effects on the resulting index of abundance was calculated using the method described in Bentley et al (2012).

As shown in Campbell (2004) a bias in the annual abundance index can result when there is an unequal number of observations within each spatial-temporal stratum used for calculating the abundance index.

In order to overcome this problem a weighting of the observations needs to be incorporated when fitting the data to the GLM. Each observation was therefore weighted such that the sum of the weights for all observations in each of the *Season-Month-Area* strata was the same for all strata. Furthermore, in order to account for the weighting given each observation in determination of the annual influence of each main effect, the sum of the weights for all observations within a given level was used instead of just the number of observations.

Interactions Models

A second set of analyses was undertaken to explore whether the inclusion of interactions between the main spatial-temporal effects improved the model fit to the data. Specifically, the following three models were examined:

Model-2: Int-1:

*CPUE = Intercept + Season +Month + Month*Area*
+ Vessel +Fishing-Method + Proportion-Tails + SOI + Moon
/ distribution = gamma, link = log

Model-3: Int-2:

*CPUE = Intercept + Season *Month +Season*Area + Month*Area*
+ Vessel +Fishing-Method + Proportion-Tails + SOI + Moon
/ distribution = gamma, link = log

Model-4: Int-3:

*CPUE = Intercept + Season *Month*Area*
+ Vessel +Fishing-Method + Proportion-Tails + SOI + Moon
/ distribution = gamma, link = log

where * indicates an interaction between the related effects. The inclusion in these interactions allows for the relative distribution of the resource between the different areas and months to be different between seasons.

iv) Derivation of Annual Index

Using the results from each GLM an annual abundance index was constructed based on the standardised CPUE. This follows the qualitative description provided previously.

For each model the standardised CPUE within each *Season-Month-Area* stratum was calculated as follows:

$$stdCPUE(season = s, month = m, area = a) = exp(I + f(S_s, M_m, A_a) + F_{ref} + V_{ref} + P_{ref})$$

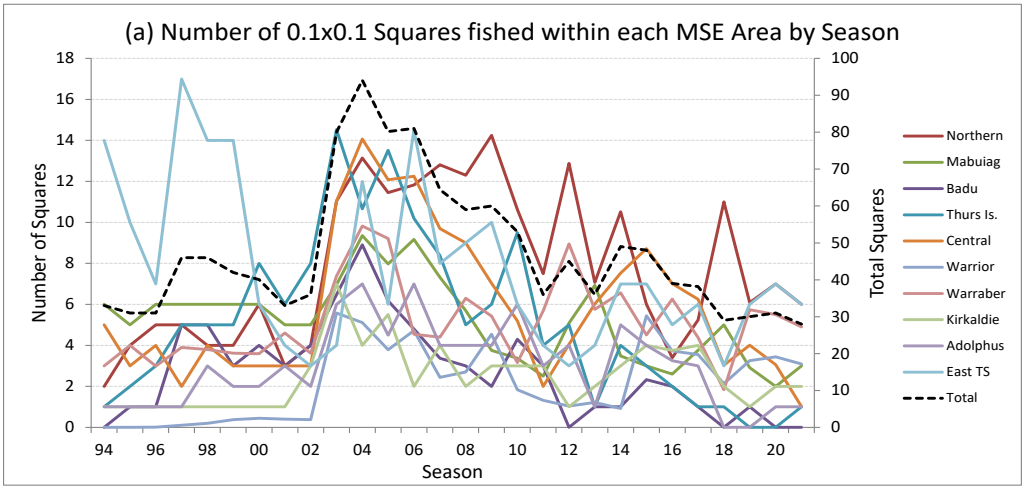
where $f(S_s, M_m, A_a)$ is the functional form of the parameters for *Season*, *Month* and *Area* as described in each of the four models above, and F_{ref}, V_{ref} and P_{ref} are the parameter values relating to each of the reference (standard) levels for *Fishing-Method*, *Vessel* and *Proportion-Tails* effects included in the model. Note, due to the over-parameterization inherent in the GLM , the values of F_h, V_{ref} and P_{ref} can be set to zero.

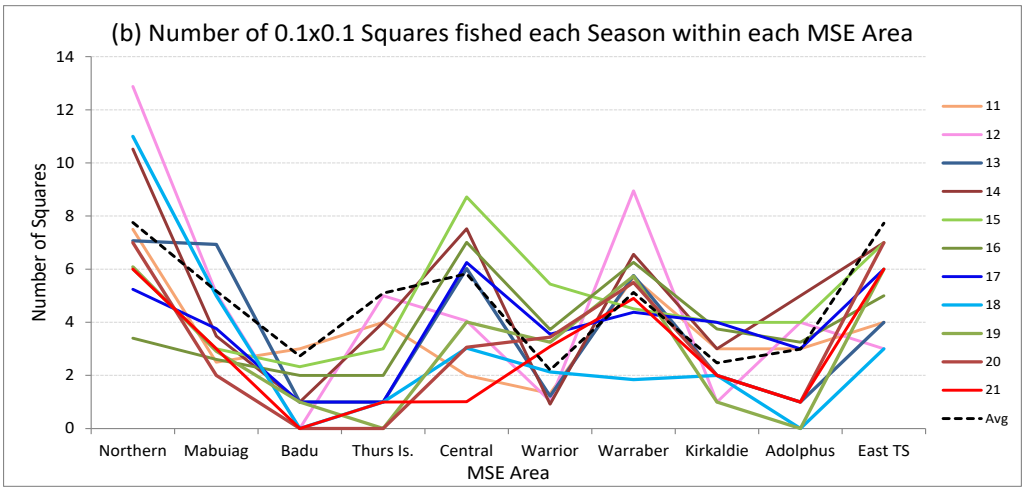
In total there are 2240 (=28 seasons x 8 months x 10 areas) *Season-Month-Area* strata. As the standardised-CPUE is taken as an index of the density of fish within each strata, an index of the abundance of lobsters across the fishery in each season and month is given by:

$$Index(season = y, month = m) = \frac{1}{\sum_{a=1}^{NA} Area_a} \sum_{a=1}^{NA} Area_a . stdCPUE(s, m, a)$$

Figure 10. Map of the MSE regions used as the area effects in the GLM.

Figure 11. Number of 0.1x0.1-degree squares fished (a) within each MSE area by fishing season, and (b) each season within each MSE area between 2011 and 2021. The average over all seasons (1994-2021) is also shown in both figures.





where $Area_a$ is the spatial size of each of the *NA Area* effects included in the GLM. Finally, an index of abundance for each season can be obtained by taking the average of the *NM* monthly indices in each season.

$$Index(season = s) = \frac{1}{NM}\sum_{m=1}^{NM}\left[\frac{1}{\sum_{a=1}^{NA} Area_a}\sum_{a=1}^{NA} Area_a . stdCPUE(s,m,a)\right]$$

Finally, a relative annual abundance index, B_s, was calculated such that the mean index over all seasons equals 1, i.e.

$$B_s = \frac{Index(season = s)}{\frac{1}{NS}\sum_{i=1}^{NS} Index(season = i)}$$

The total spatial size of the each MSE area shown in Figure 10 is unlikely to represent suitable habitat for rock lobsters. As such, to make an estimate of the spatial size of each MSE area to be used in the GLM-analysis, the number of 0.1x0.1-degree squares fished (based on the location of the mother ship recorded in the TVH logbook) within each MSE area was determined for each season. For those squares which included more than one MSE area, the square was apportioned between the different MSE areas based on the proportion of records in each area. Across the entire Torres-Strait region the number of squares fished each season between 1994 and 2021 has varied between 28 (in 2021) and 94 (in 2004) with a mean of 49.1 (c.f. Figure 11). The size of each MSE area $Area_a$, was set to the mean number of squares fished across all seasons, and then expressed as a percentage of the combined total across all areas so that $\sum Area_a = 1$.

The derivation of the annual index as described above is also dependent upon having an estimate of the stdCPUE in each *Season-Month-Area* stratum. However, as shown in the Appendix, catch and effort data are not available for all strata and for some models this prevents the estimation of the value of stdCPUE for some strata. For example, there are four *Season*Month* strata and eighteen *Season*Area* strata for which there are no fishing operations. The number of strata for which there are no data was also increased given the pre-analysis filtering of the data described previously. For the Main-Effects model these missing observations do not cause a problem, as the estimated stdCPUE in each *Season-Month-Area* stratum is just a linear combination of the values of the main effects, i.e.

$$f(S_s, M_m, A_a) = Season(s) + Month(m) + Area(a)$$

The value of stdCPUE could also be estimated for all strata in the Int-1 model as there are observations available for all eighty *Month*Area* strata. However, for the Int-2 and Int-3 models the value of stdCPUE could not be estimated for all strata. Where this occurred, the value of stdCPUE was back-filled using the corresponding value for that strata from one of the previous models where this value could be estimated. In this way, a value of stdCPUE could be ascertained for all strata.

It can be noted that for those models which do not included an interaction with the *Season* effect (i.e. the main effects and Int-1 models), the relative abundance index, B_s, reduces to the simpler form:

$$B_s = \frac{exp(S_s)}{\frac{1}{NS}\sum_{i=1}^{NS} exp(S_i)}$$

where S_i , *i=1, NS* are the parameters estimates relating to the *NS Season* effects included in the model. In these situations, the abundance is independent of the relative size of each *Area* effect included in the analysis model.

3. Results and Abundance Indices

(a) Main-Effects Model

Statistics for the Type-3 contrasts computed for each effect fitted to the Main-Effects model indicated that each effect was highly significant, while the relative impact of each level for all effects fitted to this GLM model is shown in Figure 12. For each effect the values have been scaled so that the influence of each level is relative to that of the last level (i.e, *Month*=Sep, *Area*=Eastern TS, *Method*= Hookah and *Proportion-Tail*s >80%).

Relative CPUE is relatively constant across most of the eight months included in the GLM, though the CPUE in September has the lowest relative value (c.f. Figure 12a). The CPUE is generally highest during February, March, June and July (20-28% higher than the CPUE in September) while during, April, May and August the CPUE is around 13-18% higher.

The relative CPUE across most of the ten areas included in the GLM also do not display large variation (c.f. Figure 12b). Apart from Kirkaldie, where catch rates are estimated to be on average 40% higher than in the reference area Eastern TS, the average catch rates in the other areas are estimated to be between 0-16% higher than the reference area.

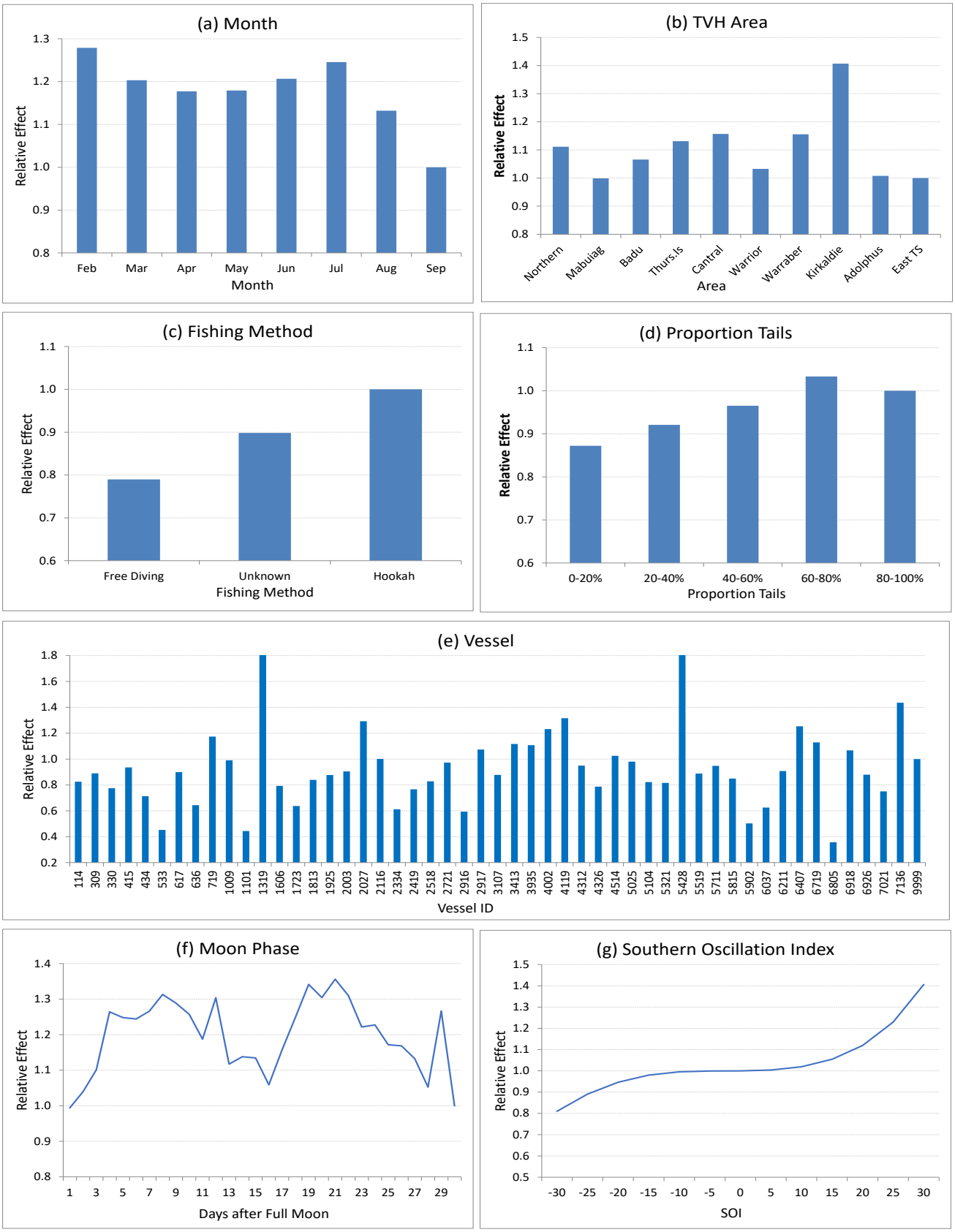
A degree of variation is seen in the estimates of the average catch rates between the three levels of method included in the model (c.f. Figure 12c). The CPUE for hookah fishing is found to be around 27% higher than for free diving and 11% higher than for unknown method. This latter result is to be expected as this fishing method is likely a combination of the two main fishing methods.

The relative CPUE is seen to generally increase as the proportion of tails increases in the catch (c.f. Figure 12d) with the relative value of each level estimate to be 87%, 92%, 97%, 103% and 100% relative to the reference level (80-100% tails) respectively. Finally, there is substantial variation in the relative CPUE across the 51 vessels included in the GLM model (c.f. Figure 12e), with the relative fishing power across the fleet varying from 40% to 200% relative to the standard vessel chosen. The distribution of relative effects across all vessels is shown in Figure 13a.

The influence of the daily moon-phase is shown in Figure 12f. The influence displays an interesting bi-modal distribution across the days between successive full moons. CPUE is lowest during days near a full moon and also low around a new moon, while CPUE is highest mid-way between these two phases (i.e. around the first and last quarters). During this latter periods CPUE is up to 35% higher than at the time of a full moon.

Finally, the monthly value of the SOI was fitted as a cubic function and the estimated influence of this effect on CPUE based on the results from the Main-Effects model is shown in Figure 12g. Note, the influence of SOI on CPUE cannot be estimated for several models as the related parameter is aliased when the GLM model includes a *Season.Month* interaction term. Catch rates are estimated to decrease during periods when the values of the SOI are negative (El Nino conditions) and increase when values of the SOI are positive (La Nina conditions). This indicates that oceanographic conditions may have influenced the high CPUEs experienced in the fishery in 2011 (when the mean SOI value was 12.7, c.f. Figure 13b) and the low CPUE experienced in the fishery in 2015 (when the mean SOI value was -10.8). However, based on the results shown in Figure 12g the influence on CPUE of the conditions prevailing in these seasons should only have been minor as the influence of SOI is small for values between -10 and 10 (i.e. when it is within 1-standard deviation of the mean), i.e. the influence on catch rates is estimated to be high only during a strong El Nino or strong La Nina. Further exploration of the influence of this and other environmental variables is warranted.

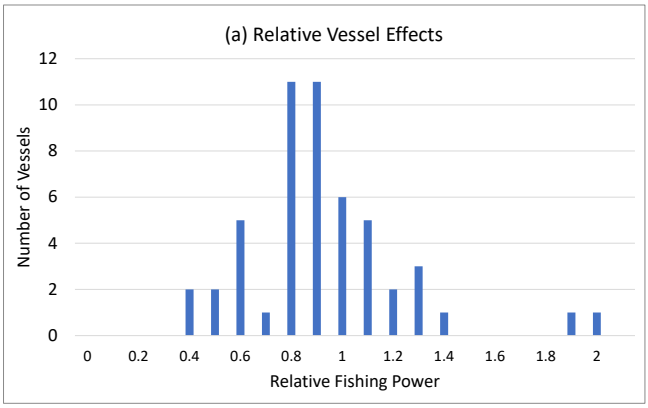
Figure 12. Relative impact of each level of the effects fitted to the Main Effects GLM.

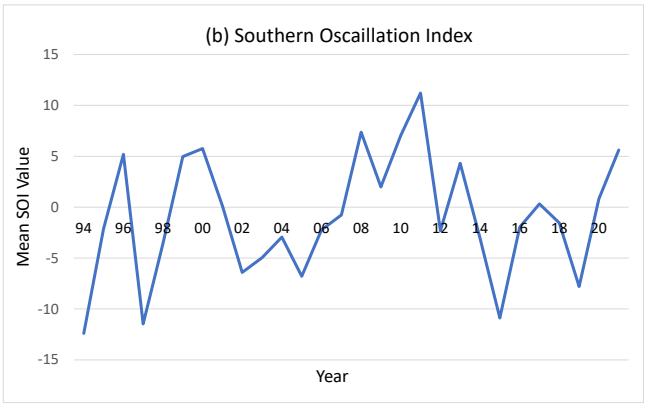


A comparison of the relative impact of each level for all effects fitted to each of the four GLM models is shown in Figure 14 and a large degree of consistency is seen across each of the four models.

Figure 14. Comparison of the relative impact of each level for all effects fitted to each of the four GLM models.

Figure 13. (a) Histogram of the distribution of the relative fishing power of the 51 vessels included in the GLM models, and (b) annual mean (since 1994) of the monthly values of the SOI over the eight months between February and September.

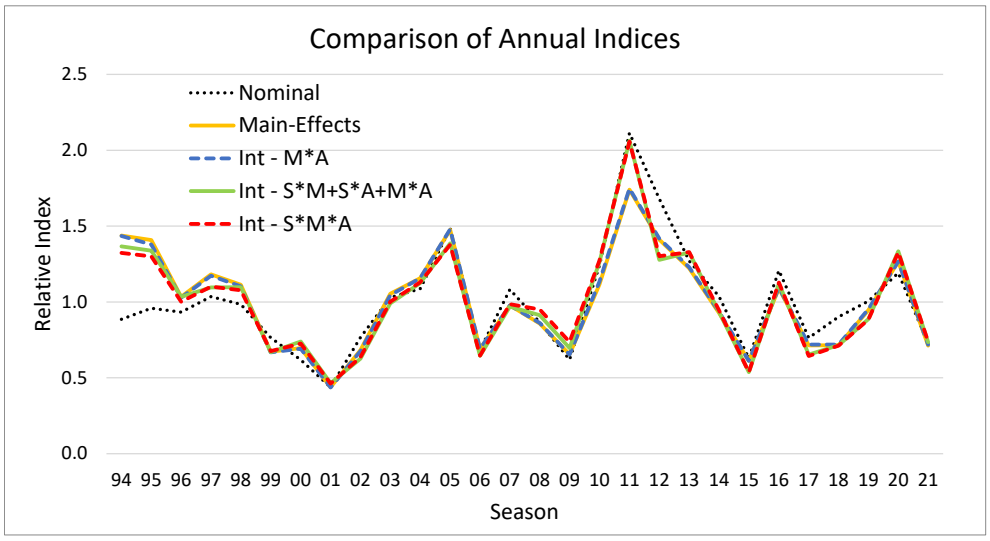




(b) Annual Abundance Indices

The relative abundance indices based on each of the four GLM models are displayed and listed in Figure 15 and Table 4 and respectively. Relative to the nominal index, each of the standardised indices displays a similar seasonal pattern but is higher at the start of the time-series and similar, if not slightly lower, than the nominal index for seasons after 2012.

Figure 15. Seasonal abundance indices for Torres Strait rock lobsters based on the standardised CPUE from the Main-Effects and several interaction models. The nominal CPUE is also shown for comparison.

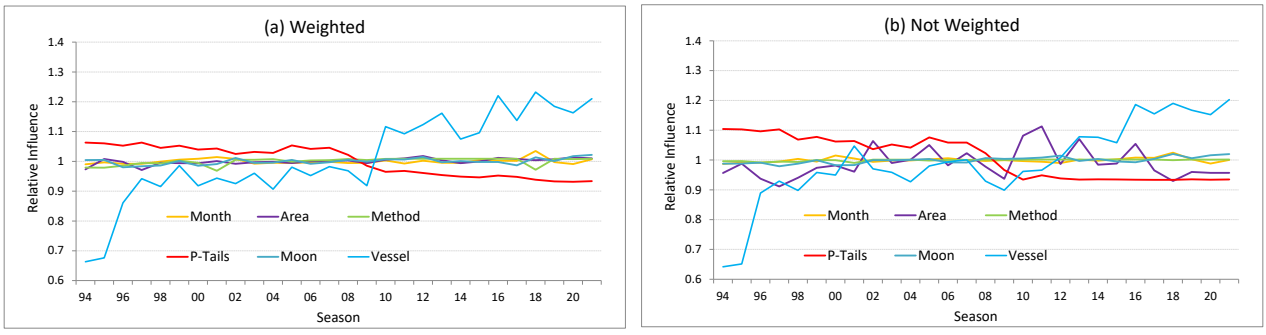


The reasons for these differences can be investigated using the annual influence of each main effect which is shown in Figure 16 for the Main-Effects model. The influence on the annual index is seen to be greatest for the *Vessel* effect followed by the *Proportion-Tails* effect, with the influence of each effect showing an opposing trend over time. The change in the influence of the *Proportion-Tails* effect correlates with the shift from the catch being all tails to now being predominantly whole (c.f. Figure 3b), which decreases CPUE (c.f. Figure 12d), while the change in the influence of the *Vessel* effect is most likely due to an (expected) increase in the relative fishing power of vessels over time. The relative influence of the *Vessel* effect is seen to be greatest towards the start and end of the time- series and explains the divergence seen between the nominal and standardised indices at these times.

