TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
PRELIMINARIES **Welcome and apologies**	**Agenda Item 1.1** **For NOTING**

RECOMMENDATIONS

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

2. No formal apologies have been received however Scientific Members, Dr Steve Purcell and Tim Skewes will only be able to participate at the meeting via video conference due to the current COVID-19 situation and related travel restrictions.
3. The QDAF Member Ms. Samantha Miller has advised that she will be participating via video conference.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No.18 28-29 October 2021
PRELIMINARIES **Adoption of agenda**	**Agenda Item 1.2** **For DECISION**

RECOMMENDATION

1. That the Working Group consider and **ADOPT** the draft agenda.

BACKGROUND

2. A first draft annotated agenda was circulated to members and observers on 23 July and again on 27 September 2021 following postponement of the meeting.
3. The draft agenda was revised to include minor comments and to better reflect the Agenda Items of matters to be discussed at the HCWG meeting and recirculated on 24 October 2021, along with Agenda Papers for the meeting.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
PRELIMINARIES **Declarations of interest**	**Agenda Item 1.3** **For DECISION**

RECOMMENDATIONS

1. That the Working Group members:

   a. **DECLARE** all real or potential conflicts of interest in Torres Strait hand collectable fisheries at the commencement of the meeting (**Table 1**).

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

   c. **ABIDE** by decisions of the Working Group regarding the management of conflicts of interest.

   d. **NOTE** that the record of the meeting must record the fact of any disclosure, and the determination of the Working Group 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. Working Group members are asked to declare all real or potential conflicts of interest or update the standing list of declared interests (**Table 1)** if required.

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.

Table 1. HCWG member and observer Declarations of Interest to be updated at the meeting. For members who are also members of the Hand Collectable Resource Assessment Group, the interest declared by those persons at the first HCRAG meeting (6-7 October 2021) are shown.

Name	Position	Declaration of interest
Members		
Anne Clarke	Chair	Previously contracted with Regional Development Australia Far North Queensland and Torres Strait. No pecuniary interests or otherwise.
Tim Skewes	Scientific Member	Independent Consultant. Previously employed by CSIRO. Scientific Member on the Hand Collectables Resource Assessment Group. Previous principal scientist and co-investigator for Torres Strait Scientific Advisory Committee (TSSAC) and TSRA funded projects focused on the sea cucumber, tropical rock lobster, finfish and traditional fisheries in Torres Strait.
Steve Purcell	Scientific Member	Has interest in invertebrate fishery research has previously worked in the assessment of sea cucumber fisheries in the Pacific and New Caledonia, and on restocking/sea-ranching research. Specialist in sea cucumber ecology and fisheries. Will be involved in a sea cucumber population survey in New Caledonia to inform the CITES Appendix II listing of black and white teatfish.
Michael Passi	Traditional Inhabitant Member Kemer Kemer Meriam	TIB licence holder and full time BDM operator. Hand Collectable Working Group Member.
Anthony Salam	Traditional Inhabitant Member Kaiwalagal	TIB licence holder
Nicholas Pearson	Traditional Inhabitant Member Kulkalgal	To be declared
Gerald Bowie	Traditional Inhabitant Member Maluialgal	To be declared
Maluwap Nona	Traditional Inhabitant Member, Gudumalulgal	TIB licence holder and full time BDM operator. Chairperson of Malu Lamar; Director of MDW Fisheries Association on Mer; Traditional Inhabitant Member on TSSAC. Applicant on the Torres Strait Sea Claim Part B with other representatives.
Selina Stoute	AFMA Member	Employed by AFMA, no pecuniary interests or otherwise
Mark Anderson	Torres Strait Regional Authority (TSRA) Member	Employed by TSRA, no pecuniary interests as an individual, TSRA holds fishing licences on behalf of traditional inhabitants.

Name	Position	Declaration of interest
Samantha Miller	QDAF Member	Employed by Queensland Government and working in the Management and Reform Section, managing the East Coast Sea Cucumber and other harvest fisheries in Queensland. No pecuniary interests or otherwise.
Danait Ghebrezgabhier	Executive Officer, AFMA	Employed by AFMA, no pecuniary interests or otherwise

Permanent Observers		
Yen Loban	TSRA Fisheries Portfolio Member	TIB licence holder; TSRA Board Member for Ngurupai
Ian Liviko	PNG National Fisheries Authority	To be declared.
Casual Observers		
Seriako Stephen	Malu Lamar	To be declared
Ian Butler	Australian Bureau of Agriculture and Resource Economics (ABARES)	Employed by the Australian Bureau of Agricultural And Resource Economics and Science (ABARES), Department of Agriculture, Water and the Environment (DAWE). No pecuniary interests or otherwise.
Quinten Hirakawa	TSRA officer	Employed by TSRA and TIB licence holder with a BDM endorsement.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
PRELIMINARIES Action items from previous meetings	Agenda Item 1.4 FOR NOTING

RECOMMENDATIONS

1. That the Working Group **NOTE:**
   a. the progress against actions arising from previous Hand Collectable Working Group meetings (**Attachment 1.4a**); and
   b. the meeting records of the HCWG members' meeting held on 7 August 2020 (Attachment 3d under Agenda Item 3) and the HCWG's 17th meeting held on 12 October 2020 via tele/video conference (**Attachment 1.4b**) are provided.

BACKGROUND

Actions arising

2. Updates are provided on the status of actions arising from the HCWG17 and previous meetings.

Meeting Record

3. The draft meeting record for HCWG17 was circulated out-of-session to members on 21 October 2020 for comment. The record was finalised out of session, emailed to Working Group members and posted on the PZJA website on 8 December 2020.

Status of actions arising from previous HCWG meetings.

#	Meeting	Action item	Responsibility	Status
1	HCWG 15 (1-2 Aug 19)	TSRA and AFMA to develop a discussion paper outlining suggested management arrangements, based on HCWG discussions for pursuing the use of hookah to fish for white teatfish, for further consultation with communities and consideration by the HCWG and the PZJA.	TSRA AFMA	**Ongoing.** The TSRA supported PZJA Traditional Inhabitant members to undertake cluster consultations in late 2019 which sought feedback from communities on the use of hookah to fish for white teatfish. An overview of the consultations outcomes was considered at HCWG 16. The HCWG recommended Malu Lamar discuss the review of the hookah prohibition at the stakeholder workshop with the view to developing management recommendations (see **Action 6** below).
2	HCWG 15 (1-2 Aug19)	AFMA to arrange a half/full day future management priorities workshop in conjunction with the next Hand Collectables Working Group meeting.	AFMA	**Ongoing.** AFMA was unable to arrange the workshop in conjunction with HCWG16 as the focus of that meeting was to seek firm advice on black teatfish for a 2020 opening. Options, including timing and means, for a future workshop will continue to be explored in consultation with members having regard for Covid 19 response measures. This matter will be discussed further under Agenda Item 5.1.
3	HCWG 16 (21 Feb 20)	Malu Lamar to make recommendations to AFMA and TSRA on an as needs basis to establish an MOU to assist in improved data collection in the Fishery.	Malu Lamar	**Ongoing.** While no formal MOU has been developed, a suite of parallel activities has since taken place including a full round of community visits focussed on Fish Receiver System education and awareness, and more recently PZJA traditional inhabitant member cluster consultations. AFMA also continues to work with individual operators to improve data collection. The TSRA is also working with Malu Lamar to agree a service level MOU that may include programs aimed at improving reporting.

#	Meeting	Action item	Responsibility	Status
				At the HCWG16 meeting, the Malu Lamar Chairperson expressed preference to maintain an ongoing action item on the development of the MOU to ensure it remains an option if needed.
4	HCWG 16 (21 Feb 20)	Malu Lamar to take the lead in convening a stakeholder workshop to further discuss and agree on cultural lore and industry agreements with respect to fishing for black teatfish and report outcomes to the HCWG.	Malu Lamar (supported by TSRA)	**Ongoing.** The stakeholder workshop was initially planned to take place on 7-8 April but had to be postponed due to the COVID-19 emergency and resulting restrictions. A further workshop was scheduled for the 4-5 August, however, did not proceed. At the face to face community meetings convened by AFMA with assistance from Michael Passi and Maluwap Nona, time was provided for participants to discuss cultural protocols. At the Black teatfish Industry Workshop held at Mer on 8-10 Feb 21, Mr Ned David, Chairperson of Gur A Baradharaw Kod (GBK) Torres Strait Sea Land Council advised that the GBK will develop a template for the development of land and sea protocols. A summary of the Mer Industry workshop, including community meeting outcomes is provided as **Attachment 1.4c.**
5	HCWG 16 (21 Feb 20)	AFMA explore media opportunities such as radio to widely communicate the additional management and reporting requirements for a black teatfish re-opening.	AFMA	**Complete.** AFMA utilised several media avenues to communicate the additional management and reporting requirements for the black teatfish re-opening. These include face to face meeting in all communities (assisted by Michael Passi and Maluwap Nona), an industry workshop at Mer (co-chaired by Mr Passi, Mr Nona and Mr Rocky Stephen), radio interviews, newspaper adverts, and digital notice boards throughout the region as well as the PZJA website and AFMA's social media platforms.

#	Meeting	Action item	Responsibility	Status
6	HCWG 16 (21 Feb 20)	Malu Lamar to discuss the review of the hookah prohibition at the stakeholder workshop with a view to developing management recommendations.	Malu Lamar (supported by TSRA)	**Ongoing.** The stakeholder workshop was initially planned to take place on 7-8 April but had to be postponed due to the COVID-19 emergency and resulting restrictions. A further workshop was scheduled for the 4-5 August; however it is no longer proceeding. TSRA have previously advised that a series of meetings in communities may now be pursued. This matter will be discussed further under Agenda Item 5.1.
7	HCWG 17 (12 Oct 20)	Scientific member Steven Purcell to share with the Working Group the link to his seminar to the FAO.	Scientific member Steven Purcell	**Completed.** The link to the presentation was circulate to the Working Group by the member on
8	HCWG 17 (12 Oct 20)	The QDAF member to share a written summary of key fisheries updates for Queensland.	QDAF member Sam Miller	**Completed.** The update was circulated to the Working Group on 21 October 2020.
9	HCWG 17 (12 Oct 20)	EO to circulate the terms of reference for RAGs outlined in the PZJA FMP1 to the Working Group for comment.	HCWG EO	**Completed.** The terms of reference were provided to the Working Group on 8 December 2020.
10	HCWG 17 (12 Oct 20)	AFMA to follow up with the Scientific member Steven Purcell on designing survey templates for the BDM Fishery to collect socio-economic data during BT reopening.	HCWG EO/ Scientific member Steven Purcell	**Ongoing.** Following feedback from industry during consultation on the timing of the opening, AFMA did not pursue additional data collection initiatives and focused more on reinforcing the daily landing and reporting required to effectively monitor the black teatfish TAC. Collection of socioeconomic data for the fishery is still considered a priority for the fishery and is to be considered by the Working Group under Agenda Item 6, along with HCRAG advice on how to progress this item.

Australian Government
Australian Fisheries Management Authority

17th Meeting of the Torres Strait Hand Collectables Working Group

12 October 2020, tele/video conference

Final Meeting Record

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

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Contents

1 Preliminaries

1.1 Acknowledgement of Traditional Owners, welcome and apologies

1. Anthony Salam opened the meeting in prayer around 10:10am.
2. The Chair welcomed attendees to the meeting via teleconference. The Chair acknowledged the Traditional Owners of the land on which the various members were located and paid respect to Elders past, present and future.
3. Attendees at the Working Group are detailed in **Table 1** below. The positions for Traditional Inhabitant Members for Maluialgal and Kulkalgal are currently vacant.
4. There is a standing meeting invitation to a representative from the Papua New Guinea (PNG) National Fisheries Authority.
5. Apologies received are detailed in the **Table 2** below.

Table 1. List of attendees at the meeting of HCWG members

Members	
Anne Clarke	Chair
Tim Skewes	Scientific member
Michael Passi	Traditional Inhabitant member, Kemer Kemer Meriam
Maluwap Nona	Traditional Inhabitant member, Gudumalulgal
Anthony Salam	Traditional Inhabitant Member - Kaiwalagal
Selina Stoute	Australian Fisheries Management Authority (AFMA) member
Keith Brightman	A/g Torres Strait Regional Authority (TSRA) member
Steven Purcell	Scientific Member
Samantha Miller	Queensland Department of Agriculture and Fisheries
Executive Officer	
Danait Ghebrezgabhier	HCWG Executive Officer, AFMA
Observers	
Maluwap Nona	Malu Lamar (Torres Strait Islanders) Corporation RNTBC
Quinten Hirakawa	TSRA Officer

Table 2. List of apologies for the meeting of HCWG members.

Apologies	
Anthony Salam	Traditional Inhabitant Member - Kaiwalagal
Mark Andersen	TSRA member

1.2 Adoption of agenda

6. The Working Group adopted the draft Agenda with the addition of a discussion item under *Agenda item 3 – Research Priorities* on establishing a resource assessment group (RAG) for the Torres Strait Beche-de-mer (BDM) Fishery in 2021.
7. The Executive Officer (EO) advised Members of the intention to record the meeting proceedings for the purpose of developing the minutes No members objected to this process.

1.3 Declarations of interest

8. The Chair advised members and observers to update their declared interests outlined in the register provided in the agenda paper. Declared interests are detailed in **Table 3** below. Working Group members agreed to address any additional conflicts of interest should they arise throughout the discussion of agenda items.

Table 3. Declared interests from each attendee

Name	Position	Declaration of interest
Members		
Anne Clarke (video conference)	Chair	Previously contracted with Regional Development Australia Far North Queensland and Torres Strait No pecuniary interests or otherwise.
Tim Skewes (video conference)	Scientific Member	CSIRO/Independent Consultant. Current co-investigator on TSSAC project 'measuring non-commercial fishing in the Torres Strait'. Current co-investigator on TSRA funded project 'Stock survey of Torres Strait Beche-de-mer species'. Previous principal scientist for Torres Strait Scientific Advisory Committee (TSSAC) project to develop a harvest strategy for the TSBDMF. Previous CSIRO researcher for TSSAC project investigating traditional take of finfish in Torres Strait.
Steve Purcell (video conference)	Scientific Member	Has interest in invertebrate fishery research has previously worked in the assessment of sea cucumber fisheries in the Pacific and New Caledonia, and on restocking/sea-ranching research. Specialist in sea cucumber ecology and fisheries. Will be involved in a sea cucumber population survey in New Caledonia to inform the CITES Appendix II listing of black and white teatfish.
Michael Passi (teleconference)	Traditional Inhabitant Member Kemer Kemer Meriam	TIB licence holder and full time BDM operator.
Maluwap Nona (teleconference)	Traditional Inhabitant Member, Gudumalulgal	TIB licence holder and full time BDM operator. Chairperson of Malu Lamar;

Name	Position	Declaration of interest
		Director of MDW Fisheries Association on Mer; Traditional Inhabitant Member on TSSAC. Applicant on the Torres Strait Sea Claim Part B with other representatives.
Anthony Salam (teleconference)	Traditional Inhabitant Member Kaiwalagal	TIB licence holder
Selina Stoute(video conference)	AFMA Member	Employed by AFMA, no pecuniary interests or otherwise
Samantha Miller (video conference)	QDAF Member	Employed by Queensland Government and working in the Management and Reform Section, managing the East Coast Sea Cucumber and other harvest fisheries in Queensland. No pecuniary interests or otherwise.
Danait Ghebrezgabhier (video conference)	Executive Officer, AFMA	Employed by AFMA, no pecuniary interests or otherwise
Casual Observers		
Keith Brightman (video conference)	TSRA officer	Employed by TSRA, no pecuniary interests or otherwise
Quinten Hirakawa (video conference)	TSRA officer	Employed by TSRA and TIB licence holder with a BDM endorsement.

9. The AFMA Member thanked all members for their availability to meet and discuss research priorities despite the challenges of teleconference meetings.

1.4 Out of session correspondence

10. All out of session correspondence on Working Group matters since the meeting of HCWG members on 7 August 2020 was taken as read and not explicitly discussed. The EO advised members that the application for the reassessment of the Wildlife Trade Approval (WTO) for the BDM Fishery was submitted to the Department of Agriculture, Water and the Environment (DAWE). A copy of the submission was circulated to the Working Group on 9 October and updates on the progress of the assessment will be provided as they becomes available.

2 Working Group Updates

2.1 Industry member update

The Working Group noted updates provided by industry members on matters relating to the BDM Fishery.

The Traditional Inhabitant member for Kemer Kemer Meriam advised the Working Group that, although he has been able to dispatch some product, fishing operations have been slow in the last two months due to bad weather. Although not ideal, this has provided fishers with a break and fishing grounds an opportunity for grounds to re-stock.

The Traditional Inhabitant member for Gudumalulgal provided an industry perspective on the need for consistency on compliance activities that are carried out across all Torres Strait Fisheries and the need to inform all BDM operators about the transparency and accountability on data collection across the industry. The member also queried when the review of the current prohibition on the use of Hookah gear to fish is likely to be discussed, including terms and conditions on how it will happen. Lastly the member expressed preference for the HCWG to resume face-to-face meetings for members located in the Torres Strait to address the communication challenges of tele/video conference meetings and make it easier to participate in discussions more effectively.

The TI member for Kaiwalagal advised that he is supportive of the recently released Management Plan. The member further provided feedback from other fishers in support of the proposed arrangements relating to the re-opening of black teatfish in April 2021 with a 20 tonne TAC, noting that the review of the hookah ban is yet to be resolved. A black teatfish reopening in April is ideal as it coincides with the opening of the crayfish season as well.

2.2 Scientific member updates

The Working Group noted updates provided by Scientific members on matters relating to the BDM Fishery.

Scientific member Tim Skewes advised the working group that:

- he is working with the project team on finalising the stock survey report.
- he will also be participating in the upcoming surveillance milestone of the sea cucumber fishery in Western Australia leading up to its first year anniversary of being Marine Stewardship Council certified. It is primarily a sandfish and redfish fishery.
- the Northern Territory is current undertaking an ecological risk assessment (ERA) for their sea cucumber fishery which will be worth keeping an eye on.

The scientific member Steven Purcell advised the Working Group that:

- he will be involved in a sea cucumber population survey in New Caledonia to inform the CITES Appendix II listing of black and white teatfish and is hopeful that there will be lessons learnt that can be shared between both counties given the similarities in teatfish populations.
- he gave a seminar hosted by the Food and Agriculture Organisation (FAO) and would be happy to share the link with the Working Group if there is interest.

ACTION – Scientific member Steven Purcell to share with the Working Group the link to his seminar to the FAO.

2.3 Government agency updates

2.3.1 AFMA

The AFMA member informed the Working Group that, following on from the PZJA's decision regarding black teatfish, AFMA is working with Malu Lamar and Traditional Inhabitant members on the HCWG to undertake outer island visits from 26 October onwards. The purpose of the visits is to explain the mandatory daily reporting arrangements for landed catch, to encourage voluntary logbook reporting and discuss the fin fish sampling project. The visits will also provide Malu Lamar the opportunity to discuss with industry any cultural law arrangements that they may want to implement during the trial reopening of black teatfish. AFMA is grateful for the TI members for Gudumalulgal, Kemer Kemer Meriam and Kaiwalagal for their willingness to assist and lead the industry discussions.

TI member for Gudumalulgal advised that Malu Lamar is fully supportive of AFMA's work in progressing this and thanked AFMA. The member further reiterated the importance of allowing all BDM operators the opportunity to play their part in the management of the fishery.

2.3.2 TSRA

The acting TSRA member informed the Working Group that the TSRA has been focused on encouraging daily reporting and is willing to continue to assist with that process from time to time as required by AFMA. The TSRA has also been very focussed on organising the upcoming Fisheries Summit and will be able to contribute more post the Summit.

2.3.3 QDAF

The QDAF member updated the Working Group on the key developments below relating to fisheries, with a more comprehensive written summary to be circulated after the meeting:

- Fisheries regulations have been streamlined
- A draft Harvest Strategy Policy has been developed for fisheries in the Coral Sea including sea cucumber, lobster and aquarium fisheries.
- The WTO accreditation for the East coast sea cucumber Fishery was approved on 28 September for one year following significant negotiations with DAWE around the conditions which prescribe tight milestones for the design and delivery of fishery independent surveys. The surveys will be fully cost recovered from industry given the Department's limited capacity and the CITES Appendix II listing requirement for the assessment of black and white teatfish stocks to be informed by fishery independent data.
- The draft Development Fishing Policy is available if the Working Group is interested.

ACTION – the QDAF member to share a written summary of key fisheries updates for Queensland.

2.3.4 Malu Lamar

The Malu Lamar Chair updated the Working Group on Malu Lamar's duty of care to provide support in the best interest of the industry and ensure that the resources remain sustainable and are available for the benefit of all Torres Strait Islanders. Malu Lamar is also keen to educate participants in other fisheries on the Native Title arrangements that apply to all nations throughout the Torres Strait and maintain the balance between common and customary laws through various avenues including the upcoming outer island visits.

3 Research priorities

In considering the research priorities for Hand collectable Fisheries, the Working Group initially considered the proposal to establish a resource assessment group (RAG) for Hand Collectable Fisheries in the Torres Strait with a focus on the BDM Fishery.

Advice on establishing a RAG for BDM (and other hand collectable fisheries)

The AFMA member sought the HCWG's advice on establishing a RAG in 2021 for the BDM and other hand collectable fisheries, consistent with what is already in place for the Tropical Rock Lobster and Finfish Fisheries. The fishery has seen an increase in effort and catch reporting in recent years and significant changes in management arrangements with the implementation of the Fish Receiver System and BDM Harvest Strategy, a recent scientific stock survey, the CITES Appendix II listing of black and white teatfish and pursuit to reopen the black teatfish fishery. Given these significant developments, a RAG will play a very important role in advising on the status of BDM stocks reviewing data collection programs as they develop, advising on and reviewing data analysis and other factors impacting on the fishery and the environment that it operates in.

The RAG would consist of members with scientific and industry expertise and focus solely on the scientific aspects of the BDM Fishery while the Working Group will continue to consider management arrangements for the BDM Fishery. The RAG would provide impartial scientific advice to the PZJA and the Working Group as well as support industry's expectation that BDM fishery is grown sustainably in line with the BDM Harvest Strategy and given the increased data and assessment requirements as a result of the CITES listing of black and white teatfish.

Working Group members expressed their full support for the establishment of a RAG in 2021 for the BDM Fishery and acknowledged that it will play an important role in supporting and progressing the science in the fishery and provide a two way sharing of knowledge between scientists and industry. Mr Nona, in his capacity as the Malu Lamar Chair also expressed full support for the establishment of a RAG in 2021 for the BDM Fishery.

The Scientific member Tim Skewes noted that no other jurisdiction has a dedicated RAG for its sea cucumber fishery and establishing one for the Torres Strait may provide a blueprint for adopting this approach more widely.

The Scientific member Steven Purcell observed that the data available for the BDM Fishery is currently heavily weighted to biological data and a RAG would need to have broader considerations that include economic and social factors of the fishery. The AFMA member confirmed that the terms of reference for RAGs provide broader remit beyond just biological data and are outlined in the PZJA Fisheries Management Paper No.1 which will be circulated to the Working Group for their comment.

ACTION – EO to circulate the terms of reference for RAGs outlined in the PZJA FMP1 to the Working Group for comment.

Research priorities

The Working Group noted the update on the outcomes of the last TSSAC research funding cycle and discussed the future research needs for the BDM Fishery. The working Group also noted that the project to develop conversion ratios for curryfish, an essential research priority identified in the last research funding round, has been withdrawn from the 2020-21 funding round as CSIRO's work plan and priorities were re-directed to other projects due to COVID-19. The project team has further advised that they are currently not in a position to resume the project in 2021-22 as they are facing a number of obstacles due to COVID-19 and staff caps within CSIRO that have limited its ability to acquire additional resources to undertake the project. In discussing research priorities for the BDM Fishery, the Working Group might consider what needs to be addressed immediately (in 2020-21) and what could be held off for the newly established RAG to consider in 2021.

To assist the Working Group with its consideration, the scientific member Tim Skewes outlined the draft recommendations from the BDM stock survey report on future research gaps, needs and opportunities for the ongoing development of the BDM fishery as follows:

- Information is still required on the stock status of Sandfish at Warrior Reef (last surveyed in 2011) and of deep water sea cucumber species (deepwater redfish/blackfish/surf redfish) which may be best obtained through dedicated surveys.
- Further investigation of deep water populations in parts of the Torres Strait to build on the outcomes of the underwater camera survey undertaken in the last survey.
- Developing conversion ratios for species that are becoming more commercially important such as curryfish.
- Analysis of additional catch data collected during the trial reopening of black teatfish and.

- ➢ Broader, industry assisted, catch sampling to collect additional data for input into the Harvest Strategy, such as fine scale effort data noting confidentiality considerations of individual fishing operations.
- ➢ Collecting social and economic information to better understand the key drivers and supply chains in the fishery, support fishers and inform the management of the fishery.
- ➢ There is interest in pursuing sea cucumber aquaculture ventures in the Torres Strait, such as the reseeding potential that is currently being investigated at Ugar, and this may require additional funding. There is currently a project underway to look at the financial and biological feasibility of sea ranching at Ugar and there is also a potential to extend this investigation to Warrior Reef. Similar work is also happening internationally in PNG and Madagascar.
- ➢ Potential exists to update and evaluate the existing Management Strategy Evaluation model for sea cucumber fisheries to support future testing and developing future iterations of BDM HS.
- ➢ Quantifying the potential impacts of climate change on BDM Fishery and evaluating alternative adaptation options, preferably through an integrated ecosystem modelling approach.

The Working Group noted the following as it discussed the research needs for the BDM Fishery:

- ***Development of curryfish conversion ratios*** - the sampling to support the development of conversion ratios for curryfish could be undertaken elsewhere (in the GBR or New Caledonia). However, since the original intention of the project was to engage industry fishers in the sampling process it was considered this could be delayed until the fishers were engaged without sustainability concerns for the species given there are default proxies in place. In the meantime, the Working Group noted that there is existing research in this area undertaken by the scientific member Steven Purcell that could be considered, if not done so already.
- ***Exploring sea ranching/re seeding opportunities*** - the Scientific member Steven Purcell advised the Working Group that such a project would need to be further developed. In his experience such ventures can be expensive to undertake with uncertain outcomes. The member further outlined that the social aspects of such ventures, particularly with respect to access arrangements and animal husbandry, would need to be considered carefully. The Working Group noted that Queensland regulates sea ranching/aquaculture operations while AFMA would take carriage of permitting for the harvest of juveniles and restocking activities.

  The QDAF member further reiterated that any aquaculture undertaking would be regulated by the Queensland Government and assessed according to the relevant policy, including environmental assessment process to manage impacts and containment arrangements. The member advised that aquaculture operations tend to be very challenging and the business plan for the proposed activity would need to address those.

- ***Outstanding stock survey of Sandfish at Warrior Reef*** - the TI member for Kaiwalagal queried whether the survey will resume given the Malu Lamar Chair's advice at HCWG16 that there may be a way to re-engage the Traditional Owners that opposed the survey. The TI member for Kemer Kemer Meriam also reiterated the need to resolve the misunderstandings with Traditional Owners on Tudu and Iama to be able to undertake future surveys as Sandfish is an important stock to those fishers. The scientific member Tim Skewes agreed that it will be important to engage TOs on the discussion regarding future surveys as well as PNG given the virgin sandfish stock is located there. The survey itself would be relatively efficient and cost effective compared to east Torres Strait due to the small area size and shallow grounds.

  The Malu Lamar Chair advised the Working Group that Malu Lamar put a stop to the survey that was planned for Warrior Reef following a complaint from TOs on Tudu. Malu Lamar understands the importance of the stock survey, especially given the positive outcome of the eastern component of the recent surveys for reopening black teatfish. Malu Lamar will convey the benefit of undertaking the survey to Tudu and will take the lead and encourage the TOs from that region that they need to pursue this as a matter of priority.

- ***Socio economic priorities*** - The Scientific member Steven Purcell observed that the current information for the BDM Fishery is heavily weighted towards biological data and proposed that the socioeconomic priorities for the fishery should be better articulated and further developed through dedicated regular surveys on socio-economic component of the fishery. Such surveys can be undertaken on a 3-5 year cycle and would complement existing biological information by providing additional information on local ecological knowledge on species, the development of the fishery and fishing behaviour over time and information on greenhouse gas emissions to inform climate change impacts. This approach can also be extended to other Torres Strait Fisheries.

  The AFMA member expressed support for pursuing a formalised socioeconomic data collection and analysis program for the BDM Fishery to complement the biological data in the fishery, noting that to be effective and successful such an initiative would need to be co-designed and co-developing with industry. As such, this priority could benefit from additional consideration by the RAG once established in 2021. In the meantime the Working Group members could start considering out of session the benefit of collecting some socio-economic data as part of the proposed black teatfish trial reopening (including appropriate survey design) and work towards engaging industry on their willingness to participate in a more structured way. AFMA will follow up with the Scientific member Steven Purcell on designing survey templates from previous studies that may be adapted for the BDM Fishery.

ACTION - AFMA to follow up with the Scientific member Steven Purcell on designing survey templates for the BDM Fishery to collect socio-economic data during black teatfish reopening.

The Working Group acknowledged that the management of the trial reopening will be a significant undertaking and it is important that AFMA continues to encourage and support catch reporting by industry as part of the process.

The AFMA member emphasised that AFMA will encourage operators to take up voluntary logbook reporting, including providing assistance on completing logbooks and also confirmed that there will be a targeted compliance and monitoring program during the opening. The TI member for Gudumalulgal reiterated that customary law will also play a role in this process as operators need to abide by them and this will be reinforced during the industry visits.

Mr Nona, in his capacity as Malu Lamar Chair further reiterated Malu Lamar's support of any research priorities that are beneficial for the BDM Fishery.

The TSRA member left meeting at 12:20pm to attend another meeting.

<u>Recommendation of research priorities for the BDM Fishery for the 2021-22 TSSAC research funding round</u>

Having regard for members advice on the various research priorities discussed above, the Working Group recommended that:

- The highest research and data needs for the BDM Fishery are the analysis of new catch data collected during the trial reopening of black teatfish to inform future openings and any follow up work from the stock survey. The exact scope of this work will be more evident once the stock survey project is finalised and the trial black teatfish reopening has concluded and as such this does not require a dedicated research project to be identified at this point.

- Following the establishment of the RAG in 2021 (which is fully supported), it will engage industry upfront to refine identified research priorities for the BDM Fishery and seek funding in the following TSSAC research round. This will also provide time to talk to industry, including TOs on Tudu about progressing future Sandfish stock surveys.
- It is important that research in the BDM Fishery is informed through a two-way exchange of knowledge between industry and researchers and this is anticipated to be achieved through the RAG.

4 Date and venue for next meeting

11. The Working Group noted the tentative date for the next meeting of the HCWG during the week beginning 5 April 2021 as proposed at the last meeting, The format of the meeting will depend on the timing around the black teatfish reopening and the COVID-19 situation at the time.
12. TI member for Kaiwalagal said a closing prayer.
13. Chair closed meeting at 12:40pm.

Summary of Actions Arising from HCWG17

#	Action item	Responsibility
Action item 1	Scientific member Steven Purcell to share with the Working Group the link to his seminar to the FAO.	Scientific member Steven Purcell
Action item 2	The QDAF member to share a written summary of key fisheries updates for Queensland.	Scientific member Steven Purcell
Action item 3	EO to circulate the terms of reference for RAGs outlined in the PZJA FMP1 to the Working Group for comment.	HCWG EO
Action item 4	AFMA to follow up with the Scientific member Steven Purcell on designing survey templates for the BDM Fishery to collect socio-economic data during BT reopening.	HCWG EO/ Scientific member Steven Purcell

Attachment A – Adopted Agenda

17th MEETING OF THE PZJA TORRES STRAIT HAND COLLECTABLES WORKING GROUP

12 October 2020: 10 am – 12 pm

Teleconference

DRAFT AGENDA

AGENDA ITEM 1 PRELIMINARIES

1.1 Acknowledgement of Traditional Owners, welcome and apologies

1.2 Adoption of agenda

1.3 Declarations of interest

1.4 Out of session correspondence

AGENDA ITEM 2 WORKING GROUP UPDATES

2.1 Industry members

2.2 Scientific members

2.3 Government Agencies

2.3.1 Australian Fisheries Management Authority (AFMA) – Management

2.3.2 Torres Strait Regional Authority (TSRA)

2.3.3 Queensland Department of Agriculture and Fisheries (QDAF)

2.4 Native Title

2.5 Papua New Guinea National Fisheries Authority

AGENDA ITEM 3 RESEARCH PRIORITIES

Expected Outcome: The Working Group will discuss and provide advice on management priorities for Torres Strait Hand Collectable Fisheries.

AGENDA ITEM 4 OTHER BUSINESS

4.1 Other Business

4.2 Date and venue for next meeting – week of 5 April 2021 (proposed)

CLOSE OF MEETING

Australian Government

Australian Fisheries Management Authority

Black teatfish Industry Workshop

8-10 February 2021, Mer

Final outcomes

Contents

Workshop background

The black teatfish industry workshop was organised for fishers from the Kemer Kemer Meriam and Kulkalgal Nations to further discuss the timing for the proposed reopening of black teatfish in 2021, explain the requirements for daily catch landing and reporting that will apply to the reopening and provide the opportunity for participants to discuss cultural protocols. AFMA invited Mr Timothy Skewes to provide an update on the results of the scientific stock survey undertaken in 2019/2020. Mr Skewes is a project team member on the survey and also a long standing scientific member on the PZJA Hand Collectable Working Group (HCWG).

AFMA worked with PZJA HCWG Traditional Inhabitant (TI) members Mr Michael Passi, Mr Maluwap Nona and Mr Nicholas Pearson to invite industry members to attend the workshop. PZJA Finfish Working Group TI member Mr Rocky Stephen, Mr Michael Passi and Mr Maluwap Nona assisted with drafting the workshop agenda. PBC Chairs from Kemer Kemer Meriam and Kulkalgal Nations and Gur A Baradharaw Kod (GBK) Torres Strait Sea and Land Council representative were also invited at the recommendation of the PBC Chairperson for Mer, Mr Doug Passi, to guide discussions on protocols. A full list of the workshop participants is provided in **Attachment 1**.

The workshop was Chaired and facilitated by Mr Passi with assistance from Mr Nona, Mr Stephen and AFMA.

Day 1 – Monday 8 February 2021

A workshop dinner was held at the Mer Community Hall for workshop participants.

Day 2 – Tuesday 9 February 2021

Welcome and introductions

The workshop commenced on 9 February with an opening prayer from Ms Amina Ghee, followed by a Welcome to Country address from Peibri Tribal Elder Victor Mabo. The Mer Gedkem Le Chair Mr Falen Passi then welcomed everyone to the workshop, including the:

- Eastern cluster Representative Mr Jimmy Gela
- The GBK Chair Mr Ned David as represented by Mr Charles David
- Malu Lamar Chairperson Mr Maluwap Nona
- Acknowledgement of the PBC Chairs of the four Nations

Mr Michael Passi, the lead workshop Chair, welcomed everyone to the workshop and thanked the Mer PBC for hosting the workshop on the Island.

Mr Nona provided an address to workshop participants in his capacity as the Malu Lamar Chair. Mr Nona advised that Malu Lamar's role is to support industry to look after their fisheries resources. Mr Nona acknowledged the hard work of industry members and the HCWG to date to get the fishery to where it is. Mr Nona also acknowledged the equitable access rights to commercial fishing conferred on Torres Strait Islanders through the Traditional Inhabitant Boat (TIB) fishing licence.

Mr Passi emphasised the need for everyone to respect each other during the workshop and highlighted the importance of discussing cultural protocols. PBC Chair Mr Passi urged industry members at the workshop to first consider cultural protocols before going out to fish under the TIB licence.

Participants recognised that AFMA cannot enforce cultural protocols that apply to the different islands but that once developed, it is important for AFMA to share any protocols that are put forward by Kemer Kemer Meriam or Kulkalgal with all TIB licence holders. \

Mr Passi provided an outline of the Agenda for the workshop and a brief overview of the objectives of the workshop, these being:

- get further industry advice on the timing for the reopening of black teatfish
- explain the daily landing and reporting requirements that will be in place during the reopening
- provide the opportunity for participants to discuss cultural protocols
- provide an update on the outcomes of the scientific stock survey

Mr Passi also provided a brief overview of the consultation undertaken to date regarding the timing of the black teatfish reopening and emphasised the importance of reporting catches through catch disposal records. Additional details on the feedback received from industry on the timing of the reopening is provided in this report.

Part 1: How did we get here?

AFMA introduced Session 1 of the workshop and invited Mr Passi, Mr Nona and Mr Stephen to outline the key milestones in the management arrangements for the Torres Strait Beche-de-mer (BDM) Fishery since the last black teatfish re-openings in 2014 and 2015, which include:

- 2016-2019 – development and implementation of the BDM Harvest Strategy (HS) which was endorsed by the PZJA on 19 Nov 2019 and has been in effect since 1 January 2020. The new BDM HS has informed the process for reopening the black teatfish fishery.
- December 2017 - implementation of the Fish Receiver System and mandatory reporting of catches on the TDB02 catch disposal record.
- December 2019 - January 2020 - Scientific stock survey in Eastern Torres Strait (last survey was in 2009).

- 27 August 2020 - PZJA agreed to set a 20t TAC for the trial reopening subject to daily catch landing and reporting and black and white teatfish were listed on Appendix II of CITES.

Mr Passi and Mr Stephen gave a recap on how the Fish Receiver System (FRS) came to be mandatory and recognised industry's role in driving this and its importance to industry to ensure that the resources are managed sustainably now and for future generations. They emphasised the importance of reporting catches through the CDRs – previous re-openings resulted in over catches of the TAC as the previous reporting system was voluntary.

Mr Passi and Mr Stephen also thanked industry for their role in driving the development of the BDM Harvest Strategy, a management system that ensures the fishery remains sustainable and lays the foundations that a successful industry can be built on. They both emphasised the importance of the FRS and the Harvest Strategy in making sure that catch limits are not exceeded. Mr Passi advised how the harvest strategy recognises that cultural lore practices can form part of the overall harvest strategy for the fishery.

The Malu Lamar Chairperson Maluwap Nona commented that industry has come so far since the last reopening of black teatfish and congratulated everyone for all their effort that has resulted in the fishery being in the good position it is in now.

The 2019/20 scientific stock survey undertaken by the CSIRO is also a significant milestone for the fishery as it provides important scientific data that, together with the catch data from the Catch Disposal Records (CDRs) submitted through the FRS, is used to set sustainable catch limits for the fishery. The last scientific stock survey was undertaken in 2009.

Mr Passi commented that it would be good for divers to provide feedback on the outcomes of the project based on their traditional knowledge to assist the project team with the interpretation of some of the findings.

Outcomes of scientific survey

Mr Timothy Skewes, project team member on the scientific survey project and also the Scientific member on the PZJA HCWG gave a presentation on the objectives and outcomes of the 2019/20 scientific stock survey. The project also undertook the mapping of the reefs around Ugar and Campbell reefs to support development of a community sea cucumber aquaculture project. A copy of the presentation is attached to this report. Participants were provided with the opportunity to discuss the outcomes of the survey with Mr Skewes and ask questions. Some participants recommended that future scientific stock surveys might include other sites as part of future scientific stock surveys – e.g. barrier reef and central Torres Strait areas and surveys during spawning to better understand species biology.

Industry feedback received to date on timing of the reopening

Michael Passi, Maluwap Nona and AFMA outlined to workshop participants the industry feedback received to date on the timing of the reopening and the rationale behind each suggested timing as summarised in the table below:

Island	Date of AFMA visit	Who visited	Feedback on timing for black teatfish reopening	Reason for suggested timing for the reopening and comments
Erub	27-28 Oct 2020	Michael Passi, PZJA HCWG TI member (Kemer Kemer Meriam) Danait Ghebrezgabhier (AFMA) Andrew Trappett (AFMA) Jo Langstreth (QDAF, Finfish biological sampling project)	Feb 2021	• Fishing black teatfish earlier in the year will not disturb their spawning in June/July. • TRL fishery open which may mitigate effort displacement seafood prices are still high during this time of year due to increased demand because of Chinese New Year festivities etc.
Ugar	30-Oct-20	Michael Passi, PZJA HCWG TI member (Kemer Kemer Meriam) Sereako Stephen, Ugar PBC Chair and Malu Lamar Director Danait Ghebrezgabhier (AFMA) Georgia Langdon (AFMA) Jo Langstreth (QDAF, Finfish biological sampling project)	Oct/Nov 2021	• Better weather for fishing thus making it safer to do daily trips; • do not want to rush the reopening; • Generally of the view that opening date should work for Eastern Islands; • Called for meeting of Eastern cluster to reach consensus on the timing of the reopening.
Mer	2-Nov-20	Michael Passi, PZJA HCWG TI member (Kemer Kemer Meriam) Maluwap Nona, Malu Lamar Chairperson and PZJA HCWG TI member (Gudumalulgal) Danait Ghebrezgabhier (AFMA) Georgia Langdon (AFMA) Jo Langstreth (QDAF, Finfish biological sampling project)	April 2021	• Participants advised the community would convene a further meeting with PZJA HCWG TI members Michael Passi and Maluwap Nona at the end of the meeting round to identify a timing for the reopening as well as cultural protocols that the Island may seek to develop for the reopening.