Table 4. Annual abundance indices for Torres Strait rock lobsters based on the standardised CPUE from the weighted GLM models. The nominal CPUE is also shown for comparison.

Season	Effort	Catch	Nominal	Model-1	Model-2	Model-3	Model-4
94	5,494	67,926	0.89	1.44	1.43	1.37	1.32
95	3,728	49,903	0.96	1.41	1.38	1.34	1.30
96	5,964	77,749	0.93	1.03	1.03	1.03	1.00
97	7,274	105,108	1.03	1.18	1.17	1.10	1.10
98	10,105	138,923	0.98	1.11	1.10	1.10	1.08
99	5,209	55,643	0.76	0.67	0.67	0.67	0.68
00	7,277	62,863	0.62	0.70	0.69	0.74	0.73
01	2,914	17,780	0.44	0.44	0.44	0.46	0.46
02	8,633	92,295	0.77	0.68	0.68	0.63	0.64
03	20,396	293,368	1.03	1.05	1.04	0.99	1.00
04	24,328	369,305	1.09	1.16	1.16	1.12	1.13
05	21,210	440,027	1.49	1.48	1.48	1.39	1.38
06	12,349	117,841	0.68	0.69	0.69	0.64	0.65
07	14,495	219,126	1.08	0.98	0.98	0.97	0.98
08	7,389	89,352	0.87	0.86	0.86	0.91	0.95
09	6,019	52,023	0.62	0.65	0.65	0.70	0.74
10	12,078	209,036	1.24	1.11	1.13	1.26	1.27
11	14,286	421,576	2.11	1.74	1.75	2.06	2.06
12	14,920	350,032	1.68	1.41	1.42	1.28	1.30
13	18,829	334,080	1.27	1.22	1.23	1.33	1.33
14	16,183	234,304	1.04	0.93	0.94	0.93	0.95
15	14,329	125,771	0.63	0.61	0.61	0.54	0.54
16	13,662	230,506	1.21	1.09	1.10	1.12	1.13
17	11,877	126,577	0.76	0.71	0.72	0.65	0.64
18	8,408	105,841	0.90	0.72	0.72	0.72	0.71
19	10,498	147,411	1.01	0.95	0.95	0.89	0.88
20	8,175	136,055	1.19	1.27	1.27	1.33	1.33
21	11,198	113,628	0.73	0.71	0.72	0.74	0.74
Mean			1.00	1.00	1.00	1.00	1.00

Figure 16. Seasonal influence of the fixed effects fitted to the Main-Effects model. Results are shown for models where the observations in each *Season*Month*Area* strata are either (a) weighted or (b) not weighted.



It is noted that the influence in the four other main effects included in the model is small over each season. The small influence of the Method effect over time is likely due to the dominance of the hookah method during most seasons, and while the percentage of sets for which the method remained unknown was appreciable before 2004, it is likely that many if not most of these sets were hookah sets. The lack of influence for the moon effect is also likely because the proportion of fishing sets around the phases of the moon has also not changed substantially over the seasons. On the other hand, the lack of

influence for the month and area effects between seasons is due to the fact that the observations in the analysis were weighted so that the weighted number of observations in each Season-Month-Area stratum was effectively the same. Removing this strata weighting (as shown in Figure 16b) indicates that the area effect does have an influence between seasons, no doubt due to the seasonal shifts of lobster abundance between areas and the ability of the fishing effort to follow these shifts.

Several criteria for assessing the goodness-of-fit for each of the GLM models are shown in Table 5. For each criterion (where smaller is better) there is a general improvement in the fit between each successive model implying that the model which includes the 3-way *Season*Month*Area* interaction provides the best fit to the data (though Model-3 was considered to have the best fit based on the often-used BIC-criteria). This model has considerably greater flexibility in accounting for inter-annual changes in the distribution of the resource across the different months and areas in comparison to the Main-Effects model which assumes that these distributions are the same for all seasons. However, the number of parameters (1696) estimated in the full interaction model is considerably greater than the number of parameters (133) estimated in the Main-Effects model. A consequence of the increase in the number of parameters is that the number of observations on which some of the parameters rely to be estimated can be small (or in some instances zero). A small number of observations increases the likelihood that the corresponding parameter is poorly estimated. The number of strata where a value from a previous model was used to estimate a value of stdCPUE for those Season-Month-Area for which there were no observations is also shown (being 8% and 28% for Models 3 and 4 respectively). Despite these issues, the resulting annual indices were found to be similar between the different models. Finally, several plots displaying the distribution of the residuals fitted to the full interaction model (Model-4) are shown in Figure 17 and indicate a relatively good fit of the model to the data.

Table 5. (a) Criteria for assessing the goodness-of-fit of each GLM. The model displaying the best fit using either the AIC or BIC goodness-of-fit criteria is shown by the shading, and (b) the number of *Season*Month*Area* strata for which the value was back-filled using a previous model.

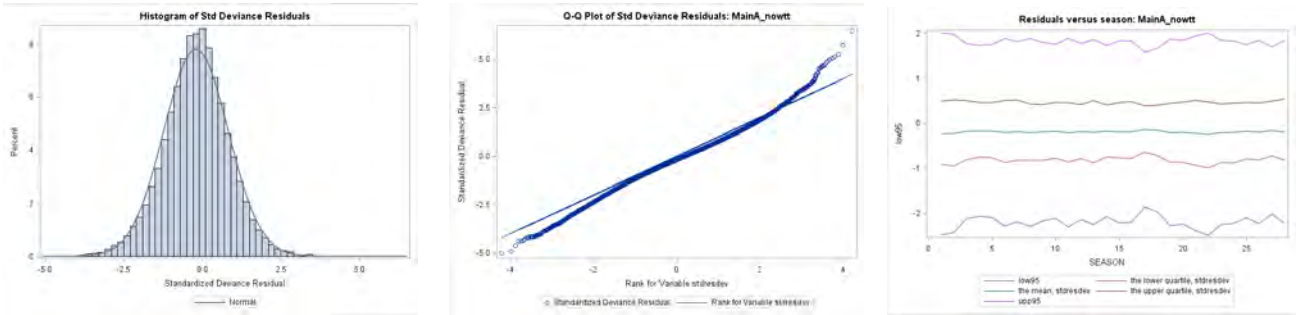
(a)

Criteria	Main-Effects	Model-2	Model-3	Model-4
N-records	50,293	50,293	50,293	50,293
N-parameters	133	196	603	1696
Deviance	22,769	22,417	18,535	15,147
Pearson Chi-Square	24,285	23,643	18,224	14,275
Log Likelihood	-194,436	-193,984	-188,513	-182,798
AICC (smaller is better)	389,138	388,359	378,232	368,989
BIC (smaller is better)	390,314	390,092	383,562	383,978

(b)

N-Strata	2240	2240	2240	2240
N-Back-filled	0	0	175	630
%-Back-filled	0%	0%	8%	28%

Figure 17. Analysis of residuals for Model 4.



4. Sensitivity Analyses

Several additional analyses were undertaken to ascertain the sensitivity of the calculated annual index of abundance to changes in the data fitted to the models.

i) Impact of COVID on distribution of fishing effort

The distribution of fishing effort (number of tender sets) across each month and season is shown in Figure 18. While the distribution of fishing effort during 2018 is seen to have very low in some months due to the low availability of quota that season, the number of tender-sets each month has generally been lower since 2019 than during previous seasons. In particular, effort levels during both February and March of the 2020 and 2021 seasons were the lowest of all the seasons compared. During 2021 this was due to the low market prices available for lobsters and the lack of suitable markets during the early stages of the 2021 fishing season. To ascertain whether the low effort in these months could influence the annual index, the models were fitted to the data with these two months excluded. An extra model was also fitted where the data for the 2018 season was also excluded. Comparison of the annual indices corresponding to fitting these reduced sets of data to both Model 2 and Model 3, and the annual indices based on the fit to all data, are shown in Figure 19. While the main trend in all indices is seen to be similar for each model, there are some differences. For example, during the last decade the index based on the reduced data is higher in 2016 and lower in 2020. Excluding the data for 2018 has no influence on the index based on only excluding the data for February and March.

Figure 18. Distribution of fishing effort (number of tender/dory sets) across each month and season

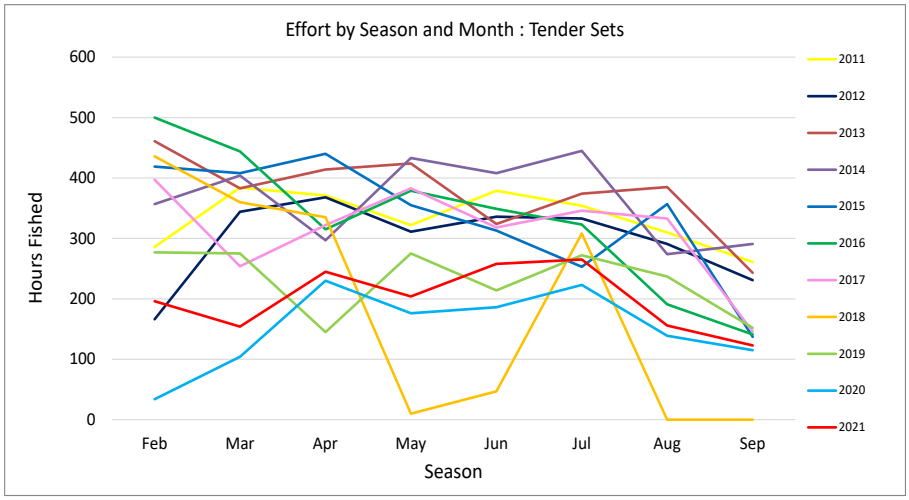
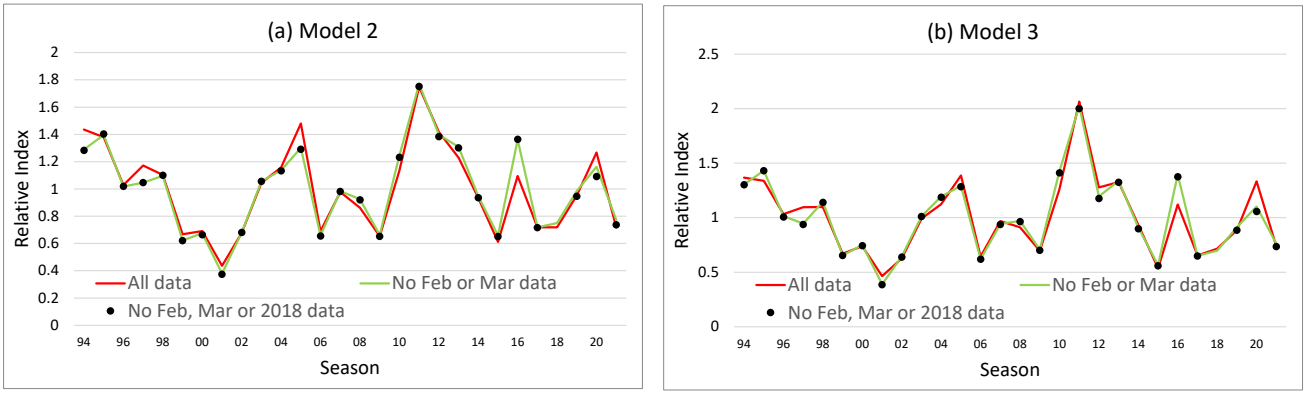


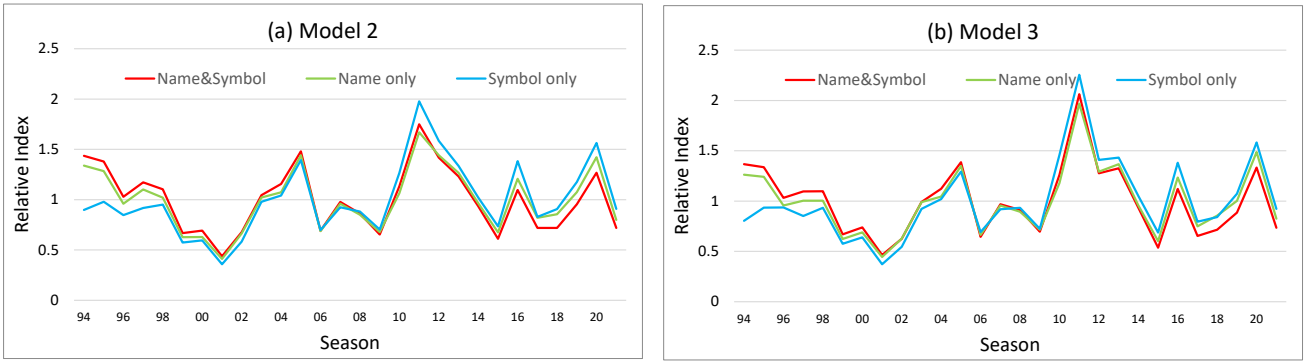
Figure 19. Comparison of the annual indices corresponding to fitting the two reduced sets of data to both Model 2 and Model 3, and the annual indices based on the fit to all data.



ii) Impact of Vessel Identifier

As described previously, due to the observation that Vessel-Names and Vessel-Symbols are not always matched (likely due to the switching of licences between vessels) a combination of both Vessel-Name and Vessel-Symbol was adopted to identify vessels in the data. Of the 102 vessels identified in this manner, only the data pertaining to the 51 vessels which had fished for 3 or more seasons and for which there were 50 or more data records were included in the final data set selected for analysis. To ascertain whether the annual abundance index is sensitive to the manner in which vessels are identified in the data, alternative models were fitted to the data where vessel were identified either by their name or symbol. Again, applying the same set of filters as above resulted in 46 different vessels by name (and 50,0545 observations) and 37 different vessels by symbol (and 55,468 observations). Comparison of the annual indices corresponding to fitting these three alternative sets of data to both Model 2 and Model 3 are shown in Figure 20. The use of vessel symbol is seen to have an appreciable impact on the annual index, especially for the earlier seasons when the index is lower and closer to the nominal index displayed in Figure 15. This index is also higher during the last decade than the index based on identifying vessels by both name and symbol. Alternatively, the index based on using vessel name is closer to the index based on identifying vessels by both name and symbol, however again it is higher during the past decade (being more similar to the index based on vessel symbol during this period).

Figure 20. Comparison of the annual abundance indices corresponding to fitting the three alternative sets of data using different vessel identifiers to both Model 2 and Model 3



5. Concluding Remarks

The above analyses, and the resulting indices of annual abundance, are based on the number of assumptions about the data and how these data describe fishing behaviour in the fishery. In particular, if there are features of the fishery which are not adequately captured by the data used in these analyses then the GLMs will not be able to standardise the CPUE for these particular features.

For example, even though the inclusion of interactions allows the model the freedom to resolve differences in the distribution of the resource across the different areas within different seasons, the model has no ability to resolve changes in the fishery which may take place within any given area (or month). In particular, the models used to standardise CPUE assume that within each season the distribution of fishing effort within any area is relatively random or that the pattern of fishing across each area remains relatively consistent over time. However, it is possible that with the introduction of new technologies (such as GPS) that over time fishers have been able to more precisely target their fishing effort to sub-regions of preferred habitat (and higher abundance) within a given area. Such 'effort creep' would result in higher catches and higher CPUE compared to the situation where no new technologies were available. The maintenance of high CPUE in light of reduced resource abundance due to effort creep (known as hyper-stability) ultimately leads to a breakdown of the linear relationship assumed between CPUE and resource abundance.

This can be a particularly critical consideration for an aggregating species such as rock lobsters, when higher CPUE can be maintained when fishers can target known aggregating sites, or the number, size and the distribution of such aggregations within a season can change in response to changes in ambient conditions within a season not related to overall abundance (e.g. oceanographic conditions). It is interesting to note that the area fished across the fishery (as measured by the number of 0.lx0.1-degree squares, c.f. Figure 10a) has been decreasing over time, with the area fished reaching a minimum during the current season (2021). However, whether this indicates that the fishing effort was more aggregated during 2018 than in other seasons remain uncertain, as the location of fishing effort currently recorded in the logbook is the location of the primary vessel and not the associated tenders which can disperse themselves widely from the primary vessel.

While the fitted GLM models used in the analyses described in this report appear to capture increases in the fishing power of the fleet due to changes in the vessels leaving and entering the fishery, continual increases in the fishing power over time for individual vessels that remain in the fishery will not be captured by the available data and fitted models and as such could result in continual biases in the calculated indices of abundance.

To help overcome this problem it would be useful to further investigate whether or not there have been increases in fishing power over time which are not currently captured by the data. With such information one could then decide whether the data currently available adequately captures the strategies used in the fishery. If not, there needs to be a further discussion as to what additional data may need to be collected so that these aspects of the fishery can be taken into account in the statistical analyses used to standardise the data. Of course, this is a discussion that is pertinent to all fisheries.

At the moment, the vessel effect fitted to the models is being used as a proxy for overall fishing efficiency or skill level of the fishers on each vessel. This may be reasonable if the set of divers on each vessel remains the same during the period that each vessel operates in the fishery. However, if there are changes in the divers on each vessel over time (and corresponding changes in the skills of each diver) then the use of the vessel effect in the manner it is currently being used may not be appropriate. Given that the data used in these analyses is the catch and effort relating to each tender set, then it would considerably improve our ability to capture any changes in fisher skills over time if the names of the individual divers on each tender were recorded and included in the data made available for these analyses. The diver names could then be used in place of the vessel identifier, as in the end it is the divers that do the fishing not the vessel. There were some comments made during the last RAG meeting held in October 2021 that due to border closures and other COVID-related restrictions that several divers who usually participate in the fishery were unable to do so this season. If these divers were ‘high-liners’ then this may have resulted in a decrease in overall skill and efficiency level of the fishery in comparison to other seasons, and partially explain the decrease seen in the abundance index for 2021.

Finally, the catches and catch-rates achieved in a fishery are also likely to be influenced by changes in oceanographic and environmental conditions which are likely to change on both a seasonal and inter-annual basis. While the current analyses attempt to model the influence of the monthly value of the Southern Oscillation Index (used to distinguish El Nino and La Nina conditions) and the daily phase of the moon on catch rates, the influence of such environmental changes is likely to require a broader understanding of oceanographic processes that impact on the fishery (including those which may influence the aggregation dynamics of the rock lobsters and delayed effects such as those which influence recruitment success or failure and which subsequently propagate through the fishery over time). Again, it would be useful to discuss how such processes can be incorporated into these models.

The use of standardised CPUE as an index of resource abundance is an important input to the stock assessments for many fisheries. This is particularly the situation for those fisheries where fishery independent surveys of the resource are not available or feasible (such as in fisheries for highly migratory species such as tunas and billfish). However, as noted above the accuracy of these indices is premised on several assumptions, particularly the ability of the logbook data used in the analyses to readily capture the important aspects of the fishery which influence catch rates. In these instances, and where possible, it is useful to incorporate fisheries independent data into the stock assessments. In particular, annual indices of resource status based on fishery independent surveys are usually seen as an important adjunct to the fishery dependent data, and where possible their inclusion in the stock assessment is highly recommended. Where such surveys are not available then attention needs to be paid to ensuring that the logbook data from the fishery captures the information necessary to adequately standardise the catch rates in the fishery as discussed above.

For the Torres Strait rock lobster fishery there are currently two sources of catch and effort data, those for the TVH and TIB sectors. The logbook data from the TVH sector is believed to provide a relatively complete and good source of catch and effort data for this sector, though improvements in compliance to ensure that all fields in the logbook are completed (e.g. area fished and hours fished) would improve the utility of these data. Also, a better recording of the locations of the fishing effort (i.e. at the tender level) together with the names of the individual divers would also improve the accuracy of the data for standardising catch rates. On the other hand, the data for the TIB sector is considered to be less complete and the measure of effort (days fished) is less accurate and incomplete in many instances. While the utility of these data to provide a useful index of resource abundance has been investigated elsewhere (Campbell et al, 2017), again greater effort needs to be placed on ensuring the completeness and accuracy of these data for such purposes. Toward this end, Torres Strait Tropical Rock Lobster Resource Assessment Group has commenced a process to review the data collected and the data requirements in the fishery for both assessment and management purposes (Anon, 2019) and this process needs to be continued.

References

Anon. 2019. Report of the Torres Strait Tropical Rock Lobster Resource Assessment Group (TRLRAG) Data Sub-Group Meeting 1, held 18 June 2019, Cairns.

Bentley, N., Kendrick, T.H., Starr, P.J., Breen, P.A. 2012. Influence plots and metrics: tools for better understanding fisheries 1 catch per unit effort standardisations. ICES Journal of Marine Science: 69, 84-88.

Campbell, R.A., 2004. CPUE standardization and the construction of indices of stock abundance in a spatially varying fishery using general linear models. Fish. Res. 70, 209–227.

Campbell, R.A. Plaganyi, E, Deng, R., 2018. Use of TIB Docket-Book Data to construct an Annual Abundance Index for Torres Strait Rock Lobster – 2018 update. Information paper presented to the 24th meeting of the Torres Strait Rock Lobster Resource Assessment Group, held 18-19 October 2018, Cairns.

Punsley, R.G., 1987. Estimation of the relative abundance of yellowfin tuna, *Thunnus albacares*, in the Eastern Pacific Ocean during 1970-1985. Inter-Amer. Trop. Tuna Comm. Bull. 19, 98-131.

Appendix: Data Summary

The following three spatial-temporal effects were included in the GLM analyses used to standardise the CPUE for lobsters caught in the Torres Strait:

1) Season (all 28 seasons between 1994 and 2021)
2) Month (all 8 months between February and September)
3) MSE-Areas (all 10 areas A101-A109 and A201&A202 combined)

The following records were also excluded from the GLM analyses:

1) Effort<0.5 hours or effort>12 hours
2) Catch is zero
3) CPUE > 150 kg/hour
4) Vessels which fished less than 3 seasons and for which there were less than 50 data records.

After applying the above filters the remaining data includes 50,293 records.