Island	Date of AFMA visit	Who visited	Feedback on timing for black teatfish reopening	Reason for suggested timing for the reopening and comments
Warraber	3-Nov-20	Michael Passi, PZJA HCWG TI member (Kemer Kemer Meriam) Maluwap Nona, Malu Lamar Chairperson and PZJA HCWG TI member (Gudumalulgal) Danait Ghebrezgabhier (AFMA) Georgia Langdon (AFMA) John Jones (AFMA)	Feb/Apr 2021	• As per feedback from Erub (Feb) and HCWG industry member recommendations (April), participants at the session advised that fishing black teatfish earlier in the year will not disturb their spawning in June/July. • TRL fishery open which may mitigate effort displacement seafood prices are still high during this time of year due to increased demand because of Chinese New Year festivities etc.
Poruma	4-Nov-20	Michael Passi, PZJA HCWG TI member (Kemer Kemer Meriam) Maluwap Nona, Malu Lamar Chairperson and PZJA HCWG TI member (Gudumalulgal) Danait Ghebrezgabhier (AFMA) Georgia Langdon (AFMA)	Oct/Nov 2021	• Better weather allows for daily trips to and from fishing grounds to meet daily reporting requirement.
Iama	5-Nov-20	Michael Passi, PZJA HCWG TI member (Kemer Kemer Meriam) Maluwap Nona, Malu Lamar Chairperson and PZJA HCWG TI member (Gudumalulgal) Danait Ghebrezgabhier (AFMA) Georgia Langdon (AFMA) Hannah Howard (AFMA)	Oct-Jan 2021/2022 or timing proposed by Kemer Kemer Meriam	• Better weather allows for daily trips to and from fishing grounds to meet daily reporting requirement. • Hookah closure in the TRL Fishery (Dec-Jan) removes temptation for some operators of fishing using gear that is prohibited in the BDM Fishery. • Ultimately will agree with the timing put forward by Kemer Kemer Meriam given the fishing grounds are in their sea country.
Masig	11-12 Jan 2021	Michael Passi, PZJA HCWG TI member (Kemer Kemer Meriam) Danait Ghebrezgabhier (AFMA) Kayoko Yamashita (AFMA)	April 2021	• Advised that there is benefit of trialing an opening that coincided with the opening of other fisheries i.e. TRL and different to the timing of the two previous openings that resulted in overcatch of the TAC. • Suggested that a Feb opening could be trialed in the future to coincide with the market for Chinese New Year.

Island	Date of AFMA visit	Who visited	Feedback on timing for black teatfish reopening	Reason for suggested timing for the reopening and comments
Badu	18-Nov-20	Maluwap Nona, Malu Lamar Chairperson and PZJA HCWG TI member (Gudumalulgal) Wez Norris (AFMA CEO) Danait Ghebrezgabhier (AFMA) Georgia Langdon (AFMA) Hannah Howard (AFMA)	April 2021	• This was the majority participant view and participants advised that the timing put forward by Kemer Kemer Meriam should be given priority. • 1 participant opted for an Oct/Nov opening.
Kubin (Moa)	19-Nov-20	Selina Stoute (AFMA) Danait Ghebrezgabhier (AFMA) Kayoko Yamashita (AFMA) Maluwap Nona, Malu Lamar Chairperson and PZJA HCWG TI member (Gudumalulgal)	Dec-Jan 2021/22 or timing proposed by Kemer Kemer Meriam	• Hookah closure in the TRL Fishery (Dec-Jan) removes temptation for some operators of fishing using gear that is prohibited in the BDM Fishery. • Ultimately however will agree with the timing put forward by Kemer Kemer Meriam given the fishing grounds are in their sea country.
St Paul (Moa	20-Nov-20	Maluwap Nona, Malu Lamar Chairperson and PZJA HCWG TI member (Gudumalulgal) Selina Stoute (AFMA) Danait Ghebrezgabhier (AFMA) Kayoko Yamashita (AFMA)	timing proposed by Kemer Kemer Meriam	• Support for timing to be proposed by Kemer Kemer Meriam. It would be good for the opening to coincide with that of another Fishery i.e. TRL
Thursday Is and surrounds	3-Dec-20	Danait Ghebrezgabhier (AFMA) Kayoko Yamashita (AFMA) John Jones (AFMA)	Oct/Nov 2021-22	• Participants (2 out of a total of 3) preferred the idea of rotating the opening of fisheries so there is only one open at a time. Thought it better to open black teatfish when the TRL Fishery is closed and toward the end of the year when people are looking for an extra income to cover expenses.

Update on new management arrangements in the fishery CITES listing, licence conditions

AFMA provided an outline of the new management arrangements in place in the fishery, including the implications of the listing of black and white teatfish on Appendix II of the Convention on International Trade of Endangered Species (CITES) and the new licence conditions that will apply to TIB and fish receiver licence holders during the black teatfish reopening.

CITES is a binding international agreement aimed at preventing international trade from driving unsustainable population decline in species listed under the Convention. The Department of Agriculture, Water and the Environment (DAWE) is Australia's CITES Scientific Authority and has made a positive non-detriment finding of the Torres Strait Beche-de-mer Fishery subject to the conditions of the Fishery's wildlife trade operation (WTO) approval. One of these conditions places a TAC limit of 20t and 15t for black and white teatfish respectively, based on the sustainable catch limits in place for the species.

More information on the CITES Appendix II listing and the WTO approval processes for the fishery can be found on DAWE's website.

Catches of black teatfish during the reopening will need to be landed and reported to AFMA on a daily basis. Fishers will be required to land their products daily to a licenced AFMA fish receiver. The fish receivers will need to weigh and record black teatfish catches on the TDB02 Catch Disposal Record and submit it to AFMA on a daily basis by taking a picture of the front page and sending it to AFMA via text message, email or fax. For this reason it is important that:

- Fishers and fish receivers make sure that their licences are not expired;
- Fishers have access to a licenced fish receiver every day that they can land their catch to;
- That fish receivers are in a location with telephone reception or internet access to be able to report landed black teatfish catches to AFMA on a daily basis; and
- That fish receivers have advised AFMA of the location of all the premises where they are likely to receive fish e.g. if they are going to camp at a different location for the duration of the opening.

AFMA also advised participants that there will be a dedicated compliance program in place before, during and after the reopening to maintain the integrity of the fishery and ensure that there is no fishing or stockpiling happening before the opening.

Part 2: Timing of black teatfish reopening

Break-out group session: Industry discussion on the timing of the reopening

AFMA staff and HCWG Scientific Member Tim Skewes left the workshop providing participants with a closed session to discuss the preferred timing for the opening and cultural protocols that might apply. The Chair requested AFMA officers and Mr Skewes to return to the workshop following break-out discussions on preferred timing.

Michael Passi and Maluwap Nona introduced the start of the session to discuss advice from each break-out group. They advised that an April reopening, if agreed, should be towards the end of the month to allow for industry and AFMA to prepare.

Each break-out group presented the outcomes of their discussions as summarised in **Table 1** (images of the presentations are also provided at **Attachment 2**). Given the three different timings suggested (April 2021, September 2021 and Dec/Jan 2021-22) for the opening and the pros and cons of each option, participants continued to discuss the most ideal timing for the reopening with the intention of agreeing on a final date by the end of the workshop.

As part of the discussion, industry considered the following key points:

- **Safety considerations** – Ugar participants outlined that safety is their main priority and that they consider fishing in April to be too risky for them due to bad weather. They proposed a September opening instead and whilst the weather is still rough they felt that it would not be as bad as April and they would be willing to travel to and from the fishing grounds then. Whilst participants generally agreed that weather is an important aspect of safety, there was an acknowledgement that an opening during good weather would not restrict the level of fishing effort on black teatfish.

- **Black teatfish spawning season considerations** – whilst all participants were cognisant of the need to time the reopening as far away from the black teatfish spawning season (June/July) as practically possible, Ugar participants proposed holding off on the opening until after the spawning season. There was an extensive discussion between the participants on whether to fish before or after the spawning season and the HCWG Scientific member provided some scientific information to inform the discussion as follows:
    - Whilst the exact impacts of fishing pressure on spawning black teatfish are not well understood there is currently TAC in place to ensure that harvest is sustainable and minimum legal size limits in place that are aimed at allowing them to reproduce at least once before they get fished.
    - If the fishery was managed based only on fishing effort, fishing some species just before or during spawning means they might become more susceptible to fishing if they aggregate during spawning or if taken after spawning, they

might not be in optimum condition due to a thinner body wall which means fishers would need to catch more of them to make up the tonnage.

- **Not delaying the opening** – given the management, reporting and monitoring arrangements that have been implemented since the last reopening and the scientific information available for the fishery, a number of participants were of the view that the reopening does not need to be delayed.

After extensive deliberations, all participants, excluding those from Ugar, agreed to support a black teatfish reopening commencing on 30 April 2021. The participants from Ugar withdrew from the recommendation making process as they could not agree to support an April reopening due to safety considerations. Ugar participants chose to withdraw rather than object as they did not want to stand in the way of a recommendation being agreed by the workshop.

Traditional Elder Dennis Passi and Councillor Noah extended an invitation to the Ugar participants for Ugar fishers to stay on and fish out of Mer during the reopening to mitigate the risk of having to undertake daily trips from Ugar in bad weather.

The Ugar participants noted the invitation from Mer to stay on the Island for the duration of the reopening to mitigate any safety risks associated with undertaking daily fishing trips from Ugar and agreed to pass on the information to the rest of the Ugar Community. The Ugar participants advised that they may decide to take up the invite of accommodation on Mer during the reopening subject to a written confirmation from the Mer PBC Chair to the Ugar PBC Chair.

The Malu Lamar Chairperson and PZJA HCWG TI member for Gudumalulgal advised that the Gudumalulgal and Maluialgal Nations have communicated to him their full support for an opening timing and date nominated by the Kemer Kemer Meriam Nation.

Michael Passi thanked all the participants for their hard work to getting to this point and important milestone to reopening the fishery after a long pause.

Table 1 Summary of advice from break-out groups on timing of opening

Community	Recommendation	Reasons
Mer	Friday 30 April	• April – Crayfish season opening gives balance for cray fishermen to continue fishing for crayfish – no clash • Diving meskep time (low tide) - Mer families have the opportunity to walk around the island to harvest black teat. • Lowtide – easier for divers to collect on deeper waters • Open before spawning season in the middle of the year • Chinese new year seafood prices are high
Erub	Dec 2021- Jan 2022	• Weather (Ugar) • After spawning • TRL open

Community	Recommendation	Reasons
Ugar	11-30 September 2021	• Safety • Vessel -Lugger (past) -Outboard/Dinghy (present) • b)Season -closed water -open water -Monsoon weather • Scientific -spawning June/August • Fisheries program -TRL hookah opening. Close 1 October -30 November.
Kulkalgal	12 April 2021	• 27th April full moon • Tide- new moon • School holidays • Natural sustainability measure • Cap on effort (TRL season) • Not in spawning time • Market value highest still

Day 3 – Wednesday 10 February 2021

Recap from Day 2 of workshop

The workshop Chair Mr Passi, opened the workshop by providing a recap of the outcomes of the previous day, including the reopening date for black teatfish fishing on 30 April 2021 put forward by participants. Mr Passi highlighted the importance of daily catch landing and reporting by industry during the reopening to ensure that the TAC is not exceeded. On the Chair's request, AFMA presented briefly on how the FRS operates and clarified that:

- Fishers that also hold a fish receiver licence cannot land to themselves and therefore either need to nominate an agent(s) that can complete and sign the catch disposal record on their behalf or land to another fish receiver licenced by AFMA. A fish receiver does not necessarily also need to be a buyer, they just need to have a current fish receiver licence from AFMA.
- Fish receivers need to advice AFMA beforehand if they intend to receive catch at a location(s) other than that nominated on their fish receiver licence e.g. if they intend to camp on an island and continue to receive catch during the black teatfish reopening.

Industry discussion on protocols

The Chair of GBK Torres Strait Sea and Land Council, Mr Ned David, requested the opportunity to address the Workshop. In his address he expressed that cultural protocols need to be considered as a priority and not as an afterthought to administration related matters. Mr David recommended a major reform of the current TIB licencing system advising that the open access rights and interests conferred by the licence clashes with Traditional Owner rights and cultural protocols.

Mr David advised participants that the GBK will develop a template for the development of land and sea protocols. The GBK will also write to the PZJA seeking major licencing reform.

Following the GBK Chair's address, workshop participants opted to not have discussions at the workshop to develop protocols but that each community should convene its own meeting to develop their individual protocols. Mr Charles David agreed to share the protocols that Iama has developed specifically for fisheries and submitted to GBK for consideration and endorsement.

Cr Noah supported the call for licencing reform and speculated whether Councils would have a role in overseeing the protocols.

The Malu Lamar Chair Mr Nona agreed to support the development of protocols and the licencing reform if it received written requests to do so from Traditional Owners. Mr Nona emphasised the need for the details of the reform and the development of protocols to be driven from the community level rather than a top-down regional approach.

Sea-ranching project presentation

Given the level of interest expressed during the workshop on the potential of sea cucumber farming in the Torres Strait, Mr Stephen and Mr Simon Naawi presented on the BDM sea ranching initiatives that they are currently pursuing on Ugar and Masig, respectively. Both industry members noted that community engagement is key for the success of sea ranching in the Torres Strait.

Mr Naawi outlined his plans in relation to his planned sea cucumber aquaculture project as follows:

- Mulusager company has been established to look into sea ranching opportunities for Sandfish on Masig
- Masig PBC has approved the set-up of the processing facility
- a Hong Kong investor has been secured to buy the product
- planning for the sea ranching operation, once it is up and running, to be a self-funding venture in the long run
- will seek approval from AFMA regarding the process for collecting Sandfish from the wild as broodstock for sea ranching purposes.

Mr Stephen presented on the research project that he is currently undertaking in partnership with the CSIRO, looking at the feasibility of sea cucumber ranching and aquaculture on Ugar. If successful, this type of initiative has the potential to be applied in other parts of the Torres Strait. Mr Stephen advised that he is encourage by the overwhelming amount of support that he has received to date including from the Ugar community, HCWG, Member from Lockhart and the CEO of the CSIRO.

Mr Stephen sought support from the PBC Chairs and industry members present at the workshop given the potential benefits to the rest of the Torres Strait Region if the project is successful. Erub Councillor Mr Jimmy Gela, Mer Councillor Mr Aven Noah and the Malu Lamar Chair Mr Nona provided their endorsement and support for the aquaculture projects on Ugar and Masig.

The PBC representative for Iama Mr David provided in principle support for the projects and advised that he will be taking the request back to the Iama community for formal support.

Participants noted that the rules and regulations relating to aquaculture are managed by Queensland whilst fishing for wild BDM is authorised by the PZJA.

Workshop close

The Chair Mr Passi thanked all participants for their time and invited elder Mr Dennis Passi, Councillor Noah and Mr Nona to provide closing remarks.

Pastor Jeffrey Ses closed the workshop in prayer around 1 pm.

Attachments

Attachment 1 - Attendance List

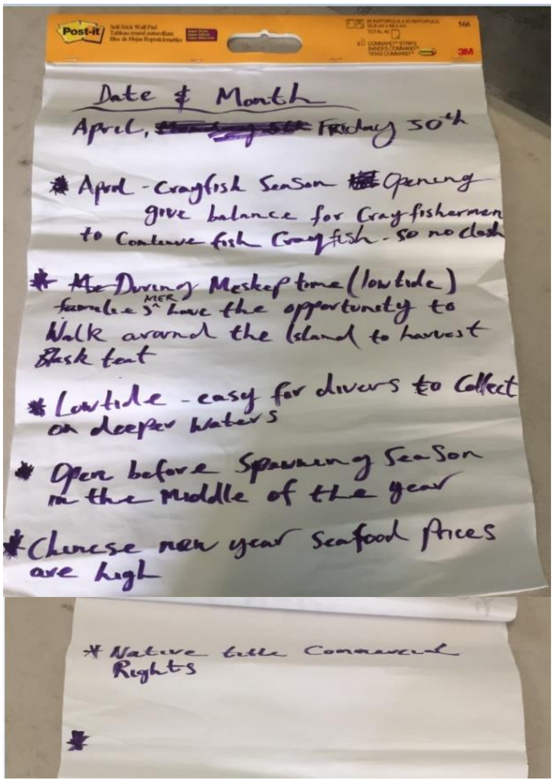
Table 1. Attendance list. Please note that some participants may not have attended all sessions of the workshop.

Name	Community	Organisation
Simon Naawi	Masig	Fisher
Kulia Nona	Mer	Fisher
Falen Passi	Mer	Mer Gedkem Le PBC Chair
Sam Kelly	Mer	Fisher
Robert Pilot	Mer	Fisher
David Gisu	Mer	Fisher
Sabu Wailu	Mer	Fisher
James	Mer	Fisher
Ron B Day	Mer	Retired Fisher
Maluwap Nona	Mer	HCWG PZJA Traditional Inhabitant member for Gudamalulgal Malu Lamar Chairperson
Aven Noah	Mer	Councillor
Michael Passi	Mer	Fisher
Dennis Passi	Mer	Elder and Fisher
John Tabo	Mer	Fisher
John Tabo (Sn)	Mer	Fisher
Harry Ghee	Erub	Fisher
Amina Ghee	Erub	Erub Fisheries Management Association
Samuel Mye	Erub	Fisher
Daniel Stephen	Ugar	Fisher
Samuel Blanco	Mer	Fisher
Gawomi Passi	Mer	Fisher
Tagai Tapau-Bon	Mer	Fisher
Andrew Passi	Mer	
Leslie Barsa	Mer	
James Epseg	Mer	
Issac Ghee	Erub	Erub Fisheries Management Association (President)
Rocky Stephen	Ugar	Kos and Abob Fisheries
Tom Stephen	Ugar	Kos and Abob Fisheries
Wrench Larry	Poruma	Fisher
Kabay Tamu	Warraber	Warraberalgal PBC Chair

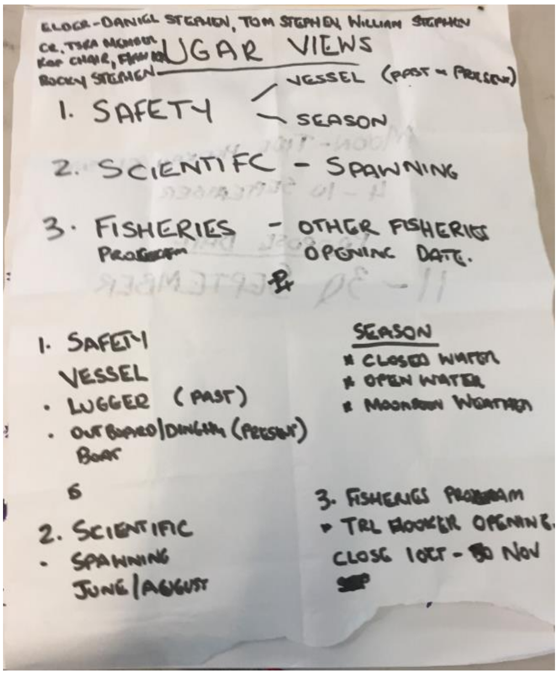
Name	Community	Organisation
Nicholas Pearson	Poruma	HCWG PZJA Traditional Inhabitant member for Kulkalgal
Jimmy Gela	Erub	Erubam Le PBC Chair
William Stephen	Ugar	Fisher
Alice Passi		Fish Receiver Agent
Arthur Naawi	Erub	Fisher
Charles David	Iama	Fisher, GBK representative
James Zaro	Mer	
Wabay Marou	Mer	
Jerrfery Roy Ses	Mer	
Darlington Rice	Mer	
Lyle Kelly	Mer	

Attachment 2 – Group discussion outcomes

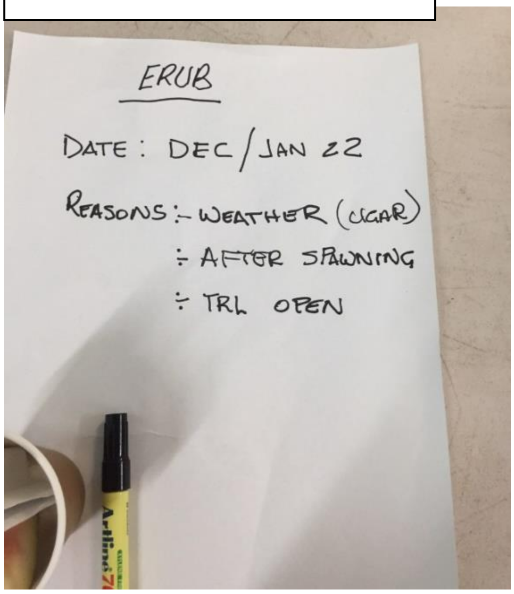
Mer discussion points



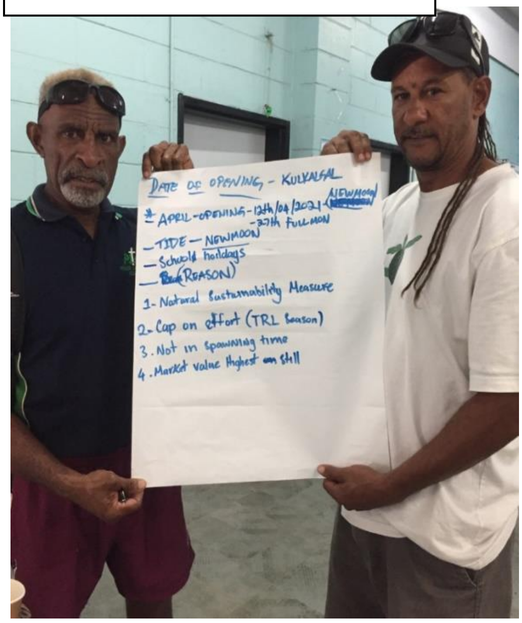
Ugar discussion points

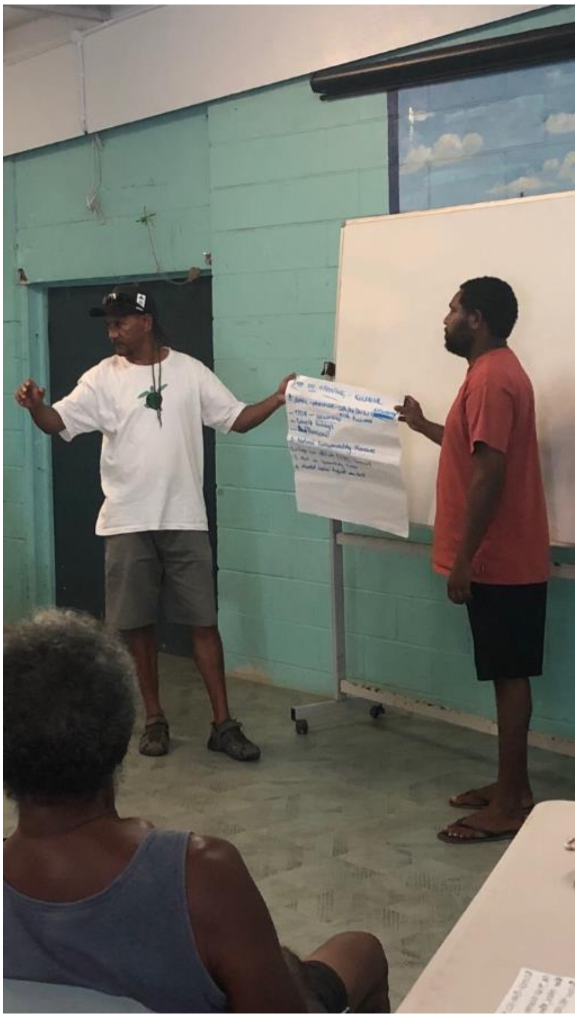


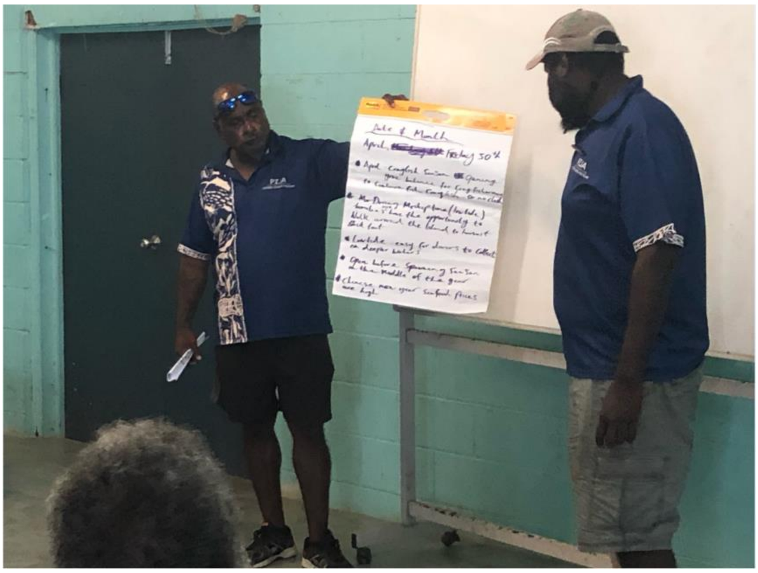
Erub discussion points



Kulkalgal discussion points







Attachment 3 – workshop Agenda

Black teatfish Workshop, Mer, 8-10 February 2021

Draft Agenda

Date:	**8-10 February 2021**
Venue:	**Mer Community Hall**
Place:	**Mer, Torres Strait**

Workshop Chair & Facilitator: Mr Michael Passi, Mr Maluwap Nona, Mr Rocky Stephen and AFMA

Day 1: Monday 8 February 2021 – Mer Community Hall (TBC)

5:30pm	Industry barbeque dinner at Mer Community Hall

Day 2: Tuesday 9 February 2021 - Mer Community Hall

08:30 am – 08:45am	Welcome address Mer PBC Chair Welcome by Mr Doug Passi (TBC) and/or Councillor Aven Noah Opening Prayer (TBA)
09:00 am – 09:30 am	Introduction to the workshop by Mr Michael Passi PZJA HCWG TI Member – Kemer Kemer Meriam Address by Malu Lamar Chairperson, Mr Maluwap Nona
09:30 am – 10:30 am	**PART 1: How did we get here?** ▪ Overview of the BDM Fishery ▪ Development and implementation of the new BDM Harvest Strategy ▪ Implementation of the Fish Receiver System and progress to date
10:30 am – 10:45 am	*Morning Tea*

10:45 am – 11:45 am	Outcome of the scientific survey 2019/2020 Mr Tim Skewes, CSIRO
1130 am – 12:00 pm	Industry feedback received to date on timing of the reopening – PZJA HCWG TI Members and AFMA Update on new management arrangements in the fishery CITES listing, licence conditions - AFMA
12:00 am – 1:00 pm	*Lunch*
	Part 2: Timing of black teatfish reopening
1:00 pm – 3:30 pm	Break-out group session: Industry discussion on the timing of the reopening
3:30 pm – 3:45 pm	Afternoon Tea
3:45 pm – 4:30 pm	Break-out group session: Industry discussion on protocols
4:30 pm – 4:50 pm	recap and close – Malu Lamar, PBC Chair, PZJA Members, AFMA
4:50 pm – 5:00 pm	Close in Prayer (TBA)

Day 3: Wednesday 10 February 2021

08:30 am – 08:45am	Welcome back to day 2 by Michael Passi Opening Prayer (TBA).
09:00 am – 09:30 am	Recap from Day 2 group sessions by participants
09:30 am - 10:30 am	Industry feedback from day 1
10:30 am – 10:45 am	*Morning Tea*
10:45 am – 12:00 pm	Next steps and questions (AFMA)
12:00 pm – 1:00 pm	*Close in Prayer (TBA) - Lunch*

Attachment 4 – AFMA presentation (provided separately)
Attachment 5 – Scientific survey presentation (Timothy Skewes) (provided separately)

Attachment 6 – Sea ranching project information sheet (Rocky Stephen)

A PROPOSAL TO ENHANCE THE BÊCHE-DE-MER FISHERIES IN UGAR ISLAND, TORRES STRAIT

In Torres Strait (TS) the bêche-de-mer (BDM) fishery brings important socio-economic benefits, contributing to regional economic development, and improving quality of life and autonomy of TS Islanders. The relative high value of BDM, scattered landing places and wide reach of buyers, combined with its easiness to harvest make the fishery difficult to manage and maintain sustainable yields.

The community of Ugar has a long tradition in the BDM fisheries. Between the 1980s and 2016 the stocks were heavily fished as jobs were very limited and the fishery provided people with significant income opportunities. The industry is very important for people living in Ugar to connect and use resources from around the home reef, with the potential to create further business opportunities, local jobs and income. The community also recognises that healthy and well managed stocks are needed to support a strong industry and livelihoods for future generations.

Improving BDM fisheries can involve management and release of individuals produced in hatcheries in the wild.

Management initiatives include minimum sizes, spatial and temporal closures, and artificial aggregation of adults to increase chances of reproduction. Aquaculture techniques such as induced spawning and rearing have become relatively straightforward and may also be employed to help bring back depleted populations (restocking), or to increase the natural supply of juveniles to stabilise production (stock enhancement). However, costs, market access, species choice, capacity and planning, monitoring and effective stakeholder engagement, communication and consultation processes must be considered as these are the main barriers to success of restocking and stock enhancement initiatives.

During the Torres Strait Science Workshop held in Ugar on the 22nd of October 2018 three key community elder fishermen identified that the stocks of BDM in Ugar have been reduced on the surrounding home reef and highly recommended the need to restock BDM populations back in their home reef. The community fully supported the elders' recommendation and endorsed the project for a Community Representative to approach CSIRO to investigate alternative options to improve BDM stocks in Ugar. As a result, CSIRO will be working closely with Community Representative Rocky Stephen to explore two options in Ugar: (a) artificial aggregation and protection of adults, and (b) release of hatchery-produced larvae and juveniles in the home reef. The project will involve key stakeholders to ensure effective engagement, communication and consultation protocols are developed in a culturally-sensitive manner. There is strong potential to trial these options in TS for the first time using state of the art aquaculture and monitoring techniques to improve the BDM fisheries in Ugar as it has been trialled in Asia and the Pacific regions with some successful outcomes. If the project is successful in Ugar it will generate the knowledge base to improve BDM stocks in the surrounding reefs of TS.

This proposal also had full support from the members of the Hand Collectables Working Group during a meeting held in Erub Island on the 24th of October 2018.

FURTHER INFORMATION

Rocky Stephen
rocky.stephen4@bigpond.com
Dr Leo Dutra
leo.dutra@csiro.au

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No.18 28-29 October 2021
INDUSTRY AND SCIENTIFIC MEMBER UPDATES	Agenda Item 2.1 For NOTING

RECOMMENDATIONS

1. That the Working Group:
   a. **NOTE** any verbal updates provided by Traditional Inhabitant industry members and Scientific members;
   b. **DISCUSS** any strategic issues, including economic trends, relevant to the development of the Torres Strait Hand Collectable Fisheries.

KEY ISSUES

1. Verbal reports are sought from industry and scientific members under this item.
2. It is important that the Working Group develops a common understanding of any strategic issues, including economic, fishing and research trends relevant to the management of Torres Strait Hand Collectable Fisheries, including within adjacent jurisdictions. This ensures that where relevant, the Working Group is able to have regard for these strategic issues and trends.
2. Working Group industry members are asked to provide any updates on trends and opportunities in markets, processing and value adding. Industry is also 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 relevant or of interest to Torres Strait Fisheries.

BACKGROUND

3. At the HCWG 17 meeting on 12 October 2020, industry and scientific members provided the following updates on matters relating to the BDM Fishery (excerpt from the meeting record):

Industry members update

a. The Traditional Inhabitant member for Kemer Kemer Meriam advised the Working Group that, although he has been able to dispatch some product, fishing operations have been slow in the last two months due to bad weather. Although not ideal, this has provided fishers with a break and fishing grounds an opportunity for grounds to re-stock.

b. The Traditional Inhabitant member for Gudumalulgal provided an industry perspective on the need for consistency on compliance activities that are carried out across all Torres Strait Fisheries and the need to inform all BDM operators about the transparency and accountability on data collection across the industry. The member also queried when the review of the current prohibition on the use of Hookah gear to fish is likely to be discussed, including terms and conditions on how it will happen. Lastly the member expressed preference for the HCWG to resume face-to-face meetings for members located in the Torres Strait to address the communication challenges of tele/video conference meetings and make it easier to participate in discussions more effectively.

c. The TI member for Kaiwalagal advised that he is supportive of the recently released Management Plan. The member further provided feedback from other fishers in support of the proposed arrangements relating to the re-opening of black teatfish in April 2021 with a 20 tonne TAC, noting that the review of the hookah ban is yet to be resolved. A black teatfish reopening in April is ideal as it coincides with the opening of the crayfish season as well.

Scientific members update

d. Scientific member Tim Skewes advised the working group that:
   - he is working with the project team on finalising the stock survey report.
   - he will also be participating in the upcoming surveillance milestone of the sea cucumber fishery in Western Australia leading up to its first year anniversary of being Marine Stewardship Council certified. It is primarily a sandfish and redfish fishery.
   - the Northern Territory is current undertaking an ecological risk assessment (ERA) for their sea cucumber fishery which will be worth keeping an eye on.

e. The scientific member Steven Purcell advised the Working Group that:
   - he will be involved in a sea cucumber population survey in New Caledonia to inform the CITES Appendix II listing of black and white teatfish and is hopeful that there will be lessons learnt that can be shared between both counties given the similarities in teatfish populations.
   - he gave a seminar hosted by the Food and Agriculture Organisation (FAO) and would be happy to share the link with the Working Group if there is interest.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No.18 28-29 October 2021
GOVERNMENT AGENCY UPDATES	Agenda Item 2.2 For NOTING & DISCUSSION

RECOMMENDATIONS

1. That the Working Group:
   a. **NOTE** the update provided by the Australian Fisheries Management Authority (AFMA) below;
   b. **DISCUSS** the progress to date against the Wildlife Trade Operation (WTO) conditions for the BDM fishery as summarised in **Table 1**;
   c. **NOTE** the Communique from the Queensland Sea Cucumber Fishery Working Group's meeting on 23 August 2021 provided under **Attachment 2.2a** and any additional verbal updates provided by Queensland Department of Agriculture and Fisheries (QDAF); and
   d. **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 BDM Fishery was first accredited as an approved Wildlife Trade Operation (WTO) in June 2005 for a period of three years and was subsequently reassessed and re-approved in 2008, 2011, 2014 and 2017.
4. The fishery was last assessed in 2020 and, as of 23 December 2020, was declared by the Delegate for the Minister of the Environment, as an approved WTO under the EPBC Act until 30 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 BDM Fishery is provided as **Attachment 2.2b**.
5. AFMA invites both the WG and Hand Collectable Resource Assessment Group (RAG) to monitor progress against each condition and provide advice on addressing conditions. To assist the WG and RAG, **Table 1** provides a summary of relevant actions taken or proposed to address each condition.

Table 1. Progress to date against the Wildlife Trade Operation (WTO) conditions for the BDM fishery. A copy of the advice to AFMA on the WTO approval is also provided as Attachment 2.2b**.**

WTO Conditions for the BDM Fishery	Progress as of September 2021
The Torres Strait Protected Zone Joint Authority must ensure that operation of the Torres Strait Bêche-de-mer is carried out in accordance with management arrangements defined in the *Torres Strait Fisheries Act 1984*, Torres Strait Fisheries Regulations 1985, Torres Strait Fisheries Management Instrument No.15 (Torres Strait Sea Cucumber Fishery), licence conditions and the Torres Strait Bêche-de-mer Fishery Harvest Strategy.	**On track:** The Torres Strait Bêche-de-mer Fishery continues to be managed in accordance with management arrangements in force under the *Torres Strait Fisheries Act 1984.*
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 Bêche-de-mer 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.
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, will inform the department of any intended changes to the fisheries legislation and subordinate instruments.
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:** AFMA, on behalf of the PZJA, will provide the first annual report by 30 November 2021.
The Protected Zone Joint Authority must complete an ecological risk assessment of the Torres Strait Bêche-de-mer Fishery by 1 January 2022 and develop an associated risk management strategy to address any risks identified in this assessment.	**On track:** The CSIRO have completed a draft ecological risk assessment for the fishery. The draft was considered by the HCRAG at its meeting on 6-8 October 2021. A summary of the draft ERA is provided for noting under Agenda Item 5.3.
The Torres Strait Protected Zone Joint Authority must ensure that there is a sufficient level of compliance measures in place to ensure the sustainable management of the Torres Strait Bêche-de-mer Fishery, in accordance with the	**On track:** To ensure AFMA's compliance efforts are targeted in the right areas an intelligence driven risk based approach, using Compliance Risk Management Teams (CRMTs) will be applied under the 2020-21

WTO Conditions for the BDM Fishery	Progress as of September 2021
management arrangements in place for the fishery.	National Compliance and Enforcement Program. The 2020-21 Program will focus on four key areas, one of which is compliance within Torres Strait Fisheries. This document explains AFMA's compliance program priorities and objectives for the 2020-21 financial year (FY) and performance in the 2019-20 FY.
By 1 November 2023 the Protected Zone Joint Authority must provide the department with a revised population estimate for Black Teatfish (*Holothuria whitmaei*) and White Teatfish (*Holothuria fuscogilva*) in the Torres Strait that is based on new information for the fishery, including catch data and fishery-independent data or scientific expert advice and an assessment of the impact of harvest on the stocks.	**On track:** This condition was considered by HCRAG at its meeting on 6-7 October 2021. The HCRAG identified data priorities to support any future black teatfish openings.
The Torres Strait Protected Zone Joint Authority must limit the seasonal take of the following species listed under the Convention on the International Trade of Endangered Species (CITES), from the Torres Strait Bêche-de-mer Fishery to no more than: 1) 15 tonnes of White Teatfish (*Holothuria fuscogilva*); and 2) 20 tonnes of Black Teatfish (*Holothuria whitmaei*). The Torres Strait Protected Zone Joint Authority must report the amount of White Teatfish and Black Teatfish harvested by weight and where available, include the number of individuals, their lengths and locations of harvest, as part of the annual reporting referred to in Condition 4	**In progress:** The current TACs for white and black teatfish are 15t and 20t respectively. Black teatfish catches during the 2021 trial opening were under the 20t TAC and catches of white teatfish to date are below the TAC. AFMA will report black and white teatfish catches for 2021 and their location of harvest as part of the annual report to the department. Information on the number of and length of individual black and white teatfish collected will be provided to the department if and when available.
The Protected Zone Joint Authority must address any over harvest of the Total Allowable Catch (TAC) for either Black Teatfish (*Holothuria whitmaei*) or White Teatfish (*Holothuria fuscogilva*) in one season and ensure that any over harvest of the species is properly accounted for in subsequent fishing seasons in line with the provisions in the Torres Strait Bêche-de-mer Fishery's Harvest Strategy.	**On track:** AFMA, on behalf of the PZJA, will address any overcatch of black or white teatfish in accordance with the provisions in the fishery's harvest strategy.

CITES listing of black and white teatfish in August 2020

6. The new WTO approval includes additional requirements that need to be met by the PZJA to manage the harvest of black and white teatfish which were listed under Appendix II of the Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES) on 28 August 2020.
7. CITES is a binding international agreement aimed at preventing international trade from driving unsustainable population decline in species listed under the Convention. Species listed under Appendix II of CITES are not necessarily threatened with extinction, and may still be traded internationally provided the trade, or a specified level of trade, has been determined to be non-detrimental to the survival of the species in the wild.
8. The Department of Agriculture, Water and the Environment (DAWE) is Australia's CITES Scientific Authority and has made a positive non-detriment finding of the Torres Strait Beche-de-mer Fishery subject to the conditions of the Fishery's wildlife trade operation (WTO) approval. One of these conditions places a seasonal TAC limit of 20t and 15t for black and white teatfish respectively.

ABARES Fishery Status Reports

9. Each year, the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) compiles fishery status reports which provide an independent assessment of the biological status of fish stocks and the economic status of fisheries managed, or jointly managed, by the Australian Government (Commonwealth fisheries). The most recent ABARES Fishery Status Report was released in 2020 and summarises the performance of these fisheries in 2018 and over time, against the requirements of fisheries legislation and policy.
10. In the 2020 report, all BDM species are classified as not being subject to overfishing, with Sandfish being the only species in the Torres Strait that continues to be classified as overfished. The fishing mortality and stock status for two species taken in 2019 remains uncertain. The status of the Torres Strait Beche-de-mer and Trochus Fisheries is summarised in the table below.

TABLE 19.1 Status of the Torres Strait Bêche-de-mer and Trochus fisheries

Stock	Biological status 2018 Fishing mortality	Biological status 2018 Biomass	Biological status 2019 Fishing mortality	Biological status 2019 Biomass	Comments
Black teatfish (*Holothuria whitmaei*)	[green]	[green]	[green]	[green]	Fishery closed. No reported catch in 2019. Last full survey (2009) indicated that stock was recovering.
Prickly redfish (*Thelenota ananas*)	[green]	[green]	[green]	[green]	Catch is below TAC. Last full survey (2009) indicated relatively stable densities.
Sandfish (*Holothuria scabra*)	[green]	[red]	[green]	[red]	Fishery closed. No reported catch in 2019. Last full survey (2009) indicated that stock was overfished.
White teatfish (*Holothuria fuscogilva*)	[green]	[green]	[green]	[green]	Catch is below TAC. Last full survey (2009) indicated relatively stable densities.
Other sea cucumbers (up to 18 species)	[yellow]	[yellow]	[yellow]	[yellow]	Uncertain biomass and fishing mortality status for at least 2 species taken in 2019.
Trochus (*Trochus niloticus*)	[green]	[yellow]	[green]	[yellow]	No catch in 2019. Uncertain biomass status.

Economic status

Estimates of NER and gross value of production are unavailable. Despite a decline in catch in 2019, NER are likely positive for this fishery. Increasing opportunities and participation for traditional inhabitants in the fishery are important objectives for this fishery.

Notes: **NER** Net economic returns. **TAC** Total allowable catch.

	Green	Red	Yellow
Fishing mortality	Not subject to overfishing	Subject to overfishing	Uncertain
Biomass	Not overfished	Overfished	Uncertain

11. ABARES fishery status reports can be accessed on the ABARES website at: https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status#sections

Compliance outcomes for the 2020-21 season

12. AFMA has been delivering domestic compliance functions in the Torres Strait in accordance with the National Compliance and Enforcement Program. There are three (soon to be four) compliance officers based in the Thursday Island office delivering both domestic and foreign compliance outcomes.

13. In March 2020 all AFMA field duties were suspended due to COVID-19, however AFMA continued to monitor fishing operations via electronic means including vessel monitoring systems (VMS), remote monitoring, surveillance, intelligence and other sources of data.

14. AFMA recommenced limited operational field activities in August 2020 and continues to conduct these activities in accordance with best practise, mandatory social distancing and hygiene and in accordance with guidelines developed for field activities.

15. Despite some operational challenges in 2020, AFMA fisheries officers have delivered the following outcomes between July 2020 – June 2021:

    a. 45 ports/freight hubs visits;

b. 68 fish receiver inspections;

c. 62 vessel inspections;

d. Joined our management team in 22 stakeholder / community meetings.

e. Regular monitoring of seafood movements throughout the Torres Strait and conducting further investigations in some cases;

f. 12 individuals were prosecuted for Torres Strait fisheries offences in 20 – 21, four of those involved the Beche-de-mer fishery.

g. During the recent black teatfish fishery trial opening (30 April to 3 May 2021) a number of breaches of the TSFA were also identified and are subject to further investigation.

16. To better target priority risks in Torres Strait fisheries, AFMA have established a specialised multi-disciplinary Compliance Risk Management Team (CRMT). Priority risks specific to the Torres Strait include unlicensed fishing, unlicensed fish receiving and non-compliance with catch/landing reporting to AFMA. Failing to report catch or landings is considered quota evasion and results in the undermining of the ongoing sustainable management of the Torres Strait Fisheries.

17. Further details are contained in AFMA's National Compliance and Enforcement Program document accessible on the AFMA website at: https://www.afma.gov.au/domestic-compliance. This document explains AFMA's compliance program priorities and objectives for the 2021-2022 financial year.

18. All stakeholders are encouraged to report any suspicious or illegal fishing activity involving your fisheries to AFMA, either directly to our Torres Strait office or CRIMFISH (1800 274 634)

Commercial catch and number of licences for the Beche-de-mer Fishery

19. Total reported catch by species in the BDM Fishery for the 2020 fishing season and 2021 season as at 18 August are shown in the table below. A more detailed data summary is provided under Agenda Item 4 (**Attachment 4b**).

Common name	TAC (t)	2020 (kg)[1]	2021 (kg)[2]
Black teatfish	0 (15[3]) (20)		17,615
Prickly redfish	15 (20[4])	15,654	8,797
Sandfish	0		
Surf Redfish	0	199	
White teatfish	15	1,767	1,308
Blackfish (Hairy)	5[5]	1399	482
Deepwater redfish	5[6]		17

1 New conversion ratios as per the BDM Harvest Strategy were implemented for some species on 1 January 2020.
[2] Catches current as at 18 August 2021.
[3] The 15t TAC was available during 2014 and 2015 only
[4] The 20t TAC was available until the end of 2017.
Yellow highlighted cells indicate an exceeded TAC
[5] New individual species TAC as of 1 January 2020, previously part of the 80t basket species TAC.
[6] New individual species TAC as of 1 January 2020, previously part of the 80t basket species TAC.

Common name	TAC (t)	2020 (kg)[1]	2021 (kg)[2]
Greenfish	40[7]	15	
Curryfish – mixed	60t basket[8]	10,521	3,961
Curryfish Herrmanni (common)		621	
Curryfish vastus		153	
Deepwater blackfish	50t basket[9]	166	72
Elephant trunkfish			
Golden sandfish			
Burrowing blackfish			
Stonefish			
Leopardfish		206	
Brown sandfish			
Lollyfish		1,272	22
Unidentified BDM			
'Basket total'		**1,644**	**94**
GRAND TOTAL		**31,972**	**32,274**

20. Number of licences in the Beche-de-mer Fishery as at 1 September 2020 and 2021 are shown in the table below.

Year	TIB licences	TVH licences	Fish Receiver licences
2020	156	1 held in trust by the TSRA	67
2021	180	1 held in trust by the TSRA	83

Legislative amendment update

21. AFMA is continuing the work with the Department of Agriculture, Water and the Environment (DAWE) to progress amendments to the *Torres Strait Fisheries Act 1984* (the Act) and the *Torres Strait Fisheries Regulations 1985* (the Regulations). The purpose of the amendments is to provide improvements to the efficiency and effectiveness of fisheries administration in the Torres Strait. The PZJA first decided to pursue legislative amendments at its meeting on 5 August 2015, which was then approved by the then Deputy Prime Minister and Minister for Agriculture and Water Resources in March 2017. AFMA advised the HCWG of this decision at its 11th meeting on 27 June 2017, and has provided periodic updates on the status of the legislative amendments at subsequent HCWG meetings.

22. At their most recent meeting on 17 August 2021, the PZJA provided policy approval to a final suite of proposed amendments to both the Act and the Regulations. A complete list of the approved proposed amendments is provided at **Attachment 2.2c**. Of particular relevance to the Working Group, the amendment to provide for catch reporting across all licence holders will allow for the implementation of mandatory daily logbook reporting by TIB licence holders. This will provide for improved data on which to base management advice and decisions.

23. 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

[7] New individual species TAC as of 1 January 2020, previously part of the 80t basket species TAC.
[8] New Curryfish species basket TAC as of 1 January 2020, previously part of the 80t basket species TAC
[9] Prior to 2020 the total allowable catch limit for basket species was 80t.

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.

24. 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 March - April 2022 where AFMA expects to be consulting with stakeholders on the legislative amendments and other fishery matters.

25. Following the public consultation period, it is expected that Parliament will be able to consider the amendments in the Winter 2022 Parliamentary sittings.

26. The expected timeline of events is summarised below:

Event	Timeline
Exposure draft prepared	By end of December 2021
PZJA and Prime Ministerial approval to release for public consultation	January 2022
Public consultation, including face to face community meetings (subject to COVID-19 requirements)	March - April 2022
PZJA advisory committees' consideration of outcomes as necessary.	To be determined
PZJA consideration of consultation outcomes.	To be determined
Introduction of the Bill to Parliament	Winter 2022 Parliamentary sittings

Electronic Catch Disposal Records

27. 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.

28. 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.

29. 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.

Standardised licence conditions

30. Licences granted by AFMA, on behalf of the PZJA are subject to conditions under section 22 of the *Torres Strait Fisheries Act 1984.* Current licence conditions have been developed over many years and as such may not always be clear or consistent. AFMA therefore intends to vary the conditions on all Master Fisherman's, fishing licences (TIB, TVH and sunset), carrier licences and fish receiver licences to ensure they are standardised across all licences of the same type, and to ensure the requirements imposed on licence holders are enforceable.

31. The new or amended conditions do not impose any new requirements on licence holders. The changes are to clarify requirements that are already known and understood by licence holders, including TIB licence holders.

32. Specifically, the varied conditions will address the following:

a. **Adding definitions** of terms from existing conditions that were previously not defined on the licence.

b. **Adding a condition** that explicitly links the fishery symbols (otherwise known as endorsements) listed on the licence with the area of waters the licence holder can operate within, and with what species they can take (for a fishing licence), carry and/or process (for a Carrier A, B or C licence) or which boats they can be in charge of (for a Master Fisherman's licence).

c. **Adding a condition** to require compliance with any applicable management plans.

d. **Adding a condition** to clarify that boats nominated on a Torres Strait licence must be Australian boats.

e. **Adding a new condition** to clarify existing and known requirements for tender boats to fish in conjunction with a primary boat.[10]

f. **Adding a new condition** on Carrier A licences to clarify known requirements that a boat with a Carrier A licence can only carry product caught by said boat or its tender boats.

g. **Amending an existing condition** on Carrier B licences to clarifying existing requirements including:

   - that Carrier B licences cannot carrying product from unlicensed fishing boats;
   - providing an exemption to allow boats with both a carrier B licence and a fishing licence to be able to process product where that product has been caught by the fishing boat nominated to the licence (or its tenders);
   - providing an exemption to allow boats with both a Carrier B licence and a fishing licence to tow its own tender boats and provide accommodation for its own crew.

h. **Amending existing conditions** on Carrier C licences relating to accommodating crew, towing boats and carrying product from licenced boats only with slight wording changes to ensure the wording is the same across all Carrier C licences.

i. **Amending an existing condition** to standardise, the requirements for carrying a Vessel Monitoring System (VMS) across all licences where applicable. VMS is required on all carrier and primary fishing boats greater than 6m in length unless an exemption is granted.

j. **Amending an existing condition** (with slight wording changes) to clarify existing requirements to land catch to licensed fish receivers and to **add** a provision for the approved use of electronic catch disposal records (eCDRS) on fish receiver licences.

k. **Amending an existing condition** relating to ownership and operation of boats on Traditional Inhabitant Boat (TIB) licences to mirror the requirements in current licence policy to ensure that:

   - the licence holder is a verified traditional inhabitant (aka who have completed a Traditional Inhabitant Identification form), who is also an Australian citizen and continues to reside in either the Protected Zone or adjacent area of Australia;

[10] The Working Group should note that this is to clarify existing licensing arrangements and does not impede on TIB industry aspirations to pursue greater flexibility for TIB primary boats to tow tenders un-associated with the primary boat, buy and receive product from other fishing boats and accommodate fishers.

- all crew on boat the nominated boat are Traditional Inhabitants who are also Australian citizens, who continue to reside in either the Protected Zone or adjacent area of Australia; and
- the boat nominated on the licence is owned by the licence holder.

33. In line with section 24HA(7) of the *Commonwealth Native Title Act 1993*, a future act notice (FAN) was issued to relevant Native Title bodies and claimants by AFMA in relation to varying Torres Strait licence conditions. Having regard to any comments provided in response to the FAN (the comment period closes on 29 October 2021), AFMA expects to implement the new conditions before the end of the calendar year. All affected licence holders will be notified accordingly.

Torres Strait Trochus Fishery update

Management arrangements

34. Many of the management arrangements applicable to the fishery are set out in *Fisheries Management Notice (FMN) No 76* and include:
    a. The taking of trochus is restricted to hand collection or by hand-held non-mechanical implements.
    b. The use of underwater breathing apparatus is not permitted.
    c. A minimum size limit of 80 millimetres and maximum size limit of 125 millimetres applies to all fishing (except traditional).
35. The total allowable catch for the Torres Strait Protected Zone (TSPZ) is 150 tonnes.

Strategic assessment

36. On 12 April 2017, AFMA applied on behalf of the Torres Strait Protected Zone Joint Authority (PZJA), for assessment of the Torres Strait Trochus Fishery under the EPBC Act as a WTO.

37. The then Department of the Environment and Energy (DOEE) assessed this application against the Australian Government '*Guidelines for the Ecologically Sustainable Management of Fisheries – 2nd Edition*'. Public consultation on the application was undertaken between 26 April to 31 May 2017. No comments were received.

38. The Torres Strait Trochus Fishery targets a single trochus species, *Tectus niloticus*, using hand-collection and diving in the TSPZ. Historically this fishery has been declared as a WTO. However, there has been no commercial fishing activity in this fishery since 2010. While there is no effort in the fishery, it does not pose any ecological risks.

39. The DOEE recommended that the fishery be exempt from the export requirements of the EPBC Act and product derived from the fishery be included on the List of Exempt Native Specimens until 9 October 2026. Should fishing effort increase in the Torres Strait Trochus Fishery, the fishery will be reassessed.

Commercial catch and number of licences

40. AFMA understands the fishery to have little to no fishing activity in recent years, with no commercial catches reported since 2018 (41kg). As of 1 September 2020 and 2021, the following number of TIB licences had trochus (TR) fishery entries:

Year	Number of TIB licences with Trochus fishery entries	Number of TVH licences
2020	71	0
2021	92	0

Torres Strait Pearl Shell Fishery update

Management arrangements

41. The gold-lipped pearl shell (Pinctada maxima) and to a lesser extent the black-lipped pearl shell (*Pinctada margaritifera*) are the main species targeted in the Torres Strait, although five other species occur.

42. Pearl farms purchase product from fishers for use in seeding for the production of pearls and also for use in making other shell products such as jewellery.

43. There are a range of input controls that apply to the Pearl Shell fishery, including:

    d. Minimum shell size limits which are aimed at ensuring the most suitable shells are taken for farming and affording some protection to young shells and spawning stocks

    e. *Pinctada maxima* must be >130mm and <230mm

    f. *Pinctada margaritifera* must be > 90mm

    g. Gear restrictions; shell can only be harvested by diving or collected by hand.

    h. Boat length restrictions; boats must not exceed 6m in length.

    i. The fishery is regulated through the *Torres Strait Fisheries (Pearl Shell) Management Instrument 2020.*

Minimum size limit trial with developmental permits

44. Following a recommendation from the HCWG in 2013, the PZJA agreed to issue developmental permits to existing licence holders for the taking of undersized pearl shell (*Pinctada maxima*). The objective of the permits was to support revitalisation of the Torres Strait pearl farming industry by developing a commercial trial to investigate whether using smaller shell for seeding and culture could increase the overall productivity of pearl farming. At the time, industry considered that smaller shell enabled them to maximise their seeding cycle potential due to more cycles, with the later seeding cycles producing larger and more valuable products.

45. Eight existing licence holders were subsequently issued developmental permits in 2015 with a competitive total allowable catch set of no more than 2,000 undersize pearl shell size between 100-130 mm to be taken within the allocated period of one year. Mandatory catch reporting of harvested pearl shell was a condition of the permit. Only two of the eight permits issued were active during the trial.

46. In 2017, AFMA undertook a review of the developmental permit trial in an effort to understand the low uptake of developmental permits that were issued.

47. Through interviews with permit holders and buyers, AFMA understood that:

    a. Approximately 800 pearl shell was reported to have been harvested during the permit period, with roughly 15-20% comprised of shell between 100-130 mm.

b. The pearl shells harvested were used for seeding in aquaculture but due to the low level of undersize pearl shell harvested, any benefits to the aquaculture sector in relation to any improvement in profitability could not be determined.

c. The primary reason as to why there is little interest in fishing the TSPSF by both TIB and TVH fishers is due to more lucrative opportunities in other Torres Strait fisheries (e.g. Tropical Rock Lobster).

Commercial catch and number of licences

48. AFMA understands the fishery to have little to no fishing activity in recent years, with no commercial catches reported since 1 December 2017. As at 1 September 2020 and 2021, the following number of TIB licences had pearl shell (PL) fishery entries:

Year	Number of TIB licences with Pearl shell fishery entries	Number of TVH licences
2020	67	4 primary/tender packages 3 individual licences 6 held in trust by the TSRA
2021	75	4 primary/tender packages 3 individual licences 6 held in trust by the TSRA

Torres Strait Fisheries Act 1984 proposed amendments		
No	**Proposals**	**PZJA policy approval date**
1	Capacity to require catch reporting across all licence holders.	PZJA Out of Session January 2017 (approved in March 2017)
2	Capacity to provide electronic licensing and monitoring to licence holders.	
3	Capacity to delegate the powers to grant and vary scientific and developmental permits.	
4	Capacity to simplify the renewal of fishing licences.	
5	Capacity to delegate the powers to contracted service providers.	
6	The implementation of Fisheries Infringement Notices.	
7	Provide for the grant of a licence without specifying a boat in the licence.	PZJA meeting 32 8 October 2019
8	Provide for a class of licence that authorises the taking of fish as well as the processing and carrying of fish taken with the use of another boat.	
9	Impose logbook requirements via the determination of a legislative instrument, exercisable by a delegate of the PZJA.	
10	Make minor technical amendments to support the introduction of other measures.	
11	Make further amendment to the Act to make it explicit that the Chief Executive Officer (CEO) of the Australian Fisheries Management Authority (AFMA) is a person to whom the Minister and the PZJA can delegate their respective functions and powers in sections 9 and 38 of the Act.	PZJA meeting 35 27 August 2020
12	Make further amendments to the Act and Regulations to be prepared for the PZJA's consideration that are consistent with providing immediate improvements to the efficiency and effectiveness of fisheries administration in the Torres Strait.	
13	Make a technical amendment to section 42(1) (q) of the Act where currently an officer may 'sell any fish seized by him or her under this Act' to make this requirement consistent with section 84(1)(t) of the *Fisheries Management Act 1991* where an officer may 'sell or otherwise dispose of any fish seized by him or her under this Act'.	PZJA meeting 38 17 August 2021
14	Extending the statutory limit of prosecution for offences under the Act from 12 months to two years, in order to make this requirement consistent with section 95(7) of the *Fisheries Management Act 1991,* which enables a prosecution for an offence to be commenced within two years after the commission of the offence.	
15	Provide for the Minister to be able to declare that a person must hold a master fisherman's licence for specific fisheries.	

Torres Strait Fisheries Regulations 1985 proposed amendments		
1	Simplified disclosure of fisheries information.	PZJA OOS January 2017 (approved in March 2017)
2	Provide a legislative authority for the collection of information, to be exercised by a person exercising powers or performing functions under the Act.	PZJA meeting 32 8 October 2019
3	Allow licences to be granted for up to five years duration.	PZJA meeting 32 8 October 2019
4	Update provisions concerning the detention of illegal foreign fishers to be brought in line with analogous provisions of the *Migration Regulations 1994*.	
5	Prescribe a condition that all licence holders must comply with any relevant plan of management.	
6	Make any additional amendments required consequential to the amendments to the Act identified above.	
7	Make further amendments to the Act and Regulations to be prepared for the PZJA's consideration that are consistent with providing immediate improvements to the efficiency and effectiveness of fisheries administration in the Torres Strait.	PZJA meeting 35 27 August 2020
8	Update the Regulations relating to distinguishing number requirements for licenced boats to align with current licencing practice	PZJA meeting 38 17 August 2021
9	Enable a licence fee to be paid for a Fish Receiver Licence and a licence to fish without a boat.	

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 assessment of the Torres Strait Bêche-de-mer Fishery (the fishery) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In October 2020 the Australian Fisheries Management Authority applied for export approval for the fishery under the EPBC Act.

The application has been assessed and I have declared the fishery an approved wildlife trade operation (WTO) under Part 13A of the EPBC Act until 30 November 2023. The list of exempt native specimens has also been amended to allow export of product from the fishery while the specimens are covered by the declaration as an approved wildlife trade operation.

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. Conditions are to be implemented in the period of the wildlife trade operation approval, unless a date is otherwise specified. Further, in assessing the management arrangements in place for this fishery, the Department has identified a number of inconsistencies in the published material relevant to the management of this fishery. In order to ensure that there is no ambiguity to fishers and for the purpose of compliance and enforcement, we urge AFMA to rectify this matter.

Two species harvested in this fishery, White Teatfish (*Holothuria fuscogilva*) and Black Teatfish (*Holothuria whitmaei*), are now listed under Appendix II of the Convention on the International Trade of Endangered Species (CITES). As such, Australia's CITES Scientific Authority must make a non-detriment finding in relation to the harvest of these species in the fishery to ensure that continued trade in these species from Australian fisheries is not detrimental to the survival of the species in the wild. Measures should be in place to limit such export in order to maintain such species throughout their range at a level consistent with their role in the ecosystems and well above the level at which they would qualify for Appendix I lising. Further information on CITES non-detriment findings can be found at Attachment 2.

Australia's CITES Scientific Authority is located in the Wildlife Trade Office of the Department of Agriculture, Water and the Environment. As required under Part 13A of the EPBC Act, Australia's CITES Scientific Authority included its assessment for the purpose of a Non-detriment finding in the Part 13A assessment for this fishery. A positive non-detriment finding has been made for this fishery and conditions have been placed in the relevant WTO to ensure that Australian CITES requirements are met.

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 3.

Yours sincerely

Laura Timmins
Delegate of the Minister for the Environment

23 December 2020

Part 13A conditions to the Torres Strait Protected Zone Joint Authority on the approved wildlife trade operation declaration for the Torres Strait Bêche-de-mer Fishery – December 2020

Condition 1:
The Torres Strait Protected Zone Joint Authority must ensure that operation of the Torres Strait Bêche-de-mer is carried out in accordance with management arrangements defined in the *Torres Strait Fisheries Act 1984*, Torres Strait Fisheries Regulations 1985, Torres Strait Fisheries Management Instrument No.15 (Torres Strait Sea Cucumber Fishery), licence conditions and the Torres Strait Bêche-de-mer Fishery Harvest Strategy.

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 Bêche-de-mer Fishery management arrangements that may affect the assessment against which *Environment Protection and Biodiversity Conservation Act 1999* decisions are made.

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.

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.*

Condition 5:
The Protected Zone Joint Authority must complete an ecological risk assessment of the Torres Strait Bêche-de-mer Fishery by 1 January 2022 and develop an associated risk management strategy to address any risks identified in this assessment.

Condition 6:
The Torres Strait Protected Zone Joint Authority must ensure that there is a sufficient level of compliance measures in place to ensure the sustainable management of the Torres Strait Bêche-de-mer Fishery, in accordance with the management arrangements in place for the fishery.

Condition 7:
By 1 November 2023 the Protected Zone Joint Authority must provide the department with a revised population estimate for Black Teatfish (*Holothuria whitmaei*) and White Teatfish (*Holothuria fuscogilva*) in the Torres Strait that is based on new information for the fishery, including catch data and fishery-independent data or scientific expert advice and an assessment of the impact of harvest on the stocks.

Condition 8:
The Torres Strait Protected Zone Joint Authority must limit the seasonal take of the following species listed under the Convention on the International Trade of Endangered Species (CITES), from the Torres Strait Bêche-de-mer Fishery to no more than:

1) 15 tonnes of White Teatfish (*Holothuria fuscogilva*); and
2) 20 tonnes of Black Teatfish (*Holothuria whitmaei*).

The Torres Strait Protected Zone Joint Authority must report the amount of White Teatfish and Black Teatfish harvested by weight and where available, include the number of individuals, their lengths and locations of harvest, as part of the annual reporting referred to in Condition 4.

Condition 9:
The Protected Zone Joint Authority must address any over harvest of the Total Allowable Catch (TAC) for either Black Teatfish (*Holothuria whitmaei*) or White Teatfish (*Holothuria fuscogilva*) in one season and ensure that any over harvest of the species is properly accounted for in subsequent fishing seasons in line with the provisions in the Torres Strait Bêche-de-mer Fishery's Harvest Strategy.

CITES Non-Detriment Findings in commercial fisheries

The Convention on International Trade in Endangered Species (CITES) is a binding international agreement, which was ratified by Australia in 1976. The purpose of CITES is to prevent international trade from driving unsustainable population decline in species listed on the Convention's three appendices.

There are three levels of CITES listing:

- Appendix I - for species threatened with extinction. CITES prohibits international trade of Appendix I species except for strictly controlled non-commercial purposes, such as scientific research.
- Appendix II - for species not currently threatened with extinction, but which may become so if harvest is not carefully controlled. CITES allows some limited international trade of these species under very tight rules and controls. CITES permits are required for all exports of Appendix II species.
- Appendix III - for species that may be threatened locally within certain countries. International trade in these species is only allowed with presentation of appropriate 'country of origin' certification. This assists countries with locally threatened populations to better manage trade of these species.

CITES requires the exporting Party's Scientific Authority to make a positive non-detriment finding (NDF) prior to export of CITES specimens listed in Appendix I and II. Australia's CITES Scientific Authority is in the Wildlife Trade Office.

A positive NDF is made when *"the sum of all harvests is sustainable in that it does not result in unplanned range reduction, or long term population decline, or otherwise change the population in a way that might be expected to lead to the species being eligible for inclusion in Appendix I"*.

To ensure that fisheries declared as approved Wildlife Trade Operations (WTO) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) continue to be able to trade internationally in CITES-listed marine species, NDFs need to be based on a level of information that meets international standards, consistent with guidance agreed by resolution by CITES Parties (https://cites.org/sites/default/files/document/E-Res-16-07-R17_0.pdf).

Consistent with Resolution Conf. 16.7 Rev CoP 17, Australia's CITES Scientific Authority has taken a risk-based approach to the information requirements for making NDFs. Under this approach, the level of information required to inform an NDF will vary depending on the biological vulnerability of the species, its global and national status, the risks posed to the species, and the degree of certainty associated with these factors. The standard information fields for NDFs include:

- species biology;
- species life history characteristics;
- species range – historic and current;
- population structure, status and trends (nationally and in the harvest area);
- threats;
- species specific (or in some instances genus specific[1]) levels of harvest/ mortality from the fishery (historic and current);
- estimates of species specific (or in some instances genus specific[1]) levels of harvest/mortality from *all sources* combined;
- results of population modelling;

[1] Genus-level reporting is acceptable for some coral species.

- management measures currently in place and proposed, including consideration of rates of compliance;
- a *scientific* assessment of the level of harvest that is considered sustainable under the management regime taking into account all sources of mortality;
- The ability of management measures to constrain harvest to the level assessed to be sustainable; and
- trade information relating to the species.

Where significant risks of species decline are identified (or credible scientific information about the species is limited), highly precautionary fishery management arrangements are likely to be required before non-detriment findings can be issued. A common requirement in this circumstance is for management arrangements to include prescriptive annual trigger limits on the harvest of each CITES listed species.

It is common practice for other countries receiving exports from Australia to monitor and review Australia's non-detriment findings. If an importing country is not satisfied with the quality or level of precaution applied in Australia's non-detriment finding, it can choose to reject an import on that basis and suspend future imports of that species from Australia.

Australian Government

Department of Agriculture, Water and the Environment

Attachment 3

Notification of Reviewable Decisions and Rights of Review[2]

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

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

being lodged. The time frame for review of certain decisions can be expedited in some circumstances.

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.

Communique 23 August 2021

The Sea Cucumber Fishery working group met for the fifth time via videoconference on 23 August 2021.

The working group accepted the previous meeting minutes and noted the progress of the meeting action items.

Fisheries Queensland provided an update on the regulatory changes that were announced in September 2020 and will commence by 1 September 2021. The working group noted that these include reforming the administration framework (licensing, quota certificates and management arrangements and reporting) to ensure consistency with other quota managed fisheries. The working group further noted the publication of a finalised sea cucumber harvest strategy, which was updated with feedback received during consultation.

Industry noted that the current fishing season is the third year under the rotational zoning strategy and a new initiative is to allocate fishers to specific zones with specific species quota, so they are responsible for fishing the same zones every third year for additional stewardship.

Industry has contracted to seek MSC accreditation for four units of assessment (black teatfish, white teatfish, curryfish and burrowing blackfish). It is anticipated that this will take approximately 12 months. An environmental risk assessment will be one of the requirements. DAF will be involved in this process.

Industry also advised that market demand had reduced slightly due to COVID in the last couple of years although prices have remained relatively stable.

AFMA advised that the Torres Strait beche-de-mer fishery is operating for the second year under a harvest strategy. While most aspects of the new harvest strategy have been implemented, the 2022 fishing season will be the first application of the harvest strategy decision rules to set total allowable catches (TAC). A trial reopening of fishing for black teatfish commenced on 30 April 2021 with a 20 tonne competitive total allowable catch (TAC) and lasted for 4 days.

GBRMPA noted that black teatfish has been used as a case study for resilience in the last three versions of the GBR Outlook Report (2009, 2014 and 2019). The fourth report will be published in 2024. The working group will continue to be updated on progress.

Fisheries Queensland provided an update on the current status of the Commonwealth Wildlife Trade Operation (WTO) approval, which was issued subject to numerous conditions until 30 September 2021. The working group noted that Fisheries Queensland has applied for a new

WTO approval. This application is currently out for public consultation and some working group members have already provided submissions. Fisheries Queensland will continue to work closely with industry to consider any new developments. Industry meetings will be scheduled for mid September to discuss further.

The working group were updated with the 2020 status of Australian fish stocks report, in which white teatfish and burrowing blackfish were assessed as 'sustainable'. There is scope for adding additional species in the future.

Fisheries Queensland provided an outline of an ecological risk assessment (ERA) for the fishery. Despite assessing the situation prior to a harvest strategy or stock assessment being in place, the risk in the fishery is considered to be managed and Fisheries Queensland is not recommending the ERA be progressed to a level 2. The ERA will be a potentially important communication tool that formally documents the minimal impact of the fishery. Fisheries Queensland undertook to share the ERA with the working group as soon as it was finalised.

The working group noted that good progress has been made by the industry-funded research team Fishwell Consulting in completing black teatfish surveys and white teatfish feasibility studies, with lead scientist Ian Knuckey included in the DAF stock assessment team. The working group also noted that a GIS layer has been prepared for the rotational zoning scheme, allowing the effect of the rotational zoning scheme to be incorporated into quantitative models.

The working group were updated with preliminary results of the white teatfish stock assessment, based on a combination of fishing data and previous research, and the black teatfish stock assessment, which is informed by the recent black teatfish survey, fishing data (complicated by a long period closed to fishing), and previous research. Model inputs and assumptions were the subject of considerable discussion and the stock assessment team agreed to conduct additional investigations as a result of the working group feedback. The working group noted that the stock assessment models will continue to be refined once the deadlines for the WTO conditions have been met.

Fisheries Queensland advised the working group of a related research project funded through GBR Foundation, which has developed a project proposal for a three year monitoring program of sea cucumber in the Great Barrier Reef. This is expected to inform management needs for multiple agencies. Industry members emphasised that their focus is on sound, reliable data, and suggested research scientist Ian Knuckey be included as part of the project's technical advisory group. DAF will likely be represented on the project's steering committee and will act as liaison with industry. A presentation from the research team will be sought for the next working group meeting.

The working group heard a presentation on the social and economic data project being undertaken by BDO EconSearch for Fisheries Queensland. Currently there is no separate report for sea cucumber due to the difficulty in de-identifying individuals when there are low numbers of participants. However, the data team are hopeful that confidentiality can be managed so that participation increases.

Fisheries Queensland provided details of the new reporting requirements that will commence on 1 September 2021, the various fact sheets and contacts to support industry through these changes (https://www.daf.qld.gov.au/business-priorities/fisheries/commercial/commercial-fishing-rules (https://www.daf.qld.gov.au/business-priorities/fisheries/commercial/commercial-fishing-rules)), and the development of the commercial fishing app. Clarification about the weight and catch disposal notice requirements, given the operational procedures in the industry, will be the subject of a separate meeting.

The next working group meeting is tentatively scheduled for December 2021 in order to discuss the results of the WTO application and the implications for industry going forward.

The Sea Cucumber Fishery Working Group members are: Fisheries Queensland (Chair - Michael Mikitis), commercial fishing (Rob Lowden, Chauncey Hammond, Ben Cochrane (apology), science (Nicole Murphy, CSIRO) and Great Barrier Reef Marine Park Authority (Jessica Stella).

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No.18 28-29 October 2021
NATIVE TITLE UPDATE	Agenda Item 2.3 For NOTING & DISCUSSION

RECOMMENDATIONS

1. That the Working Group (WG) **NOTE** any updates on Native Title matters from members, including the representative from Malu Lamar (Torres Strait Islanders) Corporation RNTBC (Malu Lamar).

BACKGROUND

2. 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*.
3. Traditional Owners and Native Title representative bodies have an important role in the management of Torres Strait fisheries. It is important therefore that the Working Group keep informed on any relevant Native Title issues arising.
4. AFMA has extended an invitation to Malu Lamar to attend this meeting as an observer and is investigating longer term arrangements for representation in consultation with PZJA agencies.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No.18 28-29 October 2021
PAPUA NEW GUINEA NATIONAL FISHERIES AUTHORITY UPDATES	Agenda Item 2.4 For NOTING

RECOMMENDATIONS

1. That the Working Group (WG) **NOTE** the fishery update to be provided by representatives from the Papua New Guinea National Fisheries Authority if in attendance (via video conference).

KEY ISSUES

2. AFMA has a standing invite for officials from the PNG National Fisheries Authority (NFA) to attend all PZJA consultative forums. If in attendance, NFA officials will provide an update on the PNG hand collectable fisheries at the meeting, including an update on the beche-de-mer fishery.

3. In 2010 PNG placed a moratorium on fishing for BDM. On 1 July 2017 the moratorium was lifted and the PNG beche-de-mer fishery has been opened three times since (2018, 2019 and 2020). AFMA understands that although the season open date usually falls on 1 July, it can vary from year to year depending on the progress of the stock biomass assessment surveys and analysis that is used to set the total allowable catches for each province. A notice issued by NFA issued by NFA in in 2017 is provided at **Attachment A** for further background.

4. Over 9- 10 September 2021 the Torres Strait Treaty Traditional Inhabitants Meeting (TIM) and Joint Advisory Committee (JAC) meeting were held. Reports for each meeting are attached (**Attachments B** and **C**).

5. 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.

BACKGROUND

6. The *Treaty between Australia and the Independent State of Papua New Guinea concerning Sovereignty and Maritime Boundaries in the area between the two Countries, including the area known as Torres Strait, and Related Matters* (the Treaty) was signed by both Parties at Sydney on 18 December 1978 and ratified by Australia on 15 February 1985. The Treaty defines the border between Australia and PNG and provides a management framework of the common border area. This area is defined by the Treaty and is known as the TSPZ.

7. Australia and PNG established the TSPZ with the principal purpose of acknowledging and protecting the traditional way of life and livelihood of the traditional inhabitants of both Parties, including their traditional fishing and free movement (Article 10(3)). A further purpose is to protect and preserve the marine environment and indigenous fauna and flora in, and in the vicinity of, the TSPZ (Article 10(4)). A range of subsidiary obligations and rights exist under the Treaty. Relevantly, Australia and PNG commit under the Treaty to co-operate in the conservation management and optimum utilisation of Protected Zone commercial fisheries (Article 21) insofar that the achievement of the purposes for the establishment of the TSPZ are not prejudiced in regard to traditional fishing (Article 20(1)).

8. The Treaty recognises the rights of both countries to Protected Zone commercial fisheries. This recognition is implemented through cooperative management and catch sharing provisions of Part 5 of the Treaty. Since the Treaty was ratified, Australia and PNG have entered into formal arrangements under Article 22 to cooperatively manage six fisheries, referred to as ‘Article 22 fisheries’. These are the commercial fisheries for prawns, tropical rock lobster, Spanish mackerel, pearl shell, and traditional fisheries for turtles and dugong.

9. The BDM Fishery is not an Article 22 fishery and is, therefore, not managed under formal catch sharing arrangements with PNG. However, Australia and PNG recognise the importance of complimentary management arrangements, shared science and strong communication between both Parties given some sea cucumber stocks are shared (e.g. Sandfish) and beche-de-mer stocks are vulnerable to overfishing.

10. Updates on the status of the respective fisheries and agreements between PNG and Australia on catch sharing arrangements and related matters usually take place at annual fishery bilateral meetings and meetings of the Torres Strait Joint Advisory Council (JAC) established under Article 19 of the Treaty, but may occur intersessionally as required by the two Parties.

ATTACHMENT A – PNG NFA 2017 update on the lifting of the Beche-de-mer moratorium

PNG BECHE-DE-MER FISHERY - GOLD OF THE SEA

Coastal and Island Fishermen throughout the country are reaping the benefits of the 7-year closure of the beche-de-mer fishery. An estimated 13 million kina has been paid already directly to the coastal and island communities throughout PNG for the 6-week period that the fishery has been open in 2017. By the time all provincial Total Allowable Catch (TAC) have been reached and the open season ends this year, we estimate that a total of 18 to 36 million kina would have been earned by the coastal and island fishermen and fisherwomen. Whole families especially women have been the main beneficiaries. Disadvantaged and isolated island communities in the coastal provinces are earning a very high income from this fishery. The value quoted in above does not include the benefits accrued to the people who are indirectly engaged in this fishery especially those who are employed by licensed exporters.

The beche-de-mer fishery is projected to generate 40 to 53 million kina in foreign revenue in the 2017 fishing season because all the beche-de-mer are being exported to overseas markets, mainly to Hong Kong and China. This is a fishery where the coastal and island communities are directly involved to generate foreign revenue for PNG. About half a million people, from the coastal and island communities benefit from the fishery.

The fishery was closed for 7 years since 2010 because there was extensive overfishing and populations of sea cucumber were severely depleted. NFA has been monitoring the recovery of the sea cucumber populations through provincial sea cucumber annual stock assessments when the fishery has been closed. NFA also consulted extensively and revised the beche-de-mer fishery management plan. Results of the annual sea cucumber surveys indicated that full recovery of the sea cucumber populations has not been achieved yet. NFA wanted to give something back to the coastal and island fishermen for the 7-year investment of no fishing and test the revised plan. The NFA Board approved the plan in 2016 and the fishery was opened on the first of April in 2017. Copies of the Beche-de-mer Fisheries Management plan can be obtained from NFA.

GOVERNANCE AND MANAGEMENT

The approved Beche-de-mer Fisheries Management Plan allows for the joint management by the National Fisheries Authority (NFA), Provincial Government, Local Level Government (NFA) and communities. Roles for NFA, provinces, LLG and communities are defined in the plan. This means the management of beche-de-mer is decentralized with the communities responsible for the day to day management of the fishery. To enable joint management, the plan establishes a National Management Advisory Committee (NMAC), Provincial Management Committees (PMAC) and Local Management Advisory Committees (LLGMAC) which is optional. Communities can also establish committees to manage the fishery at the community level. NMAC and PMAC are functional meaning that they have regular meetings and make decisions. PMACs have been involved in the decision making process to screen and approve export and buyers licenses for the 2017 open season.

Since the opening of the fishery some communities have formulated bylaws to help them manage the day to day management of the fishery under the jurisdiction of the community. Some example of community bylaws include controlling the days to harvest, the species to harvest and the areas where no fishing is allowed in order to protect undersizes or the spawning population. NFA is encouraging other communities to create community bylaws to help manage the fishery at the community level. During the course of the year and leading to the 2018 open season, NFA will work with the provinces, LLGs and communities to formulate provincial and community beche-de-mer fishery management plans especially for those communities who wish to apply such bylaws.

SEASONAL OPENING AND CLOSURE

Under the new Beche-de-mer Fishery Management Plan the fishery is scheduled to open every year for six months from the 1^{st} April to the 31^{st} September 2017. However if the TAC for the province is reached early the fishery for the province must close. The fishery is closed from the 1^{st} October to the 31^{st} March for a compulsory 6 month closure. The 6 month closure is necessary to help protect the spawning population and help the sea cucumber population grow into adults before the fishery is opened.

The fishery in a specific province is closed early if the TAC for the province is reached. Three provinces, New Ireland (TAC=43 tonnes), West New Britain (TAC=15 tonnes) and AROB (TAC= 28 tonnes) have already reached their TAC after 6 weeks of harvest. Fishing for sea cucumbers in these provinces is now closed on Wednesday 17^{th} May 2017. Selling and buying for the three provinces will cease on Monday 24^{nd} May 2017. Fishermen in these three provinces are allowed to sell their dried products for 7 days between Wednesday 17^{th} May and Wednesday 24^{nd} May. This is to ensure that the dried products for the fishermen in isolated and distant coastal and island locations are sold.

Other provinces are also approaching their TAC. Milne Bay province has the highest TAC of 118 tonnes and has already reached 53% of its TAC. The current rate of production for Milne Bay is 10 tonnes per week and is projected to close in mid-June 2017. MOMASE provinces have low TAC and are expected to reach their TAC soon. The current rate of harvest for the provinces vary from province to province but indicate that the fishery will be closed for most of the provinces by July 2017.

TOTAL ALLOWABLE CATCH

The beche-de-mer fishery is managed using a number of strategies including a minimum size limit to protect the immature individuals and allocation of Total Allowable Catch (TAC) for each maritime province to control how much sea cucumber can be harvested from each province. The TAC for each province are calculated for each year based on the harvestable sizes present on the waters and reefs of each province (see table). In order for the beche-de-mer fishery to be open every year so the coastal and island communities continue to earn an annual income, 30% of the estimated harvestable biomass (weight) is allowed to be harvested and forms the TAC for the province. Seventy percent of the biomass must remain on the reefs to repopulate and grow.

TAC for the Provinces

PROVINCE	2017 TAC (tonnes)
Milne Bay	118
Central	58
Manus	53
New Ireland	43
AROB	28
West New Britain	15
Northern	15
Morobe	9

Western	7
East New Britain	7
Madang	5
East Sepik	2
Sandaun	2

NFA is appealing to the fishermen and fisherwomen not to harvest all the sea cucumbers on the reef especially on the reef flats and shallow areas. At the end of the open fishing season a lot of sea cucumbers must still be seen on the reef.

It has taken only 6 weeks for some provinces such as New Ireland, West New Britain and Bougainville to reach their TAC. The big rush to harvest sea cucumbers from the reefs was expected because most of the sea cucumbers live in shallow waters. Fishermen and fisherwomen only have to walk on the reefs to harvest the sea cucumbers.

To ensure that the TAC is not exceeded, NFA trained and placed Compliance Monitors in all the provinces to help monitor the TAC. NFA has established an information system to monitor the TAC in all the provinces. The information system is designed to monitor the TAC in near real time and involves collection of data from the buyers and exporters on a weekly basis, data is entered and data is analyzed and summarized immediately.

SIZE LIMITS

Size limits have been set for 30 species of sea cucumbers to protect immature sea cucumbers and a portion of the recently mature young sea cucumbers. This is also the portion of the population that is harvested the following year as they grow into harvestable sizes. It is important that fishermen and fisherwomen don't take undersizes if they want to continue to earn an income from the fishery every year.

Because the largest portion of undersizes of sea cucumbers are located on the reef flat which is the shallow areas (see graph) they are easily targeted by the fishermen and fisherwomen. Harvesting of undersizes has been a major issue that was expected by NFA when the fishery opened. It was a major issue in the past leading up to the closure of the fishery in late 2009 when a large portion of the products was exported including as much as 100% undersizes for some species. NFA is appealing to the fishermen and fisherwomen not to harvest the undersizes as they are worth more if they are left for harvesting the following years.

Penalties apply to the Buyers and Exporters if they buy or export undersize beche-de-mer. The penalties include loss of the Buyers and Export licences. NFA is appealing to the Buyers and Exporters to comply with the size limits.