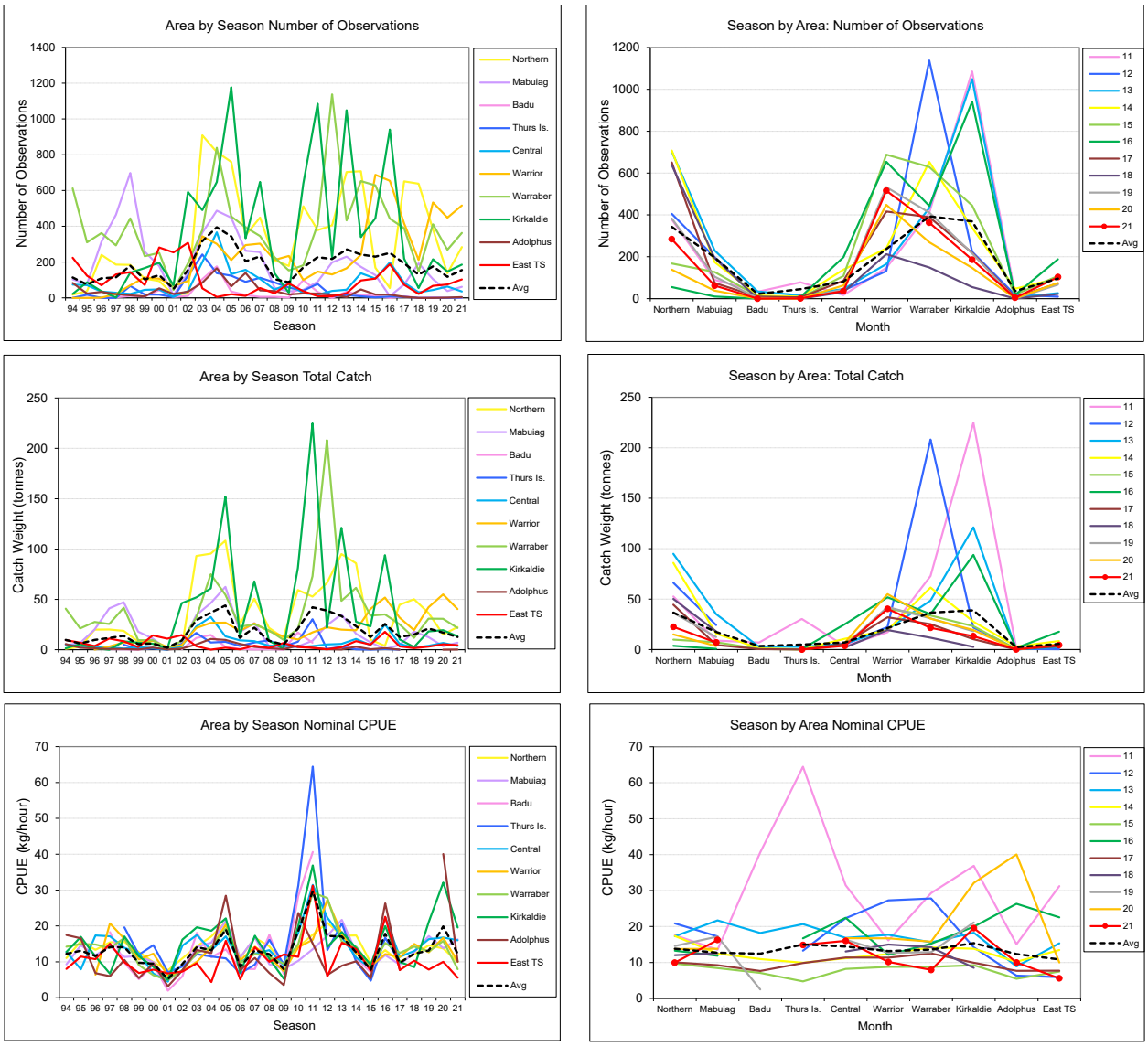
For each 2-way combination of the Season, Month and Area effects, the following figures provide:

1) Number of data observations
2) Total catch (kilograms of lobsters)
3) Nominal CPUE (kilograms per hour fished)

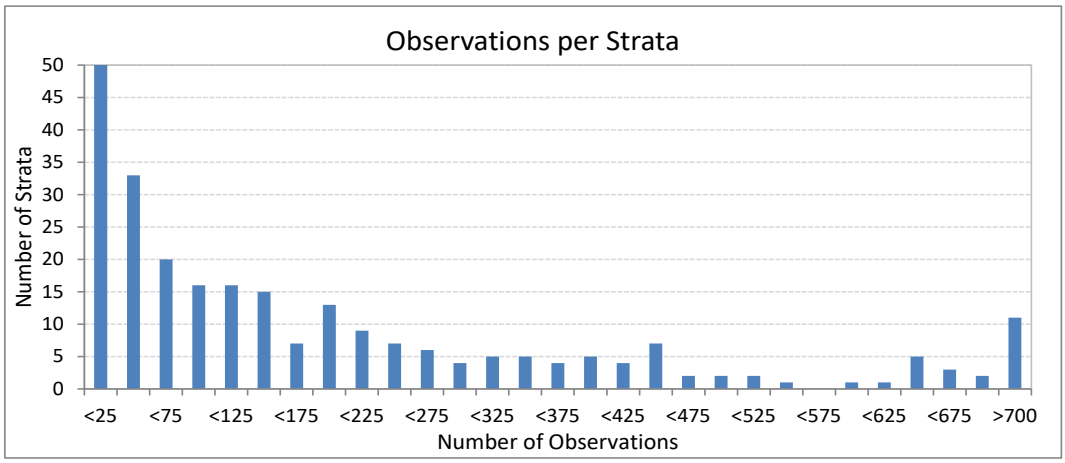
For legibility, the combinations with season are only shown for the seasons between 2011 and 2021.

A histogram of the number of observations within each stratum is also shown for each of the above 2-way combination of these effects.

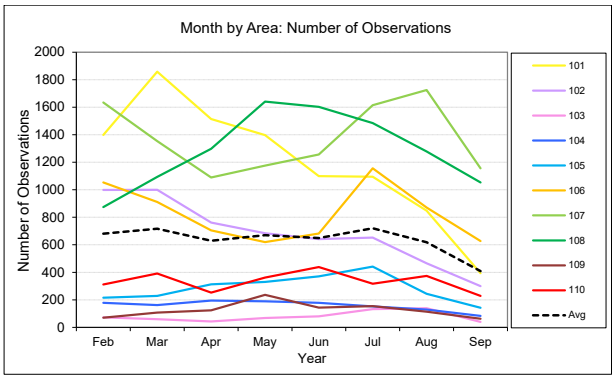
(a) Season*Area

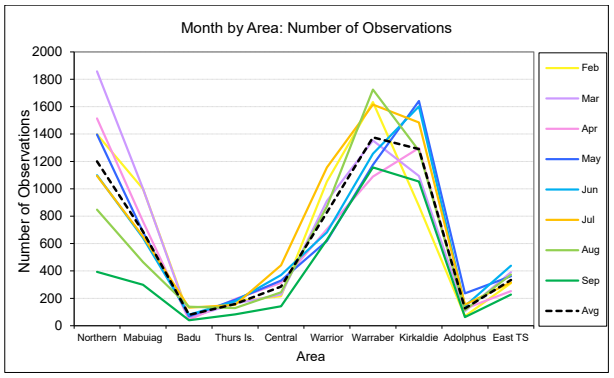


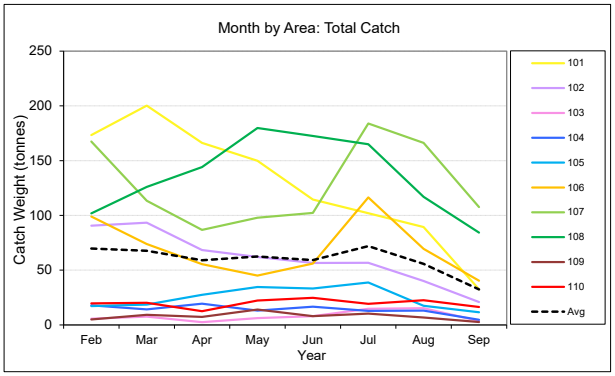
Of the 280 Season*Area strata (28 season x 10 areas) the number of observations is zero for 18 strata: There are a further 11 strata where the number of observations was between 1 and 4 and 14 strata where the number of observations was between 5 and 9. The number of observations for all other 237 strata was between 11 and 1,178.

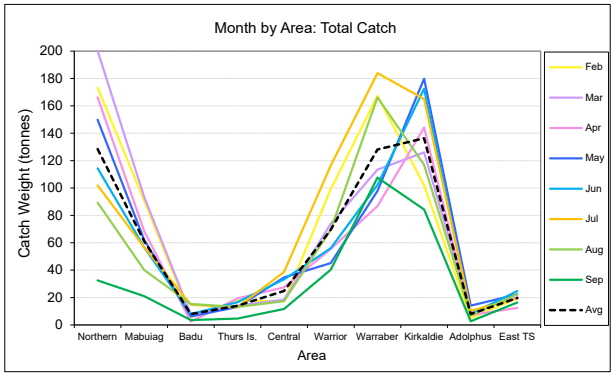


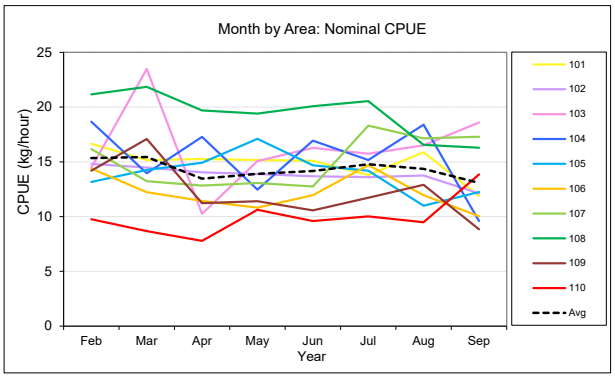
(b) Season*Month

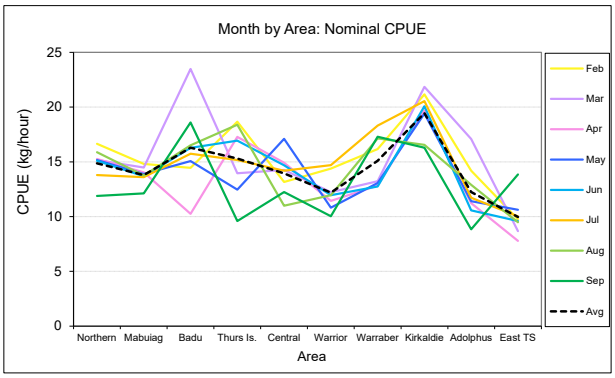




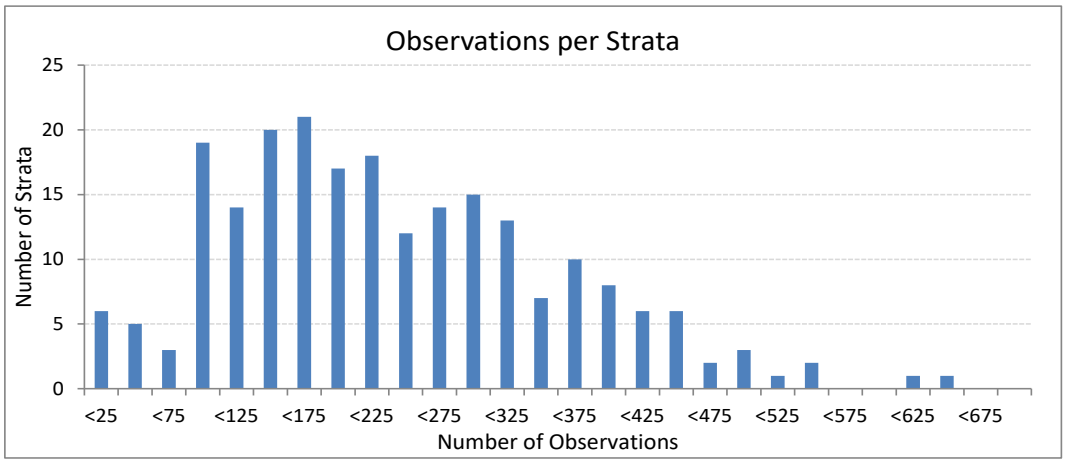




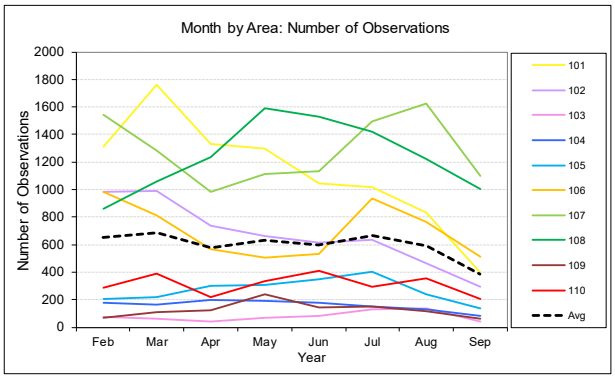


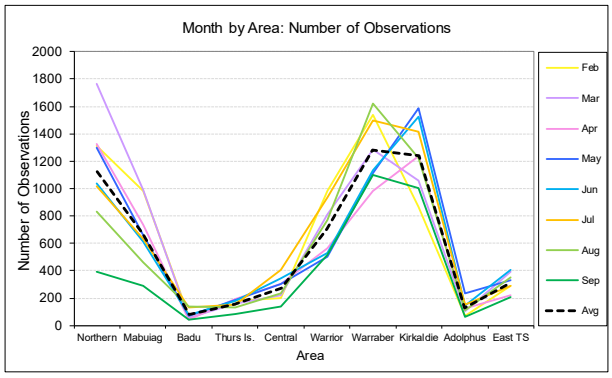


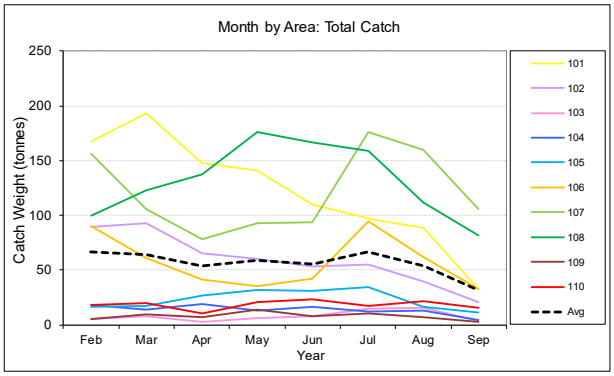
Of the 224 Season*Month strata (28 seasons x 8 months) the number of observations is zero for 4 strata (Apr-01, (May-18 and Aug-Sep-18). There was one strata (Sep-00) with only 7 observations. For the remaining 219 strata the number of observations was between 13and 625.

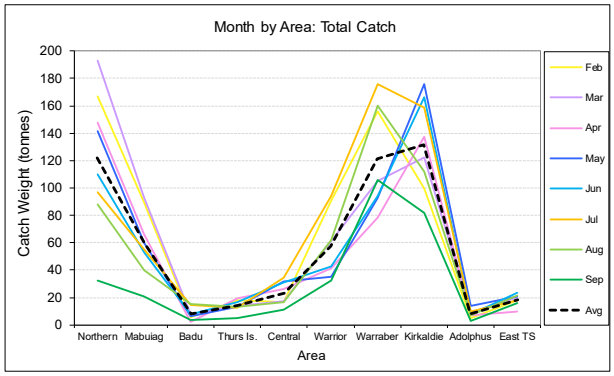


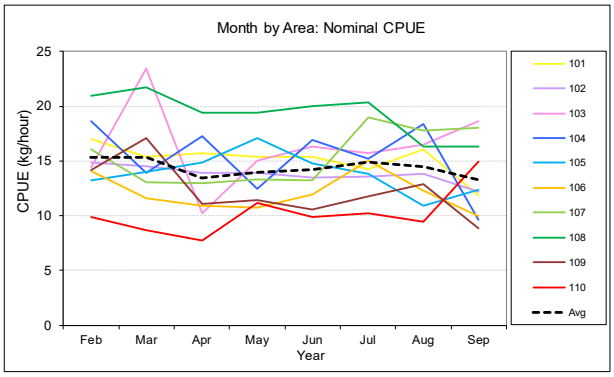
(c) Month*Area

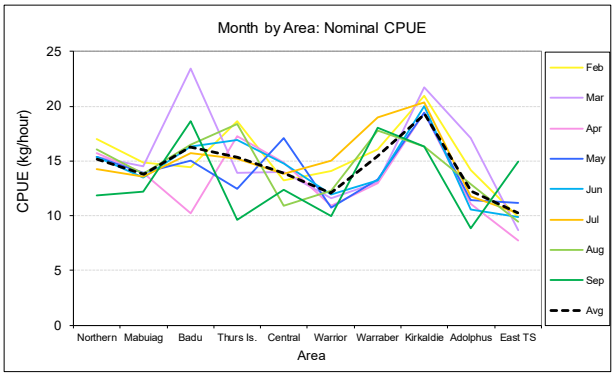




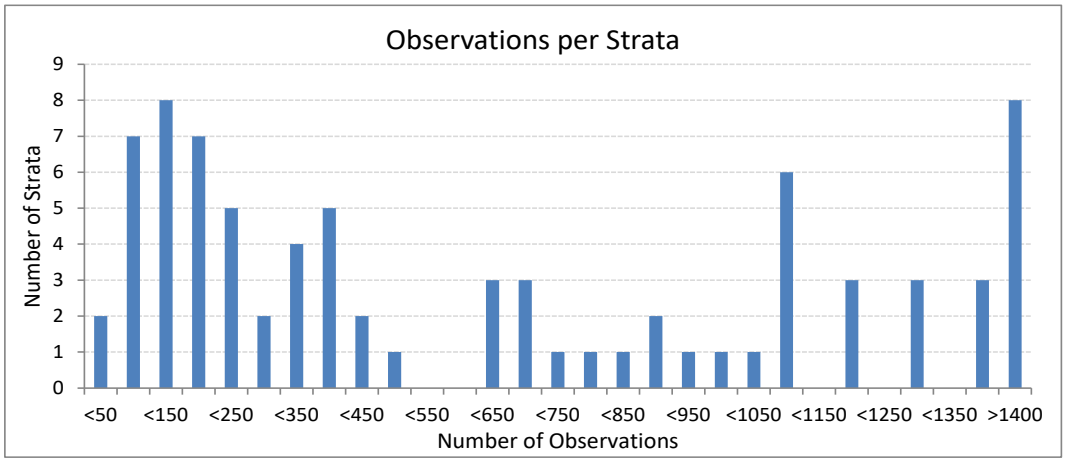








Of the 80 Month*Area strata (8 months x 10 areas) the number of observations for all strata was between 40 and 1,858.



TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
RESULTS OF THE NOVEMBER 2021 PRE-SEASON SURVEY	Agenda Item 4 For discussion and advice

RECOMMENDATIONS

1. That the RAG:
    a. **DISCUSS** and **PROVIDE ADVICE** on the results of the November 2021 pre-season survey to be presented by CSIRO at the meeting and summarised in a report provided at **Attachment 4/5a** (a survey milestone progress report is also provided at **Attachment 4b)**; and
    b. **NOTE** that in accordance with the TRL Harvest Strategy, under section 2.10 Decision Rules, if in any year the pre-season survey 1+ index is 1.25 or lower (average standardised number of 1+ age lobsters per survey transect) it triggers a stock assessment.

KEY ISSUES

2. CSIRO conducted the annual pre-season survey from 10-20 November 2021. A total of 77 sites were surveyed, selected to provide for comparison with previous surveys. The amount of seabed biota (plants and some selected animals) and also substrate type was also recorded at each survey site. Length frequency data was collected from captured TRL.
3. The pre-season survey data is a key data input (with a 70 per cent weighting) in the empirical harvest control rule (HCR), and the integrated stock assessment when it is run (every three years under the TRL Harvest Strategy).
4. The results of the November 2021 pre-season survey will be presented by CSIRO at the meeting. A summary report of the pre-season population survey is provided at **Attachment 4/5a**.
5. The RAG is being asked to review the analysis and where relevant provide advice on the findings and/or need for further analysis.
6. Of particular relevance, section 2.10 Decision Rules of the Harvest Strategy provides that:
    - **If in any year the pre-season survey 1+ index is 1.25 or lower (average standardised number of 1+ age lobsters per survey transect) it triggers a stock assessment.**

Torres Strait Tropical Rock Lobster 2021 Pre-season Population Survey

Leo Dutra, Nicole Murphy, Steven Edgar, Kinam Salee, Tony Salam, Robert Campbell, Judy Upston and Éva Plagányi

CSIRO Oceans and Atmosphere

Tropical Rock Lobster Pre-Season Survey Trip Report – 29 November 2021

Milestone Progress Report – AFMA project no. R2019/0825

INTRODUCTION

The 2021 Tropical Rock Lobster (TRL) Pre-season survey was conducted between the 10th and the 20th of November 2021. For the first time, the CSIRO team included a TIB fisher (Mr Tony Salam, along with Leo Dutra, Nicole Murphy, Kinam Salee, and Steven Edgar). The 2021 CSIRO team completed 77 survey sites (Figure 1) using the CSIRO NAIAD RIB to conduct the dives, supported by the mothership "Wild Blue" (Rob Benn Holdings) (Figure 2).