LICENSING

A licence is required in order to participate in the buying, storage and export of Beche-de-mer. This is necessary in order to control the trade of beche-de-mer in the country. There are three main types of licences required, Buyers, Storage Facility and Export. A Buyers licence is issued to individuals, normally those working for a Beche-de-mer exporter company. The Buyers licence allows the individuals to buy sea cucumbers from the fishermen and fisherwomen. A Buyers licence is like a drivers licence. It cannot be transferred and the licensed Buyer must always have in his or her possession the licence. He or she must also be present at all times in the buying of the beche-de-mer products. A Beche-de-mer export company is allowed to have a maximum of 5 buyers licence.

A Storage Facility licence is issued to the company for the use of a Storage Facility to store and process beche-de-mer. Before the Storage Facility licence is issued it must be inspected by NFA staff to ensure that it meets requirements for the storage of beche-de-mer which is a perishable food product.

An Export licence is issued to the company to allow it to export beche-de-mer to overseas markets. Companies must meet export requirements as specified in the beche-de-mer fisheries management plan before the company is allowed to export.

REVIEW OF THE BECHE-DE-MER FISHERY MANAGEMENT PLAN

NFA is committed to ensuring the Beche-de-mer Fishery benefits the coastal and island Communities, Buyers and Exporters as key stakeholders in the long term. This will be achieved through the effective implementation of the beche-de-mer fishery management plan. The plan must maintain the sustainable of the sea cucumber populations through effective control measures of the fishery. At the moment there are no examples of a tropical beche-de-mer fishery that is effectively managed around the world. NFA is challenged but is fully committed to be effective in the management of the PNG Beche-de-mer fishery and is therefore initiating the review of the current plan.

As part of the management plan review process NFA is identifying key issues affecting the implementation of the management plan including elements of the plan that are working and those that are not are not working. NFA will consult stakeholders initially in the provinces that have reached their TAC and are closing the fishery, to identify areas of the plan that can be improved. An intensive consultation workshop to review the plan will be conducted in October 2017. NFA is confident that revision of the beche-de-mer fishery management plan will significantly improve implementation in the 2018 open season.

For further information, please contact Mr Leban Gisawa, Executive Manager, Fisheries Management Unit on Phone: 3090444 or Email: lgisawa@fisheries.gov.pg

Authorized by:
Mr. John Kasu
Managing Director

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	**Councillor Getano Lui Jnr**
Co-Chair and Leader of the Papua New Guinea Traditional Inhabitant Delegation	**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.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	**Meeting No.18** **28-29 October 2021**
BLACK TEATFISH TRIAL OPENING 30 APRIL 3 MAY 2021 AND FUTURE OPENINGS	**Agenda Item 3** **FOR DISCUSSION & ADVICE**

RECOMMENDATIONS

1. That the Hand Collectables Working Group:

   a. **NOTE** the update on the outcomes of the black teatfish trial opening on 30 April – 3 May 2021 including an overview of catch and effort reporting (**Attachment A**).

   b. **NOTE** that as the 20t total allowable catch (TAC) was not exceeded (total catch was 17.6t), the harvest strategy recommendation that the fishery automatically pause for the following year if the TAC is exceeded by more than 5 percent does not apply (Condition 5).

   c. **NOTE** that having considered all available information, the Hand Collectables Resource Assessment Group (RAG) recommends that black teatfish open in 2022 with a 20t TAC on the basis that:

      i. the 2021 trial reopening TAC of 20t was not overcaught (condition 5 of the HS);
      ii. data was collected satisfactorily during the opening (condition 6 of the HS);
      iii. updated modelling analysis, inclusive of 2021 catch data, confirmed that a 20t TAC is sustainable (conservative estimate of MSY being 21t) and would not lead to a decrease in black teatfish biomass after the first year of fishing (condition 7 of the HS). In contrast, the modelling found that catches of 30t could lead to a gradual depletion of the stock.
      iv. prior to a future black teatfish opening AFMA focus on communication and education on improving voluntary reporting of area and effort data by fishers and fish receivers, including preparing fact/information sheets and organising a teleconference with all fish receivers as a cost effective way to discuss ways of improving voluntary reporting.
      v. opportunities to undertake a sub-sampling program to collect size and weight frequency data during black teatfish openings at key landing locations be explored. Noting that the sampling program would need to be scientifically designed.

2. That the Working Group, having considered the RAG advice, **DISCUSS** and **PROVIDE ADVICE** on the potential for the fishery to stay open in future, or be re-opened periodically after a pre-specified interval (Condition 7) and under what conditions including:

   a. an appropriate TAC; and

   b. any additional data that should be collected during future openings, noting an ongoing condition of the fishery remaining open is that reliable data collection continues, and preferably includes additional data such as CPUE, spatial footprint and size composition (Condition 8).

KEY ISSUES

1. The re-opening decision rule in the BDM Harvest Strategy (Section 2.11.4) sets out the conditions that need to be met when considering the potential for a previously closed fishery to stay open in future, following a successful trial opening. These are outlined below to guide the Working Group's discussion:

STEP 1 - Was data collection during the trial conducted satisfactorily (condition 6)

2. AFMA believes that reported catches accurately reflect the total amount of black teatfish that was caught and landed during the season due to the high level of industry compliance with the daily catch landing and reporting requirements that applied. AFMA had a significant compliance presence throughout the region during the opening, including land-based officers on some of the key islands which were able to support and assist industry meet the licencing and reporting requirements.

3. Having considered advice from both AFMA and industry members and observers on the reliability of total catch reported and data analysis undertaken by CSIRO, the RAG agreed that data collection during the trial opening was conducted satisfactorily.

STEP 2 - Noting the TAC was not exceeded and reliable data were collected, the data need to be analysed to review the TAC and potential for the fishery to stay open in the future, or be re-opened periodically after a pre-specified interval (Condition 7)

4. The RAG considered the CSIRO analysis of the data collected during the reopening which indicates that:
    a. there was no evidence of stockpiling before the opening
    b. there was no evidence of declining catch after a few days which would indicate depletion (low catch on the third day of the opening was due to significantly reduced fishing in observance of the Sabath). The highest daily catch and fishing effort was recorded for the fourth day of the opening (also the last day).
    c. cumulative catches were tracked and adhered to the 20t TAC.
    d. the number of fishers participating was controlled due to good organisation and centralised catch landing points.

5. A significant amount of the black teatfish catch did not include corresponding location data and the RAG agreed that this needs to improve substantially for future openings.

6. The rationale for the 20t trial opening TAC is outlined in the Background section below and includes the Working Group's advice on this matter at its 21 February and 7 August 2020 meetings.

7. In making its recommendation to reopen black teatfish in 2022 with a 20t TAC, the RAG considered the outcomes of the CSIRO modelling which was updated to include the 2021 black teatfish catch data. The modelling confirmed that a 20t TAC is sustainable (conservative estimate of MSY being 21t) and would not lead to a consistent decline in black teatfish biomass after the first year of fishing. In contrast, the modelling found that catches of 30t could lead to a gradual depletion of the stock.

8. The Working Group is asked to consider the RAG's recommendation and provide advice on a TAC for a future black teatfish opening that is set at a demonstrably conservative level, taking into account the outcomes of the trial opening.

STEP 3 - Additional data to be collected during future openings

9. AFMA broached the possibility of doing logbook reporting and some length sampling with industry at the start of consultation with industry and communities on the timing of the opening. Initial feedback from industry was positive however had concern that it may not be feasible given the realities of sea cucumber fishing operations. AFMA did not pursue these initiatives further with industry, recognising the need to first focus on some of the more fundamental aspects of the opening such as daily reporting and empowering industry to agreeing on an appropriate timing for the opening.

10. An ongoing condition of the fishery remaining open is that reliable data collection continues, and preferably includes additional data such as CPUE, spatial footprint and size composition. AFMA considers that industry is broadly interested in pursuing logbook reporting and, as is the case for the Spanish Mackerel Fishery, would be willing to assist with sampling.

11. The RAG and industry members agreed that better voluntary reporting of area and effort data should be a priority focus of future industry consultation prior to a future black teatfish opening, especially for the so called ‘weekend warriors’ that may not be familiar with reporting requirements. They further recommended that opportunities to undertake a sub-sampling program to collect size and weight frequency data during black teatfish openings at key landing locations be explored.

12. The Working Group is also invited to provide further advice on how best to improve voluntary reporting of area and effort information during future openings.

OTHER

13. The RAG recommended that the HCWG, noting the ongoing concern of the economic viability of so many licences being able to access the relatively small black teatfish TAC in a short period of time, consider the performance of licencing arrangements for the fishery in line with the *Torres Strait Fisheries Act 1984*.

BACKGROUND

14. The black teatfish opening commenced on 30 April 2021. In line with decisions of the PZJA, the TAC was set at 20 tonnes and it was mandatory for fishers to report catches to a fish receiver daily and for fish receivers to report landings to AFMA daily. A comprehensive checklist of the management arrangements that applied to fishers and fish receivers during the opening are provided at **Attachment B**. Aside from data provided by fish receivers, no other data was collected, for example size or detailed effort information (for example reef location or hours fished).

15. The fishery went for four (4) days resulting in 17.62 t of the 20 t TAC being caught. The daily black teatfish catches are summarised in Table 1 below.

Table 1. Summary of daily black teatfish catches during the opening 30 April – 3 May 2021

Fishing Day	Daily catch (kg)	Cumulative catch (kg)
30-Apr	4,016.62	4,016.62
1-May	4,905.24	8,921.86
2-May	1,722.52	10,644.38
3-May	6,971.08	**17,615.47**

16. The total catch across all sea cucumber species caught during the black teatfish opening was 20.34t, 86.6% of which was black teatfish (17.62t). A summary of the data collected during the black teatfish opening is provided in **Attachment A**.

Industry experience of the black teatfish opening

1. AFMA invited a number of fishers and fish receivers that participated during the black teatfish opening to attend part of the HCRAG's inaugural meeting. As well as sharing their on-water experiences, the industry members were able to ground truth the reported data and help explain some of the gaps such as the location of catches that lacked corresponding area information.

2. Starting the industry engagement and consultation process early will ensure that management, monitoring and reporting measures for future openings are well considered, should the PZJA agree to allow fishing for black teatfish in 2022 and beyond.

3. Industry members that fished during the opening reported that it was beneficial to have Compliance fisheries officers on ground on Mer Island. As well as enforcing the regulatory arrangements for the opening, the compliance officers also supported fishers and fish receivers with the reporting and licencing requirements to be able to participate in the opening.

4. Industry members provided feedback that that in their view the black teatfish opening should be held on Monday 9 May next year. This timing coincides with favourable tides and is unlikely to overlap with Sunday (the Sabbath).

TAC rationale

5. At its meeting on 21 February 2020, the Hand collectable Working Group (HCWG) considered very preliminary outcomes of the fishery independent sea cucumber dive survey conducted in November 2019 and January 2020 and recommended a trial reopening of the fishery for black teatfish, subject to a 15 tonnes TAC and daily reporting to AFMA (meeting record is at **Attachment C**). The PZJA's consideration in April 2020 of the HCWG's recommendation was delayed on TSRA's request to allow for a more complete CSIRO report on the stock status of black teatfish, and provide time for TSRA to consider options for filling the vacant position on the HCWG for a traditional inhabitant member for Maluialgal (inner western cluster).
6. Members of the HCWG met again on 7 August 2020. Due to unexpected changes in the availability of some traditional inhabitant members, the quorum requirements for the meeting[1] were not met.
7. To support members advice on possible arrangements for a black teatfish opening the following was presented:
    a. Preliminary[2] outcomes of the fishery independent dive survey which included: i) recorded densities across locations and within habitats; ii) standing stock population estimates; iii) length distributions; and iv) a comparison of results with previous surveys; and
    b. Preliminary population modelling together with estimates of standing stock biomass above the legal-size limit (generally known as the available biomass).

[1] PZJA Fisheries Management Paper No. 1. Management Advisory Committees, Scientific Advisory Committees, Working Groups and Resource Assessment Group.
[2] The results were considered preliminary as the final report for the project was not due until December 2020 with further work on interpreting the results across the range of species surveyed to be undertaken.

8. All members reaffirmed previous HCWG advice that based on all available information, the black teatfish stock is likely to be well above the biomass limit reference (a pre-requisite under the harvest strategy for reopening a species closed to fishing). Advice from members is detailed in the meeting record at **Attachment D** with advice on a recommended reopening TAC summarised below.
    a. The two traditional inhabitant members, AFMA and one scientific member (also a co-investigator on the current stock survey project), recommended a re-opening TAC of 20 tonnes. This recommendation was also supported by the TSRA Fisheries Portfolio Board member who is a Permanent Observer on the HCWG;
    b. The TSRA member recommended a reopening TAC of 21 tonnes; and
    c. A Scientific Member and the QDAF member recommended a reopening TAC of 15 tonnes.
9. Having consider the advice of the HCWG, the PZJA agreed to an opening TAC of 20 tonnes on the basis that the preliminary modelling work undertaken by CSIRO, although preliminary, found that across all model versions and sensitivity tests, 20 tonnes was shown to be sustainable. Although 20 tonnes (or 20.8t) is the estimated Maximum Sustainable Yield (MSY) for the preferred model, the MSY estimate was considered conservative due to the inputs used in the preliminary model.

10. The default reopening TAC for black teatfish prescribed in the harvest strategy is 15 tonnes. AFMA considered there was sufficient basis to depart from this default setting. The new modelling, albeit preliminary, gave insight into the productivity of the stock and importantly how it might respond to different levels of fishing exploitation. The preliminary modelling used the newly collected survey data and reported catch data. For these reasons, AFMA considered 20 tonnes to be consistent with the Harvest Strategy requirement for the starting TAC to be demonstrably conservative.

11. In the absence of other data or analysis the application of generally assumed conservative harvest rates of standing stock biomass estimates for sea cucumbers has been used. The standing stock biomass estimate derived from the recent survey was 818 tonnes. If applied, the rule of thumb harvest control rule of harvesting 5% of the total biomass estimate (818t) would have resulted in a TAC recommendation of 41 tonnes. The preliminary modelling indicated that catches above 30 tonnes would not be sustainable and would lead to a decline in the biomass after the first year of fishing.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No.18 28-29 October 2021

Summary of Black teatfish opening catch data 30 April -3 May 2021

1. The black teatfish trial opening lasted for four days, resulting in a total catch of 20.35t of sea cucumber, 86.46% of which was black teatfish (17.62t). A summary of all sea cucumber catches during the black teatfish opening is provided in Table 1.

Table 1. Summary provides a summary of all sea cucumber catches during the opening 30 April – 3 May

Species	Catch (wet, gutted) (kg)
Black Teatfish (Sea Cucumber)	17,615.47
Blackfish (Sea Cucumber)	224.46
Deepwater Blackfish (Sea Cucumber)	46.63
Lollyfish (Sea Cucumber)	21.67
Prickly redfish	1,962.98
Deepwater redfish	17.06
White Teatfish (Sea Cucumber)	460.48
Total	**20,348.73**

2. Apart from the third day, catches increased during the opening. Catches for 2 May were significantly low as many fishers and fish receivers observed the cultural and religious protocol of not working on Sunday (Sabbath). Table 1 provides a summary of daily black teatfish catches during the opening.

3. A total of 13 fish receivers reported black teatfish during the opening from five different locations (Mer, Erub, Ugar, Bourke and Dugong Islands). Bourke and Dugong Islands are uninhabited islands from which some fish receivers where permitted to operate during the black teatfish opening to help facilitate the daily catch landing and reporting requirements. One hundred and twenty-two (123) catch disposal record pages where submitted.

4. Of the 17.62 t of black teatfish caught, 56.5% (9.96t) was landed at Mer Island, 25.9% (4.56t) at Bourke Island and 13.7% (2.41t) at Erub Island.

5. 90.8% (16t) of the landed black teatfish catch was reported as being salted and 9.1% (1.61t) as live. For catch monitoring purposes, all reported catch was converted to wet gutted weight using the conversion ratios available for these processing methods.

6. The majority of the total catch (91.4%) was landed to eight (8) fish receivers, with over half of the catch (50.1%) landed to three (3) fish receivers.

Effort information (number of fishers and area)

7. Of the 123 CDR pages submitted for black teatfish 61% (75) also provided some voluntary effort information from the fishers on the number of fishers/crew per boat and/or the areas

fished, covering 60.9% of the catch reported. Seventy eight percent (78.6%) of those that reported effort reported both number of fishers and areas fished, 20% reported number of fishers only and 1.7% reported areas fished only.

8. Fishers reported as having fished in areas 11 (Warrior), 14 (Great North East Channel), 16 (Darnley), 17 (Cumberland) and 19 (Don Cay). A map of the reporting areas used in the catch disposal record is provided in Figure 1.

9. A total of 41 fishing licences participated in the opening. Although the effort information is somewhat limited, AFMA estimates that an average of 50.5 fishers and crew participated in the opening per day, with 41 licenced fishers having landed catch. Fifteen licences landed 73.4% of the total catch with four (4) licences accounting for 40.4% of the total landed catch. It should be noted that individual licences or boats with high catch levels against them are for multiple boats that the fishers/fish receivers did not specify in the CDR page.

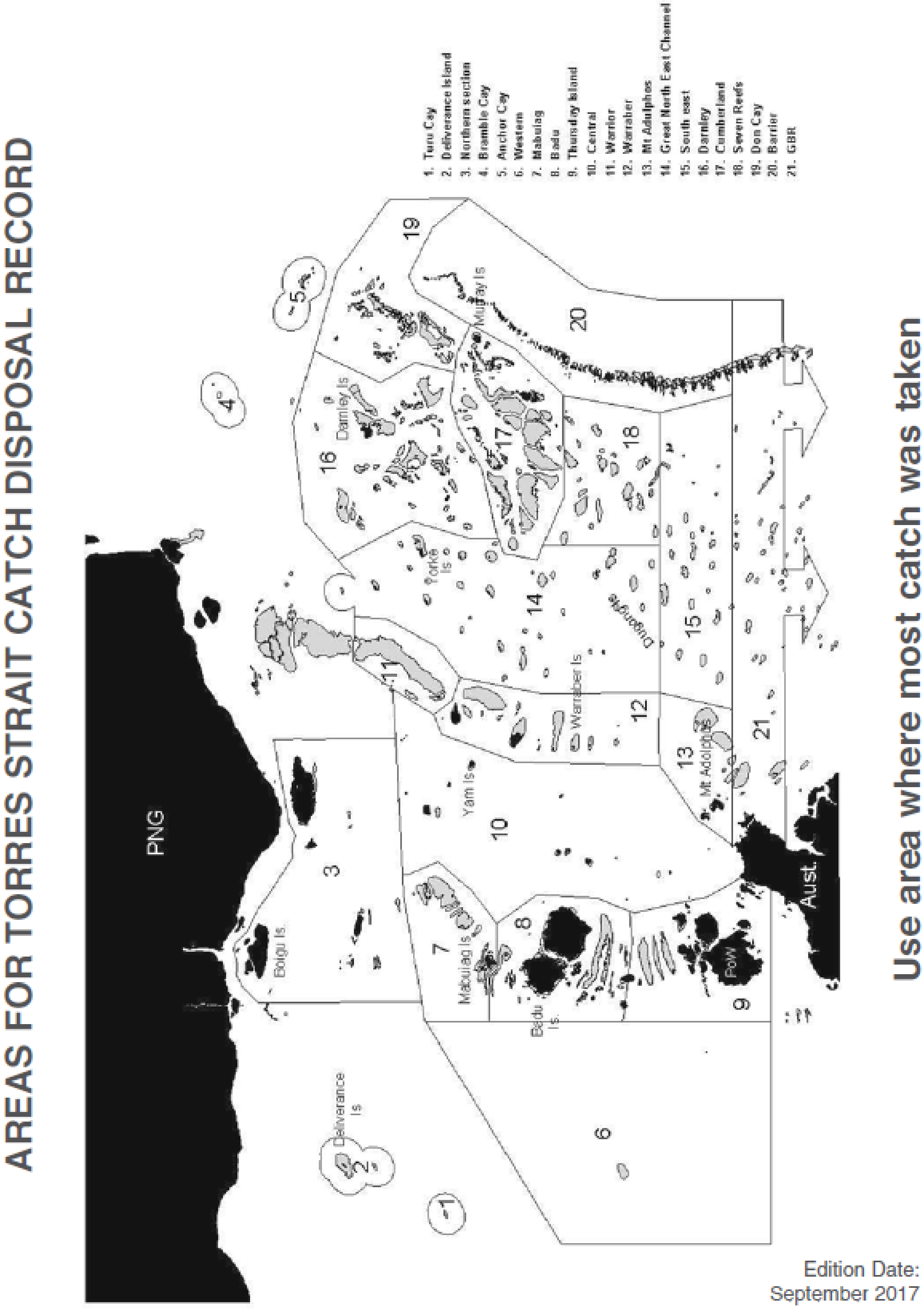
10. Based on the reporting and discussions with industry before and during the opening, AFMA believes that fishers mainly originated from the eastern and central region of the Torres Strait with some fishers travelling over from Mua Island (St Paul's), Bamaga (Northern Peninsula Area), Badu Island and Dauan Island.

11. In addition to the Islands mentioned at paragraph 10 above, some fishers were also based at Memey (Mimi Island) which is an uninhabited island on the eastern edge of central Torres Strait.

Price information

12. Some of the fishers/fish receivers and some of the buyers that AFMA has had the opportunity to talk to advised that black teatfish prices during the opening range from approximately AUD26 to approximately AUD 30 or potentially even AUD 40 depending on the quality and the level of processing. More accurate price information would assist the PZJA in getting a better understanding of the value of the fishery.

Figure 1. Map of areas for Torres Strait Catch Disposal Reporting (TDB02)



Australian Government
Australian Fisheries Management Authority

16th Meeting of the Torres Strait Hand Collectables Working Group

21 Feb 2020, Thursday Island

Meeting Record

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

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Contents

1 Preliminaries

1.1 Acknowledgement of Traditional Owners, welcome and apologies

1. Sereako Stephen opened the meeting in prayer around 9:00 am.
2. The Chair welcomed attendees to the 16th meeting of the Torres Strait Hand Collectables Working Group (HCWG 16) at the Torres Strait Regional Authority (TSRA) Board Room on Thursday Island. The Chair acknowledged the Traditional Owners of the land on which the meeting was held and paid respect to Elders past, present and future.
3. The Chair further acknowledged the role of the HCWG under the PZJA Fisheries Management Paper 1 and reminded members of Working Group of their responsibilities and respectful nature in which to abide by during the two days of meeting.
4. The Chair thanked the TSRA and Traditional Inhabitants for supporting the cultural awareness training held the day before the HCWG meeting. In speaking with other members following the training, the Chair reported that members found the training extremely helpful in building insight into the local culture and the experiences of Torres Strait Islander people. This was considered invaluable in better understanding the aspirations and values of Torres Strait Islander people and how they might relate to fisheries. The Chair thanked all members for their willingness to share their personal advice and experiences
5. Attendees at the Working Group are detailed in **Table 1** below.

Table 1. List of attendees at the HCWG15.

Members	
Anne Clarke	Chair
Tim Skewes	Scientific member
Michael Passi	Traditional Inhabitant member, Kemer Kemer Meriam
Maluwap Nona	Traditional Inhabitant member, Gudumalulgal
Frank Loban	Traditional Inhabitant member, Maluialgal
Patrick Bonner*	Traditional Inhabitant member, Kulkalgal
Tony Salam	Traditional inhabitant member, Kaiwalagal
Selina Stoute	Australian Fisheries Management Authority (AFMA) member
Mark Anderson	Torres Strait Regional Authority (TSRA) member
Danait Ghebrezgabhier	HCWG Executive Officer, AFMA
Casual Observers	
Sereako Stephen	Malu Lamar (torres Strait Islanders) Corporation RNTBC
Keith Brightman	TSRA
Kalya Yamashita	AFMA
Lyndon Peddell**	AFMA, Compliance

* Mr Bonner left the meeting at 0930 and did not return.

** In attendance for agenda items 1,2, 5 and 6.

6. Apologies received are detailed in the **Table 2** below.

Table 2. List of apologies for HCWG15.

Apologies	
Steve Purcell	Scientific Member
Yen Loban	TSRA Fisheries Portfolio Board Member
Ian Liviko	PNG National Fisheries Authority (NFA) Invited Participant
Danielle Stewart	Queensland Department of Agriculture and Fisheries (QDAF) member

1.2 Adoption of agenda

7. The Working Group accepted AFMA's recommendation to discuss agenda item 4 before item 3 and adopted the agenda.

8. The Working Group agreed to break for lunch early noting the Malu lamar representative had a short commitment outside the meeting at 1130. The Working Group wanted to ensure the Malu Lamar representative was included in all business.

1.3 Declarations of interest

9. The Chair advised members and observers, that as provided in PZJA Fisheries Management Paper No. 1 (FMP1), all members of the Working Group must declare all real or potential conflicts of interest in Torres Strait TRL Fishery at the commencement of the meeting. Where it is determined that a direct conflict of interest exists, the Working Group 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. Declarations of interests were provided by each meeting participant. These are detailed in the **Table 3** below.

11. The Working Group followed a process whereby each group of members with similar interests were asked to leave the room to enable the remaining members to:

    a) Freely comment on the declared interests;

    b) Discuss if the interests precluded the members from participating in any discussions; and

    c) Agree on any actions to manage declared conflicts of interests (e.g. the member may be allowed to participate in the discussions relating to the matter but not in the formulation of final advice).

12. The scientific member was also asked to leave the room. The AFMA member noted by way of example, that when discussing potential research projects (for example under agenda item 7 on providing advice on research pre-proposals) scientific members may have real or perceived conflicts of interest. However it is their relevant expertise in fisheries research relevant to the fishery that is highly valued in the development of Working Group advice. Having regard for the declarations made by the Scientific Member and the importance of having relevant scientific expertise, it was agreed that the scientific member be permitted to participate in discussions under all agenda items and the formulation of Working Group recommendations.

13. Those members and observers holding a fishing licence, including the TSRA officers were asked to leave the room. The remaining members agreed that although the excused members may have real or perceived conflicts of interest, their expertise is critical in the development of advice that impacts industries and traditional inhabitants more generally. It was also noted that potential conflicts can arise when specific members or communities from which the members are from are

likely to benefit directly from particular management decisions. In these situations members must be sure to consider the fishery as a whole rather than one particular operator or community over the other. Noting the importance of having traditional inhabitant industry advice and reminding members to act in the best interest of the Fishery at all times, it was agreed that the excused members be permitted to participate in discussions under all agenda items in the formulation of Working Group recommendations.

14. Government members were asked to leave the room. The remaining members noted that TSRA hold a BDM licence in trust on behalf of Traditional Inhabitants but considered the potential risk for a perceived of real conflict of interest to be manageable within the meeting and again recognised the importance of having TSRA contribute to the meeting discussions and advice.

Table 3. Declared interests from each attendee.

Name	Position	Declaration of interest
Anne Clarke	Chair	Board member of the Wet Tropics Management Authority Previously contracted with Regional Development Australia Far North Queensland and Torres Strait No pecuniary interests or otherwise.
Tim Skewes	Scientific Member	CSIRO/Independent Consultant. Previous principal scientist for Torres Strait Scientific Advisory Committee (TSSAC) project to develop a harvest strategy for the TSBDMF. Previous CSIRO researcher for TSSAC project investigating traditional take of finfish in Torres Strait.
Michael Passi	Traditional Inhabitant Member, Kemer Kemer Meriam	TIB licence holder. Has been a member of HCWG for the last 6 years. Has interest in the BDM, Trochus and Pearl Shell Fisheries.
Maluwap Nona	Traditional Inhabitant Member, Gudumalulgal	TIB licence holder, Chairperson of Malu Lamar, Traditional Inhabitant member on TSSAC
Frank Loban	Traditional Inhabitant Member, Maluialgal	TIB licence holder; Traditional Inhabitant Member on TSSAC and Finfish Working Group.
Patrick Bonner	Traditional Inhabitant member, Kulkalgal	Kulkalgal representative , Chair of Mura Porumalgal Fisheries Coproation
Tony Salam	Traditional inhabitant member, Kaiwalagal	TIB licence holder covering all fisheries. Member for kaiwalagal.
Selina Stoute	AFMA Member	Employed by AFMA, no pecuniary interests or otherwise
Mark Anderson	TSRA Member	Employed by TSRA, no pecuniary interests as an individual, TSRA holds fishing licences on behalf of traditional inhabitants.
Danait Ghebrezgabhier	Executive Officer HCWG (AFMA)	Employed by AFMA, no pecuniary interests or otherwise
Sereako Stephen	Casual Observer	TIB licence holder, Director of Malu Lamar and GBK, Chair of the Ugar RNTBC.

Name	Position	Declaration of interest
Keith Brightman	Casual Observer	Employed by TSRA, no pecuniary interests or otherwise
Kayla Yamashita	Casual Observer	Employed by AFMA, no pecuniary interests or otherwise
Lyndon Peddell	Casual Observer	Employed by AFMA, no pecuniary interests or otherwise

1.4 Action items from HCWG15 and previous meetings

15. The Working Group noted the report provided by the Executive Officer on the progress against actions arising from previous meetings, including those that are now complete (Table 4) and noted the following additional comments in relation to some of the action items:

    a. Action Item 4 – As detailed in the agenda paper, while a formal MOU has not been developed AFMA has worked directly with fishers to make significant improvements in reporting. AFMA recommended that this process continue and the action item be removed. AFMA however advised that it remained opened to suggestions from Malu Lamar and stakeholders more generally on improved processes. The TSRA Member advised that TSRA was working with Malu Lamar to agree a service level MOU. The details of the MOU were yet to be worked through however there may be scope to include programs aimed at improving reporting. The Malu Lamar Chairperson expressed preference to maintain the development of the MOU to ensure it remains an option if needed. Having regard for views tabled the Working Group agreed for the following action:

Action item 1.1 - Malu Lamar to make recommendations to AFMA and TSRA on an as needs basis to establish an MOU to assist in improved data collection in the Fishery.

    b. Action Item 5 – While Mr Frank Loban has expressed interest in presenting at a scientific conference, he called upon the other more senior members of the Working Group to also attend and present. Mr Michael Passi, Mr Simon Naawi and Mr Maluwap Nona to be put forward to the CSIRO and the TSRA as nominees for the opportunity to attend and present on the BDM Harvest Strategy at upcoming scientific conferences. This is in recognition of their extensive effort in the development of the Harvetst Strategy and the level of goodwill placed upon them by their respective communities. The Working Group noted that this is a very exciting opportunity to share the work that has happened in the BDM Fishery to date.

    c. Action item 9 – PZJA Traditional Inhabitants could not attend the last Queensland Sea Cucumber Fishery Working Group meeting due to confidentiality considerations of the agenda items being discussed. However they are supportive of HCWG Traditional Inhabitants attending their future meetings. The status update for the action item will be revised to reflect this sentiment.

16. The Working Group noted the final meeting record for HCWG 15, which was finalised out of session and published on 16 September 2019.

1.5 Out of session correspondence

17. The Working Group noted the correspondence circulated out of session since HCWG15 held on 1-2 August 2019.

2 Working Group Updates

2.1 Industry member update

18. The Working Group noted updates provided by Traditional Inhabitant industry members and observers on the recent performance and strategic issues relating to hand collectable fisheries, including economic trends, affecting the management and development of these fisheries.

19. Traditional Inhabitant members of the PZJA advisory committees recently led community and industry consultations, organised by the TSRA and supported by AFMA, to report on activities related to the PZJA fisheries over the last 12 months and seek input on key issues for the management of the fisheries in the Torres Strait. With regards to the BDM Fishery, Traditional Inhabitant members sought industry and community feedback on the proposed black teatfish trial opening, and the current prohibition on hookah. The key discussions points, feedback and recommendations relevant to the HCWG from the consultations are provided at **Attachment B**.

20. In addition to the attached consultation summary, Traditional Inhabitant members on the HCWG provided the following updates on their respective cluster consultations, strategic issues affecting the management and development of Torres Strait Fisheries and on-water industry updates.

21. The Traditional Inhabitant member for Gudumalulgal led the consultation at Gudumalulgal on 21-14 October 2019 and Kaiwalagal (on behalf of the Traditional Inhabitant member for that cluster) on 21 January 2020 and added that:

    - The implementation of the new BDM HS was discussed at the community level and reiterated its value as a tool that will ensure the sustainable management of the resource to build intergenerational wealth.
    - Issues relating to the Tropical Rock Lobster and Finfish (re the impacts of the western line closure on the Saibai and Duan communities) Fisheries were also touched on.
    - It was recognised that the use of hookah is an issue for the Eastern Nations and would need to be undertaken under Meriam protocols, if the hookah prohibition is removed.
    - Fishing has been ok and efforts are being made to encourage other TIB operators to actively participate in the fishery.
    - Operators are facing safety risks by traveling long distances with large loads of product and salt or free diving up to 20m for more catch, sometimes in inclement weather. Permitting access to deep water BDM species closer to home (i.e. white teatfish) would alleviate this safety risk and take pressure off the shallow water fishing grounds.
    - There is concern that reef walkers may not be adhering to the minimum size limits and may be depleting local resources.
    - Reiterated that even within nations one community cannot speak for another with regards to the use of hookah. Harvest for white teatfish using hookah should be permitted on a trial basis to create better income opportunities and as a safer option to how operators are currently fishing for white teatfish in deep waters.

22. The Traditional Inhabitant member for Kemer Kemer Meriam added that:

    - The Chinese ban on the live seafood import due to the Coronavirus outbreak has affected the Tropical Rock Lobster industry but not the export of BDM to the Asian market.

- Curryfish catches dropped significantly in the 2019 fishing season as operators on Erub and Masig Islands have been focused on live TRL but efforts may now shift back to sea cucumbers given the Coronavirus impacts.
- There was general lack of support from Ugar for the use of hookah due to sustainability concerns, however, not all on Ugar are opposed the use of hookah.
- Erub supported the recommendations from Mer to use hookah for harvesting white teatfish.
- Industry is pursuing the establishment of processing facilities on Mer.
- It was good to have an AFMA Compliance officer attend the cluster visit and assist with talking to operators about permits and also the catch disposal system to encourage improvement on data collection.

23. The Traditional Inhabitant member for Kemer Kemer Meriam read the summary of consultations for the Kulkalgal cluster on behalf of the Traditional Inhabitant member for that cluster. The Traditional Inhabitant member noted that a lot of the TIB operators' opposition to hookah for white teatfish may also be due to lack of understanding as most fishers on Masig and Poruma Islands have never fished for white teatfish. White teatfish fishing occurs mostly off Mer Island

24. The Traditional Inhabitant member for Kaiwalagal provided the industry update below and deferred to the Traditional Inhabitant member for Gudumalulgal for the update on the cluster consultation as he did not attend the meeting:
    - Coronavirus has affected TRL business. It is a nature of fishing and industry need to weather through it but are positive that the BDM market is still active.
    - He is currently familiarising himself with the ecological and business aspects of the BDM industry with a view to redirecting his effort into the industry, noting that it is currently harder and riskier to target high value BDM species.
25. The Traditional Inhabitant member for Gudumalulgal noted that the interest of operators in this cluster is mainly on TRL due to their distance from the BDM fishing grounds. While willing to listen to BDM and finfish related matters, they indicated they would take advice on the use of hookah from those that actively target the resource.

26. The Traditional Inhabitant member for Maluialgal advised the Working Group that he can only speak on behalf of the fishers that live in his region and not those that live away from the region. He drew the Working Group's attention to the cluster summaries provided, adding that the majority are TRL operators and the eastern grounds are too far away from them to fish. Nevertheless, they were supportive of improved reporting and timely provision of the data to AFMA to inform management.

2.2 Scientific member update

27. The Scientific member advised that he was involved in the stock survey in late 2019 and early 2020 for which he will be presenting the preliminary results under Agenda Item 4. A survey of Warrior Reef was initially included in the project. However, the scientific member was informed during the first leg of the survey that he had been banned from Warrior Reef by Malu Lamar due to a complaint from an Iama Island Traditional Owner regarding an incident that occurred in 2012 – though no formal advice on the grounds for the exclusion has been provided. As it was too late to find a replacement, and given the uncertainty regards the safety of the survey team, the Warrior Reef survey leg was cancelled. The scientific member sought clarity from Working Group members whether they objected to him presenting those results given he was excluded from Warrior Reef.

28. The Traditional Inhabitant member for Gudumalulgal, in his capacity as the Chair of Malu Lamar, advised the Working Group that specific details about the previous incident was not provided when Malu Lamar was called upon to ban the Scientific member from undertaking the Warrior Reef BdM survey. The Chair of Malu Lamar stated the organisation had acted on behalf of the people whose interests it represents to exclude the Scientific Member from the said area to avoid the issue escalating. Malu Lamar is of the view that the issue needs to be resolved by the research team and the CSIRO, AFMA, the Chair of Magani Lagaugal and the relevant individuals from Tudualgal that made the complaint and provide advice back to the Malu Lamar Board. The Malu Lamar Chair and the Malu Lamar Board member Mr Sereako Stephen offered to assist with the resolution of this matter.

29. The AFMA member acknowledged Malu Lamar's position on the matter and commented that it was unfortunate that the Traditional Owner's complaint came in very late and did not provide formal advice on the allegations so that AFMA could better understand the nature of the concerns held by Traditional Owners and as far a possible have them addressed. In the absence of having these concerns raised in detail and in a timely and formal fashion with it, AFMA had no basis on which to formally substantiate and/or investigate the concerns. Having respect for the views of the traditional owners of Iama and Tudu and noting potential safety risks, AFMA and TSRA agreed at the time to discontinue the Sandfish component of the survey. It would not have been appropriate to run the survey with a different group of scientists. CSIRO was commissioned to undertake the research based on an evaluation of their proposal and importantly their demonstrated expertise to deliver such a project. In the absence of formal advice to substantiate the claims, AFMA fully supports the Scientific member and the project team.

30. The concern raised by Traditional Owners was not anticipated by any of the agencies involved as there had been long standing support provided by stakeholders through the HCWG for this research to be undertaken. The HCWG and TSSAC still strongly supported the projectproposal. It was noted that specific to the current research project and prior to the project being funded, comment on the funding proposal was sought from every PBC Chair and relevant fisher association and no concerns or complaints were raised through that consultation process. Concerns were also not raised by traditional owners who attended the PZJA traditional inhabitant member cluster consultation held on Iama on 6 November 2019.

31. The Malu Lamar Chair further commented that matters such as this place Malu Lamar in a difficult position when representing people that operate under two laws and given the angst that still exists amongst individuals regarding past events. He agreed that there needs to be a mechanism and process in place to identify, address and resolve such issues in the future in a timely manner and suggested that a Memorandum of Understanding would provide the framework through which such situations can be mitigated and resolved in the future.

32. The TSRA member reiterated that the TSRA, as the funding body of that project, undertook all formal recognitions and notifications on the scientific activity to communities and relevant bodies. From a process perspective it is very difficult and disempowering to the HCWG for the project to be impacted given the process that was gone through to put the project up on, what seems to be, the view of one individual.

33. Some Traditional Inhabitant members on the Working Group commented that they had not been aware of the issue but understood the need to discontinue the Sandfish component of the

survey due to safety concerns. Following this discussion, the Working Group welcomed the Scientific Member to continue presenting the preliminary survey results.

34. The Chair reiterated that such complaints need to be formalised in writing in a timely fashion in the future as a matter of proper procedure.

2.3 Government updates

2.3.1 AFMA update

35. The Working Group noted the update provided by the AFMA member regarding management issues relevant to Torres Strait hand collectable fisheries as detailed in the Agenda paper, in particular:

    a. The BDM Harvest strategy was adopted by the PZJA at their meeting on 19 November 2019, and came into effect on 1 January 2020 in time for the start of the 2020 fishing season. New TACs for individual and basket species and the conversion ratios were implemented through licence conditions but the old minimum size limits are still in place pending the review of the Fisheries Management Instrument 15 which is currently underway and due to be completed in time for the 2021 fishing season.

    b. The implications for listing commercially fished beche-de-mer species on Appendix II of CITES;

        i. The species may still be traded internationally provided the trade, or a specified level of trade, has been determined to be non-detrimental to the survival of the species in the wild.

        ii. The Department of Agriculture, Water and Environment (formerly the Department of Environment and Energy) is responsible for assessing the sustainability of international trade in Australian species listed on Appendix II and undertakes this assessment based on the information provided to it by the exporting proponent.

        iii. The Commonwealth (AFMA), Queensland, Northern Territory and Western Australia have agreed to support a national approach being funded by the Queensland Sea Cucumber Industry Association (the Association) in seeking a non-detriment finding (NDF) for both black teatfish and white teatfish. Fishwell Consulting has been engaged by the Association to collate all required information for the DoEE's consideration of a non-detriment finding which must be submitted to the Department by early April 2020. AFMA will support the process for the Torres Strait and Coral Sea fisheries.

        iv. Once the take for trade is considered to be sustainable (i.e. a non-detriment finding is approved), trade is generally regulated through permits authorising export of the specimen and exporters will require a permit from the DOEE.

36. The Working Group also noted a range of other AFMA updates relating to:

    a. the latest Fishery Status Reports from the Australian Bureau of Agriculture and Resource Economics (ABARES) were released in September 2019. All BDM species are classified as not being subject to overfishing, with Sandfish being the only species in the Torres Strait that continues to be classified as overfished. The fishing mortality and stock status for two species taken in 2018 remains uncertain mainly due to the lack of more recent survey data

    b. updates on the progression of legislative amendments to the *Torres Strait Fisheries Act 1984* and *Torres Strait Fisheries Regulations 1985*; and

2.3.2 AFMA Compliance update

37. A verbal compliance update was provided by the AFMA Fisheries Officer Mr Lyndon Peddell as follows:

- Current staffing is three Fisheries compliance officers on Thursday Island with further operational support provided from other AFMA officers.
- Adherence with reporting requirements has generally been good. Officers continue to detect and report noncompliance, in most cases these matters have been dealt with through education.
- AFMA has two matters before CDPP for consideration.
- AFMA undertook at sea and aerial surveillance in partnership with Queensland Police based on specific intelligence received on addressing Tropical Rock Lobster stockpiling in the lead up to the TRL fishery opening. Compliance was good and no stockpiling was detected.
- At sea patrols have been conducted with focus on enforcing the hookah closure.
- AFMA is also working with Border Force to utilise their platforms to undertake on-water patrols and surveillance.
- Fisheries Officers have attended some community engagement visits alongside TSRA and Fisheries Management Officers and further assisted community members with compliance related matters.
- Foreign – incursions have been low in the TSPZ, some activity has been detected in the north and Deliverance island areas. No apprehensions have been made but some activities were observed in the calm weather and inclement weather may see this lessen.
- Traditional Inhabitant members requested that they be informed when operators are likely to appear in court so they can be provided with the appropriate legal assistance and representation. Mr Peddell advised that he is not at liberty to discuss details of an ongoing investigation however, each person has the right to engage legal representation.
- Industry members advised that they will be submitting information on illegal fishing activity to AFMA for further investigation.

2.3.3 TSRA Update

38. The Working Group noted the update below provided by the TSRA member:

39. TSRA response to the Corona Virus and impacts on fishers:
    - Immediate response has been to offer a loan pause for home and business loan clients affected by the virus
    - Coxswain training courses have been put on for fishers that have opted to not continue fishing due to the down turn in the market
    - A Seafood trade advisory website has been set up to provide the fishing industry with updates on what is happening at the national level to respond to Coronavirus impacts.
    - Considerations include not leasing TSRA held permits to non-traditional fishers to alleviate some of the pressure due to dislocation of effort from one fishery to another.
    - Developing a Recovery Action Plan (RAP) to better equip the region to emerge from the impacts
    - Working with the State Govt on developing the Grant Guidelines

40. Fisheries Regional Ownership Framework:
    - Steering committee continues to work towards the creation of the entity by 1 July
    - Summit dates have been locked in for 27 – 29 April at Stadium on TI

41. Warpil – Fishing for our futures
    - 60 jobs and 180 trainees over the next two years
    - Programme is focussed on the fisheries infrastructure

- Commenced at Erub with Boigu, Saibai and Mer commencing in coming months

42. Torres Strait Marine Safety Programme TSMSP
    - 470 TIB licences
    - 330 to 350 coxswains have been trained
    - 250 TIB fishers traded in fishing
    - 60 TIB vessels currently hold a certificate of operation which is required by AMSA to operate as a commercial fishing vessel. exemption to operate without a coxswain certification expires on 30 June 2020.
    - Industry members noted that recreational operators are opting to get a TIB licence as it is cheaper than getting a recreational one and provides ease of identification and recognition to be able to access areas and this may be inflating the number of actual commercial TIB fishers in the region.

43. Nationally accredited training
    - The TSRA is working with TAFE to develop a Fishing qualification that would be nationally accredited under the AQF

44. TSRA is continuing to work on the enhanced TIB representative model.
    - TSRA wished to acknowledge the work and commitment of the reps
    - All island visits had now been completed with the TIB reps leading the presentation

2.3.4 QDAF Update

45. In the absence of the Fisheries Queensland representative, the Working Group members noted the written update provided on the changes to fishing rules in Queensland that came into effect on 1 September 2019. Of note for the HCWG are the doubling of the recreational boat limit for sea cucumbers and the introduction of no take rules for white teatfish, the requirement for vessel tracking on all commercial vessels and stricter licensing requirements.

2.4 Native Title update

46. The Malu Lamar representative updated the Working Group as follows:

    - Malu Lamar continues to seek full membership status for it and GBK on various fishery advisory groups as the cultural voice of traditional communities and an acknowledgement of Malu Lamar's importance as a stakeholder.
    - With regards to the previous discussion on the outcomes of the cluster consultations, the Malu Lamar representative raised concern that not all TIB operators were represented to contribute to the discussions on the use of hookah to catch white teatfish.

47. The AFMA member acknowledged Malu Lamar's request for membership on the PZJA advisory committees has been a long standing issue. To assist in having Malu lamar's request processed the AFMA member requested that if possible, Malu Lamar formally write to AFMA and in doing so, give guidance on their proposed role on the advisory committees having regard for FMP 1. In particular how Malu Lamar would participate in recommendation making.

48. Malu Lamar welcomed this opportunity and advised that it would seek legal advice on the roles and responsibilities that such membership confers on the organisation and whether a formal Malu Lamar member on a fishery advisory group will be seen to be acting on behalf of the whole of Malu Lamar when it comes to supporting decisions and/or making recommendations.

2.5 PNG National Fisheries Authority update

49. An update was not available due to the unavailability of NFA officers.

3 Catch and effort Summary

50. The Working Group noted the catch summary for the 2019 fishing season for the BDM Fishery provided under Agenda Item 3 and noted the following highlights from the Executive Officer:

- The catch report for the 2019 fishing season has been updated to include more up to date figures as catch disposal recorders have continued to be submitted and entered in the database. As at 18 February 2020, the total reported catch was 36 tonne.
- The summary of changes in key reported metrics from the 2018 to the 2019 fishing seasons has been slightly amended to reflect the significant improvement in the timelines of reporting. Average CDR receipt time in the 2019 season was half that in 2018.
- Species level identification has also improved with no 'unidentified sea cucumbers' reported in 2019.
- Total catch reported has dropped by 46% from 2018, mainly due to the significant drop in curryfish catches. This is consistent with Industry's update that operators known to catch large amounts of curryfish on Darnley and Yorke have shifted their attention to live TRL.
- Catch reports in 2019 have slightly decreased by 7% (20 CDRs)
- Spatial and effort reporting has also improved with 69% of the CDRs submitted reporting the 'Area fished' and 70% reporting the 'Number of days fished'.

51. The AFMA member congratulated industry on their concerted effort within their respective communities to improve reporting in the fishery. AFMA will continue to ascertain the level of participation in the fishery through the number of active licences until such time a more reliable measure is available.

52. The Traditional Inhabitant member for Kemer Kemer Meriam reiterated that reporting by part-time fishers could be improved and noted this as a concern that needs to be addressed. This comment was supported by other industry members and a suggestion was made to find a way to engage part time operators to impress upon them the importance of reporting catch data or come up with a way to limit the amount of catch that they can land without infringing on their right to fish as TIB licence holders.

53. This is also an issue in the TRL fishery and a better approach may be to address the issue across the entire TIB licencing process.

4 Preliminary results of the Beche-de-mer stock survey

54. The Scientific member, Mr Tim Skewes, presented the preliminary results of the Beche-de-mer underwater dive surveys undertaken in eastern Torres Strait between November 2019-January 2020 as part of the TSRA funded and CSIRO led project 'Stock survey of Torres Strait Beche-de-mer species' (AFMA Project No. 2019/0826). As well as assessing the distribution and stock status of beche-de-mer species in the Torres Strait, the survey also undertook some exploration and mapping of deep water habitats to help inform better environmental management and ground truth reef mapping from previous projects. Sandfish populations at Warrior Reef were not surveyed as planned due to the banning of a project scientist by the Malu Lamar based on objections raised by Traditional Owners of Iama and Tudu.

55. A total of 297 sites, in 6 zones and a range of strata in East Torres Strait were surveyed, most of which had also been done in the 2002-2009 surveys. 53 new deep water sites were surveyed to investigate potential deep water populations species such as white teatfish. The deep water surveys covered 20m-50m depths and a TSRA camera system recorded underwater footage during 10 minute drifts of transects (40m – 675m long). The outputs of the survey include relative density estimates over time, and estimates of stock size. The results for the Barrier zone are excluded from the comparative density estimates as it was not surveyed every time. It is still used in the stock estimate. The project also carried out detailed sampling of sea cucumbers and habitats on Ugar reefs to support a potential reseeding project there. The

results for the Ugar mapping will be provided once they have been finalised and presented to the community.

56. The preliminary results of the survey are summarised below:

a. Black teatfish (*Holothuria whitmaei*)

i. Black teatfish density across all zones and strata surveyed averaged 7.4 per hectare (Ha) – with the average density in the reef-top buffer strata, its preferred habitat, of about 12 per Ha. None were seen in the deep water strata (>20m). The Barrier and Don Cay zones had the highest average density of black teatfish (>17/Ha) which is well above the 12.5/Ha indicative natural carrying capacity for Black teatfish from a FAO global review. The Darnley, Great North East Channel (GNEC) zones had the lowest density of black teatfish as expected but the results of this survey show a decrease from previous surveys. The results of the Seven Reefs zone on the other hand show an increase in density from previous surveys.

ii. The preliminary analysis indicates that the virgin population biomass is likely to be at approximately 10/Ha (B_0) for all zones and strata combined, which would place the limit reference level (B_{LIM}) at about 4/Ha (40% B_0). While this is slightly less than the indicative natural carrying capacity for black teatfish of 12.5/Ha, 10/Ha is acceptable for the Torres Strait given the large area of the fishery surveyed, which also includes areas that are not suitable Black teatfish habitat. The 2019/20 survey density estimate was 7.7/Ha, well above the limit reference point.

iii. The 2019/20 density is only slightly less than the 2009 density which was considered to have recovered to close to B_0 levels. Together with the very high density observed in the Barrier zone in 2019/20 (not included in 4 zone average density estimate), this indicates that the black teatfish population is currently in a healthy state.

iv. The fishery biomass for black teatfish was estimated to be 830 t (lower 90th percentile as gutted weight) pending further assessment to finalise the analysis.

b. White teatfish (*Holothuria fuscogilva*)

i. Preliminary analysis of the survey results indicates that the deep water strata (20 m - 50 m) (where sampled) in 2019/20 had the highest densities of white teatfish of any strata, with an average density of 15 per Ha. This high density was consistent in all zones sampled. They were also in high density on the reef top in the Barrier and Don Cay zones, especially on the deeper reef top habitats. Don Cay had the higher overall density of any zone at over 10 per Ha.

ii. White teatfish average (stratified) density in east Torres Strait reef zones was very variable over the years. Don Cay zone again had the highest density of White teatfish in the east Torres Strait area, and the Barrier zone had the highest ever observed.

iii. The highest overall (4-zone) average stratified average for white teatfish (shallow reefs only) observed was in 2002 at 2.5 per Ha. While the 2019/20 estimate of 1.83 per Ha was not as high as 2002, the observed density coupled with the substantial population in deeper water that is likely unfished, indicates that the white teatfish population was still in a healthy state.

iv. The preliminary fishery biomass population estimate (lower 90th percentile as gutted weight) for white teatfish in 2019/20 was 668 t, with almost half of that found in the deep water strata, but none found beyond 36m (deep water strata area is assumed to be the same as the reef edge area – more analysis will be required to better estimate the area of this habitat). The highest density occurs between the depths of 20m-36m and the species seems to prefer sandy bottom habitat.

v. Additional work is required to advise on carrying capacity and the limit reference point for this species

c. Prickly teatfish (*Thelenota ananas*)

i. Preliminary analysis of the survey results indicates that the highest density was in the Barrier edge strata, and this was true overall as well, with the reef edge having an average density of 16 per Ha. There were few prickly teatfish seen in deep water (>20 m). The Barrier zone also had the highest overall density at 18 per Ha.
ii. Overall (4-zone) density was the lowest ever observed for prickly teatfish at 1.5 per Ha, being only 63% of the 2005 estimate, and continues a downward trend for this species since 2005. This trend is concerning and will need to be further investigated through analysis of the size data collected.
iii. The Cumberland zone, which has a large area and is an important habitat for this species, had a relatively low density, especially when compared to the Barrier zone, which likely does not see high levels of fishing.
iv. The preliminary fishery biomass population estimate (lower 90th percentile as gutted weight) for prickly teatfish in 2019/20 is 336 t.
v. The low prickly redfish densities observed at Darnley were not surprising and seemed consistent with fishers' observations to that effect. It was noted that the Darnley fishing grounds are usually better known for their curryfish assemblages.

d. Curryfish (common) (*Stichopus hermmanni*)

i. Preliminary analysis of the survey results indicates that the highest common curryfish density was on the reef top buffer strata, particularly in the Darnley zone, at 38 per Ha. They were also seen on the reef edge and, to a lesser extent, on the reef top strata. Some were even observed in the deep water strata, but in low densities. The Darnley zone had the highest overall density. Cumberland and Don Cay zones also had significant densities of common curryfish.
ii. Zone and overall survey density over survey years for this species was quite variable. Overall the density was lower than in 2009, and similar to 2002, however, there was not a great variation in density over time.
iii. The preliminary fishery biomass population estimate (lower 90th percentile as gutted weight) for common Curryfish in 2019/20 was 509 t. Note that deep water strata area is assumed to be the same as the reef edge area. More analysis will be required to better estimate the area of this habitat.
iv. Provisional harvest strategy limits do not seem to have been breached, however as per prickly teatfish, the declines in density from previous surveys, while not unexpected given the level of fishing effort on them, need to be investigated further to ensure that the stock remains sustainable.

57. The Scientific Member made a general comment that some deepwater blackfish and redfish species were also observed during the survey.

58. The Scientific member also noted that the reefs in general looks to be in very good condition with high coral cover, minimal to no bleaching and no crown of thorn starfish.

59. The Scientific Member outlined the additional work below that still needs to be carried out to finalise the project as follows:
    - Analyse all data for all species
    - Refine deep water habitat estimates
    - Population modelling

- Analysis outputs suitable for CITES non-detriment
- Habitat analysis (coral, seagrass, CoT, clams)
- Ugar reef mapping for potential re-seeding

60. The Working Group thanked the Scientific member and the rest of the project team for their work on the project to date and for all their effort in making the preliminary results available for the Working Group's consideration so soon after the completion of the last survey.

61. The Working Group further noted that the next project progress update will be provided at the Hand Collectable Working Group's meeting, tentatively in August, with the project due to be completed in December 2020.

5 Future Black teatfish opening

62. The Working Group noted:
    a. that HCWG 15 (1-2 August 2019) recommended a trial opening of black teatfish, contingent on:
        a. the implementation of the beche-de-mer Harvest Strategy and that the strategy has since been agreed by the PZJA (November 2019), and
        b. remaking of the *Fisheries management Instrument No. 15* (FMI No. 15) in 2020. AFMA advised that this process was an ongoing however TAC arrangements for black teatfish could be administered through licence conditions;
    b. outcomes of the HCWG Traditional Inhabitant members community consultations to seek feedback on the proposal to restrict TIB licence holder access to a black teatfish opening through customary protocols and traditional lore (presented under item 2.1);
    c. the preliminary stock survey results for black teatfish from the Torres Strait beche-de-mer species stock survey undertaken in late 2019 (presented under Agenda Item 3);
    d. the overview of catch and effort data for the beche-de-mer fishery during the 2019 season (presented under Agenda Item 4); and

63. The Working Group supported the application the *Torres Strait Bech-de mer Fishery Harvest Strategy November 2019* (the BDM Harvest Strategy) in developing advice on an appropriate TAC and managements arrangements for a future black teatfish opening

<u>Applying the BDM harvest Strategy: Section 2.11.4 Re-opening Decision Rule</u>

Condition 1 – Using all available information, is the stock above a limit reference point level?

64. The Scientific member advised that the preliminary outcomes of the recent stock survey (AFMA Project No. 2019/0826) indicate that the black teatfish stock in the TS is very likely above the limit reference point (BLIM) and at a level that can allow the potential opening of the fishery. The Scientific member advised that through further analysis of the survey data, the Working Group will be better placed to advise on upper reference points such as a target reference point within the BDM Harvest Strategy.

65. Noting the preliminary survey outcomes together with: a) outcomes of the 2009 survey, and b) the limited recorded fishing effort on black teatfish since its closure in 2003 (two openings 2014 and 2015) the Working Group agreed that all available evidence indicates that the stock is likely above the reference point (the default limit in the BDM Harvest strategy, BLIM, being 40% of B0).

Condition 2 - Are monitoring and management adequate?

66. The AFMA Member noted that the mandatory fish receiver system that has been in place for the last two years has resulted in substantial improvements in catch and effort reporting. As presented under item 4 the timeliness of reporting along with, species identification and voluntary effort reporting has improved to a relatively high standard.
67. The AFMA member advised that should fishing for black teatfish re-open, the mandatory fish receiver system can be used to require daily reporting of landed catches. Daily reporting would be essential to minimise the risk of over catching the total allowable catch (TAC).

68. The AFMA member further advised that AFMA now having responsibility for domestic compliance is able to undertake targeted compliance activities to support a black teatfish opening.

69. A traditional inhabitant member expressed concern at the catch disposal records being the only source of data for the fishery and would prefer to have had other forms of data inputs to support the re-opening of black teatfish. The AFMA Member advised that the BDM Harvest Strategy is designed to guide management decisions based on available information. This means that management is more precautionary when there is greater uncertainty about the stock and catches. Accordingly a precautionary management approach is recommended to convening a black teatfish opening at this time.

70. Other a traditional inhabitant members advised that Eastern communities had already begun discussions on voluntary measures they would adopt to further reduce the risk of mis-reporting (see detail below under condition 3).

71. The Working Group was supportive of the improvements to reporting and general management of the fishery to date. The Working Group noted that the ability to obtain accurate and timely catch and effort data was essential under the BDM Harvest Strategy to redeveloping the fishery on an ongoing basis. Members noted the harvest strategy recommends that a) if a trial TAC is exceeded by more than 5% then the fishery should be automatically paused for the following year; and b) if data collection during the Trial opening was note conducted satisfactorily, then the fishery should be closed again and the re-opening rule process applied again.

Condition 3. If conditions 1 and 2 are met then a conditional trial opening is possible subject to the following conditions:

Accurate catch and effort reporting is required:

72. Working Group members were supportive of the additional reporting requirements that were previously discussed, these being the daily, reporting of catch by licenced fish receivers to AFMA. AFMA advised that it would make provision for catch disposal records to be submitted electronically (SMS, Email) with hard copies to be forwarded to AFMA through the mail. It was noted that operators would need to ensure that they land catches in areas with telecommunications reception. Whilst this may place operational constraints on some fishers, on balance the need for daily reporting was considered by the Working Group to be a priority.

73. Traditional inhabitant members advised that fishers in the Eastern communities (Mer, Erub, Ugar and Masig) had commenced discussions about adopting voluntary reporting procedures to further reinforce timely and accurate reporting during a black teatfish opening. For example agreeing to land to a single fish receiver. The Working Group commended industry on taking such initiative. Traditional Inhabitant members however expressed concern that part-time operators or new operators attracted to fish just for black teatfish (the 'goldrush' effect) may not adhere to either the daily reporting rules or the additional voluntary measures being developed.
74. The Working Group sought advice from Traditional Inhabitant members on how such agreements could be further developed and agreed by fishers across the region. Traditional Inhabitant members advised that provided the cultural and industry agreements were discussed at the fisher level and didn't get 'political' and fishers from the central and western nations didn't feel excluded, agreements could be successfully implemented. The Working Group noted advice from the Gudumalulgal Traditional Inhabitant member that the

Gudumalulgal communities had already confirmed that they would respect the culture lore developed by the Meriam people for a black teatfish opening. This includes cultural lore on who can fish where.

75. To assist traditional owners and the BDM industry more broadly to agree on relevant cultural lore and voluntary industry agreements to reinforce timely and accurate catch reporting, the TSRA member offered to fund Malu Lamar to convene a stakeholder workshop. The TSRA member advised that the workshop would be led by Malu Lamar and facilitated by the TSRA in consultation with AFMA.

76. The Working Group welcomed the initiative by Traditional Owners and the industry. The Working Group noted that the proposed initiatives would likely complement the regulatory measures being proposed such as daily reporting.

77. Members noted the importance in future community consultations to continue to emphasise the benefits of improved reporting in ensuring the sustainability of the black teatfish stock for future generations. Improved management and data collection will also inform the development of non-detriment findings (NDF) to allow the continued export of Black and White teatfish once their Appendix II CITES listing comes into effect in August 2020. An NDF for Black and White teatfish would place the Torres Strait BDM Fishery in the unique position of being one of very few fisheries worldwide that is able to export sustainable black and white teatfish.

78. The Working Group also asked that AFMA explore media opportunities such through regional radio to widely communicate the additional management and reporting requirements for a black teatfish re-opening.

Action item 5.1 – Malu Lamar to take the lead in convening a stakeholder workshop to further discuss and agree on cultural lore and industry agreements with respect to fishing for black teatfish and report outcomes to the HCWG.

Action item 5.2 – AFMA explore media opportunities such as radio to widely communicate the additional management and reporting requirements for a black teatfish re-opening.

Setting a precautionary trigger limit:

79. The Working Group agreed that setting a precautionary catch trigger limit as a stop-go mechanism to allow for compilation of catch data within season may not be feasible given the expected very short time period that black teatfish fishing would be open for under a conservative TAC. The 2015 opening lasted eight days.

An effective warning system required to alert fishers as catches approach the TAC:

80. AFMA advise that it would collate catches and provide daily reports to operators on how catches are tracking against the TAC throughout the black teatfish fishing season. Catch updates would be circulated via SMS, email and the PZJA website.

Consider the need for any further condition, including limitations on which species can be harvested in conjunction with a re-opened species, or with particular gear.

81. The Working Group discussed the need further conditions to support a possible future opening such as;

a. restricting catches to only black teatfish during the opening;
b. imposing trip limits on the amount (number or weight) of black teatfish that can be landed per trip, and/or
c. granting access through a tender process. This would restrict the number of fishers able to fish for black teatfish and generate revenue.

82. On balance the Working Group did not recommend any further conditions. The additional conditions briefly discussed where considered at this time to be unnecessary, complex and/or not supported by current PZJA licencing policy.

Trial fishing dates to coincide with fishing dates for other species to spread the effort:

83. The Working Group noted previous advice from Traditional inhabitant members that future black teatfish openings should coincide with fishing in the Tropical rock lobster (TRL) Fishery. This was to reduce potential management risk of having a 'goldrush' of participants entering the Fishery. However, the Working Group noted that this timing may not be possible for the current year as TRL fishing has slowed down considerably due to the current live import restrictions into China because of Coronavirus.

84. The AFMA member advised that further discussions with industry could take place as part of the proposed Workshop to agree a date for the opening. PZJA agencies would work to get a PZJA decision on having an opening sometime this year prior to the TSRA Board entering caretaker mode late April.

85. With regards to the trial opening dates, the Working Group was mindful that the fishing period needs to be long enough to provide operators with ample opportunity to fish in favourable weather and tides so as not to compromise safety.

Cultural laws and community agreements:

86. Traditional Inhabitant members reiterated that agreed that cultural lore and community agreements could be used to support additional voluntary reporting requirements and oversight as to who can fish where (see discussion under accurate catch and effort reporting).

Condition 4. Set a demonstrable conservative TAC with reference to default values.

87. The Working Group recommended adhering to the harvest strategy default trial opening TAC of 15 t for black teatfish (see Table 3 of the harvest strategy). In making this recommendation, the Working Group discussed whether a larger, but still sustainable, TAC could alleviate some of the risk of the conservative 15 t TAC being overshot as per the 2015 trial opening. One option was to set a 40 t TAC that is a little bit less than the sustainable catch estimate of 5% of the preliminary biomass estimate obtained from the scientific survey. As part of its deliberations, the Working Group considered the Scientific member's advice that while a 40 t TAC would still be considered sustainable, it is should be viewed as aspirational at this stage given the preliminary nature of the assessment and it does not completely remove the risk of TAC overshoot. The collection of high quality spatial catch and effort data during the trial opening will allow for greater confidence to set higher TACs in future seasons.

Recommendation summary

88. In line with the harvest strategy (section 2.11.4), Working Group recommended a trial fishery reopening for black teatfish subject to a 15 tonne TAC and daily reporting landed catch noting that:

a. based on all available information, including preliminary results from scientific dive surveys in November 2019 and January 2020, that the biomass of black teatfish is likely to be over the limit biomass reference point (BLIM - 40 percent of estimated unfished biomass);

b. monitoring and management arrangements (with daily reporting) are adequate;
   i. a mandatory landed catch reporting system is in place and reporting standards in the BDM Fishery have progressively improved since the system was introduced. This includes voluntary reporting of effort information.
   ii. Fish receivers will be able to submit records to AFMA electronically (SMS, email) during the opening with hard copies to be sent to AFMA in the mail.
   iii. AFMA is now responsible for domestic compliance and is committed to undertake a targeted compliance program to support a future opening.

c. although the preliminary results of the recent scientific survey suggest the stock could sustain a higher TAC, priority was given to ensuring the TAC was demonstrably conservative which is a requirement of the harvest strategy;

The Working Group welcomed the commitment from Malu Lamar, with support from TSRA, to work with fishers to agree voluntary measures to reinforce cultural lore with respect to who can fish where and further ensure accurate daily catch and effort reporting. These arrangements are likely to complement regulatory efforts to reduce the risk of exceeding the TAC.

6 Prohibition of Hookah in the Beche-de-mer Fishery

89. The Working Group noted:
    - that the issue of permitting the use of hookah in the BDM fishery is a long standing issue, with strongly divided views among stakeholders;
    - the views of Torres Strait communities on the use of hookah in the BDM fishery as discussed during PZJA Traditional Inhabitant member cluster consultations (Agenda Item 2.1);
    - that HCWG15 (1-2 August 2019) recommended a discussion paper be developed to explore a longer term strategic approach to using hookah in the BDM fishery.

90. The AFMA member sought the Working Group's agreement on AFMA's proposal to undertake a dedicated, strategic workshop to address the use of hookah in the BDM fishery, which is currently prohibited, in the context of the newly implemented BDM Harvest Strategy. The Workshop would form part of the Future management priorities workshop recommended at the last HCWG meeting.

91. The AFMA member noted some stakeholders have had long held concerns relating to the sustainability and risk of over-exploitation of using the hookah method to collect BDM, some of which have since been mitigated through the implementation of the BDM Harvest strategy and the Fish Receiver System to collect catch data. Outcomes of recent Traditional Inhabitant cluster consultations however indicate that community views on the matter are still varied and stakeholder workshop would enable those views to be better understood and possible management options developed against management objectives and capacity to cost-effectively administer and enforce various options.

92. The Traditional Inhabitant member for Gudumalulgal acknowledged some stakeholders' opposition to fishing with hookah, however, it is important to review the prohibition on hookah in the context of removing barriers to economic opportunities for Torres Strait islander communities. The prohibition on hookah is currently limiting fishing for White teatfish given the species is mostly found in deeper waters and some operators are putting themselves at risk free-diving to depths of up to 30m to fish. He expressed his concern that communities traditionally known to not fish for White teatfish, and are therefore least impacted by this decision, are commenting on behalf of those that rely on the species for their livelihoods. He further reiterated that it is important to consult with full time fishers on their views on the removal of the hookah ban as opposed to those that do not fish on a consistent basis.

93. Other Traditional Inhabitant representatives (MP) agreed/confirmed that some of the stakeholders that expressed their opposition to lifting the hookah ban during the cluster visits do not have much experience working in that fishery and lacked understanding of the hookah fishing method or the impact of the prohibition on the eastern communities that depend on this resource for their livelihoods.

94. The Working Group recommended that this issue be considered in a broader stakeholder workshop and recommended that it form part of the Malu Lamar led workshop process being organised to finalise customary arrangements for the trial opening of black teatfish. This will ensure that there is good representation of communities across the Torres Strait region and provide a good opportunity to:

- share the most recent science on the distribution and status of the white teatfish stock
- address any misinformation that may exist regarding the use of the hookah method
- discuss and perhaps agree on the arrangements that could be implemented through cultural law to complement the regulatory ones in progressing the review of the hookah prohibition.
- discuss possible options for lifting and/or amending the hookah prohibition. The Working Group noted, a number of communities support the use of hookah only for white teatfish and not other species. The Working Group also noted a suggestion from one traditional inhabitant member that a trial be undertaken to test the ability of traditional inhabitant fishers to take the catch using hookah.
- develop strategies to mitigate any of the unintended risks that may arise as a result of lifting the hookah ban.

95. AFMA advised that it would support the strategic stakeholder workshop by providing advice on the administrative and compliance capabilities that currently exist to oversee and manage possible changes to the hookah prohibition.

96. The Working Group reiterated that the perception of conflict of interest needs to be addressed during this process and that all stakeholders across
97. the region is afforded procedural fairness by having an opportunity to present their views.

Action item 6.1 – Malu Lamar to discuss the review of the hookah prohibition at the stakeholder workshop with a view to developing management recommendations.

7 Research

98. The Working Group discussed the research pre-proposal submitted by Nicole Murphy, CSIRO, on 'Determining weight conversion ratios for curryfish species *Stichopus herrmanni* and *S. vastus*', with a view to providing advice for the TSSAC's consideration at its March 2020 meeting. In considering the research application, the Working Group noted that the research application directly addresses a research priority in the Hand Collectable Fisheries Five Year Research Plan. That is to develop weight conversion ratios for the various process forms for curryfish.

99. The Working Group supported the pre-proposal progressing to a full application noting that the proposal:
- addresses an identified research priority. Having species specific weight conversion ratios will improve the accuracy of total catch data for the fishery. Species specific weight conversion rations would replace the conservative default conversion ratios currently used;
- is value for money and seeks to engage two Traditional Owners to assist with data collection to provide an understanding of local conditions and processes.

- Broader consultation with traditional owners on the full application will be undertaken through the TSSAC application process.

8 Pearl Shell and trochus fisheries

100. The Working Group noted the update from AFMA on reported fishing activity and licence numbers in the Pearl and Trochus Fisheries as detailed in the agenda paper. No commercial catches have been reported to AFMA through the Fish Receiver System during 2019 with limited activity reported in the Pearl Shell Fishery reported since 1 Dec 2017.

9 Other Business

101. Prompted by concern from a Traditional Inhabitant member that there is insufficient ongoing research in the BDM Fishery, the Working Group discussed strategic research planning for the Fishery. The Traditional Inhabitant member noted that BDM Fishery has the potential for high returns (BDM is sold the capital cities for $350/kg) but there is no ongoing research investment to maintain and expand our understanding of BDM Stocks. The member sought advice on whether the HCWG should recommend more research into the Fishery.

102. The Scientific member advise that the TS BDM Fishery would always be a small fishery compared to the Tropical Rock Lobster Fishery with moderate returns to fishers. The Scientific member agreed however that there are important research areas that need to be addressed for example, where the fishery wants to go, getting better certainty on stocks such as sandfish, understanding the potential for reseeding and how best to maximise value through optimum utilisation of the resource and value adding. The Scientific member noted that further development of a strategic research plan that focuses on maximising the return of benefits to Traditional Inhabitants across Torres Strait Fisheries overall (this is different to trying to maximise the benefits from each fishery) is needed when funding is constrained.

103. The AFMA member advised that AFMA's annual Torres Strait research commitment is around 400k and is part of AFMA's broader government budget which is constrained. In other Commonwealth fisheries, AFMA recovers most research costs from industry. As further investment into the growth of Torres Strait fisheries continues through TSRA's significant investment in fisheries infrastructure and training, the gap in research needed to support fishery expansion and AFMA's funding is likely to grow, highlighting the challenge to attract additional funding outside of AFMA.

104. The TSRA member highlighted the commitment from the Minister for Indigenous Australian's to increase economic and employment opportunities in the region and that this may be an avenue through which some of the research gaps can be addressed.

10 Date and venue for next meeting

105. The HCWG noted the tentative date for the next HCWG is week beginning 3 August to consider the final draft outcomes of the black teatfish survey.

106. The Chair thanked members for their contributions and professional conduct throughout the meeting. The Chair recognised the significance of matters being deliberating by the HCWG on

fisher's livelihoods. The Chair noted the need to have HCWG advice to the PZJA before the TSRA board enters caretaker mode to ensure consideration of a black teatfish opening later this year can be made. The Chair encouraged timely collaboration between Malu Lamar, stakeholders, TSRA and AFMA to ensure the proposed stakeholder workshop is undertaken as soon as possible noting the likely importance of community measures to supporting a successful opening.

107. The Chair again thanked TSRA for convening the cultural awareness training and thanked members for their full participation. Member were to complete the training feedback form for TSRA.

108. Mr Sereako Stephen closed the meeting with a prayer.

Table 4. Status of actions arising from previous HCWG meetings.

#	Meeting	Action item	Responsibility	Status
1	HCWG 9 (20-21 June 2016)	AFMA to review the size limits set for the Torres Strait Beche-de-mer Fishery taking into consideration the size limits in place in Queensland and the Commonwealth Coral Sea Fishery.	AFMA	**Complete.** The PZJA agreed to the final Beche-de-mer Harvest Strategy at their meeting on 19 November 2019 which was formally implemented on 1 January 2020. Changes to minimum size limits will not be implemented until the remaking of *Fisheries Management Instrument No. 15* is complete.
2	HCWG 11 (27 June 2017)	Consideration on whether or not changes should be made to the current size limit for Prickly Redfish be undertaken during the Harvest Strategy Workshop noting relevant data will be presented.	AFMA	**Complete.** The PZJA agreed to the final Beche-de-mer Harvest Strategy at their meeting on 19 November 2019 which was formally implemented on 1 January 2020. Changes to minimum size limits will not be implemented until the remaking of *Fisheries Management Instrument No. 15* is complete.
3	Out of Session (July 2018)	The TSRA to assist TIB licence holders to develop a proposal to lift the hookah ban when fishing for white teatfish, to be put up to the PZJA for consideration.	TSRA	**Ongoing (replaced with Action Item 6, below).** The TSRA supported PZJA Traditional Inhabitant members to undertake cluster consultations in late 2019 which sought feedback from communities on the use of hookah to fish for white teatfish. An overview of the consultations outcomes will be discussed under **Agenda Item 5.**
4	HCWG 14 (24 October 2018)	Malu Lamar, AFMA and TSRA to meet and discuss a way forward in terms of an MOU/combined strategy to assist in improved data collection and proposed management arrangements in support of a black teatfish opening.	Malu Lamar AFMA TSRA	**Ongoing.** AFMA suggests removing this item from the list of actions. While no formal MOU has been developed, a suite of parallel activities have since taken place including a full round of community visits focussed on Fish Receiver System education and awareness, and more recently PZJA traditional inhabitant member cluster consultations. AFMA also continues to work with individual operators to improve data collection. Having regard to clear HCWG advice at this meeting, AFMA will meet with communities to discuss black teatfish arrangements including reporting requirements.
5	HCWG 15 (1-2 August 2019)	Dr Eva Plaganyi to circulate information about upcoming scientific conferences that could serve as opportunities to showcase the Torres Strait BDM HS as a good news story.	Dr Eva Plaganyi	**Complete.** AFMA circulated information on upcoming scientific conferences on behalf of Dr Plaganyi via email on 5 August 2019.

#	Meeting	Action item	Responsibility	Status
6	HCWG 15 (1-2 August 2019)	TSRA and AFMA to develop a discussion paper outlining suggested management arrangements, based on HCWG discussions for pursuing the use of hookah to fish for white teatfish, for further consultation with communities and consideration by the HCWG and the PZJA.	TSRA AFMA	**Ongoing (linked with Action Item 3, above).** The TSRA supported PZJA Traditional Inhabitant members to undertake cluster consultations in late 2019 which sought feedback from communities on the use of hookah to fish for white teatfish. An overview of the consultations outcomes will be discussed under **Agenda Item 2.1.** Noting key issues to be discussed under **Agenda Item 6**, AFMA is recommending this action be discussed in more detail at the planned future management priorities workshop.
7	HCWG 15 (1-2 August 2019)	AFMA to arrange a half/full day future management priorities workshop in conjunction with the next Hand Collectables Working Group meeting.	AFMA	**Ongoing.** AFMA was unable to arrange the workshop in conjunction with HCWG16 as the focus of this meeting is to seek firm advice on black teatfish for a 2020 opening. AFMA is still committed to arranging a half day workshop to discuss future management priorities for Torres Strait Hand Collectable Fisheries. A time and date for the workshop is to be discussed under **Agenda Item 10**.
8	HCWG 15 (1-2 August 2019)	AFMA to populate the Hand Collectable Fisheries Five Year Research Plan based on HCWG discussions and circulate back to HCWG members out of session for comment before submitting to the TSSAC for their consideration.	AFMA	**Complete.** AFMA circulated a revised Five Year Research Plan to Working Group members' out-of-session for comment on 16 September 2019. A summary of all comments provided by members out of session was then circulated to members via email on 9 October 2019. The updated Research Plan with incorporated member comments was considered by the TSSAC at their teleconference meeting on 25 November 2019. An update on the TSSAC outcomes will be provided under **Agenda Item 7**.
9	HCWG 15 (1-2 August 2019)	AFMA to investigate the possibility of a HCWG industry member accompanying AFMA staff to the next Queensland Sea Cucumber Fishery Working Group meeting.	AFMA	**Complete.** There has been one Queensland Sea Cucumber Fishery Working Group meeting held since HCWG15 however PZJA Traditional Inhabitants were not permitted to attend. AFMA will continue to liaise with Fisheries Queensland about future Sea Cucumber Fishery Working Group meetings and possible HCWG Traditional Inhabitant member attendance.

Attachment A – Adopted Agenda

16th MEETING OF THE PZJA TORRES STRAIT HAND COLLECTABLES WORKING GROUP

Friday 21 February 2020 (8:30 am – 5:00 pm)

TSRA Boardroom, Thursday Island

DRAFT AGENDA v2

The meeting will open at 8:30 am on Friday 21 February 2020.

AGENDA ITEM 1 PRELIMINARIES

1.1 Acknowledgement of Traditional Owners, welcome and apologies

The Chair will welcome HCWG members and observers to the 16th Torres Strait Hand Collectables Working Group.

1.2 Adoption of agenda

The Working Group is invited to consider and adopt the draft agenda.

1.3 Declarations of interest

Working Group members and observers are invited to declare any real or potential conflicts of interests to the group 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 Working Group will note the status of action items arising from previous HCWG meetings.

1.5 Out of session correspondence

The Working Group will note any out of session correspondence on HCWG matters since the previous meeting.

AGENDA ITEM 2 WORKING GROUP UPDATES

2.1 Industry members

Industry members and observers will be invited to provide an update on matters relevant to Torres Strait Hand Collectable fisheries, including a report from PZJA Traditional Inhabitant members on their recent cluster consultation meetings.

2.2 Scientific members

Scientific members and observers will be invited to provide an update on matters relevant to Torres Strait Hand Collectable fisheries.

2.3 Government Agencies

The Working Group will note updates from AFMA, TSRA and Fisheries Queensland on matters relevant to Torres Strait Hand Collectable fisheries.

2.4 PNG National Fisheries Authority

The Working Group will note an update from the PNG National Fisheries Authority.

2.5 Native Title

The Working Group will note a verbal update from the Malu Lamar (Torres Strait Islander) Corporation RNTBC.

AGENDA ITEM 3 CATCH AND EFFORT SUMMARY

The Working Group is invited to note a summary of reported catch in the Beche-de-mer Fishery for the 2019 fishing season.

AGENDA ITEM 4 PRELIMINARY RESULTS OF THE BECHE-DE-MER STOCK SURVEY

The Working Group will consider the preliminary results of eastern Torres Strait stock survey of Beche-de-mer species that took place in (TBC).

AGENDA ITEM 5 FUTURE BLACK TEATFISH OPENING

In consideration of the preliminary stock survey results, and guidance under the Beche-de-mer Harvest Strategy, the Working Group will provide advice to the PZJA on an appropriate TAC and relevant management arrangements required for a possible future black teatfish opening.

AGENDA ITEM 6 PROHIBITION ON HOOKAH

The Working Group is invited to consider the outcomes of the PZJA Traditional Inhabitant member cluster consultations and provide advice on a strategic approach to pursuing the development of a proposal to remove the prohibition on hookah in the Beche-de-mer fishery.

AGENDA ITEM 7 RESEARCH

The Working Group is invited to note an update on the current TSSAC research funding cycle for 2020-21.

AGENDA ITEM 8 PEARL SHELL AND TROCHUS FISHERIES

The Working Group is invited to note an update on activities in the Torres Strait Pearl Shell and Trochus fisheries.

AGENDA ITEM 9 OTHER BUSINESS

The Working Group is invited to nominate any other business for discussion.

AGENDA ITEM 10 DATE AND VENUE FOR NEXT MEETING

The Working Group 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 attend the meeting as an observer must contact AFMA (fisheriesTI@afma.gov.au).

Attachment B – PZJA Traditional Inhabitant Members Cluster Consultations 2019-20

Attached separately.

Summary of Actions Arising from HCWG16

#	Action item	Responsibility
Action item 1.1	Malu Lamar to make recommendations to AFMA and TSRA on an as needs basis to establish an MOU to assist in improved data collection in the Fishery.	Malu Lamar
Action item 5.1	Malu Lamar to take the lead in convening a stakeholder workshop to further discuss and agree on cultural lore and industry agreements with respect to fishing for black teatfish and report outcomes to the HCWG.	Malu Lamar
Action item 5.2	AFMA explore media opportunities such as radio to widely communicate the additional management and reporting requirements for a black teatfish re-opening.	AFMA
Action item 6.1	Malu Lamar to discuss the review of the hookah prohibition at the stakeholder workshop with a view to developing management recommendations.	Malu Lamar

Summary of HCWG16 Meeting Recommendations

#	Recommendation
1	In line with the harvest strategy (section 2.11.4), Working Group recommended a trial fishery reopening for black teatfish subject to a 15 tonne TAC and daily reporting landed catch noting that: a. based on all available information, including preliminary results from scientific dive surveys in November 2019 and January 2020, that the biomass of black teatfish is likely to be over the limit biomass reference point (BLIM - 40 percent of estimated unfished biomass); b. monitoring and management arrangements (with daily reporting) are adequate; i. a mandatory landed catch reporting system is in place and reporting standards in the BDM Fishery have progressively improved since the system was introduced. This includes voluntary reporting of effort information. ii. Fish receivers will be able to submit records to AFMA electronically (SMS, email) during the opening with hard copies to be sent to AFMA in the mail. iii. AFMA is now responsible for domestic compliance and is committed to undertake a targeted compliance program to support a future opening. c. although the preliminary results of the recent scientific survey suggest the stock could sustain a higher TAC, priority was given to ensuring the TAC was demonstrably conservative which is a requirement of the harvest strategy.
2	The Working Group recommended that this issue [prohibition on hookah] be considered in a broader stakeholder workshop and recommended that it form part of the Malu Lamar led workshop process being organised to finalise customary arrangements for the trial opening of black teatfish.