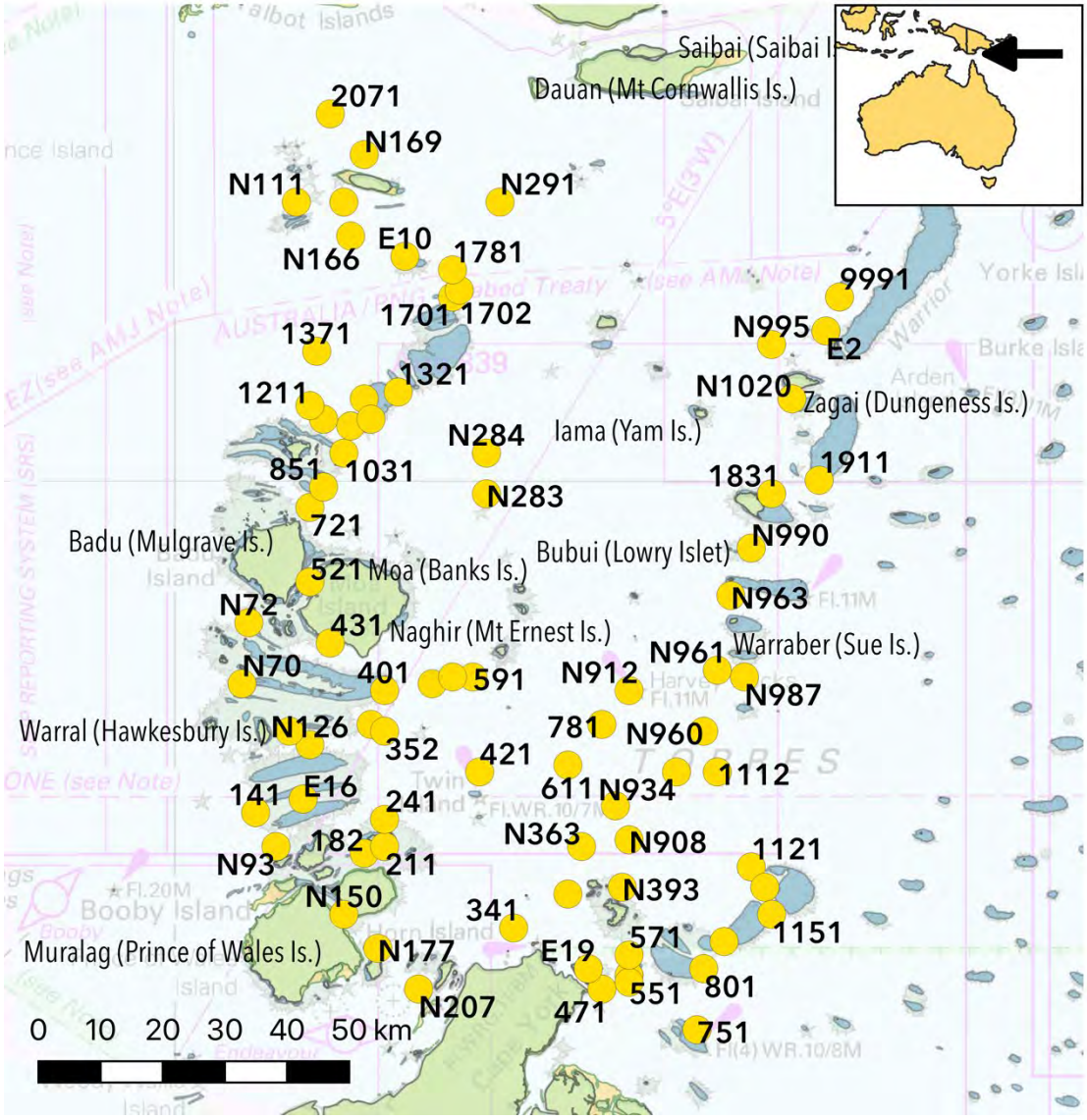


Figure 1. Map of western Torres Strait showing the sites surveyed during the 2021 TRL pre-season survey.

Conditions during the 11-day survey varied with winds ranging between 0-25 knots. From days 1-7 of the survey, winds were weak (0-10 knots), increasing to 15-25 knots in the last 4 days of the survey (Figure 3). Underwater visibility averaged around 3m (range 1-9m) with neap tidal flows allowing for a good visual census and collection of TRL.

Figure 2. Boats used during the 2021 pre-season survey: Mothership "Wild Blue" (left) and CSIRO tender (right) used to support dive operations.

Figure 3. Weather and sea conditions during the 2021 TRL pre-season survey. Top: Good weather and weak winds prevailing at the initial 7 days of the survey. Bottom: windy and rainy conditions during last 4 days of the survey.

METHOD

Survey permits

Three research permits are required to conduct research associated with TRL population surveys. These include:

- Protected Zone Joint Authority Permit
  - Collect no more than 400 lobster per survey within the area of Australian Jurisdiction in the Torres Strait Tropical Rock Lobster Fishery
- Queensland General Fisheries Permit
  - Collect lobster in tidal waters east of longitude 142˚ 31′ 49″ east and north of latitude 14˚ south
- Great Barrier Reef Marine Park Authority Permit
  - Collect no more than 30 juvenile lobster in total (≤90mm carapace length) per year from 7 sites from within the Great Barrier Reef Marine Park Zone (Figure 2; sites E19, 471, 541, 551, 571, 751, 801), and
  - Collect no more than 5 juvenile lobster per site per year from within the Great Barrier Reef Marine Park Zone

Site survey

The CSIRO TRL Dive Team used the standard 2000m^2 belt transect method (2 divers per site each scanning 2m by 500m) with transect distance measured using a Chainman® device. For a proportion of sites (n=4) where the full 500m distance could not be swum the observed lobster counts were standardised to an area of 2000m^2. At the completion of each transect divers recorded:

- The number of lobsters caught per age-class;
- The number and age-class of those observed but not caught;
- Depth;
- Visibility;
- Current speed;
- Distance and direction swum from site co-ordinate.

In addition, species of interest (i.e. pearl oyster (*Pinctada maxima*), crown-of-thorns starfish and holothurian species) were counted and the habitat characterised using percent cover for the various substrate and biota types (percent cover of sand, mud, consolidated rubble, limestone pavement, boulders, seagrass, algae, sponges, whips and live coral). The presence of bleached coral was also noted, where applicable.

Caught lobsters (n=172) were measured (tail width, TW) to provide fishery-independent size-frequency data. As in previous 2 years, temperature and depth profiles were measured at sites using a small Van Essen CTD Diver logger attached to a diver's harness. In 2021 additional water column data (Chlorophyll, Depth, fluorescent dissolved organic matter, conductivity, dissolved oxygen, salinity, turbidity, total suspended solids, total dissolved solids, pH and temperature) were collected (up to 17m deep) using a hand-held sounder (Xylem - YSI EXO2 Multiparameter water quality sonde) deployed from the mothership Wild Blue.

Survey data analysis

Upon completion of the dives, the data were entered into the project's relational database and verified for accuracy. Post survey data analyses will be carried out and presented at upcoming

TRL RAG meeting on the 15th of December 2021. Some preliminary results are presented below.

Preliminary results

A total of 77 sites were dived. As previously, divers attempt to complete the full transect length at each site but occasionally only a partial transect was completed due to bottom time limits of dive tables and weak currents. In 2021, additional survey pre-planning was done to reduce the probability of partial transects and this was successfully implemented as out of the 77 sites only 4 had partial transects (or 5% of total; down from 24% in 2020). In total, 356 TRL were observed and categorised into age classes in the 2021 pre-season survey compared to 333 in 2020 and 446 in 2019 (Table 1). Of these, 172 were measured (TW) and their sex determined. Males comprised 55% of the lobsters measured (n=95) and females 45% (n=78). In contrast, in the 2020 survey where 179 were measured, males comprised 45% of the measured lobster population and females 55%.

As in previous surveys, age 1+ lobsters comprised the majority of the lobsters observed in the 2021 survey (n=307). Age 2+ lobsters were rarely observed (n=4), as most fished lobsters have emigrated from Torres Strait during August/September to undertake the breeding migration. Age 0+ lobster numbers were the lowest (n=45) recorded in the last 3 surveys. Further detail on the lobster spatial distribution as well as habitat monitoring results will be presented at the forthcoming TRLRAG meeting, together with the standardised survey index that is used as an input to the empirical harvest control rule (eHCR)

Table 1. Comparison of lobster numbers per age class observed between 2019, 2020 and 2021 pre-season surveys.

Age	2019	2020	2021
0+	92	101	45
1+	350	225	307
2+	4	7	4
Total	446	333	356

Acknowledgements

We wish to sincerely thank the master (Rob Benn) and crew (Cohen Brock) of the Wild Blue for excellent assistance in all aspects of the pre-season dive survey in Torres Strait, and in logistic support prior to, during and after the field survey. We gratefully acknowledge funding support for the survey from AFMA and CSIRO.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
RECOMMENDED BIOLOGICAL CATCH	Agenda Item 5 For discussion and advice

RECOMMENDATIONS

1. That the RAG:

- **NOTE** on 31 August 2021, Senator the Hon. Jonathon Duniam determined a total allowable catch (TAC) of 200,000 kilograms of TRL in the Australian waters of the TRL Fishery for the 2021-22 fishing season.
    (i) It is expected that the TAC will be increased once the outcomes of the scientific assessment process and the TAC sharing arrangements under the Treaty between Australia and Papua New Guinea (PNG) have been taken into account.
- **NOTE** that TRLRAG 31 (12 October 2021) discussed the implications of lower than expected total average catch multiplier on the application of the eHCR in recommending a biological catch for the 2021-22 season and recommended that CSIRO present two possible options for addressing the data anomaly:
    (i) **Option 1:** replace the actual catch values and substitute them with the TAC value in outlier years (2019-20 and 2020-21); use the actual catches in the three years prior (2016-17, 2017-18 and 2018-19) and apply an average of all five years catch values.
    (ii) **Option 2:** noting that there has been a change in the relative proportion of the TAC caught between the TIB and TVH sectors in recent years, use the combined sector (TIB, TVH and PNG) average catch proportion against the global TAC over the recent five-year period, capping any overcatch at 100 per cent of the TAC, and apply this proportion to the TAC for 2019-20 and 2020-21 to obtain an estimated catch value for those years.
- **CONSIDER** the recommended biological catch (RBC) estimates derived through the application of the empirical harvest control rule (eHCR), including the options to address the lower than expected total average catch multiplier - to be presented by CSIRO (**Attachment 4/5a**).
    (i) noting that the RBC covers the Torres Strait Protected Zone (TSPZ) (Australia and PNG).
- Having regard to the above, and in accordance with the TRL Harvest Strategy, **DISCUSS** and **PROVIDE ADVICE** on a RBC for the 2021-22 fishing season.

KEY ISSUES

Implications of low catch multiplier on the empirical Harvest Control Rule and options to address

2. TRLRAG 31 (12 October 2021) discussed the implications of a lower than expected average catch multiplier on the eHRC, which in one season may not be as influential as the total catch is averaged over a five year period. However, if the negative average total catch trend was to continue, it would start to drive the RBC calculation down.

3. While the eHCR has been extensively tested to handle a series of uncertainties and has been demonstrated to be fairly robust, the impacts of exceptional circumstances such as COVID-19 and market collapse, are not accounted for.

4. The average catch multiplier is considered to be a check and balance mechanism. If for example, the pre-season survey indicated the upcoming season was going to be an average season, in the absence of any exceptional circumstances, it could be expected that the TAC would be close to, or fully caught. However, if the total catch was artificially low (due to exceptional circumstances) then the RAG may consider making some adjustments to account for the lower catches so as to not unnecessarily reduce the TAC. Alternatively, the RAG could consider applying the default eHCR which will reduce the TAC for next season though is not necessarily scientifically justified.

5. Noting that the fishery dependent data had not yet been analysed or corroborated with industry anecdotes, the RAG recommended that CSIRO present two different options (as discussed) for dealing with the under-catch in both the 2019-20 and 2020-21 fishing season's data in the eHCR at the next RAG meeting.

    - **Option 1:** replace the actual catch values and substitute them with the TAC value in outlier years (2019-20 and 2020-21); use the actual catches in the three years prior (2016-17, 2017-18 and 2018-19) and apply an average of all five years catch values.

    - **Option 2:** noting that there has been a change in the relative proportion of the TAC caught between the TIB and TVH sectors in recent years, use the combined sector (TIB, TVH and PNG) average catch proportion against the global TAC over the recent five-year period, capping any overcatch at 100 per cent of the TAC, and apply this proportion to the TAC for 2019-20 and 2020-21 to obtain an estimated catch value for those years.

Application of eHCR

6. The eHCR uses the pre-season survey 1+ and 0+ indices, both standardised catch per unit effort (CPUE) indices (TVH and TIB), applies the natural logarithms of the slopes of the five most recent years' data and includes an upper catch limit of 1,000 tonnes. The relative weightings of the eHCR indices are 70% pre-season survey 1+ index, 10% pre-season survey 0+ index, 10% TIB sector standardised CPUE and 10% TVH sector standardised CPUE. The eHCR includes a maximum catch limit of 1000 tonnes.

Recommended Biological Catch

7. The eHCR will be applied to provide RBC estimates for the 2021-22 fishing season.

8. The RAG is being asked to review CSIRO's application of the eHCR and in accordance with the TRL Harvest Strategy, provide advice on a RBC for the 2021-22 fishing season, with regard to:

    - section 2.10 Decision Rules of the TRL Harvest Strategy which provides that if in any year the pre-season survey 1+ index is 1.25 or lower (average standardised number of 1+ age lobsters per survey transect) it triggers a stock assessment.

        (i) Having regard to the pre-season survey results presented under Agenda Item 4, and whether the pre-season survey trigger has been triggered.

    - section 2.10 Decision Rule Scenarios of the TRL Harvest Strategy which provides that under Scenario 1 or 2, if the pre-season trigger has not been triggered, the RAG should consider whether the eHCR RBCs remain within the ranges tested by management strategy evaluation (MSE).

9. The RAG should also note that under the TRL Harvest Strategy, the stock assessment model is to be updated every three years and the most recent stock assessment was undertaken in 2019. Having considered the final 2019 stock assessment results at their

meeting on 7 May 2020, TRLRAG 28 agreed that no revisions were to the eHCR were required. An updated stock is assessment is schedule for 2022.

BACKGROUND

TAC setting process

10. Under subsection 13 of the Plan, the Minister must determine a TAC for the TRL Fishery prior to the start of a fishing season. In making a TAC determination, the Minister must:
    - consult with any advisory committee that the PZJA has established under subsection 40(7) of the *Torres Strait Fisheries Act 1984*, to provide advice relating to the TRL Fishery; and
    - have regard to Australia's obligations under the Torres Strait Treaty.
11. Under section 13 the Minister may also consider the views of any person with an interest in the TRL Fishery or the ecologically sustainable use of the TRL Fishery and take into account the amount of TRL taken in the TRL Fishery as a result of other fishing, such as traditional fishing or recreational fishing.
12. Subsection 14 provides for the Minister to determine an increase to the TAC for a fishing season. Subsections 8-11 prescribe how a TAC is to be administered, including the issuing of a notice when the TAC for the Traditional Inhabitant sector has been reached.
13. Further background on the TAC setting process, how catch is shared between Australia and PNG, and how each sector's catches will be managed for the 2021-22 fishing season is provided in the Tropical Rock Lobster Fishery Management Arrangements Booklet 2021-22 available from the PZJA website.

Setting the start of 2021-22 season TAC

14. At its meeting on 18-19 October 2018, the TRLRAG advised that the start of season catch limit should cover 1 December through to the end of February, and be based on the maximum annual catch amount for the period 2005-2018, being 200 tonnes. This is to minimise the risk that the limit could artificially constrain fishing effort, particularly in a year of high TRL abundance.
15. The TRLRAG further advised that if needed, an additional 100 tonnes be added to the start of season catch limit amount, to account for catches from PNG.
16. It was further agreed that the start of season catch limit be overridden in seasons where the TRL stock abundance is exceptionally low and the final RBC is likely to fall below the start of season catch limit or where overridden by the Harvest Strategy decision rules. In such cases, the use of the start of season catch limit should not be used in subsequent seasons until reviewed by the TRLRAG.
17. The above approach was applied for setting the start of season TAC for the 2021-22 fishing season with no objections from the TRLRAG.
18. At its meeting on 31 August 2021, the PZJA agreed for the TRL Fishery to a start of season TAC of 200,000 kgs (unprocessed weight) for the 2021-22 fishing season. Noting this, the Minister subsequently determined the TAC under section 13 of the *Torres Strait Fisheries (Quotas for Tropical Rock Lobster (Kaiar)) Management Plan 2018* (the Management Plan).
19. It is expected that the TAC will be increased once the outcomes of the scientific assessment process and the TAC sharing arrangements under the Treaty between Australia and PNG have been taken into account. Any increase in the TAC is expected to be determined by the end of February 2022. Further details on the expected timeline is provided at **Attachment 5b**.

Summary of Torres Strait TRL 2021 CPUE, Pre-season Population Survey, and eHCR analyses

Summary Report for Tropical Rock Lobster Resource Assessment Group – December 2021

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CSIRO Oceans and Atmosphere

SUMMARY

The newly adopted Torres Strait tropical rock lobster *Panulirus ornatus* (TRL) fishery Harvest Strategy uses an empirical (data-based) Harvest Control Rule (eHCR) to rapidly provide a Recommended Biological Catch (RBC) based on the recent catches, survey abundance indices and Catch-Per-Unit-Effort (CPUE) from TIB and TVH sectors. The eHCR recommended catch is generally considered fairly robust across a number of alternative scenarios because it is based on medium-term (5 years) trends in all indices, plus the contributions of the trends in the CPUE indices (10% for each of the 2 CPUE indices) are small relative to the weight accorded to the fishery-independent survey. The eHCR is also designed to dampen variability in the TAC by focussing on 5-year trends in data. However, the 2020-2021 and 2019-2020 total catch were only around 51% and 78% respectively of the TAC (lower than the average proportion achieved) due to a number of external factors affecting the fishery. As these factors were outside the range of impacts for which the eHCR was tested, TRLRAG31 (video conference, 12 October 2021) proposed alternative methods that could be used to make an *ad hoc* adjustment to inputs to the eHCR, and this document summarises these alternatives used in calculating alternative RBCs for consideration by the TRLRAG.

TRL CATCH

A summary of the recent catches is shown in Table 1, which also compares total catch with the total TAC (all sectors). The TRLRAG31 recommended that CSIRO present two different options for dealing with the under-catch in both the 2019-20 and 2020-21 fishing season's data in the eHCR at the next (December) RAG meeting:

- Option 1: replace the actual catch values and substitute them with the TAC value in outlier years (2019-20 and 2020-21); use the actual catches in the three years prior (2016-17, 2017-18 and 2018-19) and apply an average of all five years catch values.
- Option 2: noting that there has been a change in the relative proportion of the TAC caught between the TIB and TVH sectors in recent years, use the combined sector (TIB, TVH and PNG) average catch proportion against the global TAC over the recent five-year period, capping any overcatch at 100 per cent of the TAC, and apply this proportion to the TAC for 2019-20 and 2020-21 to obtain an estimated catch value for those years.

These two options are summarized further in Tables 1-2 below.

Table 1. Summary of recent catch (t) per sector and shown as a percentage of the TAC

SEASON	TIB	TVH	AUS-TOTAL	PNG-TOTAL	TS_TOTAL	TAC	Catch/ TAC
2013	142.5	361.7	504.2	108.3	612.5	871	70.3%
2014	198.8	273.2	472.0	261.2	733.2	616	119.0%
2015	202.6	152.7	355.3	235.7	591.0	769	76.9%
2016	267.1	243.0	510.1	248.0	758.2	796	95.2%
2017	111.5	166.3	277.8	113.0	390.8	495	79.0%
2018	127.4	128.3	255.7	156.4	412.1	320	128.8%
2019	260.6	155.9	416.5	167.0	583.5	641	95.1%
2020	216.2	145.1	361.3	90.4	451.7	582	77.6%
2021	123.2	116.3	239.4	*81.24**	320.6	623.5	51.3 %
5 yr average based on actual catches (t)					431.7		

**Final value to be confirmed noting that total PNG catches from Jan- Nov provided and Jan-Oct extrapolated for full month of November and to include December 2020, based on average catch*

Table 2. Summary of alternative methods for adjusting inputs to the eHCR

SEASON	TS_TOTAL	Option 1: Adjusted total for eHCR	TAC	Catch/ TAC	Adjusted catch proportion (capped)	Option 2: Adjusted total for eHCR based on ave catch proportion	TAC	Catch/ TAC
2013	612.5	-	871	70.3%	-	-	871	70.3%
2014	733.2	-	616	119.0%	-	-	616	119.0%
2015	591.0	-	769	76.9%	76.9%	-	769	76.9%
2016	758.2	-	796	95.2%	95.2%	-	796	95.2%
2017	390.8	390.8	495	79.0%	79.0%	390.8	495	79.0%
2018	412.1	412.1	320	128.8%	100%	412.1	320	128.8%
2019	583.5	583.5	641	95.1%	95.1%	583.5	641	95.1%
2020	451.7	**582**	582	77.6%		**519.4**	582	77.6%
2021		**614.9**	614.9			**556.4**	623.5	
5 yr average to input to eHCR		**516.7**			89.24%	**492.4**		

TRL CPUE

The full details of the TRL CPUE analyses are presented in accompanying TRLRAG32 documents by Campbell et al. 2021(a,b). As previously, the default standardised TIB CPUE series used as an input to the eHCR is the Main Effects Model 2 including Seller-effect (Table 3). However, the full 3-way interaction model (Model 3) has considerably greatly flexibility in accounting for inter-annual changes in the distribution of the resource across the different months and areas in comparison to the Main-Effects model and hence a sensitivity is also presented using Model3 as an alternative. Note though that the number of parameters estimated in the full interaction model is considerably greater than that in the Main-Effects model (Campbell et al. 2021a).

For TVH, the default model that is applied is the Int-1 version (Model 2) (Table 3) but as an alternative, a sensitivity used Model-3 which was considered to have the best fit based on the BIC-criterion (Campbell et al. 2021b). As above, this model has a large number of parameters but also considerably greater flexibility in accounting for inter-annual changes in the distribution of the resource across the different months and areas.

Table 3: Summary of the 2017-2021 (A) TIB and (B) TVH standardised catch per unit effort indices from four alternative models. Green highlight reflects the default model used.