Australian Government
Australian Fisheries Management Authority

Black teatfish trial opening
Checklist for Fishers

Start date: 30 April 2021
Total Allowable Catch: 20 tonnes

BEFORE 30 April 2021

CHECK	• Your new and existing licence conditions • That you have a Beche-de-mer (BD) entry on your licence
RENEW	Your TIB fishing licence if it has expired or is due to expire soon
UPDATE	Your contact details with AFMA: • mobile phone number • email
PLAN	Ahead with your licenced fish receiver – know who you are going to land to daily
NOMINATE	If required, an authorised agent to sign the fisher details section of the catch disposal record (CDR). The same person cannot sign the fisher details section and the fish receiver section of the CDR.

DURING black teatfish season

LAND CATCHES DAILY	Land your black teatfish catch to a licenced fish receiver on the **same day** the catch is taken. This means **daily**. Make sure you have mobile phone reception and internet connection to stay up to date with daily catch updates from AFMA via SMS and **www.pzja.gov.au**
CHECK	Your mobile phone, email and **www.pzja.gov.au** for AFMA messages on: 1. Daily catch update 2. When to stop fishing (the day after the TAC Date#)

AFTER TAC DATE
DO NOT FISH FOR BLACK TEATFISH

The TAC Date is the day that the PZJA or its delegate determines based on its reasonable belief that the TAC will be reached. You cannot fish the day after the TAC Date.

Black teatfish trial opening
Rules for Fishers

Fishers MUST

- ✓ Hold a current TIB fishing licence with a Beche-de-mer (BD) entry.
- ✓ Make sure that all crew are traditional inhabitants*.
- ✓ Land black teatfish catches to a licenced fish receiver **on the same day** the catch is taken. This means **daily**.

* FAQs and the form for Traditional Inhabitant identification verification can be found on **www.pzja.gov.au**

Fishers MUST NOT

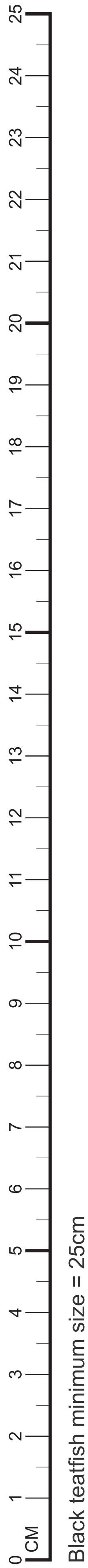
- ✗ Fish for or stockpile black teatfish **before** 30 April 2021
- ✗ Use hookah gear
- ✗ Take black teatfish that are smaller than 25 centimeters (see ruler for length)
- ✗ Fish from a boat greater than 7m in length
- ✗ Fish for black teatfish **after the TAC Date.**

For more information, contact AFMA

Thursday Island Office
Phone: (07) 4069 1990
Fax: (07) 4069 1277
Email: tistaff@afma.gov.au

AFMA Licensing
Phone: 1300 723 621
Phone: (02) 6225 5555
Email: licensing@afma.gov.au

Report illegal fishing to CRIMFISH on 1800 274 634



Australian Government
Australian Fisheries Management Authority

Meeting of the Torres Strait Hand Collectables Working Group members

7 August 2020, Video conference

Final Meeting Record

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

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1 Preliminaries

1.1 Acknowledgement of Traditional Owners, welcome and apologies

1. Quinten Hirakawa opened the meeting in prayer around 9:20 am.
2. The Chair welcomed attendees to the meeting via video conference. The Chair acknowledged the Traditional Owners of the land on which the various members were located and paid respect to Elders past, present and future.
3. Attendees at the Working Group are detailed in **Table 1** below. The position of Traditional Inhabitant Member for Maluialgal is currently vacant.
4. The Chair welcome the Scientific member, Steven Purcell, to his first meeting of the HCWG.
5. The AFMA Member advised that this meeting did not meet the requirements for quorum under PZJA Fisheries Management Paper 1, due to the absence of three traditional inhabitant members. As a result any recommendations and advice from the meeting will be of individual working group members as opposed to advice of the Hand Collectables Working Group (HCWG).

6. Apologies received are detailed in the **Table 2** below.

Table 1. List of attendees at the meeting of HCWG members

Members	
Anne Clarke	Chair
Tim Skewes	Scientific member
Michael Passi	Traditional Inhabitant member, Kemer Kemer Meriam
Maluwap Nona	Traditional Inhabitant member, Gudumalulgal
Selina Stoute	Australian Fisheries Management Authority (AFMA) member
Mark Anderson	Torres Strait Regional Authority (TSRA) member
Steven Purcell	Scientific Member
Nick Boucher	Queensland Department of Agriculture and Fisheries
Executive Officer	
Danait Ghebrezgabhier	HCWG Executive Officer, AFMA
Observers	
Maluwap Nona	Malu Lamar (Torres Strait Islanders) Corporation RNTBC
Yen Loban	TSRA Fisheries Portfolio Board Member
Nicole Murphy	Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Eva Plaganyi-Lloyd	CSIRO
John Jones*	Compliance Manager, AFMA
Ian Butler	Australian Bureau of Agricultural and Resource Economics and Sciences, Department of Agriculture, Water and the Environment

Keith Brightman	TSRA
Quinten Hirakawa	TSRA

* John Jones attended the preliminaries of the meeting and then left to remain on standby to re-join the meeting as required. That is when advice was required on compliance related matters. Mr Jones however was note recalled to the meeting.

Table 2. List of apologies for the meeting of HCWG members.

Apologies	
Anthony Salam	Traditional Inhabitant Member - Kaiwalagal
Patrick Bonner	Traditional Inhabitant Member - Kulkalgal
Ian Liviko	PNG National Fisheries Authority (NFA) Invited Participant

1.2 Adoption of agenda

7. Given the video conferencing format of the meeting and in order to allow adequate time for the presentation of the preliminary survey results and consideration of a future black teatfish reopening, Working Group members:
   a. accepted the traditional inhabitant member recommendation to bring forward Agenda Item 4 - the Preliminary survey results and Agenda Item 5 - Future black teatfish reopening
   b. agreed, as recommended by the Chair, to take the following agenda items as read:
      i. Agenda item 1.4 - Action items from previous meetings
      ii. Agenda item 1.5 - Out of session correspondence
      iii. Agenda item 2.3.1 – Government, native title and scientific updates
8. However, with regards to Agenda Item 2 – Working Group updates, the Chair noted that it would be valuable for industry to provide a general update together with an update on any impacts that COVID-19 related restrictions and impacts may have had on their fishing operations

1.3 Declarations of interest

9. The Chair advised members and observers, that having regard for the video conferencing format and potential for technology issues, members and observers were invited to update the register of interest provided in the agenda paper by exception and that members would not be asked to leave the meeting. Declared interests are detailed in **Table 3** below. No members objected to this process.
10. Table 3. Declared interests from each attendee.

Name	Position	Declaration of interest
Members		
Anne Clarke	Chair	Previously contracted with Regional Development Australia Far North Queensland and Torres Strait No pecuniary interests or otherwise.
Tim Skewes	Scientific Member	CSIRO/Independent Consultant.

Name	Position	Declaration of interest
		Current co-investigator on TSSAC project 'measuring non-commercial fishing in the Torres Strait'. Current co-investigator on TSRA funded project 'Stock survey of Torres Strait Beche-de-mer species'. Previous principal scientist for Torres Strait Scientific Advisory Committee (TSSAC) project to develop a harvest strategy for the TSBDMF. Previous CSIRO researcher for TSSAC project investigating traditional take of finfish in Torres Strait.
Steve Purcell	Scientific Member	Has interest in invertebrate fishery research has previously worked in the assessment of sea cucumber fisheries in the Pacific and New Caledonia, and on restocking/sea-ranching research; no pecuniary interests or otherwise.
Michael Passi	Traditional Inhabitant Member Kemer Kemer Meriam	TIB licence holder
Maluwap Nona	Traditional Inhabitant Member, Gudumalulgal	TIB licence holder; Chairperson of Malu Lamar; Director of MDW Fisheries Association on Mer; Traditional Inhabitant Member on TSSAC.
Selina Stoute	AFMA Member	Employed by AFMA, no pecuniary interests or otherwise
Mark Anderson	Torres Strait Regional Authority (TSRA) Member	Employed by TSRA, no pecuniary interests as an individual, TSRA holds fishing licences on behalf of traditional inhabitants.
Nick Boucher	QDAF Member	Employed by Queensland Government Managing the East Coast Sea Cucumber Fishery. Previously worked with the TSRA on Torres Strait Fisheries – no pecuniary interests or otherwise
Danait Ghebrezgabhier	Executive Officer, AFMA	Employed by AFMA, no pecuniary interests or otherwise
Permanent Observers		
Yen Loban	TSRA Board, Fisheries Portfolio Member	TIB licence holder; TSRA Board Member for Ngurupai
Casual Observers		
Eva Plaganyi-Lloyd	CSIRO	
Nicole Murphy	CSIRO	
Ian Butler	Australian Bureau of Agriculture and Resource Economics (ABARES)	Employed by ABARES, DAWE, no pecuniary interests or otherwise
Keith Brightman	TSRA officer	Employed by TSRA, no pecuniary interests or otherwise
Quinten Hirakawa	TSRA officer	

1.4 Action items from HCWG16 and previous meetings

11. All updates on the status of action items arising from previous HCWG meetings were taken as read and were not explicitly discussed (**Table 4**).

12. The Working Group noted the final meeting record for HCWG 16, which was finalised out of session and published on 3 April 2020.

1.5 Out of session correspondence

13. All out of session correspondence on Working Group matters since HCWG16 was taken as read and not explicitly discussed.

2 Working Group Updates

2.1 Industry member update

14. Both Traditional Inhabitant Members, advised members that rough weather over the past few weeks has made it challenging to go fishing but the stocks in the fishing grounds appear to be healthy. The member has had discussion with other full time TIB operators on ramping up fishing operations once the weather improves.

15. COVID-19 related restrictions have given the members a chance to discuss and reflect on various issues in the fishery with other traditional inhabitant members on the HCWG and other operators in the community. This has given them an insight into how to do business in the community, including management arrangements for the reopening of black teatfish.

3 Catch and effort Summary

16. Working Group members noted the Executive Officer's update on Beche-de-mer (BDM) catches for the 2020 fishing season (as at 24 July 2020) noting that under AFMA's Information Disclosure Policy, data on reported catch within a season can only be provided for species that have been reported as being caught by five or more operators.

    a. A bit over 14 tonnes of BDM had been reported as being caught across 14 different species. A total of 20 different licenced TIB fishers have landed BDM to a total of eight different licenced fish receivers.

17. Industry members agreed that the catch summary is a fair representation of catches for the 2020 fishing season to date.

18. The issue about different product forms being weighed by fishers or fish receivers was questioned because the catch weights in gutted-weight equivalents will be in error unless the appropriate conversion ratios are used according to each product form. Incorrect reporting of product form in this fishery will probably result in underestimation of the overall catch, so this is an important issue to get right.

19. The AFMA Member clarified that BDM is required to be weighed at the point of landing to a licence fish receiver. Landed product can be processed and agreed conversion ratios for various processing methods are used to convert all reported catch to a standard weight (wet gutted). Where species specific conversion ratios are not available, the most conservative

conversion factor calculated for other species from that same processing method is applied. The reported catch data provided in the summaries is converted weight.

4 Preliminary results of the Beche-de-mer stock survey

20. The Scientific member and co-investigator for the project, Mr Tim Skewes, presented the preliminary results of the Beche-de-mer underwater dive surveys undertaken in eastern Torres Strait between November 2019-January 2020 as part of the TSRA funded and CSIRO led project 'Stock survey of Torres Strait Beche-de-mer species' (AFMA Project No. 2019/0826). As well as assessing the distribution and stock status of beche-de-mer species in the Torres Strait, the survey also undertook some exploration and mapping of deep water habitats to help inform better environmental management and ground truth reef mapping from previous projects.

21. A total of 297 sites, in 6 zones and a range of strata (equivalent to reef habitat areas) in East Torres Strait were surveyed, most of which had also been done in the 2002-2009 surveys. 53 new deep water sites were surveyed to investigate potential deep water population species such as white teatfish. The deep water surveys covered 20m-50m depths and a TSRA camera system recorded underwater footage during 10 minute drifts of transects (40m – 675m long). The outputs of the survey include relative average densities for species by zones and strata, comparative density over time, and standing stock estimates for the stock. The results for the Barrier and GNEC zone are excluded from the comparative density estimates as they were not surveyed during all previous surveys, however they are still used in the 2019/20 standing stock estimate. The project also carried out detailed sampling of sea cucumbers and habitats on Ugar reefs to support a potential reseeding project there, the results of which were also tabled at the meeting but not discussed.

PART 1 – Preliminary survey results

22. The preliminary results presented here were produced for consideration by the Working Group members to facilitate decisions related to the reopening of the BTF fishery, and as a "first pass" assessment of the sustainability of currently targeted species. The full analysis and recommendations will be contained in the Final report due end December 2020. The preliminary results of the survey are summarised below:

    a. **Black teatfish (*Holothuria whitmaei*)**

    i. Black teatfish density across all zones and strata surveyed averaged 7.4 per hectare (Ha) – with the average density in the reef-top buffer strata, its preferred habitat, of about 12 per Ha. None were seen in the deep water strata (>20m). The Barrier and Don Cay zones had the highest average density of black teatfish (>17/Ha) which is well above the 12.5/Ha indicative healthy density for Black teatfish from a FAO global review. The higher densities observed at these sites are consistent with industry's reports of observations.

    ii. The Darnley, Great North East Channel (GNEC) zones had the lowest density of black teatfish as expected but the results of this survey show a decrease from previous surveys. The results of the Seven Reefs zone on the other hand show an increase in density from previous surveys.

    iii. The 2019/20 4-zone density is only slightly less than the 2009 density which was considered to have recovered to close to B_0 levels. Together with the very high density observed in the Barrier and Don Cay zones, especially in the preferred reef top buffer strata, in 2019/20 and the similarity of the density in these areas to closed population densities in the GBR, this indicates that the black teatfish population is currently in a healthy state.

iv. The conservative stock estimate for black teatfish was 817.8t (gutted weight), this being the lower 90th percentile of the estimated biomass of 1,238t (gutted weight) to account for the uncertainty in the estimate due to natural variation in densities and the extrapolation of the survey results to produce the biomass estimate.

v. The length frequency data showed the presence of some of the largest Black teatfish recorded however there was a slightly lower relative proportion of legal size animals compared to 2009 and the average size was slightly smaller than that measured in 2009, but larger than other surveys. Members noted the advice from one of scientific members that this could be a sign of shrinking of larger individuals and/or the presence of new recruitment to the fishery (hence a greater proportion of smaller animals are present).

vi. Additional work is required to advise on carrying capacity and the limit reference point for this species.

b. White teatfish (*H. fuscogilva*)

i. The survey results indicates that the deep water strata (20 m - 50 m) (where sampled) in 2019/20 had the highest densities of white teatfish of any strata, with an average density of 15 per Ha. This high density was consistent in all zones sampled. They were also noted in high density on the reef top in the Barrier and Don Cay zones, especially on the deeper reef top habitats. Don Cay had the higher overall density of any zone at over 10 per Ha.

ii. White teatfish average (stratified) density in east Torres Strait reef zones was very variable over the years. Don Cay zone again had the highest density of White teatfish in the east Torres Strait area, and the Barrier zone had the highest ever observed.

iii. The highest overall (4-zone) average stratified average for white teatfish (shallow reefs only) observed was in 2002 at 2.5 per Ha. While the 2019/20 estimate of 1.83 per Ha was not as high as 2002, the observed density coupled with the substantial population in deeper water that is likely unfished, indicates that the white teatfish population was still in a healthy state.

iv. The preliminary fishery biomass population estimate (lower 90th percentile as gutted weight) for white teatfish in 2019/20 was 543 t, with almost half of that found in the deep water strata, but none found beyond 36m (deep water strata area is assumed to be the same as the reef edge area – more analysis will be required to better estimate the area of this habitat). The highest density occurs between the depths of 20m-36m and the species seems to prefer sandy-bottom habitat.

v. Density estimates in deep water far surpassed density in shallow water. Delineating deep water habitat will be challenging to come up with a biomass estimate given their depth.

vi. Currently the area of the deep water strata is assumed to be the same as the reef slope area. This is likely to be an underestimate therefore this will result in an underestimation of the stock.

vii. Additional work is required to advise on carrying capacity and the limit reference point for this species.

c. Prickly teatfish (*Thelenota ananas*)

i. The survey results indicates that the highest density was in the Barrier edge strata, and this was true overall as well, with the reef edge having an average density of 16 per Ha.

There were few prickly teatfish seen in deep water (>20 m). The Barrier zone also had the highest overall density at 18 per Ha.

ii. Overall (4-zone) density was the lowest ever observed for prickly teatfish at 1.5 per Ha, being only 63% of the 2005 estimate, and continues a downward trend for this species since 2005.

iii. The Cumberland zone, which has a large area and is an important habitat for this species, had a relatively low density, especially when compared to the Barrier zone, where high levels of fishing are unlikely.

iv. The preliminary fishery biomass population estimate (lower 90th percentile as gutted weight) for prickly teatfish in 2019/20 is 375t.

v. The low prickly redfish densities observed at Darnley were not surprising and seemed consistent with fishers' observations to that effect. It was noted that the Darnley fishing grounds are usually better known for their curryfish assemblages.

vi. Juvenile/small sea cucumbers were not observed.

vii. The level of depletion observed is expected given the level of fishing on the species and the TAC has been reduced previously in response to industry's concerns that under reporting may be occurring in the fishery.

viii. Industry members further confirmed that sustainability of the species was a concern for them and they have been rotating between the key fishing grounds using traditional knowledge and understanding on a 3-4 month basis and have seen the benefit in the recovery of the larger individuals.

ix. The scientific member Tim Skewes commented that the 3-4 month cycle rotational strategy is most likely allowing larger animals from other areas of the reef to move in.

x. The scientific member Steven Purcell added that the variation in density may also be due to the species' daily cryptic (hiding/burrowing) and semi-aggregation behaviour, which may in turn be influencing the abundance estimates.

xi. The scientific members and industry members agreed that further opportunities should be pursued to enable science to inform industry's rotational strategies and traditional ecological knowledge to help inform future scientific stock surveys especially with regards to juvenile/settlement areas.

d. Curryfish (common) (*Stichopus herrmanni*)

i. The survey results indicates that the highest common curryfish density was on the reef top buffer strata, particularly in the Darnley zone, at 38 per Ha. They were also seen on the reef edge and, to a lesser extent, on the reef top strata. Some were even observed in the deep water strata, but in low densities. The Darnley zone had the highest overall density. Cumberland and Don Cay zones also had significant densities of common curryfish.

ii. Zone and overall survey density over survey years for this species was quite variable. Overall the density was lower than in 2009, and similar to 2002, however, there was not a great variation in density over time.

iii. The preliminary fishery biomass population estimate (lower 90th percentile as gutted weight) for common Curryfish in 2019/20 was 632t. Note that deep water strata area is assumed to be the same as the reef edge area. More analysis will be required to better estimate the area of this habitat.

iv. Provisional harvest strategy limits do not seem to have been breached, however as per prickly teatfish, the declines in density from previous surveys, while not unexpected given the level of fishing effort on them, need to be investigated further to ensure that the stock remains sustainable.

v. Species specific identification can be challenging for curryfish species and a dedicated project on collecting morphological info and understanding habitat preference for Curryfish species is a priority.

e. Curryfish (*S. vastus*)

i. The survey results indicates density increased significantly since the 2009 survey. Industry confirmed that they do come across a lot more *S. vastus* while fishing although none of the traditional inhabitant members on the HCWG target *S vastus* specifically – they are usually just included in the curryfish catch.
ii. We were not able to produce a preliminary fishery biomass estimate at this stage due to the extreme patchiness of this species. more analysis will be done for the final report.
iii. Acknowledged that species identification is key and more work needs to be done to standardise naming of Curryfish species.
iv. Industry commented that curry fish processing can be fiddly and requires careful handling and a lot of patience. Some industry members are working on best processing methods and have worked out a way to dry the product. If successful, dry curryfish can fetch up to $155/kg (dried) compared to $28/kg (wet)
v. The Traditional Inhabitant Member, Gudumalulgal requested that full time TIB operators be invited to participate at HCWG meetings to share their expertise in the industry.
vi. AFMA Member confirmed that it strongly supports additional industry expertise being made available to the HCWG as required.

f. Surf redfish (*Actintopyga mauritiana*)

i. The survey observed low densities of this species most likely due to its cryptic behaviour during daytime. A dedicated surf redfish survey on the wave-exposed reef crests is likely required to search for individuals.
ii. This is currently a closed species and current abundance is not sufficient to warrant re-opening the fishery.
iii. The scientific member Steven Purcell remarked that the low abundance for this species was a concern.

g. Deepwater redfish (*A. echinites*)

i. This species has gone through a significant decline due to extensive fishing effort but seems to have recovered.
ii. It has a very patchy distribution and this makes it hard to survey.
iii. The preliminary fishery biomass population in 2019/20 is 70t.

h. Hairy blackfish (*A. miliaris*)

i. Similar to Deepwater redfish, this species is also hard to survey due to its patchy distribution. Previous surveys have found a couple of high density patches but none were seen in this survey.
ii. It is hard to determine whether the density trends are due to patchiness in distribution or to fishing.
iii. The preliminary fishery biomass population in 2019/20 is 10t.

i. Greenfish (*S. chloronotus*)

i. Greenfish is not a heavily fished species but populations tend to be variable over time and space, making them challenging to survey.
ii. They can be one of the most abundant sea cucumber species in the Torres Strait – they were extremely abundant during the 2009 survey.

iii. The preliminary fishery biomass population in 2019/20 is 706t.

23. The scientific member Tim Skewes advised that none of the preliminary results appears to raise immediate sustainability concerns that need to be addressed as a matter of urgency prior to the project being finalised in December 2020 and before the start of the 2021 fishing season.

24. Having considered the results and advice from the scientific member, Working Group members agreed to consider the finalised survey results and their implications for future management arrangements across all species (noting black teatfish results are being considered in detail at this meeting) in the Beche-de-mer Fishery at their meeting in early 2021.

25. With agreement from the project team and traditional inhabitant members at the meeting, the AFMA Member advised that AFMA would make arrangements for further discussions between industry and the project team to inform the further word required to interpret the current survey results across all species. In consultation with participants, these meetings would likely be organised for the coming months.

26. The scientific member Tim Skewes also advised that future scientific stock surveys could benefit from Industry input with regards to future areas to be surveyed given that some specific areas that have high densities and/or specific length compositions have been observed by fishers for some species.

27. Working Group members thanked the Scientific member and the rest of the project team for their work on the project to date and noted that the next project progress update is due in October, with the project due to be completed in December 2020.

Part 2 - Black teatfish stock status

28. Following the presentation of the survey results, the Scientific Member Tim Skewes provided additional information and clarification on the status of black teatfish stock in the Torres Strait and interpretation of the survey results in the context of the harvest strategy HS, the current gaps in the knowledge and comparison with management strategies used by other jurisdictions.

29. Default values of B_{TARG} and B_{LIM} in the Commonwealth Harvest Strategy Guidelines are 48% B0 for B_{TARG} and 20% B0 for B_{LIM}. However, there is broad recognition that these reference levels may be too low for sea cucumbers. The Torres Strait Beche-de-mer Fishery Harvest Strategy has a conservative proxy value of B_{LIM} of 40%B0. It is envisaged that these reference levels, including values of B_{TARG}, will be developed as more data become available. The scientific member Tim Skewes agreed to provide members with supporting resources on harvest strategy reference levels.

30. When drawing comparisons with other surveys, such as the ones undertaken for the Great Barrier Reef, unbiased comparisons between locations are difficult as sea cucumber density varies across reef habitats and in relation to distance from terrigenous influence (across shelf)—and likely several other lesser known gradients. Comparison depends on a clear delineation of the surveyed habitats and historical surveys in Torres Strait have been carried out using the same sample design and survey approach. The current report is showing better confidence in the biomass estimate and this is a sign that future surveys should replicate the sampling protocol for comparability. The results of the surveys are also consistent with industry's reports that stock abundance has increased for certain species.

31. It is hard to compare between various density reference points used in Australia and globally due to how habitat is defined in the various studies, however, by comparing density estimates in similar habitats between regions, it appears that black teatfish density in Torres Strait compares favourably to other regions, including closed areas on the GBR, indicating that black

teatfish densities in the Torres Strait are in a reasonable state. This inference is supported by comparisons with densities in other reports across all habitats and within the species preferred habitats.

PART 3 – modelling analyses

32. Dr Eva Plaganyi presented the results of supplementary modelling analyses that built on the survey results for the Black teatfish stock in the Torres Strait. The biomass dynamic model uses the total 4-zone average biomass reported in the survey results and reported catch data to explore the changes over time to the biomass and productivity of the black teatfish population and see which life history parameters are consistent with the trends in the data. Whilst acknowledging there are limited data and large uncertainties, this type of analysis can help inform on sustainable fishing levels. This level of information cannot be obtained from a stock survey which is a static measure of the standing stock biomass at a given point in time.

33. The model is simple due to the limited information that is currently available for the fishery (i.e., relatively few values in the survey time series (5)) but provides a useful first step in exploring a range of alternative harvest scenarios with different levels of precautions added to support decision making. The fact that there is some contrast in the time series (a decline followed by a recovery) however provides some confidence to use the data to estimate productivity. Consistent with the BDM HS's tiered approach, the model incorporates precaution to deal with the level of uncertainty of the data for the fishery.

34. Key precautions when fitting to the 2019/20 survey estimate is to use the lower 90th percentile estimate and for models where the total biomass is estimated, the models estimate a lower biomass estimate and apply fairly conservative estimates of the growth rate parameter *r* so as not to over-estimate the productivity of the stock (especially given recruitment is sometimes sporadic in this species). Although a number of alterative sensitivities were considered, the model base-case doubled the starting 1995 survey estimate based on consideration of reasons why this estimate may be an under-estimate. The exact correction factor isn't known, but this assumption results in a steeper declining trend in survey indices in the early years (catches were also doubled) which also adds to the precaution applied. The model will get more refined and improved as more data become available.

35. As well as standing stock biomass estimates derived from surveys and catch data, the model uses a combination of the intrinsic growth rate (r) and the carrying capacity (K) parameters to obtain an estimate of productivity and replacement yield in the fishery (that is more robust than either parameter on its own) and hence a relatively robust estimate of Maximum Sustainable Yield (MSY) (assuming a Schaefer logistic growth model). The biomass estimate from the 1995 survey was doubled to provide an estimate of the carrying capacity of the stock. This was considered to be an appropriate starting point as the fishery was in its initial phases and the stock survey at the time is likely to have underestimated the biomass of the stock, relative to any other period in the surveyed history of the fishery.

36. The base-case model estimates the stock is currently at around two-thirds (67%) of *K*, and even though this is uncertain, all models suggest considerable stock recovery (well above BLIM), and hence it is reasonable to suggest MSY could be used as the sustainable replacement yield to inform decisions on a sustainable TAC.

37. Given the data inputs and the conservative parameter settings applied, the base case model was used to forward project the biomass trajectory under different exploitation levels, with 15t TAC and 30t TAC presented. The results suggest that 20-21 tonnes (MSY) may be a sustainable catch level for the trial reopening of the black teatfish fishery. This estimate is slightly higher than the 15t default opening TAC recommended by the BDM HS agreed in 2019.

The model projections suggest that a constant annual TAC of 30t would not be sustainable and would lead to a consistent decline in the biomass of the stock after the first year of fishing.

38. There was concern expressed by the TSRA Member that the base-case model (Model 4) did not accurately match the abundance estimates from the stock survey (the survey estimate is 818 tonnes for 2019/20 whereas the model estimate is around 300 tonnes). This was because the base-case model was selected as the base-case based on formal model selection methods which provides the best fit (with fewest associated parameters) to all of the observed data, including surveys from previous years and reported removals, and thus most plausible explanation of the trend in the data that the model are fitted to. Models are not reality but simplified depictions that help the understanding of some of the properties of complex systems.

39. Dr Plaganyi explained that in addition to the base-case model, a number of additional model versions were run and results of some of these presented in the accompanying report and at the meeting, including versions that fixed the biomass at higher levels more similar or identical to the 2019/20 survey biomass estimate. Across all model versions tried, the MSY estimate was roughly in the range 17-28t (with 22t estimates for the version identically matching the survey biomass level) and hence the MSY estimate of 21t was considered relatively robust.

40. In this instance, the biomass dynamic model uses conservative assumptions to provide assurance that the stock is at a healthy place and uses the different pieces of information that that are available for the fishery to explain how the productivity of the stock will respond to different levels of exploitation. That is, it provides information on how stock levels might change over time (the trend in biomass: constant, increasing, declining).

41. This level of information cannot be obtained from a stock survey alone which is a static measure of the standing stock biomass at a given point in time and does not take into account the level of susceptibility of the stock to fishing. Furthermore, the base case model could be considered as representing the fished areas only, as opposed to the entire region (which the survey results are extrapolated to). Poor catch reporting can underestimate stock productivity. This is because a decline in stock biomass may be attributed to low catches and hence associated low productivity of the stock, whereas if the catches were actually higher, this means the stock productivity must have been higher.

42. The following additional data would help refine model analyses in the future:
    - Available biomass would be a better index to use when managing a recovering stock because it accounts for the lag effect in recruitment to the fishery, especially if they are a slow growing species, to give them a chance to reproduce.
    - Additional data– (catch per species, effort (e.g., data on hours spent fishing per day and number of fishers for each reported catch), catch per unit effort, spatial footprint (approximate areas or reefs fished by each fisher for each reported catch) and species composition) or better certainty in catch data will help to refine and substantially improve modelling results, and assess the accuracy of the current productivity estimate.
    - spatial aspects need to be accounted for in the modelling to reconcile the absolute biomass estimates with the trends in the survey data. Data loggers/tracking devices could be used to quantify spatial footprint and dive times etc
    - Sub-samples of catches could be sampled by fishers/individuals to collect data such as size measurements

43. A TSRA observer acknowledged the value of the modelling work but argued that it was full of uncertainty and as such should not be used to inform the discussion on setting a trial reopening TAC for black teatfish. The TSRA officer alleged that the supplementary modelling work was prepared in secrecy and outside of the scope of the project contract and without any consultation with traditional owners. He further alleged the purpose of undertaking this work was not explained adequately.

44. The AFMA Member advised that it took exception to the accusation made by the TSRA officer that the supplementary work was undertaken in secrecy and implication that AFMA and the project team have not been transparent. The information was not purposefully held back and a copy of the report was shared with the TSRA as soon as it became available. The project team has worked hard to undertake the analysis in time for the meeting. The purpose of the analysis is to support members in developing advice, including traditional inhabitant members. The modelling is not intended to replace data but simply add further lines of evidence for the working group to consider. This meeting provides an opportunity for members to understand and review the information with the project team.

45. Dr Plaganyi advised that there was nothing sinister about the additional work and expressed regret at the misunderstanding that this has caused. Dr Plaganyi outlined that the project team had gone through a considerable amount of effort to upskill to be able to use additional tools to provide insight into the application of the HS using a bootstrapping approach that was previously applied in this fishery but requires time to implement, in the midst of the disruption that the current COVID climate has caused for everyone. The intention of the additional work was to provide as strong a scientific basis as possible to inform the Working Group and industry's consideration of the survey results in light of a future reopening of black teatfish.

46. The Scientific member Steve Purcell advised that in his view the report is very well put together particularly give the time constraints. The survey is of high quality and the modelling advances the analysis. The member understood why some members find it confusing that the model biomass estimates do not match with the survey estimates of biomass. The modelling unlike the survey, incorporates all catch data and potential stock recovery rates. The survey results unlike the modelling also incorporates areas that are not necessarily fished.

47. The Scientific member, Tim Skewes, further advised members that the modelling uses all available information and gives an indication of the potential susceptibility of the species to fishing. It tries to explain why the population dropped so much historically noting catch was very much a likely driver of that decline. This involves a lot of work and it is unfair to say it was done in secret.

48. The TSRA Fisheries Portfolio Board member suggested that the Working Group members proceed to discussing the opening of the fishery based on the advice of the initial modelling work that a trial TAC level of 20-21t is considered sustainable. The Board member further suggested that the modelling be revisited following an initial opening to assess whether higher catch levels are possible for black teatfish in the fishery, following the collection of good quality fishing data.

49. AFMA Member noted that through the development of the HS industry had made clear their preference to rebuild a fishery for this stock cautiously over time and that the collection of data was a long-term commitment. Periodic surveys alone will not resolve uncertainties, good quality catch and effort data is required

50. The TSRA observer withdrew his allegation of the supplementary work being undertaken in secrecy and that it is not a reflection of the science rather an expression of frustration at not having being able to access the supplementary information earlier.

51. To conclude her presentation Dr Plaganyi outlined further research opportunities in exploring the potential uses of a revised and updated MSE (incorporating multispecies spatial operating model):
    - Could model all key species, with age structure and spatial component and bound the range of uncertainties
    - A tool to more comprehensively evaluate the risks of different TAC alternatives
    - A tool to validate the new Harvest Strategy (HS) and help implement rules such as how best to use indicators to adjust TACs e.g. size measurements used to inform on age structure and hence available biomass

- Can explore how adding data reduces uncertainty and hence consequences for management recommendations
- More broadly can contribute to aspirational development of an integrated ecosystem model that incorporates climate change

5 Future Black teatfish opening

Recommending a TAC based on information presented at the meeting

52. In recognition that new information (the modelling and estimates of available biomass) had been tabled at the meeting and circulated only a few days before the meeting, the AFMA member sought advice from members on whether or not they would like additional time to consider the information, including at a future HCWG meeting. The AFMA member noted that a further meeting of the HCWG could be convened.

53. Both traditional inhabitants together with the TSRA Board Fisheries Portfolio member advised they did not want further time. They supported using the information available and noted industry's commitment and understanding on the need to improve data for the fishery overtime.

Is the stock above the limit reference point?

54. Working Group members agreed that, all available information indicates that the stock is above the limit reference point, thus satisfying the first condition of *Section 2.11.4 Re-opening Decision Rule* of the TSBDM HS.

Recommending a TAC based on harvesting an agreed proportion of the estimated standing stock biomass for 2019/20

55. Working Group members discussed the merits of recommending a TAC based on a percentage (e.g., 10%) of the standing stock biomass estimate (available biomass or total) versus a modelling approach to recommending a starting black teatfish TAC to the PZJA. The Scientific Member Tim Skewes advised working group members that he considers the modelling approach to be more reliable and expressed his preference to use this as a basis for decision making, including setting catch limits, along with other lines of evidence. The 5-10% rules of thumb are derived from existing literature to inform exploitation levels for sea cucumbers in the absence of other data and analysis for a given fishery. A 5 % exploitation rate is intended to provide a conservative harvest limit taking into account the slow growth rate and susceptibility to depletion of sea cucumber species generally. It is hard to estimate an upper exploitation limit for these species and 10% was therefore identified as a rule of thumb for the maximum level of take that a healthy sea cucumber stock could sustain.

56. The scientific member, Steve Purcell, advised that 5% exploitation level is of limited application to black teatfish as populations have still been depleted at this level of fishing—the East Coast fishery being a well-studied example. Importantly, rules of thumb do not abrogate the need to collect good fishery data to inform the management and decision making in a fishery. Rules of thumb are based on observations that may be thought of as precautionary but can sometimes be misleading as they may not always account for change in productivity due to changes in recruitment.

Member advice on a reopening TAC

57. Working Group members proceeded to individually recommend a trial opening TAC that they consider to be demonstrably conservative as per Condition 4 of the Reopening decision rule of the BDM HS.

58. None of the Working Group members recommended applying the rule of thumb approach described above.

59. **AFMA Member supported a recommended trial opening TAC of 20t** based on the conservative model outputs.

60. **Traditional Inhabitant Member Gudumalulgal** recommended a TAC of 20t noting that 21t would still be considered sustainable but the 1t would provide a buffer should the TAC be exceeded. The member also recommended an April 2021 re-opening to allow enough time for the engagement of individual TIB operators to get their perspectives on the arrangements for the reopening.

61. **Traditional Inhabitant Member Kemer Kemer Meriam** – reiterated his agreement with Traditional Inhabitant Member, Gudumalulgal with regards to recommending a 20t TAC level. The member also reiterated that it is important to undertake consultation with full time fishers on all the elements of a black teatfish trial reopening, including presentation of the scientific basis for the recommended TAC and the additional catch reporting requirements that would in place.

62. **The TSRA Member recommended** a TAC of 21t, relying on the provisions in the HS to provide the 5% buffer should catches exceed the set Trial TAC. The member further confirmed that the TSRA Board have supported for the TSRA Fisheries section to undertake community visits, given the stakeholder workshop could not proceed due to COVID-19 restrictions.

63. Traditional Inhabitant Member, Gudumalulgal left the meeting at 3pm to pay respects to an elder that has passed away at Badu.

64. **The Scientific Member Steven Purcell recommended** the more conservative 15t Trial TAC for the reopening as the rate that can be demonstrated by the science as being more sustainable especially in light of the CITES Appendix II Listing for black teatfish coming into effect at the end of August. The member noted that the model indicates that 20t would be a sustainable and is based on a precautionary biomass estimate. However this is the maximum sustainable yield (MSY) level that can be taken without impeding the sustainability of the stock and if exceeded runs the risk of having to close the fishery in the future. Whereas a 15t TAC would lower that risk and would support the sustainable redevelopment of the fishery as more CPUE data becomes available to support setting higher TACs in future years. The present lack of data from fishers about fishing effort and areas being fished for each reported catch leaves too much uncertainty (i.e., no way to monitor) about how the stock of black teatfish will respond over subsequent years of re-opening the fishery.

65. **The QDAF Member recommended** a 15t Trial TAC, which is consistent with Table 3. 'TAC Recommendations' which is referred to under the Reopening Decision Rule in the Torres Strait Beche-de-mer Fishery Harvest Strategy. QDAF would support higher TACs in the fishery in the future, if the scientific data supports it and the TAC is not exceeded during the trial openings. QDAF recommended the 15t amount to be consistent with the harvest strategy, because previous trial black teatfish openings have reached or exceeded the TAC quickly and as black teatfish is now a CITES Listed species there can be flow on effects in other jurisdictions when TACs are exceeded.

66. **The Scientific Member Tim Skewes recommended** a trial TAC of 20t as a conservative MSY estimate based on a conservative stock biomass estimate, noting that 21t would still be considered sustainable but the 1t would provide a buffer should the TAC be exceeded. The member stated that he is comfortable that this is a precautionary and justifiable catch limit that balances precaution with the livelihood considerations for Torres Strait Islanders. The member further commented that the current information adequately justifies this level of take from a

CITES Listing perspective also and that other considerations need to be progressed in the fishery such as managing the level of effort and minimising product wastage during processing which this meeting has not touched on.

67. The Permanent observer on the Working Group, Yen Loban, TSRA Fisheries Portfolio Board Member, supported the recommendations of the Traditional Inhabitant Member, Gudumalulgal and the Traditional Inhabitant Member Kemer Kemer Meriam on their recommended TAC of 20 tonnes and the need to undertake community visits prior to the trial reopening, including a presentation of the science that has informed the recommended TAC.

68. Given Working Group members' recommendations and the view expressed to aim for a black teatfish trial opening in April 2021, the AFMA member advised that AFMA will engage with the traditional inhabitant members that have not had a chance to participate in the discussion today to get their views on the recommended TAC levels. AFMA would advise the HCWG on the process for doing so.

6 Date and venue for next meeting

69. The HCWG noted that a tentative date for the next meeting of the HCWG during the week beginning 5 October had been proposed by AFMA, the format of the meeting will depend on the COVID-19 situation at the time. The need for this meeting was contingent in part on advice from members at this meeting on whether or not any management responses to the preliminary stock survey outcomes (for example advice on BDM TACs limits for the 2021 season) need to be considered. Based on advice from members under agenda item 4, this discussion can be held next year.

70. Other items noted by AFMA requiring advice this year include:

- Research priorities for 2022-23; and
- Legislative instrument amendments.

71. The Working Group noted that AFMA would liaise with members on a suitable process to progress these items (out of session or in-session in a meeting).

72. The Chair concluded the meeting of the HCWG at approximately 3:30pm

73. Quinten Hirakawa closed the meeting with a prayer.

Table 4. Status of actions arising from previous HCWG meetings.