(A) TIB Seller

	Model-1	Model-2	Model-3	Model-4
	Main-Effects	Int - M*A	Int - S*M+S*A+M*A	Int - S*M*A
2017	0.9177	0.9277	0.9111	0.9097
2018	0.8645	0.8657	0.8597	0.8472
2019	1.1176	1.1082	1.1420	1.1408
2020	1.2340	1.2256	1.2292	1.2116
2021	1.0240	1.0152	1.1439	1.1155

(B) TVH Int1

TVH	Model-1	Model-2	Model-3	Model-4
	Main-Effects	Int - M*A	Int - S*M+S*A+M*A	Int - S*M*A
2017	0.7135	0.7186	0.6536	0.6440
2018	0.7155	0.7188	0.7153	0.7117
2019	0.9458	0.9534	0.8865	0.8840
2020	1.2667	1.2668	1.3336	1.3268
2021	0.7116	0.7183	0.7351	0.7374

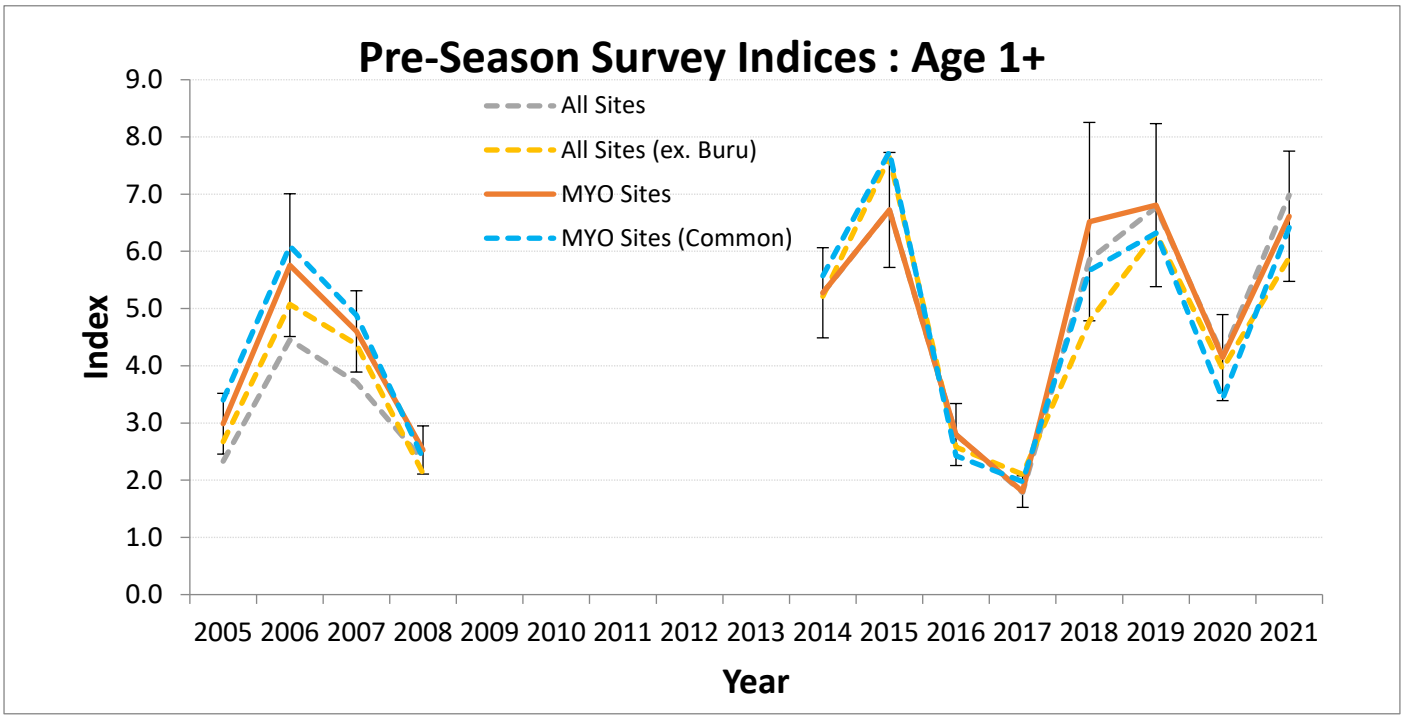
PRE-SEASON SURVEY

An overview of the 2021 Tropical Rock Lobster (TRL) Pre-season Population Survey is provided in the accompanying document by Dutra et al. (2021). Abundance indices for recruiting (1+ age class) tropical rock lobsters (*Panulirus ornatus*) were higher compared to 2020 and similar to years 2015, 2018 and 2019 (Figure 1). Standard errors were smaller when compared to 2018 and 2019 surveys, suggesting a more consistent count of lobsters across the sites surveyed.

Abundance indices for recently-settled (0+) tropical rock lobsters in 2021 were lower when compared with 2020 and the second lowest on record. In previous years, there were large differences in the number of 0+ lobsters observed between the Western and Eastern sides of the Torres Strait. However, in 2021 0+ lobsters were more evenly observed across the eastern and western sites (Figure 2).

As previously, the Midyear Only (MYO) standardised index is the default one used in the eHCR. This index is based on 74 transects (for recent years 2017-2021, except 2018 has 73) that have sites in common with the Midyear time series that started in 1989. The MYO Sites (Common) index is based on 64 sites that are common across all years and both surveys (i.e. Midyear and Preseason). Figure 1 also shows the All Sites index which is based on between 74-82 sites since 2017. As there are only three transects for the Buru region (less than for other regions) in each of the last few years, the final standardized index is run excluding Buru, and hence based on between 71 to 79 sites in the past five years. There are some fairly minor differences between these different indices (Figure 1), which are useful in exploring sensitivity of the index to these alternatives.

Recruiting (Age 1+) and recently-settled (Age 0+) lobster abundance



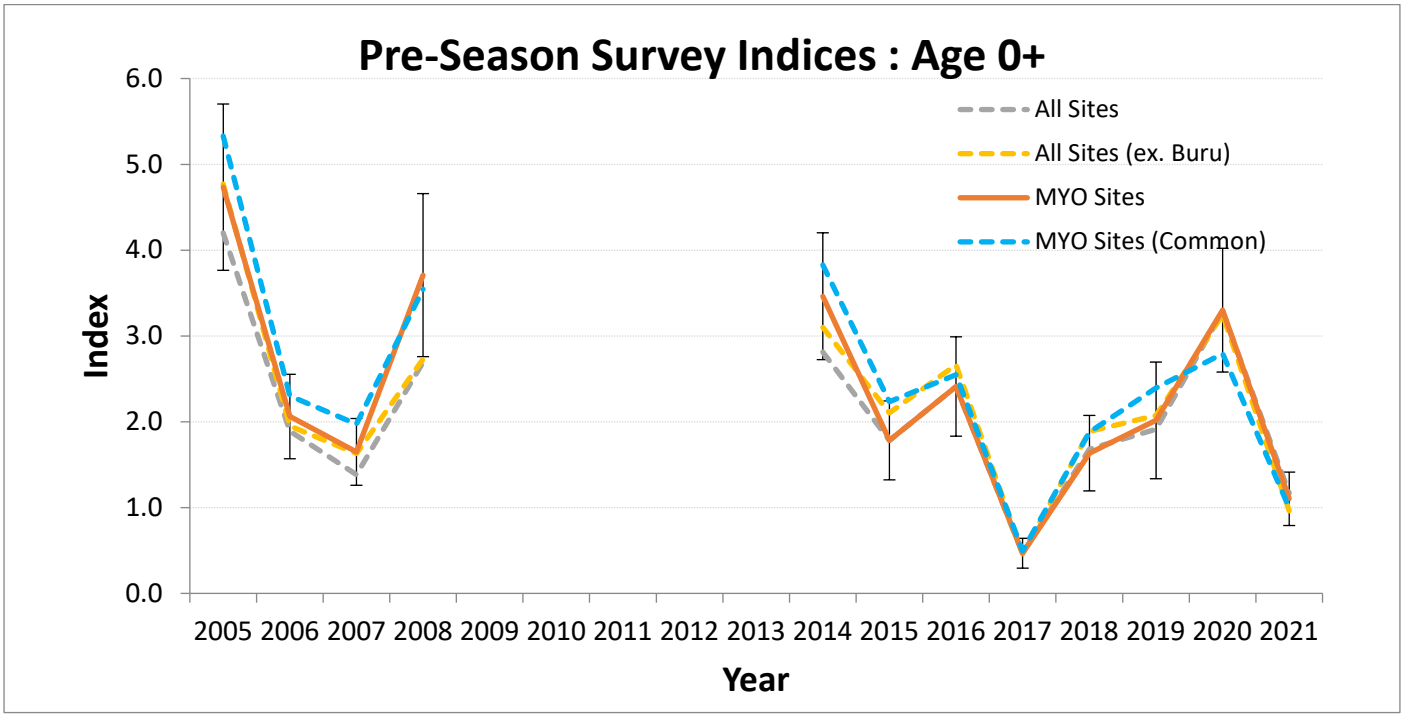


Figure 1 Abundance indices of recruiting (1+) and recently-settled (0+) tropical rock lobsters (*Panulirus ornatus*) recorded during pre-season surveys in Torres Strait between 2005 and 2021. The data represent abundance indices for all sites, as well as reduced series including Midyear-Only Sites (MYO). Error bars of MYO indices represent standard errors. (Note: Pre-season surveys were not conducted during 2009-2013).

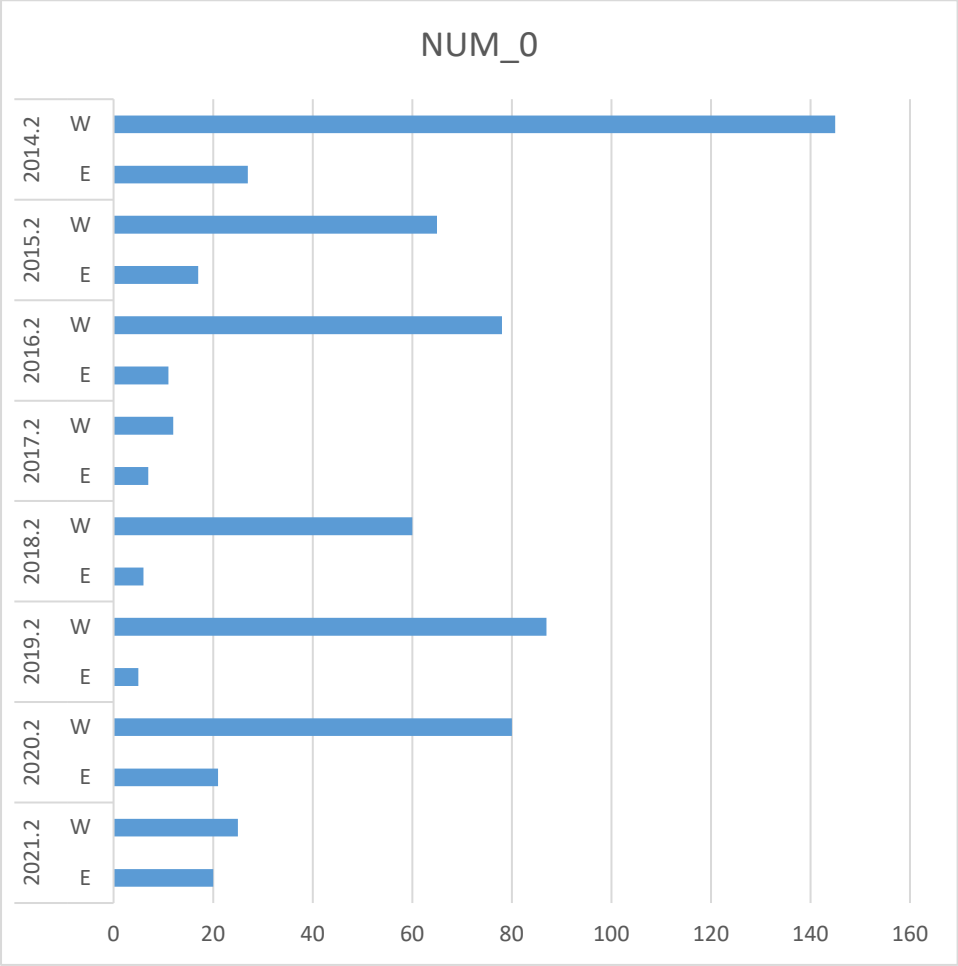


Figure 2. Number of recently-settled (0+) tropical rock lobsters (*Panulirus ornatus*) observed in the Western (W) and Eastern (E) side of Torres Strait, for pre-season surveys between 2014-2021.

eHCR Background

The eHCR formula outputs a RBC in December for the following year of fishing. This calculation is the multiple of the average catch over the last five years and a statistic which measures the relative performance of the fishery based on the following five data inputs (Fig. 3): (1) Fishery-independent recruiting lobster (1+) standardised relative numbers; (2) Fishery-independent recently-settled lobster (0+) standardised relative numbers; (3) standardised CPUE for TIB sector and (4) standardised CPUE for TVH sector; and (5) total catch (TIB,TVH,PNG) (using data available up until end of October). Different weightings are applied to the four abundance indices included in the relative performance statistic used in the eHCR. These are based on extensive testing to compare performance of alternative weightings while also considering the information content and reliability of each series, as well as a preference expressed by the stakeholders to use a portfolio approach in determining the RBC (Plagányi et al. 2018). The fishery-independent Preseason 1+ index is the primary index and is most reliable and direct in terms of indexing the biomass of lobsters that will be available to be caught in the next fishing season. Hence, this index is assigned the highest weighting of 70%. The fishery-independent Preseason 0+ index provides an early indication of the following year's recruitment, whereas the CPUE indices aim to index the relative abundance of the large 2+ lobsters, the survivors of which will migrate out of the Torres Strait to spawning grounds to the East. Each of these three secondary indices (Survey 0+ and CPUE (TIB and TVH)) are assigned a weighting of 10% (30% total) in the eHCR formula.

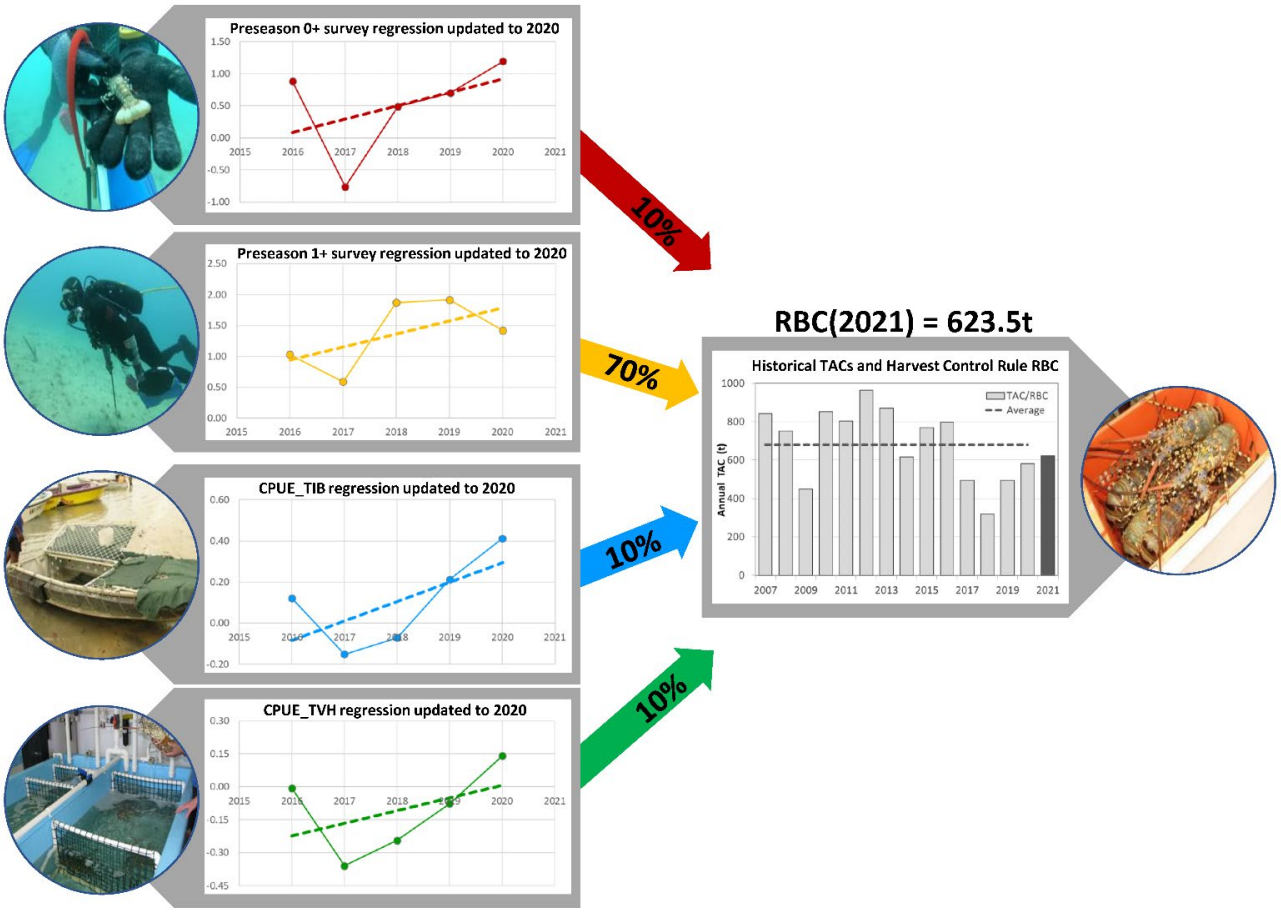


Fig. 3. Schematic summary of the empirical harvest control rule (eHCR) used to calculate the TRL (Tropical Rock Lobster) RBC (Recommended Biological Catch) (**example shown for last year's RBC**) based on the CPUE (Catch Per Unit Effort) data from two fishery sectors, the scientific survey indices of two age classes, and the total average catch over the past five years (source (Plagányi et al. 2021)).

Simulation testing (Plagányi et al. 2016) showed that the best approach is to use the slope of the trends in the secondary indices over the last five years' data (after first taking the natural logarithm of the data) for each of the abundance indices. This allows the RBC to be based on medium-term trends in abundance, rather than on just the current abundance.

Hence the HCR rule is as follows (see also Figure 3):

$$RBC_{y+1} = \left[0.7 \cdot \left(1 + s_y^{presurv,1}\right) + 0.1 \cdot \left(\left(1 + s_y^{presurv,0}\right) + \left(1 + s_y^{CPUE,TVH}\right) + \left(1 + s_y^{CPUE,TIB}\right)\right)\right] \cdot \bar{C}_{y-4,y} \qquad (1)$$

where

$\bar{C}_{y-4,y}$ is the average achieved catch during the past 5 years, including the current year i.e. from year *y*-4 to year *y*,

$s_y^{presurv,1}$ is the slope of the (logarithms of the) fishery-independent survey 1yr abundance index, based on the 5 most recent values;

$s_y^{presurv,0}$ is the slope of the (logarithms of the) fishery-independent survey 0yr abundance index, based on the 5 most recent values;

$s_y^{CPUE,TVH}, s_y^{CPUE,TIB}$ is the slope of the (logarithms of the) TVH and TIB CPUE abundance index, based on the 5 most recent values.

eHCR (Empirical Harvest Control Rule) Application

The TRL fishery transitioned to using an empirical Harvest Control Rule (eHCR) to inform the Recommended Biological Catch (RBC) in December 2019, hence a stock assessment only needs to be conducted every three years unless the stock assessment is triggered by a decision rule. The eHCR used the latest available catch, CPUE and pre-season survey data as shown in Table 3 below. Alternative options are also presented for discussion by the forthcoming TRLRAG and as specified below.

In accordance with the TRL Harvest Strategy, the RAG are required to consider whether:

a) The pre-season survey limit was triggered (is Preseason 1+ index < 1.25?);

b) The eHCR RBC remains within the revised ranges tested by management strategy evaluation (MSE);

c) The updated stock assessment (if a stock assessment year) does not indicate any need for revision of the eHCR; and

d) The application of the eHCR should continue unchanged and be applied to provide the RBC for the 2021/22 fishing year.

Note that in the eHCR calculations use the average catch for the past five years, which is based on actual catch values for 2016-17, 2017-18 and 2018-19 and the TAC value in the under-caught (outlier) years of 2019-20 and 2020-21 (Option 1, see Table 2) or an average proportion of the TAC for the latter two outlier years (Option2, Table 2).

Table 4: Summary of index (1+slope), average catch (t) and RBC (t) for each of the five eHCR options considered.

	Option 1 Index_MYO; Seller; Int1 - using avg catch option 1	**Option 2** Index_MYO; Seller; Int2 - using avg catch option 2	**Option 3** Default - using actual 2021 catch	**Option 4** Alternative CPUE (Mod3) for TIB & TVH - using avg catch option 1	**Option 5** Alternative CPUE (Mod3) for TIB & TVH - using avg catch option 2
Preseas1	1.215	1.215	1.215	0.850	1.215
Preseas0	1.242	1.242	1.242	0.124	1.242
CPUE_TIB	1.058	1.058	1.058	0.108	1.081
CPUE_TVH	1.057	1.057	1.057	0.109	1.086
Ave Catch (t)	516.70	492.44	431.70	516.70	492.44
RBC (t)	**612.8**	**584.0**	**512.0**	**615.5**	**586.6**

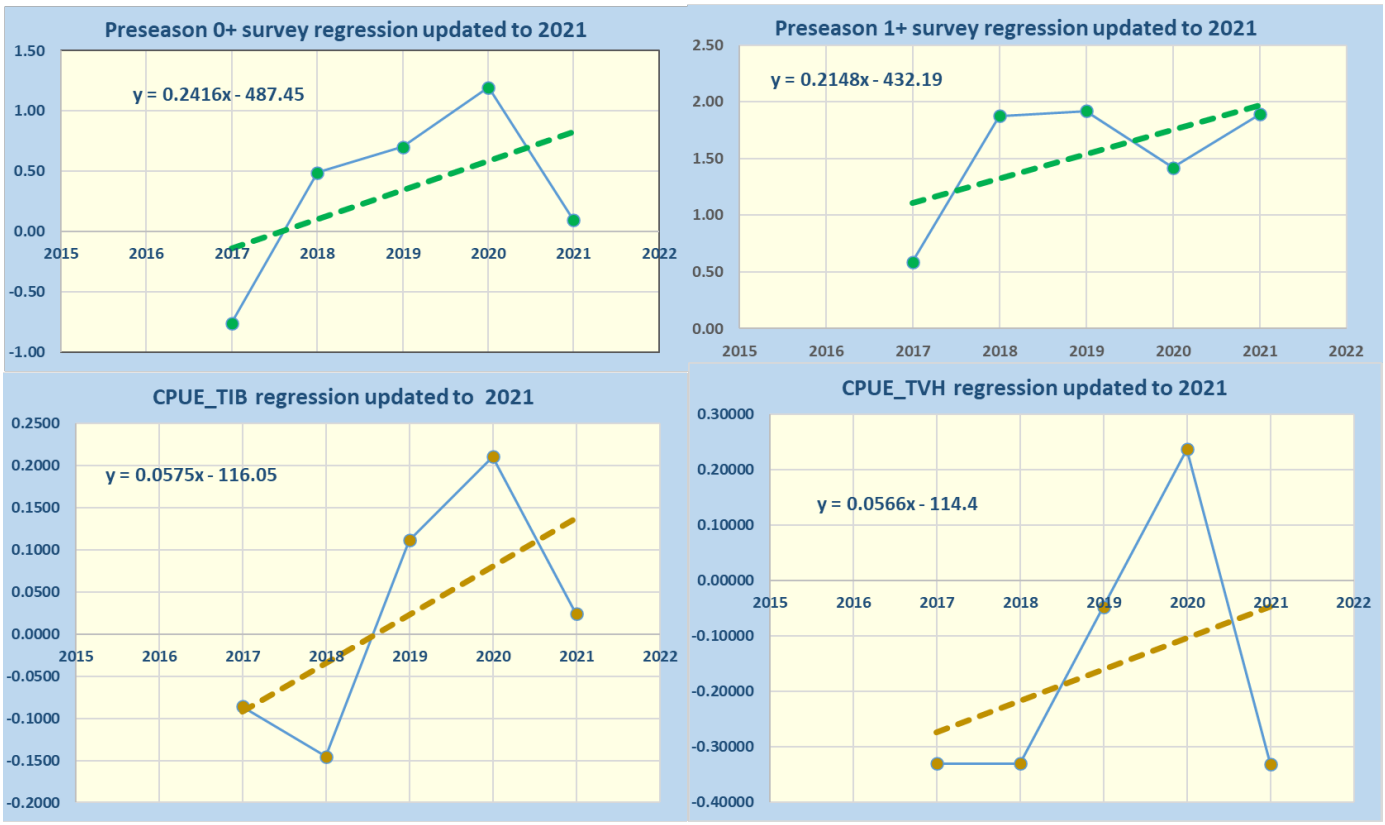


Figure 4. Summary of eHCR inputs and calculations showing the slopes of fitted regression lines to the log-transformed Preseason 0+ and 1+ indices, as well as the standardised CPUE data for the TIB (Seller model version) and TVH (Int-1 Model version) sectors.

Discussion

The eHCR uses the average catch over the past five years as a multiplier to inform the RBC. This dampens the influence of the most recent catch value, but if the recent value is negatively biased (as is a possibility in this case for the two most recent values), then it can have a reasonably substantial effect on the calculation of the RBC. In the absence of COVID-19, it was predicted that the total catch in 2020 would be close to the TAC, hence the total average catch was considered to be slightly negatively biased. On the other hand, it was acknowledged in 2020 that the TIB CPUE data could be considered positively biased and that COVID-19 indirectly impacted the eHCR indicators in different ways (TRLRAG 2020, Plagányi et al. 2021). The management forum considered a range of alternative scenarios and sensitivity tests pertaining to implementation of the eHCR, before deciding whether to recommend the default implementation of the eHCR, or to undertake an ad-hoc adjustment.

As there was insufficient information to fully quantify the impacts of COVID-19 on the fishery-dependent data, the TRLRAG felt they could not reasonably justify stepping outside the bounds of the agreed harvest strategy and hence there was agreement to accept the default application of the eHCR without any ad-hoc adjustments. The global TAC for the Torres Strait Protected Zone (TSPZ) for the 2020-21 season was thus set at 623.5 tonnes, which was only slightly lower than the long-term average (since 2006) of 678t. However, ongoing disruptions to export markets for TRL have again impacted catches in 2021, and there is

concern that these ongoing factors unduly bias (negatively) the average catch estimates used in the eHCR, and hence a number of alternative scenarios are considered in this discussion, as a basis to inform discussions at the forthcoming TRLRAG.

The influences of COVID-19 on the fishery-dependent catch and effort data highlighted the valuable role that fishery-independent surveys play in terms of providing reliable information to ensure sustainable catches. Ongoing work is focused on improving understanding of potential improvements to the standardisation of CPUE data, and in particular, how to account for inter-sector interactions.

Exceptional Circumstances

Harvest Control Rules are often complemented by "exceptional circumstances" clauses to account for unexpected events (Butterworth 2008) – for example, sizeable "walkouts" of South African west coast lobsters emerging onto beaches in response to low-oxygen events, greatly increasing the stock's mortality rate (Johnston and Butterworth 2005, Plaganyi et al. 2007). The TRL Harvest Strategy Development report of Plaganyi et al. (2016) included as Appendix 4 some preliminary guidelines for developing exceptional circumstances clauses, and this is copied here as Appendix 1 to inform discussions at the TRLRAG.

Pre-season trigger point

The TRL eHCR specifies that a stock assessment will be conducted every three years to rigorously assess stock status and productivity, and check that the eHCR is working as it is supposed to. As a stock assessment is only scheduled for every third year, action may not be taken quickly enough if the spawning biomass drops to very low levels, and hence an additional precaution has been built into the Harvest Strategy. Based on analysis of the historical pre-season and mid-year survey indices, a pre-season 1yr survey trigger point of 1.25 (average number of lobsters per survey transect and lower than any historically observed values) has been set, such that if this lower limit (LRP) is triggered in any year, then the required action is that a stock assessment be conducted in the following year. This is similar to what is done in some other fisheries, such as decision rules for some of the New Zealand substocks whereby a stock assessment is mandated if CPUE decreases below a specified base level (Bentley et al. 2005). If the stock assessment suggests that the spawning stock biomass is above the LRP, then the process continues as previously. However, if spawning biomass is assessed as below the LRP, then a stock assessment is again triggered in the following year. If the second stock assessment suggests the stock is above the LRP, then the process again continues as previously, but if the spawning biomass is below LRP (i.e. two consecutive years with spawning biomass below LRP), then the fishery is closed and appropriate action (e.g. implementing surveys, analysing size structure and environmental information) is put in place. In general, the eHCR is therefore applied every year unless the LRP is triggered in two consecutive years.

Supply Chain considerations

Some of our earlier research analysed fishery supply chains and found that the key components of lobster supply chains that were most vulnerable to external shocks were the Chinese consumers, processors and airports (Plaganyi et al. 2014). Our scientific scenarios have played out in real life and highlight the need for transformative changes to develop more resilient supply chains to ensure the ongoing sustainability and security of seafood and other natural resources production (Lim-Camacho et al. 2017).

The economic market linkages and global connectedness of our trade systems may increasingly be subject to unforeseen social-ecological vulnerabilities (Adger et al. 2009) and transformative changes to develop more resilient supply chains (Lim-Camacho et al. 2017) may be needed to ensure ongoing sustainability of global production ecosystems (Nyström et al. 2019). Many small-scale fisheries lack the capacity to mitigate global market forces and more international solutions are needed, such as development of

insurance opportunities by international financial institutions (Knight et al. 2020). Plagányi et al. (2021) highlight that more work is needed to ensure that supply chains are adaptable enough to ensure that the outlets for seafood products are maintained in the future. This is vital not only for economic stability, but also the livelihood and mental health of fishers, their socio-cultural wellbeing, and food and nutrition security globally (Hicks et al. 2019).

Previous studies have identified the need to build resilience to changing climate as an increasingly important challenge to supply chains (Levermann 2014, van Putten et al. 2016, Lim-Camacho et al. 2017). COVID-19 has confronted supply chains with similar disruptions to transport and markets as climate change is predicted to do, and hence Plagányi et al. (2021) applied the same method to analyse the connectivity of supply chains and to identify the key agents in these chains which may be fragile and hence in need of focused attention. These analyses highlight the changes which can result from lessening the dependence on a single key element and strengthening or adding alternative complementary pathways and connections and that market diversification is essential to fisheries sustainability (Plaganyi et al. 2014, Lim-Camacho et al. 2017, Knight et al. 2020). Fishery businesses should ideally pay more attention to supply chain risks and business continuity planning (Ogier et al. 2021). We recommend therefore that = Supply Chain Index (SCI) be used in combination with market demand (Hobday et al. 2014, Pascoe et al. 2021) and supply analysis and supplemented by qualitative assessment of each supply chain phase.

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Literature cited

Adger, W. N., H. Eakin, and A. Winkels. 2009. Nested and teleconnected vulnerabilities to environmental change. Frontiers in Ecology and the Environment **7**:150-157.

Bentley, N., P. A. Breen, S. W. Kim, and P. J. Starr. 2005. Can additional abundance indices improve harvest control rules for New Zealand rock lobster (Jasus edwardsii) fisheries? New Zealand Journal of Marine and Freshwater Research **39**:629-644.

Butterworth, D. S. 2008. A commentary on: salvaged pearls: lessons learned from a floundering attempt to develop a management procedure for Southern Bluefin Tuna. Fisheries Research **94**:351-354.

Hicks, C. C., P. J. Cohen, N. A. Graham, K. L. Nash, E. H. Allison, C. D'Lima, D. J. Mills, M. Roscher, S. H. Thilsted, and A. L. Thorne-Lyman. 2019. Harnessing global fisheries to tackle micronutrient deficiencies. Nature **574**:95-98.

Hobday, A. J., R. H. Bustamante, A. Farmery, A. Fleming, S. Frusher, B. Green, S. Jennings, L. Lim-Camacho, A. Norman-Lopez, S. Pascoe, G. Pecl, E. Plaganyi, I. van Putten, P. Schrobback, O. Thebaud, and L. Thomas. 2014. Growth opportunities and critical elements in the supply chain for wild fisheries and aquaculture in a changing climate. Final Report. FRDC-DCCEE Marine National Adaptation Program 2011/233.

Johnston, S. J., and D. S. Butterworth. 2005. Evolution of operational management procedures for the South African West Coast rock lobster (Jasus lalandii) fishery. New Zealand Journal of Marine and Freshwater Research **39**:687-702.

Knight, C. J., T. L. Burnham, E. J. Mansfield, L. B. Crowder, and F. Micheli. 2020. COVID-19 reveals vulnerability of small-scale fisheries to global market systems. The Lancet Planetary Health **4**:e219.

Levermann, A. 2014. Climate economics: Make supply chains climate-smart. Nature News **506**:27.

Lim-Camacho, L., É. E. Plagányi, S. Crimp, J. H. Hodgkinson, A. J. Hobday, S. M. Howden, and B. Loechel. 2017. Complex resource supply chains display higher resilience to simulated climate shocks. Global Environmental Change **46**:126-138.

Nyström, M., J. B. Jouffray, A. V. Norström, B. Crona, P. Søgaard Jørgensen, S. R. Carpenter, Ö. Bodin, V. Galaz, and C. Folke. 2019. Anatomy and resilience of the global production ecosystem. Nature **575**:98-108.

Ogier, E., S. Sen, S. Jennings, A. Magnusson, D. C. Smith, E. Colquhoun, S. Rust, and J. Morison. 2021. Impacts of Covid-19 on the Australian seafood industry: January-June 2020. FRDC, Canberra.

Pascoe, S., P. Schrobback, E. Hoshino, and R. Curtotti. 2021. Demand Conditions and Dynamics in the SESSF: An Empirical Investigation. FRDC, Canberra.

Plagányi, É., R. A. Deng, M. Tonks, N. Murphy, S. Pascoe, S. Edgar, K. Salee, T. Hutton, L. Blamey, and L. Dutra. 2021. Indirect Impacts of COVID-19 on a Tropical Lobster Fishery's Harvest Strategy and Supply Chain. Frontiers in Marine Science **8**:730.

Plagányi, É. E., R. Deng, R. Campbell, D. Dennis, T. Hutton, M. Haywood, and M. Tonks. 2018. Evaluating an empirical harvest control rule for the Torres Strait Panulirus ornatus tropical rock lobster fishery. Bull. Mar. Sci **94(3)**:1095–1120.

Plagányi, É. E., D. Dennis, R. Deng, R. Campbell, T. Hutton, and M. Tonks. 2016. Torres Strait tropical lobster (TRL) Panulirus ornatus Harvest Control Rule (HCR) development and evaluation

Plaganyi, E. E., R. A. Rademeyer, D. S. Butterworth, C. L. Cunningham, and S. J. Johnston. 2007. Making management procedures operational - innovations implemented in South Africa. Ices Journal of Marine Science **64**:626-632.

Plaganyi, E. E., I. van Putten, O. Thebaud, A. J. Hobday, J. Innes, L. Lim-Camacho, A. Norman-Lopez, R. H. Bustamante, A. Farmery, A. Fleming, S. Frusher, B. Green, E. Hoshino, S. Jennings, G. Pecl, S. Pascoe, P. Schrobback, and L. Thomas. 2014. A Quantitative Metric to Identify Critical Elements within Seafood Supply Networks. Plos One **9**.

Rademeyer, R., D. Butterworth, and É. Plagányi. 2008. A history of recent bases for management and the development of a species-combined Operational Management Procedure for the South African hake resource. African Journal of Marine Science **30**:291-310.

TRLRAG. 2020. Torres Strait Tropical Rock Lobster Resource Assessment Group Meeting 30. Meeting Record - 16 December 2020.

van Putten, I. E., A. K. Farmery, B. S. Green, A. J. Hobday, L. Lim-Camacho, A. Norman-López, and R. W. Parker. 2016. The environmental impact of two Australian rock lobster fishery supply chains under a changing climate. Journal of Industrial Ecology **20**:1384-1398.

APPENDIX 1 – Guidelines for consideration under Exceptional Circumstance

The extract below is based on (Rademeyer et al. 2008)

Preamble

The pre-agreed HCR formulae for computing the TAC is based on pre-agreed resource monitoring data inputs. This combination of formulae and data will have been simulation tested to ensure anticipated performance that is adequately robust given inevitable scientific uncertainties about data and models of the resource dynamics and fishery. However, occasionally "Exceptional Circumstances" can arise which may indicate the need for recommendations to deviate from the outputs of the HCR, or necessitate bringing a more comprehensive review forward.

On a number of occasions below, the text requires judgements to be made of whether an effect is "appreciable" (for example, whether an abundance survey result is *appreciably* outside the range predicted in the simulation tests used in selecting the OMP). Such judgements are the province of the TRLRAG.

1. Metarule Process

Metarules can be thought of as "rules" which pre-specify what should happen in unlikely, exceptional circumstances when application of the TAC generated by the HCR is considered to be highly risky or highly inappropriate. Metarules are not a mechanism for making small adjustments, or 'tinkering' with the TAC from the HCR.
While the broad circumstances that may invoke the metarule process can be identified, it is not always possible to pre-specify the data that may trigger a metarule.
Examples of what might constitute an exceptional circumstance in the case of [hake] include, but are not necessarily limited to:

- Survey estimates of abundance that are appreciably outside the bounds predicted in the HCR testing.
- CPUE trends that are appreciably outside the bounds predicted in the HCR testing.
- Anomalous environmental conditions.

The primary focus for concluding that exceptional circumstances exist is if the population assessment/indicator review process provides results appreciably outside the range of simulated population and/other other indicator trajectories considered in HCR evaluations. Similarly, if there are regulatory changes likely to effect appreciable modifications to outcomes predicted in terms of the assumptions used for projections in the HCR evaluations, or changes to the nature of the data collected for input beyond those for which allowance may have been made in those evaluations, this would constitute grounds for concluding that exceptional circumstances exist in the context of continued application of the current HCR.

IF the TRLRAG agrees that exceptional circumstances exist, the severity of the exceptional circumstances needs consideration and a pre-agreed "Process for Action" could be followed.

For example, if the risk is to the resource, action could include at least an x% decrease in the TAC output by the HCR (or fishery closure), depending on severity.

If the risk is to socio-economic opportunities within the fishery, action could include at least a y% increase in the TAC output by the HCR, depending on severity.

The procedure for regular review and potential revision of the HCR is the process for updating and incorporating new data, new information and knowledge into the management procedure, including the operating models (OMs) used for testing the procedure. This process is likely to occur every 3 years, but can be initiated at any time if there is sufficient reason for this.

If a stock assessment is conducted every three years, a process such as the following could be followed:

- Conduct an in depth stock assessment and review population, fishery and related ecosystem indicators, and any other relevant data or information on the population, fishery and ecosystem.
- On the basis of this, determine whether the assessment (or other) results are outside the ranges for which the HCR was tested (note that evaluation for exceptional circumstances could be carried out in parallel with this process), and whether this is sufficient to trigger a review/revision of the HCR.
- Review whether enough has been learnt to appreciably improve/change the operating models (OMs), or to improve the performance of the HCR, or to provide new advice on tuning level (chosen to aim to achieve management objectives).
- On the basis of this, determine whether the new information is sufficient to trigger a review/revision of the HCR.

Reference

Adger, W. N., H. Eakin, and A. Winkels. 2009. Nested and teleconnected vulnerabilities to environmental change. Frontiers in Ecology and the Environment **7**:150-157.

Bentley, N., P. A. Breen, S. W. Kim, and P. J. Starr. 2005. Can additional abundance indices improve harvest control rules for New Zealand rock lobster (Jasus edwardsii) fisheries? New Zealand Journal of Marine and Freshwater Research **39**:629-644.

Butterworth, D. S. 2008. A commentary on: salvaged pearls: lessons learned from a floundering attempt to develop a management procedure for Southern Bluefin Tuna. Fisheries Research **94**:351-354.

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Knight, C. J., T. L. Burnham, E. J. Mansfield, L. B. Crowder, and F. Micheli. 2020. COVID-19 reveals vulnerability of small-scale fisheries to global market systems. The Lancet Planetary Health **4**:e219.

Levermann, A. 2014. Climate economics: Make supply chains climate-smart. Nature News **506**:27.

Lim-Camacho, L., É. E. Plagányi, S. Crimp, J. H. Hodgkinson, A. J. Hobday, S. M. Howden, and B. Loechel. 2017. Complex resource supply chains display higher resilience to simulated climate shocks. Global Environmental Change **46**:126-138.

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Ogier, E., S. Sen, S. Jennings, A. Magnusson, D. C. Smith, E. Colquhoun, S. Rust, and J. Morison. 2021. Impacts of Covid-19 on the Australian seafood industry: January-June 2020. FRDC, Canberra.

Pascoe, S., P. Schrobback, E. Hoshino, and R. Curtotti. 2021. Demand Conditions and Dynamics in the SESSF: An Empirical Investigation. FRDC, Canberra.

Plagányi, É., R. A. Deng, M. Tonks, N. Murphy, S. Pascoe, S. Edgar, K. Salee, T. Hutton, L. Blamey, and L. Dutra. 2021. Indirect Impacts of COVID-19 on a Tropical Lobster Fishery's Harvest Strategy and Supply Chain. Frontiers in Marine Science **8**:730.

Plagányi, É. E., R. Deng, R. Campbell, D. Dennis, T. Hutton, M. Haywood, and M. Tonks. 2018. Evaluating an empirical harvest control rule for the Torres Strait Panulirus ornatus tropical rock lobster fishery. Bull. Mar. Sci **94(3)**:1095–1120.

Plagányi, É. E., D. Dennis, R. Deng, R. Campbell, T. Hutton, and M. Tonks. 2016. Torres Strait tropical lobster (TRL) Panulirus ornatus Harvest Control Rule (HCR) development and evaluation

Plaganyi, E. E., R. A. Rademeyer, D. S. Butterworth, C. L. Cunningham, and S. J. Johnston. 2007. Making management procedures operational - innovations implemented in South Africa. Ices Journal of Marine Science **64**:626-632.

Plaganyi, E. E., I. van Putten, O. Thebaud, A. J. Hobday, J. Innes, L. Lim-Camacho, A. Norman-Lopez, R. H. Bustamante, A. Farmery, A. Fleming, S. Frusher, B. Green, E. Hoshino, S. Jennings, G. Pecl, S. Pascoe, P. Schrobback, and L. Thomas. 2014. A Quantitative Metric to Identify Critical Elements within Seafood Supply Networks. PLoS ONE **9**.

Rademeyer, R., D. Butterworth, and É. Plagányi. 2008. A history of recent bases for management and the development of a species-combined Operational Management Procedure for the South African hake resource. African Journal of Marine Science **30**:291-310.

TRLRAG. 2020. Torres Strait Tropical Rock Lobster Resource Assessment Group Meeting 30. Meeting Record - 16 December 2020.

van Putten, I. E., A. K. Farmery, B. S. Green, A. J. Hobday, L. Lim-Camacho, A. Norman-López, and R. W. Parker. 2016. The environmental impact of two Australian rock lobster fishery supply chains under a changing climate. Journal of Industrial Ecology **20**:1384-1398.

Expected timeline for finalising a total allowable catch (TAC) for the Australian Torres Strait Tropical Rock Lobster Fishery (TRL Fishery)

Key:

Scientific assessment and advice
PNG-Australia agreement
Administrative step for Australia

Steps	Description	Indicative timeline
Agree timeline and process	AFMA CEO and PNG NFA Director General to meet to agree on process for agreement on catch sharing arrangements for the Torres Strait Tropical Rock Lobster Fishery (TRL Fishery) for the coming fishing season.	July
PNG and Australian catch and effort data compiled	Australian and PNG catch and effort data are compiled[1].	By 31 October
Pre-season scientific survey	Survey data are collected and used to update TRL survey abundance indices used to calculate a recommended biological catch (RBC)[2]. Survey must be conducted in November to provide comparable results overtime and the most accurate estimate of annual lobster recruitment into the fishery.	November
Australian start of season TAC determined	Minister to determine a 200 tonnes start of season[3] TAC for the Australian TRL Fishery for the 2021-22 fishing season, as per section 13 of the *Torres Strait Fisheries (Quotas for Tropical Rock Lobster (Kaiar)) Management Plan 2018* (the Plan)[4]. Start of season TAC based on advice received from TRLRAG and TRLWG in October-November 2018. TAC to apply to Australian TRL Fishery only.	By mid-November

[1] These data are provided to CSIRO to update catch per unit effort indices used to calculate a recommended biological catch for the coming fishing season.
[2] A RBC is the total amount of TRL that can be sustainably taken out of the water by all fishers (commercial, traditional, recreational) each season, while leaving enough in the water to breed.
[3] The Australian TRL Fishery fishing season runs from 1 December each year to 30 September the following year.
[4] The Plan is accessible online at https://www.legislation.gov.au/Details/F2018L01645

RBC calculation	CSIRO to use empirical Harvest Control Rule (eHCR) to calculate a RBC. Every three years (starting in 2019), CSIRO to update and run the stock assessment model to evaluate the performance of the eHCR. Preliminary stock assessment results are usually available within 4-5 weeks of the pre-season scientific survey.	Late November through to early December
TRL Resource Assessment Group (TRLRAG) and TRL Working Group (TRLWG) advice[5]	TRLRAG to review the survey results, CPUE analyses and application of the eHCR. Advice provided on a final RBC. TRLWG to review TRLRAG advice. Advice provided on a final global TAC[6]. Every three years (starting in 2019), TRLRAG and TRLWG to consider preliminary results of stock assessment. Advice provided on finalising the assessment.	Mid-December
PZJA agreement to final global TAC	PZJA to review TRLRAG and TRLWG advice and agree to final global TAC.	January (date of PZJA meeting to be confirmed)
Agree final global TAC, shares of the TAC, cross-endorsement apportionments and any preferential entitlements	AFMA CEO and PNG NFA Director General to meet to agree, as per the terms of the Torres Strait Treaty, on: - a final global TAC as per article 23(2); - shares of the final global TAC as per article 22(1) (e.g. 15%:85% split); - cross-endorsement apportionments as per articles 23(4) and 25; - preferential entitlement to any unfished cross-endorsement apportionments as per article 25. An exchange of letters is required to formalise the agreement.	By 31 January
Australian final TAC determined	Minister to determine a final TAC for the Australian TRL Fishery for the 2020-21 fishing season, as per section 14 of the Plan. TAC to apply to Australian TRL Fishery only.	By end of February

[5] Officers from PNG NFA are invited to attend all PZJA advisory forums.
[6] A global TAC is the total amount of TRL that can be sustainably taken out of the water by both Australian and PNG commercial fishers each season.