#	Meeting	Action item	Responsibility	Status
1	HCWG 15 (1-2 August 2019)	TSRA and AFMA to develop a discussion paper outlining suggested management arrangements, based on HCWG discussions for pursuing the use of hookah to fish for white teatfish, for further consultation with communities and consideration by the HCWG and the PZJA.	TSRA AFMA	**Ongoing.** The TSRA supported PZJA Traditional Inhabitant members to undertake cluster consultations in late 2019 which sought feedback from communities on the use of hookah to fish for white teatfish. An overview of the consultations outcomes was considered at HCWG 16. The HCWG recommended Malu Lamar discuss the review of the hookah prohibition at the stakeholder workshop with the view to developing management recommendations (see **Action 6** below).
2	HCWG 15 (1-2 August 2019)	AFMA to arrange a half/full day future management priorities workshop in conjunction with the next Hand Collectables Working Group meeting.	AFMA	**Ongoing.** AFMA was unable to arrange the workshop in conjunction with HCWG16 as the focus of that meeting was to seek firm advice on black teatfish for a 2020 opening. Options, including timing and means, for a future workshop will continue to be explored in consultation with members having regard for Covid 19 response measures.
3	HCWG 16 (21 February 2020)	Malu Lamar to make recommendations to AFMA and TSRA on an as needs basis to establish an MOU to assist in improved data collection in the Fishery.	Malu Lamar	**Ongoing.** While no formal MOU has been developed, a suite of parallel activities have since taken place including a full round of community visits focussed on Fish Receiver System education and awareness, and more recently PZJA traditional inhabitant member cluster consultations. AFMA also continues to work with individual operators to improve data collection. The TSRA is also working with Malu Lamar to agree a service level MOU that may include programs aimed at improving reporting. At the HCWG16 meeting, the Malu Lamar Chairperson expressed preference to maintain an ongoing action item on the

#	Meeting	Action item	Responsibility	Status
				development of the MOU to ensure it remains an option if needed.
4	HCWG 16 (21 February 2020)	Malu Lamar to take the lead in convening a stakeholder workshop to further discuss and agree on cultural lore and industry agreements with respect to fishing for black teatfish and report outcomes to the HCWG.	Malu Lamar (supported by TSRA)	**Ongoing.** The stakeholder workshop was initially planned to take place on 7-8 April but had to be postponed due to the COVID-19 emergency and resulting restrictions. A further workshop was scheduled for the 4-5 August, however it is no longer proceeding. TSRA advise that a series of meetings in communities may now be pursued.
5	HCWG 16 (21 February 2020)	AFMA explore media opportunities such as radio to widely communicate the additional management and reporting requirements for a black teatfish re-opening.	AFMA	**In progress.** To date, AFMA has identified a number of media avenues to communicate the additional management and reporting requirements for a black teatfish re-opening. These include radio interviews, newspaper adverts, and digital notice boards throughout the region as well as the PZJA website and AFMA's social media platforms.
6	HCWG 16 (21 February 2020)	Malu Lamar to discuss the review of the hookah prohibition at the stakeholder workshop with a view to developing management recommendations.	Malu Lamar (supported by TSRA)	**Ongoing.** The stakeholder workshop was initially planned to take place on 7-8 April but had to be postponed due to the COVID-19 emergency and resulting restrictions. A further workshop was scheduled for the 4-5 August, however it is no longer proceeding. TSRA advise that a series of meetings in communities may now be pursued.

Attachment A – Adopted Agenda

MEETING OF THE PZJA TORRES STRAIT
HAND COLLECTABLES WORKING GROUP MEMBERS

7 August 2020 (9:00 am – 3:00 pm)

Teleconference

DRAFT AGENDA

The meeting will open at 9:00am on **7** August 2020.

AGENDA ITEM 1 PRELIMINARIES

1.1 Acknowledgement of Traditional Owners, welcome and apologies

The Chair will welcome HCWG members, permanent observers, and casual observers to the meeting of Torres Strait Hand Collectables Working Group members.

1.2 Adoption of agenda

The working group is invited to consider and adopt the draft agenda.

1.3 Declarations of interest

Working group members are invited to declare any real or potential conflicts of interests to the group 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 working group will note the status of action items arising from previous HCWG meetings.

1.5 Out of session correspondence

The working group will note any out of session correspondence on HCWG matters since the previous meeting.

AGENDA ITEM 2 WORKING GROUP UPDATES

The Working Group will note updates from members and observers on matters relevant to Torres Strait Hand Collectable fisheries.

2.1 Industry members

2.2 Scientific members

2.3 Government Agencies

2.2.1 Australian Fisheries Management Authority (AFMA) – Management

2.2.2 Australian Fisheries Management Authority (AFMA) – Compliance

2.2.3 Torres Strait Regional Authority (TSRA)

2.2.4 Queensland Department of Agriculture and Fisheries (QDAF)

2.3 Native Title

2.4 Papua New Guinea National Fisheries Authority

AGENDA ITEM 3 CATCH AND EFFORT SUMMARY

3.1 The working group will note a summary of reported catch in the Beche-de-mer Fishery for the 2020 fishing season to date.

AGENDA ITEM 4 PRELIMINARY RESULTS OF THE BECHE-DE-MER STOCK SURVEY

4.1 The Working Group will consider the preliminary results of the eastern Torres Strait stock survey of Beche-de-mer species that took place in November 2019 and January 2020.

AGENDA ITEM 5 FUTURE BLACK TEATFISH OPENING

5.1 In consideration of the preliminary stock survey results, and guidance under the Beche-de-mer Harvest Strategy, the Working Group will provide advice to the PZJA on an appropriate TAC and relevant management arrangements required for a possible future black teatfish opening.

Expected Outcome: The Working Group will **provide advice to the PZJA** on a suitable time and appropriate management arrangements, including a recommended total allowable catch, required to conduct a black teatfish opening in accordance with the decision rule in the BDM harvest strategy for re-opening a closed species.

AGENDA ITEM 6 OTHER BUSINESS

6.1 Other Business

The Working Group is invited to nominate any other business for discussion.

6.2 Date and venue for next meeting

The Working Group will consider a date and venue for HCWG17.

CLOSE OF MEETING

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting 18 28-29 October 2021
APPLYING THE HARVEST STRATEGY TO REVIEW TOTAL ALLOWABLE CATCHES (TACs)	Agenda Item 4 FOR DISCUSSION & ADVICE

RECOMMENDATIONS

1. That the Hand Collectables Working Group (HCWG),

   a. **NOTE** that on 19 November 2019 the Protected Zone Joint Authority (PZJA) agreed to adopt the Torres Strait Beche-de-mer (BDM) Fishery Harvest Strategy. Current total allowable catches (TACs) were agreed in line with the starting TACs recommended in the harvest strategy and have applied since 1 January 2020.

   b. **NOTE** that at its meeting on 6-8 October 2021, the Hand Collectables Resource Assessment Group (HCRAG) applied the harvest strategy to all new information available since the adoption of the harvest strategy to select species where survey results indicated a need for review and recommended that:

      i. no changes to the current TACs for the 2022 BDM fishing season are required.
      ii. that the basket trigger limit for curryfish vastus be increased to 30t in light of the additional information available for the species and the survey results indicating a more even relative abundance.
      iii. that the HCWG continue to consider the review of the current hookah prohibition in relation to white teatfish and undertake further community consultation on management arrangements that would support sustainable harvesting of white teatfish using hookah.

   c. **NOTE** that the RAG recommended the following short-medium term data, research, and analysis needs:

      i. stock assessment modelling to assess the potential (and extent) for an increase to the white teatfish TAC.
      ii. consistent with the BDM harvest strategy and where there is sufficient information available, determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible.
      iii. ongoing data collection to better understand fishing practices for lollyfish on Poruma as there may be some evidence of home reef depletion.

   d. Having **CONSIDERED** the HCRAG advice **DISCUSS** and **PROVIDE ADVICE** on recommended**:**

      i. TACs for the 2022 fishing season commencing on 1 January 2022 (noting black teatfish will be considered under Agenda item 3)
      ii. further data, research and analysis needs.

KEY ISSUES

1. The BDM Fishery Harvest Strategy is based on a tiered framework which accounts for improvements in data and information. The HS applies to 18 species (inclusive of the 3 closed species).

2. Current TAC's reflect the starting TACs recommended in the harvest strategy (Table 3 Starting HS TAC Recommendations).

3. Since the harvest strategy was agreed, a scientific survey has been undertaken and basic catch data has been collected for almost two fishing seasons (2020 and 2021) through the fish receiver system. A summary of catch data as reported in the TBDO2 Catch Disposal Records is provided in **Attachment A**. Further a preliminary stock assessment was undertaken for black teatfish (please note black teatfish is to be considered by the WG under Agenda Item 3).

4. The HCWG considered preliminary results of the scientific survey in August 2020 and were satisfied that the results did not raise immediate sustainability concerns that needed to be urgently addressed before the 2021 fishing season.

5. The newly formed HCRAG has now met (6-8 October 2021) and has applied the harvest strategy to the new information available for the fishery.

6. Noting that there are 18 species to assess, the HCRAG reviewed 10 species selected on the basis of either being an identified target species under the harvest strategy and/or a species identified by CSIRO for further discussion as a result of the recent survey findings. The HCRAG agreed to consider the remaining species (8) at their next meeting which is tentatively scheduled for June/July 2022.

7. A summary of the HCRAG's draft advice on each species is outlined in the Species Assessment Sheet (SAS) (**Attachment B**). In summary the RAG recommended that:

   a. all species assessed remain in the low tier of the harvest strategy. This is because a transition to the middle tier requires at least two primary indicators and is not applicable during the initial years of HS implementation as insufficient detailed historical fishery data are available. For the high tier to apply a time series of high-quality species-specific surveys together with a reasonable level of catch is required.

   b. no change to TACs for any species assessed; and

   c. change to the curryfish vastus trigger limit from 15t to 30 t in light of the additional information available for the species and the survey results indicating a more even relative abundance.

8. The HCRAG also identified key data and analysis priorities as outlined above.

9. An overview of each harvest strategy tier is provided in the Background section below.

BACKGROUND

10. A summary of each harvest strategy tier is provided below

    Low Tier

11. In the low tier, the minimum data needed for each species is the total catch taken each fishing season. The low tier has rules to guide:

    a. what happens to a species if the TAC is over caught or a trigger limit for a species within a joint TAC is reached; and

b. what happens if there is no data reported for a species at all.

12. Depending on the information available, the low tier allows single species TACs to be maintained or reduced. For species with individual triggers, within a joint TAC, the low tier may allow changes to the joint TAC, or to individual species triggers (up or down).

Middle Tier

13. To transition to the middle tier, two or more primary indicators must be available. The harvest strategy states however that the middle tier is not applicable during the initial years of HS implementation as insufficient detailed historical fishery data are available.

14. For the purposes of the middle tier the primary indicators are:

    a. Catch per unit effort;

    b. Spatial footprint;

    c. Average size; and

    d. Catch proportion.

15. The information from these primary indicators will guide how much TACs should be varied. If the primary indicators suggest an increase is possible, there are pre-agreed rules that set a maximum level that the TAC can increase by before high-quality survey data is required (refer to Table 3 in the harvest strategy for the Max middle tier TAC increase).

High Tier

16. The high tier may be applied to all species if species-specific, high quality survey data becomes available. Under this tier, TACs may be adjusted upwards (in cases where there is evidence of scope to increase TACs) or downwards (in cases where there are concerns about the status of a fished species).

Closed Species

17. A species may be closed to fishing if it has been overfished, the TAC has been significantly over caught, or if fishing has been occurring but there is no reported catch. The harvest strategy has rules to guide how to re-open a fishery if enough information is available.

Beche-de-mer 2020 fishing season catch data

Key messages

1. Some of the key reporting improvements that have continued in the 2020 fishing season include:
    a. no 'unidentified sea cucumbers' have been reported;
    b. fishers have continued to provide voluntary, high level, effort and spatial information that continues to provide some insight into how the fishery operates;
    c. operators are not landing catch after it has been overly processed (i.e. dried) meaning the timeframe between the product being caught and landed to a fish receiver is minimised; and
    d. fishers have continued to voluntarily report damaged product separately.
2. There are some important aspects of the catch reports that still need to improve, mainly species level identification of curryfish species and the level of effort and spatial reporting which has declined since the 2018 and 2019 fishing seasons.
3. A summary of key reporting metrics and status from 2018 – 2020 are summarised in **Table 1.**

Table 1. Summary of changes in key reporting metrics from 2018 to 2020.

Metric	2018	2019	2020	Change since 2019
Number of CDRs submitted	258	239	140	↓(41%)
Total catch reported (tonnes)	64.3	39.00	31.97	↓ (18%)
No. of species reported	14	14	11	↓
% of CDRs reporting Area Fished	84%	69%	60%	↓
% of CDRs reporting Number of Days Fished	77%	70%	64%	↓
% of CDRs reporting Number of Fishers	96%	71%	65%	↓
Number of licenced TIB fishers reporting BDM	34	40	30	↓
Number of licenced Fish Receivers reporting BDM	13	17	15	↓

Reported landed catch

4. A total of 31.97 tonnes of beche-de-mer catch was reported across 11 different species in the BDM Fishery in the 2020 fishing season. A summary of reported catches by species for the 2019, 2020 and 2021 (as at 18 Aug) fishing seasons is provided in Table 3. It should

be noted that some of the differences in catches between the 2019 and 2020 fishing seasons may be due to changes to the conversion ratios on 1 January 2021, following the implementation of the BDM Harvest Strategy.

5. Prickly redfish (15.65 t) and curryfish (11.29 t) were the most caught species, followed by white teatfish (1.77t), blackfish (hairy) (1.40t) and lollyfish (1.27t).
6. The prickly redfish TAC of 15t was slightly exceeded for the second time since 2005. With the exception of prickly redfish and white teatfish, 2020 catches where less than 2019 catches across all species.
7. 2020 season catches were reported across 140 Catch Disposal Records (CDRs) (i.e. number of CDR pages submitted), from 15 fish receivers and 30 licenced traditional inhabitant boat (TIB) fishers. A summary of licences in the BDM fishery is outlined in Table 4.
8. Although the total number of CDRs submitted for 2020 has dropped by 41% compared to the 2019 season, the corresponding reduction in total reported catch is only 18%.

Processed State

9. In the 2020 fishing season, BDM catch was reported in eight different processed states including: boiled, boiled and chilled, boiled and frozen, boiled and salted, frozen and green, salted, whole weight and damaged.
10. 59% of the catch was reported as ‘salted’ and 33% as ‘boiled and salted’.
11. The improvements in the number of CDRs and fishers voluntarily reporting damaged product separately have continued.

Voluntary Section

12. Of the 140 CDRs submitted during the 2020 fishing season, 59% of records contained voluntary, high level information on the number of fishers, areas fished and number of days fished.

Catch by Area

13. 60% of the records reported the ‘Area Fished’, a summary of which is provided in Table 2 for the fishing seasons 2019, 2020 and 2021 to date. 25% of the catch reported for 2020 did not have corresponding spatial information.
14. By volume of catch, more than 70% of the 2019 and 2020 catches were reported as having been caught in areas 14 (Great North East Channel), 16 (Darnley), 17 (Cumberland) and 19 (Don Cay).

Table 2. Summary and comparison of BDM catches in the reporting areas in the BDM Fishery during the 2019, 2020 and 2021 fishing seasons. Note that 2021 catches are current as at 18 August 2021.

Area Fished	2019 (t)	2020 (t)	2021 (t)
11 (Warrior)	1.7	1.45	0.97
12 (Warraber)	0.02		
14 (Great North East Channel)	10.2	4.64	0.95
16 (Darnley)	4.7	3.46	3.46
17 (Cumberland)	7.0	10.21	9.86
18 (Seven Reefs)	0.6		

19 (Don Cay)	3.4	4.37	1.86
Not reported	7.4	7.84	15.17
Total	**35.0**	**31.97**	**32.27**

Catch by trip length (number of days fished)

15. 64% of records reported the 'number of days fished' (compared to 70% in 2019), which accounted for 86% of the total reported catch volume (compared to 88% in 2019).
16. Reported trip lengths ranged from 1-10 days, with only 13% of the total reported catch having been caught on single day trips (compared to 37% in 2019). It is highly likely that fishers and fish receivers are recording catch from multiple trips on one CDR record which may be underestimating the number of single day fishing trips undertaken in the fishery.

Number of Fishers and fish receivers

17. 65% of the records reported number of days fished. Majority of those records (85%) indicate that 2 or 3 people fished per trip (assuming that one record corresponds to one trip which is not always the case). More specifically, 61% of the catch was reported to have been caught in dinghies with 2-3 people.
18. Of the 30 fishers that landed catch in 2020, 12 had also landed BDM in 2019 and 2018. A total of 7 fishers were reported as having landed catch for the first time in 2020 since the implementation of the Fish Receiver System in 2017.
19. Of the 15 fish receivers that received catch in 2020, 9 had consistently received catch since 2018 and 12 since 2019.

Table 3. Breakdown of reported BDM catch[1] by species since 2005.

Common name	TAC (t)	2005 (kg)	2007 (kg)	2010 (kg)	2011 (kg)	2012 (kg)	2013 (kg)	2014 (kg)	2015 (kg)	2016 (kg)	2017[2] (kg)	2018[3] (kg)	2019 (kg)	2020 (kg)[4]	2021 (kg)[5]
Black teatfish	0 (15[6]) (20)				75	2,001	138	16,624	23,303						17,615
Prickly redfish	15 (20[7])	5,564	128	146	11,056	1,255	5,888	9,173	28,110	11,211	12,185	14,741	11,875	15,654	8,797
Sandfish	0			5	31	2,152	26	6				18			
Surf Redfish	0	734					52	1			747			199	
White teatfish	15	186			3,179	13,924	12,633	16,341	4,200	990		1,774	1,564	1,767	1,308
Blackfish (Hairy)	5[8]		128		507	73	216	1,960	3,596	1,098	11,118	1,368	3,475	1399	482
Deepwater redfish	5[9]			7			5,024	4,229	5,546		160	172	50		17
Greenfish	40[10]						1	1	14		63	1,013	271	15	
Curryfish – mixed	60t basket[11]				1,118				6,099	1,085	597	42,392	14,538	10,521	3,961
Curryfish Herrmanni (common)													1,343	621	
Curryfish vastus													491	153	
Deepwater blackfish	50t basket[12]												177	166	72
Elephant trunkfish					4	28	2		133			190	12		
Golden sandfish							52	351	55			8	32		
Burrowing blackfish													10		
Stonefish				459							6				
Leopardfish											6,876	2,322	958	206	
Brown sandfish												30	204		
Lollyfish													3,997	1,272	22
Unidentified BDM												67			
'Basket total'		**186**	**256**	**466**	**1,629**	**101**	**5,295**	**6,541**	**15,443**	**2,183**	**19,831**	**47,761**	**25,558**	**1,644**	**94**
GRAND TOTAL		**6,484**	**256**	**617**	**15,970**	**18,803**	**24,032**	**48,686**	**71,056**	**14,384**	**32,764**	**64,300**	**38,997**	**31,972**	**32,274**

[1] No catch reported in 2006, 2008, 2009
[2] Catch data for 2017 is converted weights where processed form is known (47kg unknown), based on catch reported through tax invoices, HC01, TDB01 and TBD02. Verification was conducted to remove possible duplicates between records.
[3] Data for fishing seasons 2018 onwards is reported through TDB02 Catch Disposal Records only and converted to wet weight gutted using CSIRO recommended conversion factors.
4 New conversion ratios as per the BDM Harvest Strategy were implemented for some species on 1 January 2020.
[5] Catches current as at 18 August 2021.
[6] The 15t TAC was available during 2014 and 2015 only
[7] The 20t TAC was available until the end of 2017.
Yellow highlighted cells indicate an exceeded TAC
[8] New individual species TAC as of 1 January 2020, previously part of the 80t basket species TAC.
[9] New individual species TAC as of 1 January 2020, previously part of the 80t basket species TAC.
[10] New individual species TAC as of 1 January 2020, previously part of the 80t basket species TAC.
[11] New Curryfish species basket TAC as of 1 January 2020, previously part of the 80t basket species TAC
[12] Prior to 2020 the total allowable catch limit for basket species was 80t.

Table 4. Number of licences in the Beche-de-mer Fishery as at 1 September 2020 and 2021.

Year	Number of TIB licences with BDM fishery entries	Number of TVH licences	Fish Receiver licences
2020	156	1 licence held in trust by the TSRA	67
2021	180	1 licence held in trust by the TSRA	83

Australian Government
Australian Fisheries Management Authority

Torres Strait Bêche-de-mer (BDM) Fishery

Species Assessment Sheets - 2021

Hand Collectables Resource Assessment Group (HCRAG) Meeting No.1
6-7 October 2021
Thursday Island/Videoconference

Table of Contents

Purpose

This document is intended to be used in conjunction with the *Torres Strait Beche-de-mer Harvest Strategy 2019* (the Harvest Strategy), applicable species stock assessments and annual catch and effort summaries.

The individual species assessment sheets (SAS) are aimed at guiding the Hand Collectables Resource Assessment Group's (HCRAG) assessment of commercial sea cucumber species in the BDM fishery in line with the Harvest Strategy, and to determine the recommended biological and/or total allowable catches for the fishing season commencing on 1 January each year.

The SAS provide a stepped application of the harvest strategy decision rules to recommend RBCs and/or TACs for each species, taking into account the latest scientific and fishing information available. The SAS also provides a summary of the basic information on stock status and assessment details for each species.

This resource is also intended to be used by the HCRAG to identify information gaps and research needs for each species that can feed into the TSSAC research need identification and prioritisation process for Torres Strait Fisheries.

Individual target species

White teatfish

<table>
<tr><th colspan="7">HCRAG Species Assessment Sheet</th></tr>
<tr><td>Common names</td><td colspan="6">White teatfish – Holothuria fuscogilva</td></tr>
<tr><td>Pre-HS TAC</td><td colspan="6">15 tonnes</td></tr>
<tr><td>Status open/closed</td><td colspan="6">Open</td></tr>
<tr><td>Current TAC</td><td>15 tonne</td><td colspan="5">Based on harvest strategy starting TAC</td></tr>
<tr><td>Basket trigger</td><td colspan="6">N/A</td></tr>
<tr><td>Minimum size limit</td><td colspan="6">32cm</td></tr>
<tr><th colspan="7">New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)</th></tr>
<tr><td rowspan="4">Latest scientific survey data</td><th>Year</th><th colspan="2">Standing stock biomass (90th percentile) (t)</th><th colspan="2">Standing stock biomass above min species size limit (t)</th><th>Is standing stock biomass above the default limit reference point?</th></tr>
<tr><td>2019/20</td><td colspan="2">880</td><td colspan="2">142.9</td><td>Yes</td></tr>
<tr><th>Survey adequate for species</th><th colspan="2">Any unexpected results</th><th colspan="2">Any concerns with biomass trend or absolute abundance</th><th>Need for management response</th></tr>
<tr><td>Yes</td><td colspan="2">No</td><td colspan="2">No</td><td>HCWG to discuss</td></tr>
<tr><td>Comments on scientific survey findings</td><td colspan="6">CSIRO analysis: Deepwater survey undertaken for the first time in 2019/20. Confident that white teatfish population for East Torres Strait has been quantified. Survey trend for shallow reef population fairly constant over time. Review TAC – potential to increase, however some population modelling and/or fishery dependent data required. .</td></tr>
<tr><td>Catch data</td><td colspan="6">Available for 2020 and 2021 (as at 18 Aug 2021).</td></tr>
<tr><td>Price data (as advised by industry at HCRAG01 meeting)</td><td colspan="6">Beach price is $30/kg (salted), $40 - $50/kg (gutted and salted)</td></tr>
<tr><td>Any other considerations?</td><td colspan="6">Listed on Appendix II of CITES. Listed as vulnerable on the IUCN Red list due to a decreasing population trend globally.</td></tr>
<tr><td>Any other changes in the fishery?</td><td colspan="6">None identified</td></tr>
<tr><td>Any other sources of mortality apart from fishing?</td><td colspan="6">None identified</td></tr>
<tr><th colspan="7">Low Tier</th></tr>
<tr><td rowspan="3">Total catch data</td><th>Fishing season</th><th>Catch (t)</th><th>TAC (t)</th><th>% TAC caught</th><th>TAC or basket trigger exceeded?</th><th>% of TAC overcatch</th></tr>
<tr><td rowspan="2">2020</td><td rowspan="2">1.77</td><td rowspan="2">15</td><td rowspan="2">11.8 %</td><td>TAC: No</td><td rowspan="2">N/A</td></tr>
<tr><td>Basket: N/A</td></tr>
</table>

	2021[1]	1.31	15	8.7 %	TBA	TBA
Decision rules	No concerns from RAG and additional industry members regarding the total reported catch.					

Species specific data gaps and needs

General need to improve area and effort reporting in catch disposal records.

Species Specific Research and Priorities

Consistent with the BDM harvest strategy and where there is sufficient information available, the RAG recommended a tactical research project to determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible. Modelling analysis to inform a sustainable TAC increase for white teatfish.

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
HCRAG recommendations	2022	15t	N/A	N/A	15t

The RAG did not recommend any changes to the TAC.

[1] Catches for the 2021 season to date – as of 18 August 2021.

Prickly redfish

HCRAG Species Assessment Sheet

Common names	Prickly redfish – *Thelenota ananas*	
Pre-HS TAC	15 tonnes (changed from 20 tonnes to 15 tonnes in 2017)	
Status open/closed	Open	
Current TAC	15 tonnes	Based on harvest strategy starting TAC
Basket trigger	N/A	
Minimum size limit	35cm	

New information

Latest scientific survey data	**Year**	**Standing stock biomass (90th percentile) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	2019/20	461	253.3	Yes
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	Yes	*HCWG to discuss*

Comments on scientific survey findings	CSIRO analysis: Slight decline (in slope – density over time), suggesting some concern given reports of sustained high catches. Close monitoring recommended. Stock assessment needed.
Catch data	Available for 2020 and 2021 (as at 18 Aug 2021).
Price data (as advised by industry at HCRAG01 meeting)	Beach price is $61-$85/kg (clarify product type)
Any other considerations?	On the list for possible CITES listing consideration in the future and listed as endangered on the IUCN red list.
Any other changes in the fishery?	Industry use a voluntary rotational harvesting approach.
Any other sources of mortality apart from fishing?	None identified.

Low Tier

Total catch data	**Fishing season**	**Catch (t)**	**TAC (t)**	**% TAC caught**	**TAC or basket trigger exceeded?**	**% of TAC overcatch**
	2020	15.65	15	104.36 %	TAC: Yes Basket: N/A	4.36%
	2021[2]	8.79	15	58.6 %	TBA	TBA

[2] Catches for the 2021 season to date – as of 18 August 2021.

Decision rules	No concerns from RAG and additional industry members regarding the total reported catch.
	Reported overcatch does not trigger any of the overcatch decision rules (refer to section 2.11.1.1 of the harvest strategy).
	RAG advised that a TAC reduction may need to be considered if the species continues to be overcaught in subsequent fishing seasons.

Species specific data gaps and needs

General need to improve area and effort reporting in catch disposal records.

Species Specific Research and Priorities

Consistent with the BDM harvest strategy and where there is sufficient information available, the RAG recommended a tactical research project to determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
HCRAG recommendations	2022	**15t**	**N/A**	**N/A**	**15t**

The RAG did not recommend any changes to the TAC.

Deepwater redfish

HCRAG Species Assessment Sheet				
Common names	Deepwater redfish – *Actinopyga echinites*			
Pre-HS TAC	Part of 80t basket species TAC			
Status open/closed	Open			
Current TAC	5 tonnes	Based on harvest strategy starting TAC		
Basket trigger	N/A (previously 5t basket trigger limit)			
Minimum size limit	20cm			
New information				
Latest scientific survey data	**Year**	**Standing stock biomass (90th percentile) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	2019/20	66	55	No evidence ~~to support~~ that the species is below the default LRP
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	No	*HCWG to discuss*
Comments on scientific survey findings	CSIRO analysis: Catches low relative to biomass. Increasing overall trend in density. No concern for TAC.			
Catch data	Available for 2020 and 2021 (to date).			
Price data (as advised by industry at HCRAG01 meeting)	Not targeted much due to low beach price of 3/kg (wet), $7/kg (boiled) and $80-$100/kg (dried)			
Any other considerations?	Assessed as Uncertain by ABARES in the 2020 Fishery Status Reports – given its low density it is unclear if catches of this species would impede effective recruitment and recovery of the species. The species is listed as vulnerable on the IUCN red list.			
Any other changes in the fishery?	None identified			
Any other sources of mortality apart from fishing?	None identified			

Low Tier

	Fishing season	Catch (t)	TAC (t)	% TAC caught	TAC or basket trigger exceeded?	% of TAC overcatch
Total catch data	2020	0	5	0 %	TAC: No Basket: N/A	N/A

	2021[3]	0.017	5	0.11 %	TBA	TBA
Decision rules	No concerns from RAG and additional industry members regarding the total reported catch.					

Species specific data gaps and needs

General need to improve area and effort reporting in catch disposal records.

Species Specific Research and Priorities

Consistent with the BDM harvest strategy and where there is sufficient information available, the RAG recommended a tactical research project to determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
HCRAG recommendations	2022	**5t**	**N/A**	**N/A**	**5t**

The RAG did not recommend any changes to the TAC.

[3] Catches for the 2021 season to date – as of 18 August 2021.

Hairy blackfish

HCRAG Species Assessment Sheet				
Common names	Hairy blackfish – *Actinopyga miliaris*			
Pre-HS TAC	Part of 80t basket species TAC			
Status open/closed	Open			
Current TAC	5 tonnes	Based on harvest strategy starting TAC		
Basket trigger	N/A (previously 5t basket trigger limit)			
Minimum size limit	22cm			
New information since the TAC was last considered (in this it was the implementation of the Harvest Strategy)				
Latest scientific survey data	**Year**	**Landed (wet gutted) weight (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	2019/20	15	-	*Insufficient information to assess the status of the stock in relation to the LRP*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Limited	No	Yes	*HCWG to discuss*
Comments on scientific survey findings	CSIRO analysis: Status still remains relatively unknown. Possible decline or natural variability. Stock assessment needed. Targeted survey sampling may need to be factored into future fishery surveys.			
Catch data	Available for 2020 and 2021 (as at 18 Aug 2021).			
Price data (as advised by industry at HCRAG01 meeting)	Has a low beach price of $3 – $7.50/kg but dry product can fetch up to $80-100/kg. $15/kg (frozen whole? Seek clarification from industry)			
Any other considerations?	Assessed as Uncertain by ABARES in the 2020 Fishery Status Reports – given its patchy distribution and low density it is unclear if catches of this species would impede effective recruitment and recovery of the species.			
Any other changes in the fishery?	None identified			
Any other sources of mortality apart from fishing?	None identified			

Low Tier						
Total catch data	**Fishing season**	**Catch (t)**	**TAC (t)**	**% TAC caught**	**TAC or basket trigger exceeded?**	**% of TAC overcatch**
	2020	1.4	5	28 %	TAC: No Basket: N/A	N/A

	2021[4]	0.5	5	10 %	TBA	N/A
Decision rules	No concerns from RAG and additional industry members regarding the total catch.					

Species specific data gaps and needs

General need to improve area and effort reporting in catch disposal records. Potential for cryptic behaviour to impact on surveys.

Species Specific Research and Priorities

Consistent with the BDM harvest strategy and where there is sufficient information available, the RAG recommended a tactical research project to determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
HCRAG recommendations	2022	**5t**	**N/A**	**N/A**	**5t**

The RAG did not recommend any changes to the TAC.

[4] Catches for the 2021 season to date – as of 18 August 2021.

Greenfish (not assessed by HCRAG)

HCRAG Species Assessment Sheet		
Common names	Greenfish – *Stichopus chloronotus*	
Pre-HS TAC	Part of 80t basket species TAC	
Status open/closed	Open	
Current TAC	40 tonnes	Based on harvest strategy starting TAC
Basket trigger	N/A	
Minimum size limit	nil	

New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)

	Year	Standing stock biomass (90th percentile) (t)	Standing stock biomass above min species size limit (t)	Is standing stock biomass above the default limit reference point?
Latest scientific survey data	2019/20	739	N/A	*RAG to discuss*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	No	*RAG to discuss*

Comments on scientific survey findings	CSIRO analysis: Catches low. Generally increasing density trend. No concern for TAC.
Catch data	Available for 2020 and 2021 (to date).
Any other considerations?	**RAG members to provide advice**
Any other changes in the fishery?	**RAG members to provide advice. For example, fishing behaviour/market demand? **
Any other sources of mortality apart from fishing?	**RAG members to provide advice**

Low Tier

	Fishing season	Catch (t)	TAC (t)	% TAC caught	TAC or basket trigger exceeded?	% of TAC overcatch
Total catch data	2020	0.015	40	0.04 %	TAC: No Basket: N/A	N/A
	2021[5]	0	40	0	N/A	N/A

Decision rules	Is the total catch reliable? **RAG members to provide advice**
	Not overcaught so overcatch decision rules not triggered (refer to section 2.11.1.1 of the harvest strategy).

[5] Catches for the 2021 season to date – as of 18 August 2021.

	For species with an individual TAC, should the TAC be reduced or maintained (refer to section 2.11.1 of the harvest strategy)? *RAG members to provide advice*

Middle Tier (not applicable during initial years of HS) (data for 2020 fishing season)

	CPUE (at least 3 years required)	Average size (over 3 years)	Spatial footprint (% of areas fished)	Catch proportion (average over past 3 years)
Are two or more primary indicators available?	1 record for 2020 – no reports of 'days fished' and 'number of fishers'	Not being collected.	Not reported for 2020	Average catch of species relative to total catch for all BDM spp 0.05% of total 2020 catch
RAG advice	Based on harvest strategy data needs to develop reliable primary indicators the RAG should identify any gaps in the current data collection program and possible options to address those gaps. The information above is a summary of data held and not an analysis of primary indicators.			

High Tier

	Are the surveys comparable	Are the inter-survey intervals acceptable	Has there been sufficient catch (average catch used in decision rule)
Standardised biomass survey index	*RAG to discuss*	*RAG to discuss*	*RAG to discuss*
RAG advice	Can the survey-based decision rule be applied to this species? If yes, is it a high assessment priority currently?		

Species specific data gaps and needs

to be completed at the meeting

Species Specific Research and Priorities

to be completed at the meeting

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
HCRAG recommendations	2022				

General RAG comments

Basket species – curryfish

Curryfish common

<table>
<tr><th colspan="7">HCRAG Species Assessment Sheet</th></tr>
<tr><td>Common names</td><td colspan="6">Curryfish common – Stichospus herrmanni</td></tr>
<tr><td>Pre-HS TAC</td><td colspan="6">Part of 80t basket species TAC</td></tr>
<tr><td>Status open/closed</td><td colspan="6">Open</td></tr>
<tr><td>Current TAC</td><td colspan="2">60 tonnes (Curryfish basket TAC)</td><td colspan="4">Based on harvest strategy starting TAC</td></tr>
<tr><td>Basket trigger</td><td colspan="6">N/A</td></tr>
<tr><td>Minimum size limit</td><td colspan="6">31cm</td></tr>
<tr><td colspan="7">New information</td></tr>
<tr><td rowspan="4">Latest scientific survey data</td><td>Year</td><td colspan="2">Standing stock biomass (90th percentile) (t)</td><td colspan="2">Standing stock biomass above min species size limit (t)</td><td>Is standing stock biomass above the default limit reference point?</td></tr>
<tr><td>2019/20</td><td colspan="2">667</td><td colspan="2">632.4</td><td>Yes</td></tr>
<tr><td>Survey adequate for species</td><td colspan="2">Any unexpected results</td><td colspan="2">Any concerns with biomass trend or absolute abundance</td><td>Need for management response</td></tr>
<tr><td>Yes</td><td colspan="2">No</td><td colspan="2">Yes</td><td>HCWG to discuss</td></tr>
<tr><td>Comments on scientific survey findings</td><td colspan="6">CSIRO paper: Possible decline (noting fairly negative trend fitted to survey data). Stock assessment needed. Close monitoring recommended – part of ‘Curryfish mixed’ (catch split 50:50 between Curryfish species when not identified). Appears that the herrmanni:vastus split is changing over time, with higher proportion of vastus. Could be an identification problem with S. Vastus during the 1995/96 survey.</td></tr>
<tr><td>Catch data</td><td colspan="6">Available for 2020 and 2021 (as at 18 August 2021).</td></tr>
<tr><td>Price data (as advised by industry at HCRAG01 meeting)</td><td colspan="6">Beach price $15-22/kg (boiled and salted), $150/kg (dried)</td></tr>
<tr><td>Any other considerations?</td><td colspan="6">Listed as vulnerable on the IUCN red list</td></tr>
<tr><td>Any other changes in the fishery?</td><td colspan="6">While common curryfish used to make up most of the catch in the past, industry reported noticing a generally even split between the two curryfish species with some regional differences.</td></tr>
<tr><td>Any other sources of mortality apart from fishing?</td><td colspan="6">None identified. Previously recorded high discard levels have reduced due to more appropriate species processing methods.</td></tr>
<tr><td colspan="7">Low Tier</td></tr>
<tr><td rowspan="2">Total catch data</td><td>Fishing season</td><td>Catch (t)</td><td>TAC (t)</td><td>% TAC caught</td><td>TAC or basket trigger exceeded?</td><td>% of TAC overcatch</td></tr>
<tr><td>2020</td><td>0.6
10.5 (mixed)</td><td>60</td><td>1 %
17.5 % (mixed)</td><td>TAC: No
Basket: N/A</td><td>N/A</td></tr>
</table>

	2021[6]	3.96 (mixed)	60	TBA	TBA	TBA
Decision rules	No concerns from RAG and additional industry members regarding the total catch. The RAG agreed to consider the need for a trigger limit for the species.					

Species specific data gaps and needs

RAG agreed it is a high priority to improve species differentiation in catch disposal records as well as general improvements to area and effort reporting.

Species Specific Research and Priorities

The RAG further noted the ongoing research need to develop conversion ratios for curryfish species. Consistent with the BDM harvest strategy and where there is sufficient information available, the RAG recommended a tactical research project to determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible

HCRAG recommendations	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
	2022	**60t**	**N/A**	**N/A**	**60t**

The RAG did not recommend any changes to the TAC.

[6] Catches for the 2021 season to date – as of 18 August 2021.

Curryfish vastus

HCRAG Species Assessment Sheet				
Common names	Curryfish vastus – *Stichopus vastus*			
Pre-HS TAC	Part of the 80t basket species TAC			
Status open/closed	Open			
Current TAC	60 tonnes (Curryfish basket TAC)	Based on harvest strategy starting TAC		
Basket trigger	15 tonnes species trigger limit			
Minimum size limit	15cm			
New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)				
Latest scientific survey data	**Year**	**Standing stock biomass (90th percentile) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	2019/20	168	168	Yes
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	Yes	HCWG to discuss
Comments on scientific survey findings	CSIRO analysis: Higher ratio of curryfish vastus observed in 2019 survey. Close monitoring recommended – part of 'Curryfish mixed' (suggest splitting catch 50:50 between curryfish species when not identified).			
Catch data	Available for 2020 and 2021 (as at 18 August 2021).			
Price data (as advised by industry at HCRAG01 meeting)	Beach price $15-22/kg (boiled and salted), $150/kg (dried)			
Any other considerations?	None identified			
Any other changes in the fishery?	Industry reported noticing a generally even split between the two curryfish species with some regional differences and increasingly more curryfish vastus.			
Any other sources of mortality apart from fishing?	None identified			

Low Tier						
Total catch data	**Fishing season**	**Catch (t)**	**TAC (t)**	**% TAC caught**	**TAC or basket trigger exceeded?**	**% of TAC overcatch**
	2020	0.15 10.5 (mixed)	60 (15t trigger limit)	0.25 % 17.5 % (mixed)	TAC: No Basket: No	N/A
	2021[7]	- 3.96 (mixed)	60 (15t trigger limit)	TBA	TBA	TBA

[7] Catches for the 2021 season to date – as of 18 August 2021.

Decision rules	No concerns from RAG and additional industry members regarding the total catch. The RAG recommended increasing the trigger limit to 30t.

Species specific data gaps and needs

RAG agreed it is a high priority to improve species differentiation in catch disposal records as well as general improvements to area and effort reporting.

Species Specific Research and Priorities

The RAG further noted the ongoing research need to develop conversion ratios for curryfish species. Consistent with the BDM harvest strategy and where there is sufficient information available, the RAG recommended a tactical research project to determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible

HCRAG recommendations	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
	2022	**60t**	**N/A**	**N/A**	**60t**

The RAG did not recommend any changes to the TAC. The RAG recommended increasing the trigger limit to 30t.

Basket species

Elephant's trunkfish

HCRAG Species Assessment Sheet		
Common names	Elephant trunkfish – *Holothuria fuscopunctata*	
Pre-HS TAC	Part of 80t basket species TAC	
Status open/closed	Open	
Current TAC	Part of 50t basket species TAC	Based on harvest strategy starting TAC
Basket trigger	15 tonnes	
Minimum size limit	24cm	

New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)

Latest scientific survey data	Year	Standing stock biomass (90th percentile) (t)	Standing stock biomass above min species size limit (t)	Is standing stock biomass above the default limit reference point?
	2019/20	451t	-	Not assessed
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	Yes	*HCWG to discuss*

Comments on scientific survey findings	CSIRO analysis: Catch rates low. Possible decline or natural variability. Stock assessment needed.
Catch data	Available for 2020 and 2021 (as at 18 August 2021).
Price data (as advised by industry at HCRAG01 meeting)	Beach price $2/kg (wet-gutted)
Any other considerations?	None advised
Any other changes in the fishery?	None identified
Any other sources of mortality apart from fishing?	None identified.

Low Tier

Total catch data	Fishing season	Catch (t)	TAC (t)	% TAC caught	TAC or basket trigger exceeded?	% of TAC overcatch
	2020	No catch reported	50	-	TAC: No Basket: No	N/A
	2021[8]	No catch reported	50	TBA	TBA	TBA

[8] Catches for the 2021 season to date – as of 18 August 2021.

Decision rules	No concerns from RAG and additional industry members regarding the total catch.				

Species specific data gaps and needs

General improvements to area and effort reporting.

Species Specific Research and Priorities

None identified

HCRAG recommendations	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC/trigger limit (t)
	2022	**50t (15t trigger limit)**	**N/A**	**N/A**	**50t (15t trigger limit)**

The RAG did not recommend any changes to the basket TAC or the trigger limit for the species.