TRLRAG advice	Every three years (starting in 2019), TRLRAG to review the final stock assessment results. Advice provided on the need to review the eHCR and conduct a stock assessment in subsequent years, as per Harvest Strategy rules.	February/March
If relevant, submit any formal requests for cross-endorsement	PNG and/or Australia to provide formal request to the other Party seeking cross-endorsement pursuant to article 26 of the Torres Strait Treaty. Request to include: - a copy of the licence/s for which a Treaty endorsement is sought[7]; - a copy of any licence conditions in force for the licence/s; - boat particulars; - details for payment of applicable fees. It will take approximately 6 weeks for Australia to complete the domestic processes to issue a Treaty endorsement/s[8].	By 31 March

[7] For PNG licence/s, each licence needs to be current at the time of the formal request, valid for the period for which a Treaty endorsement is sought and have the same details as that written in the formal request, and valid in PNG for the same fishery as it is proposed to operate in Australian waters.
[8] Australia's domestic process include requirements to undertake native title notification pursuant to sub-sections 24HA(2) and (7) of the Commonwealth *Native Title Act 1993*, which takes a minimum of 1 month, and to seek approvals to issue a Treaty endorsement/s.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
QUEENSLAND EAST COAST TRL FISHERY STOCK ASSESSMENT OVERVIEW	Agenda Item 6 For noting

RECOMMENDATIONS

1. That the RAG **NOTE** an overview of the Queensland East Coast TRL Fishery stock assessment presented by Fisheries Queensland stock assessment scientist, Dr Fay Helidoniotis (via video conference). Please note that due to confidentiality reasons the presentation cannot be made publicly available.

KEY ISSUES

2. Fisheries Queensland is undertaking a stock assessment for the Queensland east coast Tropical Rock Lobster Fishery which expected to be completed in early 2022.
3. Given the TRL fisheries between the Queensland east coast and the Torres Strait are considered a single biological population, it is important that the two jurisdictions collaborate together on their respective stock assessments as required.
4. The RAG is invited to note a presentation from Dr Fay Helidoniotis who is undertaking the stock assessment for the Queensland TRL Fishery.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG)	MEETING 32 15 December 2021
INTERACTIONS BETWEEN THE TRL AND TORRES STRAIT PRAWN FISHERY	Agenda Item 7 For discussion and advice

RECOMMENDATIONS

1. That the RAG:
    a. **NOTE** a presentation by CSIRO on the results of a preliminary analyses of available observer data on TRL bycatch in the Torres Strait Prawn Fishery (TSPF) as collected from the AFMA Observer Program from 2007 and 2019 (**Attachment 7a**).
    b. **DISCUSS** and **PROVIDE ADVICE** on the results including implications and suggestions for future work.

KEY ISSUES

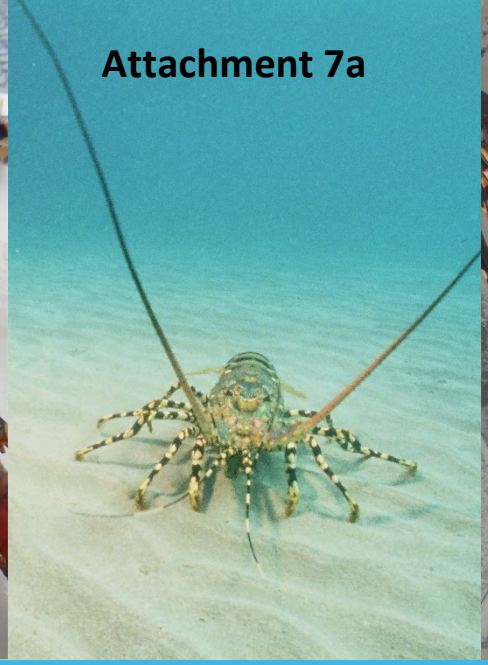
2. Understanding TRL interactions in both the Australian TSPF and PNG prawn trawl fishery for the purposes of the TRL stock assessment and monitoring overall fishing mortality against the TRL TAC has been raised as an important issue by both the TRL RAG (Meeting no. 19 on 13 December 2016), TRL Working Group (WG) (Meeting no. 8 on 8 November 2018) and the Australia-PNG Fisheries Committee Bilateral meeting (4 March 2019).
3. Monitoring interactions between the prawn and lobster fisheries is also one of six objectives for the TRL fishery as agreed to by the PZJA in 1988.
4. TRLRAG 27 (10-11 December 2019) noted that the impacts of the TSPF on the TRL fishery may be significant and recommended that an analyses of the available AFMA Observer Program data be undertaken by CSIRO.

BACKGROUND

5. The TSPF has a number of management measures in place that reduces the potential level of interactions with TRL. Specifically:
    a. under the *TSPF Management Plan 2009* trawl boats in the TSPF are prohibited from taking, processing or carrying TRL or TRL products. This ban has been in place since 1987.
    b. there are extensive spatial closures in the TSPF which overlap with key TRL Fishery grounds - see map provided at **Attachment 7b**.
6. Discards of TRL are not required to be recorded in the TSPF logbook (NP16). There are numerous bycatch species in the TSPF and given this it is not practical that they all be recorded in the logbook.
7. However, it is a condition of TSPF licences that licence holders carry an AFMA scientific observer when required to do so, to collect fishery independent scientific data. The AFMA Observer Program in the TSPF aims to observe 2.6% of actual days fished in a given TSPF season. A range of biological data is collected through sampling, including length, sex, weight, fate and life status.

8. From the available data, 2,807 individual lobsters were sampled by the AFMA Observer Program from 2007 to 2019. Of these, approximately 99% of discarded lobsters in an observed trip were recorded as discarded alive - 75% of these were recorded as “alive and vigorous”, 24% recorded as “alive and sluggish”, 0.5% recorded as “alive, just”. Less than 1% is recorded as dead.
9. These observer data on fate (discarded/retained) and life status appear consistent with a historical report on the *Joint Australia/Papua New Guinea Research Program on the Tropical Rock Lobster* (*Panulirus ornatus*) *in Torres Strait* undertaken by CSIRO and PNG Department of Primary Industries in September 1984 which examined the post-capture survival rates of TRL in the TSPF.
10. This study reported that trawled TRL were generally in ‘excellent condition’ and that TRL that was trawled and returned to the sea have a good chance of surviving predation. A summary of the report notes is provided at **Attachment 7c**, and a copy of the technical report can be provided by AFMA on request.





Pictures by Leo Dutra

TRL bycatch in the Torres Strait Prawn Fishery (TSPF) recorded during the AFMA Observer Program from 2007 to 2019

Marjoleine Roos, Laura Blamey, Éva Plagányi, Steven Edgar, and Rob Campbell

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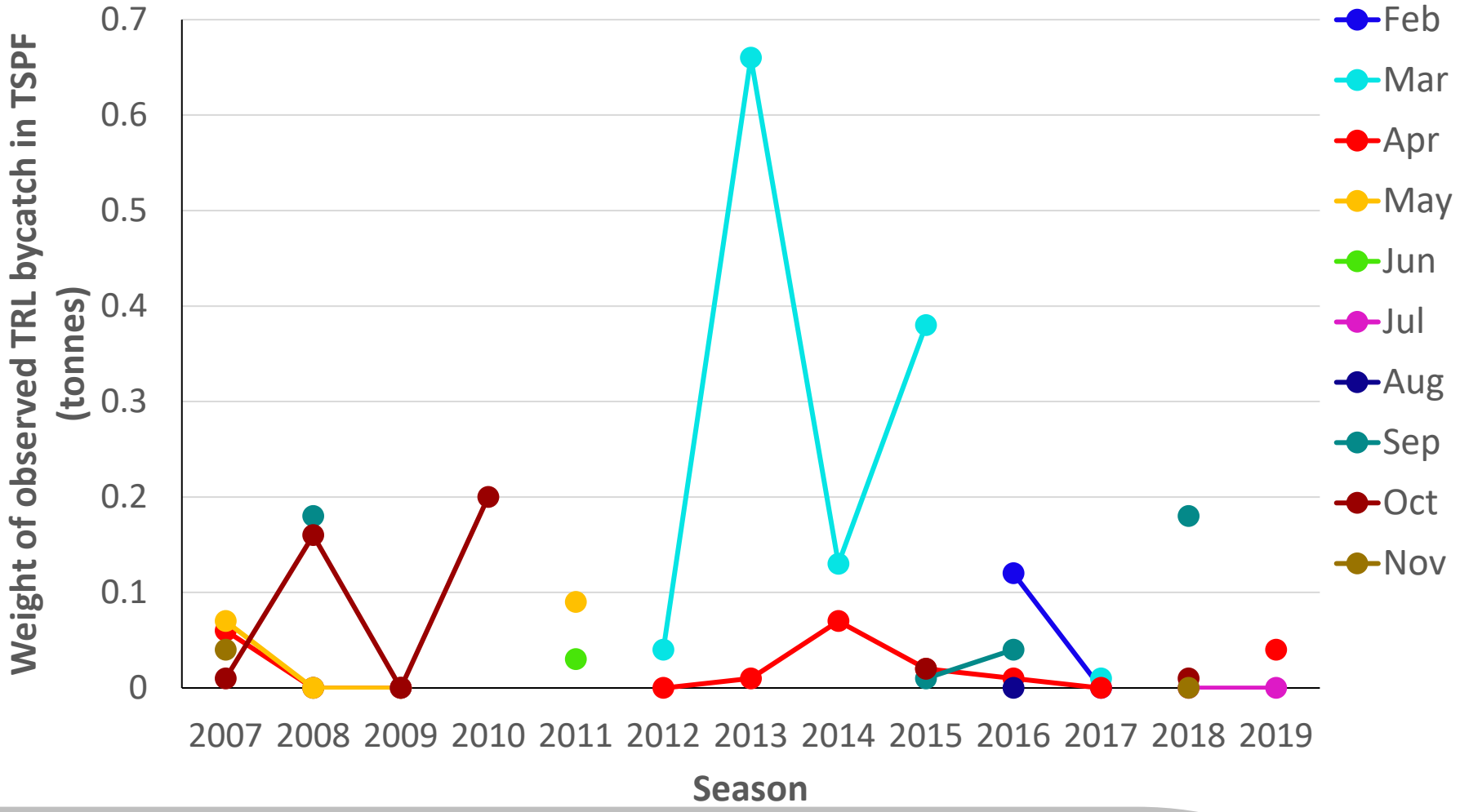
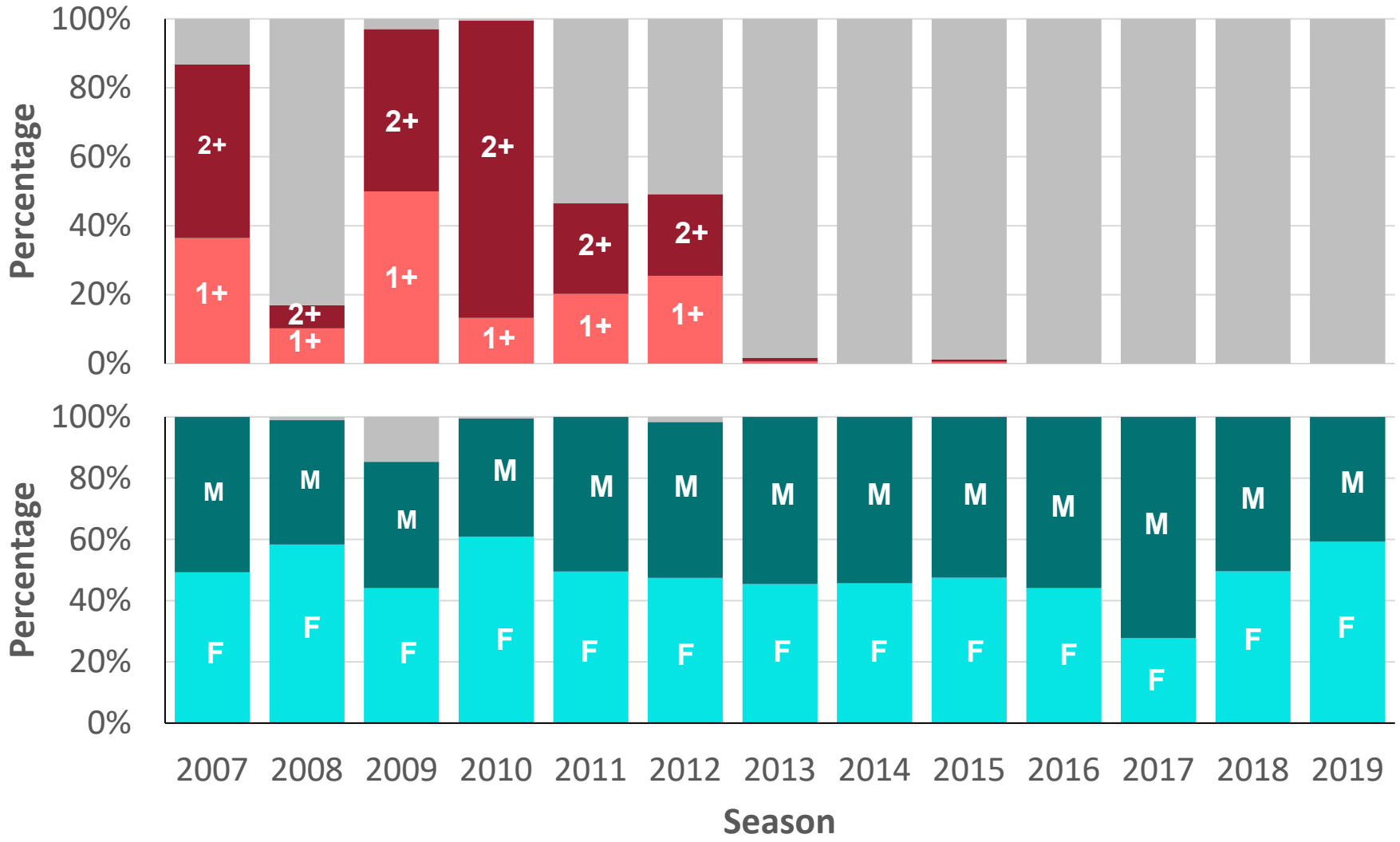
TRLRAG32 Dec 2021

CSIRO acknowledges the Traditional Owners of the land, sea and waters, of the area that we live and work on across Australia We acknowledge their continuing connection to their culture and we pay our respects to their Elders past and present

TRL bycatch weight recorded over the years per month



Age class and sex ratios of TRL bycatch



TRL bycatch versus TRL fishery catches

Season	Observed TRL bycatch (tonnes)	Scaled TRL bycatch (tonnes)	AUS-total (tonnes)	Scaled TRL bycatch*/ AUS total	TS-total incl PNG (tonnes)	Scaled TRL bycatch*/ TS total
2012	0.04	1.6	500.3	0.32%	703.4	0.23%
2013	0.67	25.7	504.2	5.10% #	612.5	4.20% #
2014	0.20	7.8	472.0	1.65%	733.2	1.06%
2015	0.43	16.6	355.3	4.67% #	591.0	2.81% #
2016	0.17	6.4	510.1	1.25%	758.2	0.84%
2017	0.02	0.6	277.8	0.22%	390.8	0.15%
2018	0.19	7.2	255.7	2.82%	412.1	1.75%
2019	0.04	1.6	416.5	0.39%	609.4	0.26%

* 98.5% of lobsters alive; 1.2% dead; 0.3% life status not recorded; 87.7% of live ones returned
* Post-capture mortality uncertain
# uncertain extrapolation potentially biased by small number of anomalously high lobster bycatch in March

Concluding remarks

- Footprint TSPF trawlers appears relatively local (mainly GNEC and western Darnley), not overlapping with main TRL Fishery zones
- TRL bycatch in TSPF seems variable between and within years
- TRL bycatch may be up to 4% of total lobster fishery catch, but most years considerably smaller
- TRL bycatch age class quite steady over years, sex ratio some variation.

<u>Potential future work:</u>

- Small number of high lobster bycatch: their effect on extrapolated values and what they mean
- More detailed spatial analyses (e.g., fishery regions)
- (if feasible) Collect weight data on all individual lobsters as bycatch → age classes

Thank you

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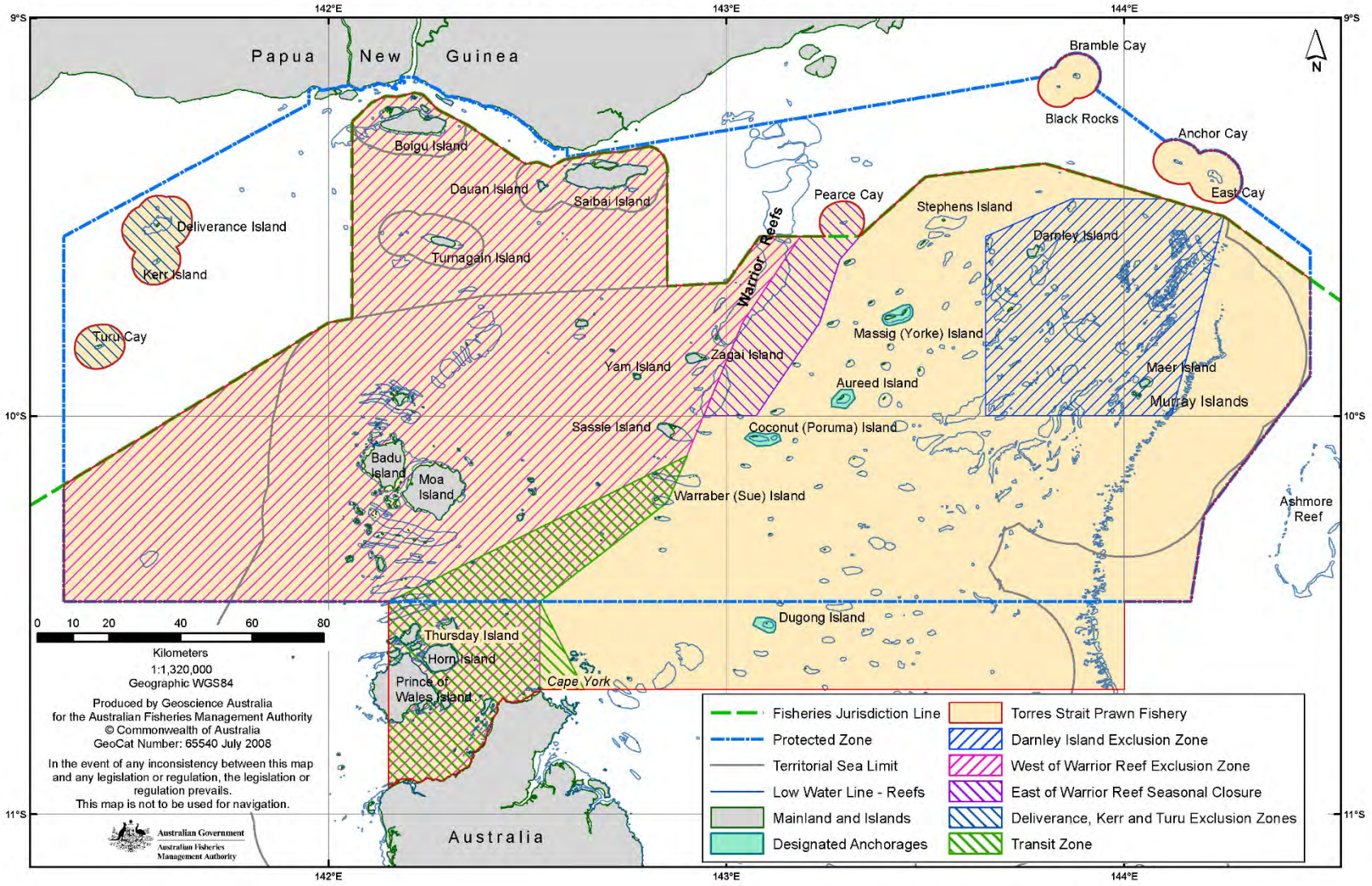
Torres Strait Prawn Fishery and Closures



Notes on the "Melisa" TRL Tagging Program, September 1984

Introduction

Joint CSIRO / PNG DPI Fisheries study in NE channel of TS during September 1984, using the PNG research trawler "Melisa".

Staff

Jim Prescott, Dan Tyson (PNG)
Clive Turnbull, Aubrey Harris, Clive Jones (CSIRO)
Geoff Williams (BRS)

Objectives:

1. To trawl and tag the lobster migration in the NE channel to determine whether they migrate into the GOP.
2. Measure the degree of predation by sharks on tagged TRL returned to the sea from prawn trawlers.
3. Recapture TRL that were tagged in western and southern TS during May/July of 1984 by CSIRO/PNG.

Methods & Results

Tagging in NE channel

- Total of 2373 tagged (527 trawled by Melissa and 1846 trawled by commercial trawlers).
- Permission from QBFP for commercial trawlers to hold TRL for use to collect in the morning & tag. So large percentage of the tagged TRL had been held in fin bins for 4-8 hrs.
- 45 tag returns (8 Aust. Trawlers in NE Channel and 37 from Kulasi and joint venture trawler in GOP) plus 6 from tagging near Daru. ~2% return rate.
- The results indicate than TRL trawled up, tagged and released from trawlers in the NE channel migrated into the GOP.

Survival

- Trawled TRL were generally in good condition – only 5 (over 500) were damaged despite 2hr shots with a single 40m (20 fathom) stern trawl net that resulted in large amounts of material in the cod end.
- On several occasions tagged animals were returned while trawling. Although they were thrown as far as possible away from the trawler many were recaptured, indicating that they make it back to the sea bed and that they need to be released while the nets are up.
- On one occasion, good weather allowed us to video tagged TRL rapidly descending to the sea bed through a school of sharks (~50) that was feeding on trash fish. All of the TRL appeared to safely descend through the feeding sharks.
- Dolphins following the vessel at night turned towards TRL and bugs that were thrown amongst them but they then ignore them.
- On two occasions (once near and island and the other occasion near a reef) underwater observations were made of tagged lobsters being released. The behaviour on both occasions was similar. They initially aggregated on the sea bed then quickly dispersed in small groups in every direction. The lobster released near the reef were followed down a sand ridge to 25m then disappeared from view. Only a few lobsters moved towards the reef.

West & Southern TS tagging

- No tag returns from but 6 TRL with first left pleopod regrowing were observed suggesting that the animals had been tagged but shed the tag, indicating movement from the western and southern TS into the NE channel. The first left pleopod was clipped on the tagged animals.

Notes from a report on capture of lobsters by trawlers

"Catches of tropical spiny lobster by Australian prawn trawlers, September to October 1981", Geoff Williams, BRS.

- Vessels working TS prawn grounds during September and October 1981 made the largest catches of TRL by Australian trawlers to date.
- Isolated catches of more than 1000 lobsters per night were reported by many boats during 18-25th September 1981.
- The largest catches were in the Pearce Cay region, NE of Moon Passage.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
TRL Fishery Research Priorities	Agenda Item 8 For DISCUSSION & ADVICE

RECOMMENDATIONS

1. That the RAG **DISCUSS** and provide **ADVICE** on the research priorities provided in the draft rolling five year research plan for 2023/24 to 2027/28 (the Research Plan) for the Torres Strait Tropical Rock Lobster (TRL) Fishery (**Attachment 8a**), including advice on feasibility, timing and indicative costing of essential, unfunded research project(s), and identifying any new research needs.
2. That the RAG **NOTE**:
    a) The current status of recently identified research needs, as last reviewed by TRLRAG 30 (held via video conference on 6 October 2020) (**Table 1**); and
    b) That projects for the 2022/23 funding round are currently being considered by the TSSAC, which includes fishery independent surveys, stock assessment, harvest control and Recommended Biological Catch (RBC) work for the TRL Fishery.

KEY ISSUES

Research priorities for the TRL Fishery

3. The TRL RAG last discussed research priorities on 6 October 2020 for the 2021-22 TSSAC research funding round and recommended that:
    a) The highest 'essential' priority for the fishery remains the need to undertake **fishery independent surveys, stock assessment, harvest control and Recommended Biological Catch** (RBC) work.
    a) Undertaking an update to the 2007 **Ecological Risk Assessment** (ERA) for the TRL Fishery remains an essential priority. Assessment by CSIRO this financial year is dependent on prioritisation against other high priority fisheries. Funding can be sourced from the AFMA TRL Fishery budget (~$20,400).
    b) **Improvement of data collection** (to be pursued by the TRL RAG data sub-group) remains an essential priority.
    c) **Understanding fisher behaviour** and capturing information on the impacts of COVID-19 on the fishery remain essential priorities.
    d) **Understanding connectivity, environmental drivers and adaptation strategies** also remain an essential priority, noting that a recently funded climate project led by CSIRO (Leo Dutra) that will provide greater insights into available environmental information and advice on what should be collected to develop downscaled climate effects models for Torres Strait Fisheries. More specifically, the RAG supported further work on understanding connectivity, highlighting that a discrete tagging project of 0+ and 1+ lobsters could help better understand any potential disparities between pre-season survey data, and fishery dependent data.
    e) Following initial qualitative data collection through improvements to fishery dependent data, more specific resources can be dedicated to **understanding changes to fishing power** to develop a representative and structured annual

fishing power survey. This will be better facilitated when face-to-face stakeholder engagement is more feasible. As such, this research item remains as desirable.

f) Considering that perhaps the original driver for the **science peer review** is now less important, the RAG agreed it could be moved down in terms of priority against other research needs, and is now prioritised as desirable.

4. Given that the 2022/23 TSSAC funding round is already being considered by the TSSAC, the RAG is being invited to discuss and provide advice on research priorities for the TRL Fishery for 2023/24 financial year and beyond.

BACKGROUND

TSSAC Research Funding Process

5. Each year the PZJA TSSAC invites applications for funding to undertake research to support the management of Protected Zone Fisheries. The TSSAC seek input from each fishery advisory committee to identify research priorities.
6. PZJA fisheries research is generally funded by AFMA. The AFMA research budget is generally set at around $420,000 each year. In addition to the AFMA research funding, TSRA has recently committed in-principle to contributing $150,000 each year towards PZJA fisheries research. This allows around $570,000 annual for all Torres Strait research.
7. Additional funding can also be sought from other bodies such as the Fisheries Research and Development Corporation (FRDC), when needed, and when projects align with FRDC objectives.
8. Assuming no change to available AFMA and TSRA funding, considering expected research commitments and in the absence of securing further funding, available research funding across all Torres Strait Fisheries in the 2023-24 financial year will be around $84,000.
9. A detailed breakdown of committed TSSAC funds for multi-year projects 2021/22 – 2024/25 is provided at **Attachment 8b**.

TSSAC Fisheries Strategic Research Plan 2018-2023 and rolling five-year fishery specific research plans

10. TSSAC operates under a SRP which guides priority setting for research in Torres Strait fisheries over a five year period. 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.
11. There are 3 research themes within the SRP, under which the TRLRAG and TRLWG could identify research priorities for the TRL Fishery (**Attachment 8c**). There are several strategies under each theme and suggested ideas to help RAGs and Working Groups to think about the sorts of projects which may fit within these themes and strategies.
12. The TSSAC requires each fishery to develop a rolling five year research plan, which fits into the themes identified in this SRP.

Table 1. Overview of recent research needs identified or discussed at previous TRLRAG and TRLWG meetings with an update on current status.

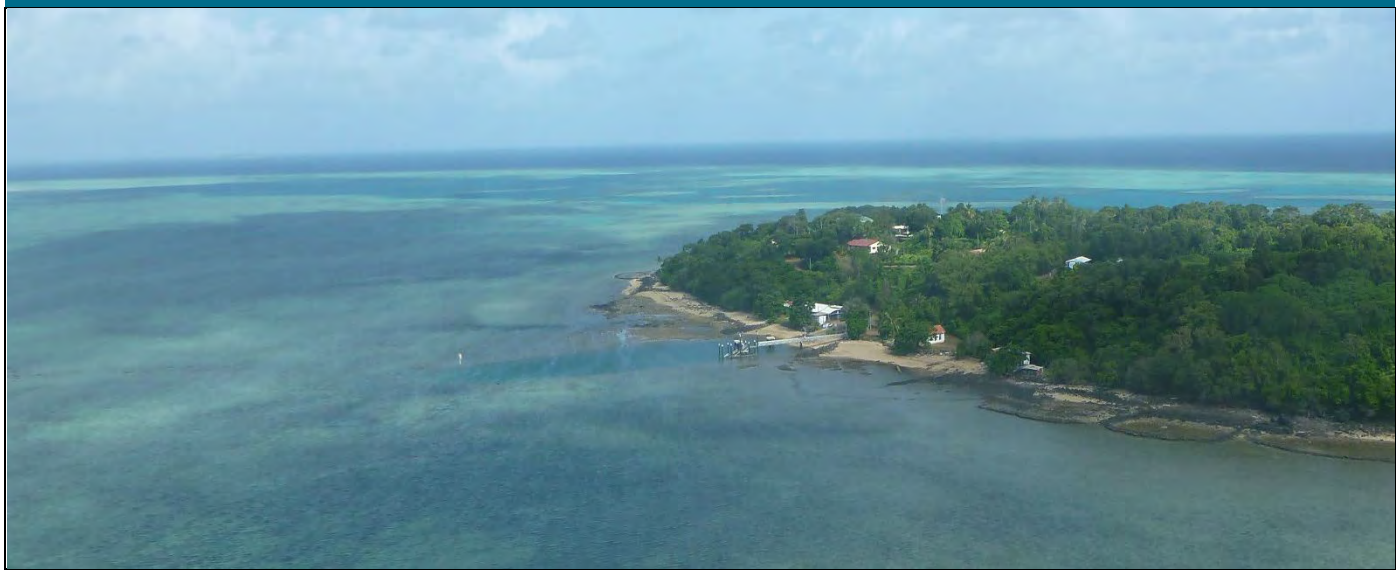
Research need	Detail	TRLRAG Prioritisation	Status	Comments/Questions
Fishery surveys, stock assessment, harvest control rules and recommended biological catch (RBC)	• Monitor ongoing changes in the fishery and update or develop fishery performance indicators as required. • Recommend a recommended biological catch (RBC) annually for each season. • Every third year update and implement the long-term stock assessment. • Conduct a pre- season survey in November each year, including seabed habitat monitoring. • Continue development of a harvest strategy for the TRL Fishery including an empirical harvest control rule. • Facilitate data sharing with PNG. • Development of a tiered harvest strategy for the TRL Fishery.	**Essential** (as per TRLRAG 29 advice)	**Currently funded** under AFMA Research Project (2019/0825) until 2021-22.	Currently scoped as a three year project from 2022-23 onwards, and under consideration by the TSSAC. Estimated projected cost is $290,000 annually
Ecological risk assessment (ERA)	• Conduct an update to the 2007 ERA for the TRL Fishery.	**Essential** (as per TRLRAG 29 advice)	Assessment this financial year dependent prioritisation against other high priority fisheries. Funding can be sourced from the AFMA TRL Budget (~$20,400).	TRLRAG 29 agreed that because the Fishery is based on a single species, collected by hand, there is unlikely to be any significant change in the ecological risk factors relating to the TRL fishery since the last ERA was undertaken in 2007.
Improvement of data collection	• Improved monitoring of commercial catch and effort in all sectors of the fishery. • Estimate of non-commercial take of TRL. • Alternative monitoring techniques of effort, for example GPS tracking.	**Essential** (as per TRLRAG 29 advice)	Due to the timing of 2021 black teatfish opening in the Torres Strait Beche-de-mer Fishery, commencing on 30 April 2021, and the level of AFMA resources required to support a successful opening, AFMA had to reprioritise some of our other fisheries work during the first half of 2021, including TRL. This, combined with COVID-19 impacts and ongoing travel restrictions has unfortunately impacted the ability of the RAG data sub-group to	The RAG has supported the continuation of the data sub-group as a means to progress options for addressing ongoing fishing dependent data needs for the fishery. The funding for RAG data sub-groups is to be sourced from the AFMA TRLRAG budget.

Research need	Detail	TRLRAG Prioritisation	Status	Comments/Questions
			reconvene in 2021. The next meeting of the RAG data sub-group is still to be confirmed and will aim to be in the first half of 2022.	
Understanding fisher behaviour	• Understanding the drivers and incentives in determining fishing behaviour in all sectors. • Understanding fishing behaviour under output controls: the impact of ITQs or competitive quota on the fishery (including social impacts); the extent and impact of discard mortality; the effect of changing market preferences on fishing behaviour under output controls; the extent of value adding e.g. moving to live product, targeting different sizes; the extent of high grading under output controls. • Work should also include capturing information on the impacts of COVID-19 on the fishery to ensure that analysis of fishery data is accounting for potential 'COVID noise'. • Commencing initial conversations with industry now, to capture qualitative information on fishing activities, would be a useful approach.	**Essential** (as per TRLRAG 29 advice)	Currently unfunded and requires an indicative cost estimate.	TRL Data Sub-group should commence initial conversations with industry and collection of qualitative data, with a view to developing a structured quantitative survey over time.
Understanding connectivity, environmental drivers and adaptation strategies	• Understanding of migration of different age classes of lobsters between, and within, jurisdictions (e.g. PNG, QLD East Coast and Torres Strait). • Understanding of recruitment connectivity between, and within, jurisdictions, including key areas of larval release within each jurisdiction. • Management implications of movement and recruitment connectivity between, and within, jurisdictions. • Understanding large scale environmental perturbations and their impacts on lobster recruitment, availability and aggregations.	**Essential** (as per TRLRAG 29 advice)	Currently unfunded and requires an indicative cost estimate	• industry could be engaged to undertake a discrete tagging project of 0+ (recently settled) and 1+ (juvenile) lobsters to examine movement from the East Coast into the Torres Strait. • Useful to help better understand any potential disparity between pre-season survey data, and the fishery catch data, noting that the most recent tagging study is over 30 years old. • The currently-funded climate project work led by CSIRO (Leo Dutra) will provide greater insights into the available environmental information, and advice on what information should be collected to develop

Research need	Detail	TRLRAG Prioritisation	Status	Comments/Questions
				downscaled climate effects models for TS fisheries.
Understanding changes to fishing power through time	Understanding changes in fishing behaviour and power over time (e.g. changes to the size of engines, use of GPS, gear, areas fished, time fished, experience of divers), to inform the standardisation of CPUE data.	**Desirable** (as per TRLRAG 29 advice)	TRL Data Sub-group to progress once progress on improving data collection has been made – funding for sub-group meetings to be sourced from RAG budget	Following initial qualitative data collection, more specific resources can be dedicated towards the project to develop a representative and structured annual fishing power survey. This will be better facilitated when face-to-face stakeholder engagement is more feasible, allowing for trusted relationships with industry to be built up over time.
Science peer review	Consistent with AFMA's best practice *Guidelines for quality assurance of Australian fisheries research and science information* (the Guidelines), a peer review be conducted of the TRL Fishery survey design.	**Desirable** (as per TRLRAG 29 advice)	This project is currently estimated to cost between $60,000 - $80,000 depending on final scope. The Chair and independent scientific member agreed to finalise the Terms of Reference for the review out-of-session (TRL RAG 29)	Original driver for this research need may be now less important.
Mid-year survey	Conduct mid- year survey, as required under the Harvest Strategy for the TRL Fishery.	To be conducted only if requirement to undertake a mid-year survey is triggered under the Harvest Strategy – indicative cost $110,000 with in-kind contribution from CSIRO	n/a	Unless triggered under the Harvest Strategy for the TRL Fishery, this project is not a priority for the TRL Fishery.

DRAFT Rolling Five Year Research Plan 2023/24-2027/28

Torres Strait Tropical Rock Lobster Fishery



Compiled by AFMA with TRLRAG advice

September 2021

ABOUT THIS PLAN

The Torres Strait Scientific Advisory Committee (TSSAC) seeks input from each fishery advisory body (Resource Assessment Group (RAG), Management Advisory Committee (MAC) or Working Group (WG)) to identify research priorities over five year periods from 2022/23 to 2026/27. This template is to be used by the relevant advisory body to complete their five-year plan. The plans are to be developed in conjunction with the TSSAC Five-year Strategic Research Plan (SRP) with a focus on the three research themes and associated strategies within the SRP.

All fishery five-year plans will be assessed by the TSSAC using a set of criteria, and used to produce an Annual Research Statement for all Torres Strait fisheries.

The TSSAC then develop scopes for the highest ranking projects in order to publish its annual call for research proposals. There are likely to be more scopes that funding will provide for so TSSAC can consider a number of proposals before deciding where to commit funding.

The fishery five-year plans are to be reviewed and updated annually by the Torres Strait forums to add an additional year onto the end to ensure the plans maintain a five year projection for priority research. Priorities may also change during the review if needed.

RESEARCH PRIORITIES

Table 1. Five-year Torres Strait Tropical Rock Lobster Fishery research plan for 2023/24 to 2027/28.

Proposed Project	Objectives and component tasks	Year project to be carried out and indicative cost*						Evaluation		
		2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	Priority essential / desirable	Priority ranking 1-5 (1 = highest)	Theme
Fishery surveys, stock assessment, harvest control rules and recommended biological catch (RBC)	➢ Monitor ongoing changes in the fishery and update or develop fishery performance indicators as required. ➢ Recommend a recommended biological catch (RBC) annually for each season. ➢ Every third year update and implement the long-term stock assessment. ➢ Conduct a pre- season survey in November each year, including seabed habitat monitoring. ➢ Continue development of a harvest strategy for the TRL Fishery including an empirical harvest control rule. ➢ Facilitate data sharing with PNG. ➢ Development of a tiered harvest strategy for the TRL Fishery.	290,824 (funded under AFMA Research Project 2019/ 0825)	Estimated 290,000	Estimated 290,000	Estimated 290,000	290,000 (not yet scoped)	290,000 (not yet scoped)	Essential	1	1
Ecological risk assessment (ERA)	➢ Conduct an update to the 2007 ERA for the TRL Fishery.	20,400	0	0	0	0	0	Essential	1	1
Improvement of data collection • Data sub-group to progress alongside RAG meetings – funding for sub-group meetings to be sourced from RAG budget	➢ Improved monitoring of commercial catch and effort in all sectors of the fishery. ➢ Estimate of non- commercial take of TRL. ➢ Alternative monitoring techniques of effort, for example GPS tracking.	20,000	0	0	0	0	0	Essential	1	1,3
Understanding fishing behaviour	➢ Understanding the drivers and incentives in determining fishing behaviour in all sectors. ➢ Understanding fishing behaviour under output controls: the impact of ITQs or competitive quota on the fishery (including social impacts); the extent and impact of discard mortality; the effect of changing market preferences on fishing behaviour under output controls; the extent of value	To be advised TRL Data Sub-group should commence initial conversations with industry and collection of qualitative data, with a view to developing a structured quantitative survey over time.						Essential	2	1

	adding e.g. moving to live product, targeting different sizes; the extent of high grading under output controls. ➢ Work should also include capturing information on the impacts of COVID-19 on the fishery to ensure that analysis of fishery data is accounting for potential 'COVID noise'.				
Understanding connectivity, environmental drivers and adaptation strategies	➢ Understanding the drivers and incentives in determining fishing behaviour in all sectors. ➢ Understanding fishing behaviour under output controls: the impact of ITQs or competitive quota on the fishery (including social impacts); the extent and impact of discard mortality; the effect of changing market preferences on fishing behaviour under output controls; the extent of value adding e.g. moving to live product, targeting different sizes; the extent of high grading under output controls.	To be advised	Essential	2	1
Understanding changes to fishing power through time	➢ Understanding changes in fishing behaviour and power over time (e.g. changes to the size of engines, use of GPS, gear, areas fished, time fished, experience of divers), to inform the standardisation of CPUE data.	To be advised Sub-group to progress once progress on improving data collection has been made – funding for sub-group meetings to be sourced from RAG budget	Desirable	2	1
Science peer review	➢ Consistent with best practice Guidelines for quality assurance of Australian fisheries research and science information (the Guidelines), a peer review be conducted of the TRL Fishery survey design, stock assessment and draft Harvest Strategy. Terms of reference to be developed and considered by the TRLRAG	60,000 - 80,000 (dependent on final scope)	Desirable	3	
Mid-year survey Note: unless triggered under the Harvest Strategy for the TRL Fishery, this project is not a priority for the TRL Fishery.	➢ Conduct mid- year survey, as required under the Harvest Strategy for the TRL Fishery.	To be conducted only if requirement to undertake a mid-year survey is triggered under the Harvest Strategy – indicative cost $110,000 with in-kind contribution from CSIRO	Only if triggered under HS priority = essential	Only if triggered under HS priority ranking = 1	1

Committed Torres Strait Scientific Advisory Committee (TSSAC) funds for multi-year projects 2021-22 to 2024-25

Research priority theme	Project Title	Cost per year			
		2021/22	2022/23	2023/24	2024/25
1a - Fishery stocks, biology and marine environment.	Fishery independent survey, stock assessment, Harvest Strategy and Recommended Biological Catch calculation for the Torres Strait Tropical Rock Lobster Fishery	$291,000	(estimate $290,000)	(estimate $290,000)	(estimate $290,000)
1a - Fishery stocks, biology and marine environment.	Finfish Fishery: Coral Trout and Spanish Mackerel Biological Sampling 2021-2024	$122,000	$128,000	$135,000	
1a - Fishery stocks, biology and marine environment.	Finfish Fishery Spanish mackerel stock assessment	$57,000	$59,000	$61,000	
1a - Fishery stocks, biology and marine environment.	Designing a close-kin mark-recapture study for Torres Strait Spanish mackerel	$93,000			
Total cost for all projects (including yet to be scoped TRL)		**$563,000**	**$477,000**	**$486,000**	**$290,000**
Available research budget (if TSRA funding continues at $150,000 and AFMA at $420,000 per year)[1]		NA – funding round complete	$570,000	$570,000	$570,000
Remaining funding available if TRL project continues funding in future			~$93,000	~$84,000	~$280,000

[1] The TRL stock assessment and survey is ongoing work generally funded each year. This work usually costs around $290,000 a year. Although this project proposal will be assessed against all others, its considered a high priority for Torres Strait research and is likely to be funded. This can be taken into account when looking at the likely funding available for 2023-24 and beyond.

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.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) **Cairns / Video conference**	**MEETING 32** **15 December 2021**
OTHER BUSINESS	**Agenda Item 9** **For Discussion**

RECOMMENDATIONS

1. That the RAG **NOMINATE** any other business for discussion.

TROPICAL ROCK LOBSTER RESOURCE ASSESSMENT GROUP (TRLRAG) Cairns / Video Conference	MEETING 32 15 December 2021
DATE AND VENUE FOR NEXT MEETINGS	Agenda Item 10 For Discussion

RECOMMENDATIONS

1. That the RAG **NOMINATE** a date and a venue for the next meeting noting proposed meeting dates in the table below alongside key agenda items.

Proposed Date	Key agenda items
July 2022 (during a moontide closure) (TBC)	TRLRAG Data Sub-Group (meeting 2) - Assess and identify improvements to fisher dependent data inputs to the Torres Strait TRL Fishery assessment framework - Consider a draft data plan
October 2022	TRLRAG (meeting 33) - Consider any related intersessional work undertaken by CSIRO - Discuss research and data needs planning, including: • Consider Data Sub-Group meeting outcomes and future work • Discuss research priorities and any updates to the five-year research plan.
14 December 2022	TRLRAG (meeting 34) - Consider results of the November 2022 pre-season survey - Consider CPUE analyses for the 2021-22 fishing season - Consider the recommended biological catch (RBC) estimates derived through the application of the empirical harvest control rule (eHCR) under the TRL Harvest Strategy and provide advice on a RBC for the 2022-23 fishing season - Consider any intersessional work undertaken by CSIRO