Lollyfish

HCRAG Species Assessment Sheet

Common names	Lollyfish - *Holothuria atra*	
Pre-HS TAC	Part of 80t basket species TAC	
Status open/closed	Open	
Current TAC	Part of 50t basket species TAC	Based on harvest strategy starting TAC
Basket trigger	40 tonnes	
Minimum size limit	15cm	

New information since the TAC was last considered (in this it was at the implementation of the Harves Strategy)

Latest scientific survey data	**Year**	**Standing stock biomass (90th percentile) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	2019/20	5,668	-	Yes
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	Yes	*HCWG to discuss*

Comments on scientific survey findings	CSIRO analysis: Noted catch increase. Possible decline or natural variability. Stock assessment needed.
Catch data	Available for 2020 and 2021 (as at 18 August 2021).
Price data (as advised by industry at HCRAG01 meeting)	Beach price $2-$5/kg (wet-gutted)
Any other considerations?	None advised
Any other changes in the fishery?	Further information required from Poruma fishers on reduced catches to ascertain whether this is due to home reef depletion given its susceptibility to being caught.
Any other sources of mortality apart from fishing?	None identified

Low Tier

Total catch data	**Fishing season**	**Catch (t)**	**TAC (t)**	**% TAC caught**	**TAC or basket trigger exceeded?**	**% of TAC overcatch**
	2020	1.3	50 (40t basket trigger limit)	2.6 %	TAC: No Basket: No	N/A
	2021[9]	0.021	50 (40t basket trigger limit)	TBA	TBA	TBA
Decision rules	No concerns from RAG and additional industry members regarding the total reported catch.					

[9] Catches for the 2021 season are as of 18 August 2021.

Species specific data gaps and needs
General improvements to area and effort reporting.

Species Specific Research and Priorities
None identified

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC/trigger limit (t)
HCRAG recommendations	2022	**50t (40t trigger limit)**	**N/A**	**N/A**	**50t (40t trigger limit)**
The RAG did not recommend any changes to the basket TAC or the trigger limit for the species.					

Burrowing blackfish (not assessed by HCRAG)

HCRAG Species Assessment Sheet		
Common names	Burrowing blackfish – *Actinopyga spinea*	
Pre-HS TAC	Part of the 80t basket species TAC	
Status open/closed	Open	
Current TAC	Part of 50 tonne basket species TAC	Based on harvest strategy starting TAC
Basket trigger	5 tonnes	
Minimum size limit	22 cm	

New information since the TAC was last considered (in this it was the implementation of the Harvest Strategy)

	Year	**Standing stock biomass (90th percentile) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
Latest scientific survey data	2019/20	N/A	N/A	*RAG to discuss*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	N/A	N/A	N/A	*RAG to discuss*

Comments on scientific survey findings	CSIRO paper (**attachment B of agenda item 5**): N/A
Catch data	Available for 2020 and 2021 (as at 18 Aug 2021). Refer to **attachment A of Agenda Item 5.**
Any other considerations?	**RAG members to provide advice**
Any other changes in the fishery?	**RAG members to provide advice. For example, fishing behaviour/market demand? **
Any other sources of mortality apart from fishing?	**RAG members to provide advice**

Low Tier

	Fishing season	**Catch (t)**	**TAC (t)**	**% TAC caught**	**TAC or basket trigger exceeded?**	**% of TAC overcatch**
Total catch data	2020	No catch reported	50 (5t trigger limit)	No catch reported	TAC: No Basket: No	N/A
	2021[10]	No catch reported	50 (5t trigger limit)	TBA	TBA	TBA

Decision rules	Is the total catch reliable? **RAG members to provide advice**
	Not overcaught so overcatch decision rules not triggered (refer to section 2.11.1.1 of the harvest strategy).

[10] Catches for the 2021 season to date – as of 18 August 2021.

	For species with individual triggers within a basket with a joint TAC, should the joint TAC or individual triggers be changed (up or down) (refer to section 2.11.1.2 of the harvest strategy)? **RAG members to provide advice**

Species specific data gaps and needs
to be completed at the meeting

Species Specific Research and Priorities
to be completed at the meeting

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC/trigger limit (t)
HCRAG recommendations	2022				
General RAG comments					

Deepwater blackfish

HCRAG Species Assessment Sheet

Common names	Deepwater blackfish – *Actinopyga palauensis*	
Pre-HS TAC	Part of 80t basket species TAC	
Status open/closed	Open	
Current TAC	Part of 50t basket species TAC	Based on harvest strategy starting TAC
Basket trigger	0.5t	
Minimum size limit	22cm	

New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)

Latest scientific survey data	**Year**	**Landed weight (wet gutted) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	2019/20	104	-	*Not assessed*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Limited	No	Yes	*HCWG to discuss*
Comments on scientific survey findings	CSIRO analysis: Status still remains relatively unknow. Stock assessment needed. Targeted survey sampling may need to be factored into future fishery surveys.			
Catch data	Available for 2020 and 2021 (as at 18 Aug 2021).			
Price data (as advised by industry at HCRAG01 meeting)	Beach price $15/kg (wet-gutted)			
Any other considerations?	None identified			
Any other changes in the fishery?	None advised			
Any other sources of mortality apart from fishing?	None identified			

Low Tier

	Fishing season	Catch (t)	TAC (t)	% TAC caught	TAC or basket trigger exceeded?	% of TAC overcatch
Total catch data	2020	0.17	50 (0.5t trigger limit)	0.34 %	TAC: No Basket: No	N/A
	2021[11]	0.07	50 (0.5t trigger limit)	TBA	TBA	TBA

[11] Catches for the 2021 season to date – as of 18 August 2021.

Decision rules	No concerns from RAG and additional industry members regarding the total reported catch.				
Species specific data gaps and needs					
General improvements to area and effort reporting.					
Species Specific Research and Priorities					
May benefit from a dedicated survey in the future.					
HCRAG recommendations	**Fishing season**	**RBC (t)**	**Overcatch to be discounted (t)**	**Other source(s) of mortality (t)**	**TAC/trigger limit (t)**
	2022	**50t (0.5t trigger limit)**	**N/A**	**N/A**	**50t (0.5t trigger limit)**
The RAG did not recommend any changes to the basket TAC or the trigger limit for the species.					

Golden sandfish (not assessed by HCRAG)

HCRAG Species Assessment Sheet				
Common names	Golden sandfish – *Holothuria lessoni*			
Pre-HS TAC	Part of 80t basket species TAC			
Status open/closed	Open			
Current TAC	Part of 50t basket species TAC	Based on harvest strategy starting TAC		
Basket trigger	0.5 tonnes			
Minimum size limit	22cm			
New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)				
Latest scientific survey data	**Year**	**Standing stock biomass (90th percentile) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	Not included in 2019-20 survey	-	-	*RAG to discuss*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	No	N/A	N/A	*RAG to discuss*
Comments on scientific survey findings	CSIRO paper (**attachment B of agenda item 5**): N/A			
Catch data	Available for 2020 and 2021 (as at 18 Aug 2021). Refer to **attachment A of Agenda Item 5.**			
Any other considerations?	**RAG members to provide advice**			
Any other changes in the fishery?	**RAG members to provide advice. For example, fishing behaviour/market demand? **			
Any other sources of mortality apart from fishing?	**RAG members to provide advice**			

Low Tier						
Total catch data	**Fishing season**	**Catch (t)**	**TAC (t)**	**% TAC caught**	**TAC or basket trigger exceeded?**	**% of TAC overcatch**
	2020	No catch reported	15	-	TAC: No Basket: No	N/A
	2021[12]	No catch reported	15	-	TBA	TBA
Decision rules	Is the total catch reliable? **RAG members to provide advice**					
	Not overcaught so overcatch decision rules not triggered (refer to section 2.11.1.1 of the harvest strategy).					

[12] Catches for the 2021 season to date – as of 18 August 2021.

	For species with individual triggers within a basket with a joint TAC, should the joint TAC or individual triggers be changed (up or down) (refer to section 2.11.1.2 of the harvest strategy)? **RAG members to provide advice**

Species specific data gaps and needs

to be completed at the meeting

Species Specific Research and Priorities

to be completed at the meeting

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC (t)
HCRAG recommendations	2022				

General RAG comments

Brown sandfish (not assessed by HCRAG)

HCRAG Species Assessment Sheet				
Common names	Brown sandfish – *Bohadschia vitiensis*			
Pre-HS TAC	Part of the 80t basket species TAC			
Status open/closed	Open			
Current TAC	Part of the 50t basket species TAC	Based on harvest strategy starting TAC		
Basket trigger	3 tonnes			
Minimum size limit	25cm			
New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)				
Latest scientific survey data	**Year**	**Standing stock biomass (90th percentile) (t)**	**Standing stock biomass above min species size limit (t)**	**Is standing stock biomass above the default limit reference point?**
	Not included in 2019-20 survey	-	-	*RAG to discuss*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	-	-	-	*RAG to discuss*
Comments on scientific survey findings	N/A			
Catch data	Available for 2020 and 2021(as at 18 Aug 2021). Refer to **attachment A of Agenda Item 5.**			
Any other considerations?	**RAG members to provide advice**			
Any other changes in the fishery?	**RAG members to provide advice. For example, fishing behaviour/market demand? **			
Any other sources of mortality apart from fishing?	**RAG members to provide advice**			

Low Tier						
Total catch data	**Fishing season**	**Catch (t)**	**TAC (t)**	**% TAC caught**	**TAC or basket trigger exceeded?**	**% of TAC overcatch**
	2020	No catch reported	50 (3t trigger limit)	N/A	TAC: No Basket: No	N/A
	2021[13]	No catch reported	50 (3t trigger limit)	TBA	TBA	TBA
Decision rules	Is the total catch reliable? **RAG members to provide advice**					
	Not overcaught so overcatch decision rules not triggered (refer to section 2.11.1.1 of the harvest strategy).					

[13] Catches for the 2021 season to date – as of 18 August 2021.

	For species with individual triggers within a basket with a joint TAC, should the joint TAC or individual triggers be changed (up or down) (refer to section 2.11.1.2 of the harvest strategy)? **RAG members to provide advice**

Species specific data gaps and needs
to be completed at the meeting

Species Specific Research and Priorities
to be completed at the meeting

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC/trigger limit (t)
HCRAG recommendations	2022				
General RAG comments					

Leopardfish (not assessed by HCRAG)

HCRAG Species Assessment Sheet

Common names	Leopardfish – *Bohadschia argus*	
Pre-HS TAC	Part of the 80t basket species TAC	
Status open/closed	Open	
Current TAC	Part of the 50t basket species TAC	Based on harvest strategy starting TAC
Basket trigger	40 tonnes	
Minimum size limit	30cm	

New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)

Latest scientific survey data

Year	Standing stock biomass (90th percentile) (t)	Standing stock biomass above min species size limit (t)	Is standing stock biomass above the default limit reference point?
2019/20	508	-	*RAG to discuss*

Survey adequate for species	Any unexpected results	Any concerns with biomass trend or absolute abundance	Need for management response
Yes	No	No	*RAG to discuss*

Comments on scientific survey findings	CSIRO paper (**attachment B of agenda item 5**): catches low. Generally increasing density trend. No concern for TAC.
Catch data	Available for 2020 and 2021 (as at 18 Aug 2021). Refer to **attachment A of agenda item 5.**
Price data	$15/kg (gutted-salted), $120/kg (dried)
Any other considerations?	**RAG members to provide advice**
Any other changes in the fishery?	**RAG members to provide advice. For example, fishing behaviour/market demand?**
Any other sources of mortality apart from fishing?	**RAG members to provide advice**

Low Tier

Total catch data

Fishing season	Catch (t)	TAC (t)	% TAC caught	TAC or basket trigger exceeded?	% of TAC overcatch
2020	0.2	50 (40t basket trigger limit)	0.004 %	TAC: No Basket: No	N/A
2021[14]	No catch reported	50 (40t basket trigger limit)	TBA	TBA	TBA

Decision rules	Is the total catch reliable? **RAG members to provide advice**

[14] Catches for the 2021 season to date – as of 18 August 2021.

<table>
<tr><td rowspan="2"></td><td colspan="5">Reported overcatch does not trigger any of the overcatch decision rules (refer to section 2.11.1.1 of the harvest strategy).</td></tr>
<tr><td colspan="5">For species with individual triggers within a basket with a joint TAC, should the joint TAC or individual triggers be changed (up or down) (refer to section 2.11.1.2 of the harvest strategy)? *RAG members to provide advice*</td></tr>
<tr><th colspan="6">Species specific data gaps and needs</th></tr>
<tr><td colspan="6">*to be completed at the meeting*</td></tr>
<tr><th colspan="6">Species Specific Research and Priorities</th></tr>
<tr><td colspan="6">*to be completed at the meeting*</td></tr>
<tr><td rowspan="2">HCRAG recommendations</td><th>Fishing season</th><th>RBC (t)</th><th>Overcatch to be discounted (t)</th><th>Other source(s) of mortality (t)</th><th>TAC/trigger limit (t)</th></tr>
<tr><td>2022</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">*General RAG comments*</td></tr>
</table>

Pinkfish

HCRAG Species Assessment Sheet		
Common names	Pinkfish – *Holothuria edulis*	
Pre-HS TAC	Part of 80t basket species TAC	
Status open/closed	Open	
Current TAC	Part of 50t basket species TAC	Based on harvest strategy starting TAC
Basket trigger	N/A	
Minimum size limit	N/A	

New information

	Year	Standing stock biomass (90th percentile) (t)	Standing stock biomass above min species size limit (t)	Is standing stock biomass above the default limit reference point?
Latest scientific survey data	2019/20	85	-	*Not assessed*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	Yes	*HCWG to discuss*

Comments on scientific survey findings	CSIRO paper: Possible decline or natural variability. Stock assessment needed.
Catch data	Available for 2020 and 2021 (as at 18 August 2021).
Price data (as advised by industry at HCRAG01 meeting)	Currently no market demand for the species
Any other considerations?	None identified
Any other changes in the fishery?	None identified – this species is hardly fished
Any other sources of mortality apart from fishing?	None identified

Low Tier

	Fishing season	Catch (t)	TAC (t)	% TAC caught	TAC or basket trigger exceeded?	% of TAC overcatch
Total catch data	2020	No catch reported	50	N/A	TAC: No Basket: N/A	N/A
	2021[15]	No catch reported	50	TBA	TBA	TBA
Decision rules	No concerns from RAG and additional industry members regarding the catch data.					

[15] Catches for the 2021 season to date – as of 18 August 2021.

Species specific data gaps and needs
N/A

Species Specific Research and Priorities
None identified

	Fishing season	RBC (t)	Overcatch to be discounted (t)	Other source(s) of mortality (t)	TAC/trigger limit (t)
HCRAG recommendations	2022	**50t**	**N/A**	**N/A**	**50t**

The RAG did not recommend any changes to the basket TAC or the trigger limit for the species.

Amberfish (not assessed by HCRAG)

HCRAG Species Assessment Sheet		
Common names	Amberfish – *Thelenota anax*	
Pre-HS TAC	Part of the 80t basket species TAC	
Status open/closed	Open	
Current TAC	Part of the 50t basket species TAC	Based on harvest strategy starting TAC
Basket trigger	N/A	
Minimum size limit	N/A	

New information since the TAC was last considered (in this it was at the implementation of the Harvest Strategy)

	Year	Standing stock biomass (90th percentile) (t)	Standing stock biomass above min species size limit (t)	Is standing stock biomass above the default limit reference point?
Latest scientific survey data	2019/20	478	-	*RAG to discuss*
	Survey adequate for species	**Any unexpected results**	**Any concerns with biomass trend or absolute abundance**	**Need for management response**
	Yes	No	No	*RAG to discuss*

Comments on scientific survey findings	CSIRO paper (**attachment B of agenda item 5**): Catches low. No concern for TAC.
Catch data	Available for 2020 and 2021 (as at 18 Aug 2021). Refer to **attachment A of Agenda Item 5.**
Any other considerations?	**RAG members to provide advice**
Any other changes in the fishery?	**RAG members to provide advice. For example, fishing behaviour/market demand? **
Any other sources of mortality apart from fishing?	**RAG members to provide advice**

Low Tier

	Fishing season	Catch (t)	TAC (t)	% TAC caught	TAC or basket trigger exceeded?	% of TAC overcatch
Total catch data	2020	No catch reported	50	-	TAC: No Basket: N/A	N/A
	2021[16]	No catch reported	50	TBA	TBA	TBA
Decision rules	Is the total catch reliable? **RAG members to provide advice**					

[16] Catches for the 2021 season to date – as of 18 August 2021.

<table>
<tr><td rowspan="2"></td><td colspan="5">Not overcaught so overcatch decision rules not triggered (refer to section 2.11.1.1 of the harvest strategy).</td></tr>
<tr><td colspan="5">For species with individual triggers within a basket with a joint TAC, should the joint TAC or individual triggers be changed (up or down) (refer to section 2.11.1.2 of the harvest strategy). *RAG members to provide advice*</td></tr>
<tr><th colspan="6">Species specific data gaps and needs</th></tr>
<tr><td colspan="6">*to be completed at the meeting*</td></tr>
<tr><th colspan="6">Species Specific Research and Priorities</th></tr>
<tr><td colspan="6">*to be completed at the meeting*</td></tr>
<tr><td rowspan="2">HCRAG recommendations</td><th>Fishing season</th><th>RBC (t)</th><th>Overcatch to be discounted (t)</th><th>Other source(s) of mortality (t)</th><th>TAC/trigger limit (t)</th></tr>
<tr><td>2022</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">*General RAG comments*</td></tr>
</table>

Closed species

Surf redfish (closed)

<table>
<tr><th colspan="5">HCRAG Species Assessment Sheet</th></tr>
<tr><td>Common names</td><td colspan="4">Surf redfish – Actinopyga mauritiana</td></tr>
<tr><td>Pre-HS TAC</td><td colspan="4">0 tonnes</td></tr>
<tr><td>Status open/closed</td><td colspan="4">Closed since 2003 due to sustainability concerns</td></tr>
<tr><td>Minimum size limit</td><td colspan="4">22cm</td></tr>
<tr><td colspan="5">New information</td></tr>
<tr><td rowspan="4">Latest scientific survey data</td><td>Year</td><td>Standing stock biomass (90th percentile) (t)</td><td>Standing stock biomass above min species size limit (t)</td><td>Is standing stock biomass above the default limit reference point?</td></tr>
<tr><td>2019/20</td><td>20</td><td>6.7</td><td>RAG to discuss</td></tr>
<tr><td>Survey adequate for species</td><td>Any unexpected results</td><td>Any concerns with biomass trend or absolute abundance</td><td>Need for management response</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>RAG to discuss</td></tr>
<tr><td>Comments on scientific survey findings</td><td colspan="4">CSIRO paper (attachment B of agenda item 5): Species remains closed – Harvest Strategy closed species rule applies.</td></tr>
<tr><td>Catch data</td><td colspan="4">This species is closed to fishing however 200kg of catch was reported by a fisher in 2020. This matter was followed up by AFMA Compliance.</td></tr>
<tr><td>Any other considerations?</td><td colspan="4">*RAG members to provide advice*</td></tr>
<tr><td colspan="5">Re-opening Decision Rule (2.11.4 section of the harvest strategy) – this rule can only be applied if, using all available and reliable information, it can be established that the stock is above a limit reference point level.</td></tr>
<tr><td colspan="5">Species specific data gaps and needs</td></tr>
<tr><td colspan="5">*to be completed at the meeting*</td></tr>
<tr><td colspan="5">Species Specific Research and Priorities</td></tr>
<tr><td colspan="5">*to be completed at the meeting*</td></tr>
<tr><td colspan="5">*General RAG comments*</td></tr>
</table>

Sandfish (closed)

<table>
<tr><th colspan="5">HCRAG Species Assessment Sheet</th></tr>
<tr><td>Common names</td><td colspan="4">Sandfish – Holothuria scabra</td></tr>
<tr><td>Pre-HS TAC</td><td colspan="4">0 tonnes</td></tr>
<tr><td>Status open/closed</td><td colspan="4">Closed since 1998 due to sustainability concerns</td></tr>
<tr><td>Minimum size limit</td><td colspan="4">18cm</td></tr>
<tr><td colspan="5">New information</td></tr>
<tr><td rowspan="4">Latest scientific survey data</td><td>Year</td><td>Standing stock biomass (90^{th} percentile) (t)</td><td>Standing stock biomass above min species size limit (t)</td><td>Is standing stock biomass above the default limit reference point?</td></tr>
<tr><td>Planned for but not included in 2019-20 survey</td><td>unknow</td><td>unknown</td><td>RAG to discuss</td></tr>
<tr><td>Survey adequate for species</td><td>Any unexpected results</td><td>Any concerns with biomass trend or absolute abundance</td><td>Need for management response</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>RAG to discuss</td></tr>
<tr><td>Comments on scientific survey findings</td><td colspan="4">CSIRO paper (attachment B of agenda item 5): No survey undertaken. Harvest Strategy closed species rule applies.</td></tr>
<tr><td>Catch data</td><td colspan="4">This species is closed to fishing</td></tr>
<tr><td>Any other considerations?</td><td colspan="4">Assessed as ‘Overfished’ but ‘Not subject to overfishing’ by ABARES in the Annual Fishery Status Reports as no recovery in overall density was observed between 1998 and 2010, and there is no other robust information to inform stock status
RAG members to provide advice</td></tr>
<tr><td colspan="5">Re-opening Decision Rule (2.11.4 section of the harvest strategy) – this rule can only be applied if, using all available and reliable information, it can be established that the stock is above a limit reference point level.</td></tr>
<tr><td colspan="5">Species specific data gaps and needs</td></tr>
<tr><td colspan="5">*to be completed at the meeting*</td></tr>
<tr><td colspan="5">Species Specific Research and Priorities</td></tr>
<tr><td colspan="5">*to be completed at the meeting*</td></tr>
<tr><td colspan="5">*General RAG comments*</td></tr>
</table>

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
MANAGEMENT OPTIONS FOR THE UTLISATION OF WHITE TEATFISH	Agenda Item 5.1 FOR DISCUSSION & ADVICE

RECOMMENDATIONS

1. That the Working Group:

   a. **NOTE** that the recent stock survey of sea cucumbers in east Torres Strait undertaken by CSIRO (AFMA project 2019/086):

      i. confirmed previous understanding that white teatfish are a deeper water sea cucumber species. The survey found ~50 per cent of white teatfish is found in the deep water strata (none found beyond 36m);

   b. provides preliminary information that the white teatfish TAC could be increased. The Hand Collectable Resource Assessment Group (HCRAG) recommended at its meeting on 6-7 October 2021, that stock assessment modelling be undertaken to assess the potential (and extent) for an increase to the white teatfish TAC.

   c. **NOTE** that based on industry advice over time, to fish in deeper waters they require the use of hookah equipment.

   d. **NOTE** there have been divided views among stakeholders on the use of hookah equipment in the BDM Fishery (summary of community consultation discussions on this matter are provided as **Attachment A**)

   e. **NOTE** the HCRAG recommended at its meeting on 6-7 October 2021, that the HCWG continue to consider the review of the current hookah ban in relation to white teatfish and undertake further community consultation on management arrangements that would support sustainable harvesting of white teatfish using hookah.

   f. **NOTE** that white teatfish is now listed under Appendix II of the Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES); and

   g. **DISCUSS** and **PROVIDE ADVICE** on the relative management priority to develop advice to the PZJA on management options to support the utilisation of white teatfish TAC against other future management priorities[1] and if recommended as a short-to-medium term priority:

      i. key considerations for assessing management options; and

      ii. an appropriate workplan noting AFMA's draft workplan outlined in **Table 1**.

KEY ISSUES

1. It is a long-standing matter for some in the BDM industry to have the prohibition on the use of hookah equipment in the BDM Fishery amended to enable full utilisation of the white teatfish TAC. As a result, is has also been a long-standing management issue considered by the HCWG.
2. In recent years management resources for the BDM Fishery have focused on the implementation of the mandatory fish receiver system, harvest strategy and reopening of the black teatfish fishery. Subject to HCWG advice on future management priorities and the

[1] Future management priorities are to be discussed under Agenda Item 8

resourcing required to service those priorities, it may now be timely to refocus on developing management options to support the utilisation of the white teatfish TAC.

3. Consistent with previous discussions held by the HCWG, developing management options is likely to be complex resulting from:
   a. divided views among stakeholders on the use of hookah equipment in the BDM Fishery generally (see Background for more detail);
   b. the potential impact of options on the performance of broader management objectives. The BDM Fishery is open access to traditional inhabitants. TACs are fished competitively by licence holders and input controls are in place to constrain fishing efficiency. In doing so, the catch per unit of effort by a fisher is constrained allowing the TAC to be shared by relatively more fishers. These same arrangements however place a regulatory barrier to fishers being able to fully take the TAC of the white teatfish; and
   c. the feasibility (inclusive of cost) of implementing, monitoring, and enforcing different options (for example allowing the use of hookah equipment in certain areas, by certain fishers and for certain species only).
4. AFMA is seeking advice from the HCWG on the relative priority of directing management resources to develop advice to the PZJA on management options to support the utilisation of white teatfish TAC.
5. Future management priorities for hand collectable fisheries are to be discussed under Agenda Item 8. If this matter is recommended as a short-to-medium term priority, then AFMA seeks HCWG advice on:
   a. key considerations for assessing management options. The key considerations can then be used to help guide discussions with broader stakeholders; and
   b. an appropriate workplan. AFMA has developed a draft workplan which is outlined in **Table 1.**

BACKGROUND

2. The *Torres Strait Fisheries Management Instrument No. 15* currently prohibits the use of any underwater breathing apparatus (such as hookah) in the BDM Fishery.
6. Objectives adopted for the Torres Strait Bêche-de-mer Fishery are (PZJA website):
   a. to provide for the sustainable use of all bêche-de-mer stocks in Torres Strait;
   b. develop bêche-de-mer stocks for the benefit of Australian Traditional Inhabitants (as defined by the Torres Strait Treaty); and
   c. develop an appropriate long term management strategy for sandfish.

7. Objectives of the *Torres Strait Fisheries Act 1984*

In the administration of this Act, regard shall be had to the rights and obligations conferred on Australia by the Torres Strait Treaty and in particular to the following management priorities:

   a. to acknowledge and protect the traditional way of life and livelihood of traditional inhabitants, including their rights in relation to traditional fishing;
   b. to protect and preserve the marine environment and indigenous fauna and flora in and in the vicinity of the Protected Zone;
   c. to adopt conservation measures necessary for the conservation of a species in such a way as to minimise any restrictive effects of the measures on traditional fishing;
   d. to administer the provisions of Part 5 of the Torres Strait Treaty (relating to commercial fisheries) so as not to prejudice the achievement of the purposes of Part 4 of the Torres Strait Treaty in regard to traditional fishing;
   e. to manage commercial fisheries for optimum utilisation;

f. to share the allowable catch of relevant Protected Zone commercial fisheries with Papua New Guinea in accordance with the Torres Strait Treaty;

g. to have regard, in developing and implementing licensing policy, to the desirability of promoting economic development in the Torres Strait area and employment opportunities for traditional inhabitants.

Table 1. Draft workplan to develop management options to support the utilisation of the white teatfish TAC.

Date	Activity	Note
Feb-April	AFMA to undertake a round of community meetings on a range of Torres Strait Fishery matters (details TBA).	
March	Industry management options workshop	• Expected outcome: industry participants to develop management options. • HCWG industry members to facilitate workshop. • HCWG industry members to assist AFMA with nominating fishers from the BDM Fishery to attend the workshop. • Malu Lamar to be invited to advise on native title matters. • Subject to the availability of facilities, convene in Eastern Islands. (note subject to HCWG and a PZJA decision this workshop may also serve as a pre-black teatfish opening briefing)
April/May	Black teatfish opening? Note HCWG advice on a future opening is pending	
June/July	HCRAG	If relevant, HCRAG to consider and provide advice on any data, assessment and potential stock impacts associated with each option.
July/Aug	HCWG	Having regard for any advice from the HCRAG, discuss and provide advice to the PZJA on a preferred management option.
Aug/Sep	Administration	AFMA to prepare draft arrangements to implement to the HCWG preferred management option. Note this will, at a minimum include remaking the Management Instrument for the Fishery.
Oct	Native Title Notification	If required, AFMA to undertake notification under section 24HA of the *Native Title Act 1993*.
Jan	PZJA	Consider management options having regard for HCWG advice, HCRAG advice, industry management options workshop advice and native title notification responses if undertaken.
TBA	Implementation	Implementation will depend on the nature of the management option agreed.

PZJA Traditional Inhabitant Members Cluster Consultations 2019/20

Meetings Summary for Hand Collectables Working Group

Traditional Inhabitant members of PZJA advisory committees recently undertook community and industry consultations to report on activities related to PZJA fisheries over the last 12 months and seek input on key issues for the management of fisheries in the Torres Strait. The meetings were led by the PZJA Traditional Inhabitant Members, with support provided by TSRA and AFMA.

The Hand Collectables Working Group (HCWG) Meeting #15 recommended the PZJA Traditional Inhabitant Members use these meetings as an opportunity to seek industry and community feedback on the proposed black teatfish trial opening and the current prohibition on hookah.

The meetings were delivered as outlined in the Table 1 below:

Table 1. PZJA Traditional Inhabitant Members consultation schedule

Community	Date	Presenters
Erub	16 October 2019	Michael Passi (HC), Les Pitt (TRL), John Tabo (Finfish) Support: Liz McCrudden (TSRA), Neville Johnston (TSRA), Georgia Langdon (AFMA)
Mer	17 October 2019	
Ugar	5 February 2020	Michael Passi (BDM), Les Pitt (TRL), John Tabo (Finfish) Rocky Stephen (SAC and Finfish), William Stephen (PMAC) Support: Neville Johnston (TSRA)
Boigu	22 October 2019	Maluwap Nona (HC, SAC), Aaron Tom (TRL), Tenny Elisala (Finfish) Support: Liz McCrudden (TSRA), Natalie Couchman (AFMA)
Saibai	23 October 2019	
Dauan	24 October 2019	
Masig	5 November 2019	Hilda Mosby (Finfish), Gavin Mosby (SAC, PMAC), James Billy (TRL), Patrick Bonner (HC), Paul Lowatta (Finfish) – Masig only Mark David (TRL) – Iama only Francis Pearson (PMAC) -Poruma only Support: Liz McCrudden (TSRA), Andrew Trappett (AFMA)
Iama	6 November 2019	
Pourma	7 November 2019	
Warraber	8 November 2019	
Badu	22 November 2019	James Ahmat (TRL), Frank Loban (Finfish, HC, SAC) Support: Liz McCrudden (TSRA), Neville Johnston (TSRA), Georgia Langdon (AFMA)
Mabuiag	23 November 2019	
Kubin	25 November 2019	
St Pauls	26 November 2019	
Thursday Island	21 January 2020	Patrick Mills (TRL, SAC), Tony Salam (HC), Harry Nona (Finfish, TRL). Support: Liz McCrudden (TSRA), Neville Johnston (TSRA), Georgia Langdon (AFMA)

Table 2 below provides an overview of the key discussion points, feedback and recommendations relevant to the HCWG from all consultations.

Table 2. Summary of discussions – Beche-de-mer fishery – Cluster visits 2019/20

Kemer Kemer Meriam - 15-17 October 2019 and 5 February 2020		
Presenter – Michael Passi		
Black teatfish proposed trial opening	**Hookah for harvesting white teatfish**	**Other discussion**
• Mer and Erub indicated support for the black teatfish trial opening to be driven using a cultural lore framework. • PBC and councils to be leaders in the process • AFMA and the TSRA should seek engagement and input from GBK and Malu Lamar • AFMA will not regulate access, rather the PBC's will take a leadership role in facilitating discussions and access arrangements • Meeting participants generally noted that if black teatfish is opened, everyone is going to fish it – what does this mean for the full time slug operators? There needs to be a decision about who can access it, and people need to respect that. It was agreed the decision needs to be made by the communities, and not by AFMA/TSRA. • Meeting participants at Erub noted community concerned about going over the black teatfish limit again and also with increased catches of giant clams. There are claims that last time lots of people came over from the West and over-harvested giant clams during the black teatfish opening.	• At Mer it was suggested that if a trial for hookah to target white teatfish was allowed then all other BDM species should be closed. • Generally the use of hookah for white teatfish was not supported by Ugar due to fear of over fishing and targeting other species.	• Increased investment and support for fishers is needed to improve the value of catch – e.g. drying facilities on islands for BDM. • Suggestion to have one central fish receiver in each community. AFMA agreed that is a good idea that communities can arrange amongst themselves, as long as the product is landed, weighed and recorded to a licenced fish receiver as per licence conditions.

<table>
<tr><th colspan="3">Gudumalulgal – 21-24 October 2019</th></tr>
<tr><td colspan="3">Presenter – Maluwap Nona</td></tr>
<tr><td>Black teatfish proposed trial opening</td><td>Hookah for harvesting white teatfish</td><td>Other discussion</td></tr>
<tr>
<td>Across each community there was general support for the black teatfish trial opening to be run through traditional law/lore. Noting that fishers have the right to access any part of a fishery under the current TIB licence conditions.
There is no black teatfish habitat in Gudumalulgal waters so there is some concern that access to the trial will be limited for Gudumalulgal industry members.
Native title bodies must be involved in the trial opening.</td>
<td>Broadly Traditional Owners present at the Gudumalulgal meetings recommend opening hookah to access white teatfish only. Other species cannot be taken by hookah. This is an important economic opportunity which can be managed under the TAC and compliance measures.
Ensure white teatfish is included in the BDM survey.</td>
<td>Suggestion the PZJA should review options for spatial opening and closures – like rotational grazing to increase the sustainability of the fishery.
There was discussion regarding the current Class C licence conditions. It is recommended these should be reviewed to enable primary vessels to tow other TIB licence holders to finishing grounds and provide resources.</td>
</tr>
</table>

<table>
<tr><th colspan="3">Kulkalgal – 4-8 November 2019</th></tr>
<tr><td colspan="3">Presenter – Patrick Bonner</td></tr>
<tr><td>Black teatfish proposed trial opening</td><td>Hookah for harvesting white teatfish</td><td>Other discussion</td></tr>
<tr>
<td>Masig industry members suggested the black teatfish trial opening should occur in February as it aligns with the opening of the TRL hookah season. Concerns were raised regarding the spawning time and the proposed mid-year opening.
Noted it was important for communities, managers and scientists to know timing of spawning for all species. There is a strong need to feed this information back to communities - ground truth the scientific understanding.</td>
<td>Masig meeting participants provided mixed support for opening hookah for white teatfish
It was noted that if white teatfish was opened for hookah access then the fishermen would not be able to target or collect any other species (this is not maximising a fisherman’s effort in the fishery)
Compliance was recognised as a significant challenge</td>
<td>Recommendation for AFMA to develop online/app catch reporting tool.
Recommendation should be made to PZJA, Commonwealth & State Ministers and TSRA for the regulation of the fisheries to acknowledge traditional lore.
The collection of spatial data in logbooks should become compulsory for all fisheries.
The PZJA to support training opportunities on island for fisheries to develop skills in processing, harvesting and transporting and local industry champions could be supported to train fisheries across Kulkalgal islands.</td>
</tr>
</table>

• Recommendation for CSIRO to provide spawning time for each BDM species
• It was noted most communities in the east have adjacent black teatfish habitat (Masig eastwards).
• Poruma, Iama and Warraber agreed on the following recommendations for the Black teatfish trial opening:
  ○ The trial should only be opened for the five communities where black teatfish is abundant – Ugar, Erub, Mer, Masig and Poruma
  ○ The access to the trial must be led by PBC and community leaders
    ▪ PBCs should provide letters of support for HCWG members to take to the next meeting to ensure PZJA members are speaking with the correct authority
  ○ Malu Lamar and GBK must be involved from the start of the trial development
  ○ Traditional lore needs to be recognised in the policy/management plan for the trial opening
• The trial opening should take into consideration the spawning time of BDM
	○ The majority from all clusters need to be in support for hookah to be allowed
	  ○ A full management plan would need to be driven by PBC and fishermen (not just those targeting white teatfish).
	  ○ It was noted outside the meeting that support for hookah varies across Masig industry members
	• At Poruma, Iama and Warraber strong advice received that hookah should not be allowed for the take of any BDM species, including white teatfish, due to the potential impacts on the sustainability of the fishery and issues in regulation/compliance.
	• Recommendation that TSRA should support someone from Central islands to go to Masig Island to inform the industry on what the challenges and impacts are of having both hookah and free divers operating in the same region.
		• Kulkalgal industry should have employment opportunities during the BDM survey on Warrior Reef and hold community information sessions prior to the survey to gain insight from industry.
		• Kulkalgal research must utilise local knowledge and engage local people before the research.
		• The meeting participants at Iama, Poruma and Warraber agreed on the proposed development of a Community Management Plan as a priority:
		  ○ Now the TRL and BDM harvest strategies are in place, it is the right time to develop a community management plan that recognises cultural protocols.
		  ○ The TSRA should prioritise their development to work alongside the current PZJA management plans and harvest strategies
		  ○ The community management plans should provide guidance on:
		    ▪ Spatial closures
		    ▪ Rotational reef harvesting
		    ▪ Depth regulations
		    ▪ Tide regulations
		    ▪ Cultural practices
		    ▪ Anchorage regulations on reefs and in cultural fishing sites
		  ○ Each Nation should create their own community management plan suitable for their cultural protocols, reefs and industry

		• They should be e collaborative between the PBCs, TSRA and the PZJA

Maluiligal – 21-26 November 2019		
Presenter – Frank Loban		
Black teatfish proposed trial opening	**Hookah for harvesting white teatfish**	**Other discussion**

• Meeting participants at Badu indicated the black teatfish access should be through partnerships with PBCs. However, concern was raised with having to potentially ask eastern communities for permission, where the majority of the black teatfish habitat is located. It was suggested perhaps permission should be reciprocal for kaiar for eastern fishers coming to the west.
• At St Pauls and Kubin there was limited support for the proposed black teatfish opening using traditional lore to regulate access. Attendees noted that if fishers from the east want come work kaiar they don't need permission, so why should western fishers need to seek permission. Even though that is the respectable thing to do, it needs to work both ways. Attendees agreed that the proposal needs more discussion on that matter with community elders and industry outside of this meeting.
• At Mabuiag meeting participants indicated the black teatfish access should be through partnerships through PBCs. There was general consensus that traditional lore should be followed, noting there was an
	• There was limited discussion regarding the use of hookah for white teatfish at Badu. One meeting participant indicated support, however a broad consensus was not voiced.
	• At St Pauls and Kubin there was general support for the use of hookah to collect white teatfish was mixed. This issue requires more discussion with industry to fully understand the benefits and risks.
	• Mabuiag indicated support for the use of hookah to collect white teatfish. It was strongly expressed that hookah should not be used for other species, which presents compliance issues which would need to be worked through.
		• The long term vision of the BDM fishery must consider the following:
		  ○ Risk of overfishing (citing international examples).
		  ○ Review the option of having season opening and closures for specific species.
		  ○ Review options of implementing quota systems in the future.
		• The collection of spatial data in logbooks becoming compulsory for all fisheries, however must ensure confidentially and privacy of fishing locations.
		• CSIRO should hold a meeting on Badu in the future to discuss the science and survey with fishers to increase understanding.
		• Discussions on minimum size limits (MSL) – compliance. AFMA explained how the MSL are measured but above all (i.e. undisturbed from tip to tip), the limits are in place as an added layer of protection to ensure the animals can reach a size to breed first and that AFMA will be making waterproof rulers available when new MSL come in to effect.

understanding that permission would need to be sought from eastern communities where black teatfish is present. It was acknowledged that there is a lot of detail to be worked through, but this approach at a high level was supported.		• A pilot project on re-seeding of sandfish at Ugar was discussed, including the potential for expansion in the future.

Kaiwalagal – 21 January 2020		
Presenter – Maluwap Nona (as proxy for Tony Salam)		
Black teatfish proposed trial opening	**Hookah for harvesting white teatfish**	**Other discussion**
• General support from the Kaiwalagal meeting participants for cultural lore to be used in the trial black teatfish opening to guide who has access to the trial at certain times. • It was suggested the timing of the opening should take into consideration limiting effort - for example open the trial during a hookah opening when a number of fishers will be targeting TRL. • Suggestion for the inclusion of triggers during the opening, which would control who can access the trial. For example when 10% of the TAC is remaining only local fishers to those waters should have access. Fisheries from other areas should leave. • Recommendation for a BDM industry meeting to discuss the strategic management plan and individual community needs, including trial openings.	• General support from meeting participants for the use of hookah for white teatfish noting that they were mostly not BDM fishers and would take the advice from those who are on the most appropriate management arrangements.	• Traditional spatial closures are currently encouraged by fishers to improve the sustainable management of the fishery. • Surveys to open a fishery must involve and take direction from Traditional Owners. They have a wealth of industry and environmental knowledge which is beneficial to scientific surveys. The involvement of local industry and community provides training opportunities. • Advice from TIB Fisherman that the PZJA agencies seek advice from fulltime operators in the industry regarding management arrangements and plans for the BDM fishery going forward.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
MANAGEMENT Torres Strait Fisheries (Beche-de-mer) Management Instrument	Agenda Item 5.2 FOR DISCUSSION & ADVICE

RECOMMENDATIONS

1. That the Working Group **DISCUSS** and **PROVIDE ADVICE** on repealing and making a new legislative instrument under section 16 of the *Torres Strait Fisheries Act 1984* (the Act) for the Torres Strait Beche-de-mer Fishery.

KEY ISSUES

2. Under section 16 of the Act the PZJA may make legislative instruments to regulate fishing[1]. These instruments are one of a range of tools used to manage Torres Strait Fisheries (other tools include, licence conditions, management plans and polices).
3. AFMA proposes the management instrument in place for the Beche-de-mer Fishery be repealed and replaced to:
    a. implement new size limits prescribed in the BDM Fishery Harvest Strategy, agreed by the PZJA on 19 November 2019 (meeting 33);
    b. insert a new section which prohibits a person from possessing, using or having control of underwater breathing apparatus and beche-de-mer on a boat. This is to strengthen existing prohibitions on the use of underwater breathing apparatus and clarify any ambiguity that may arise in relation to whether bêche-de-mer was taken with the use of prohibited equipment.
    c. provide an exemption to the prohibition on taking, processing or carrying bêche-de-mer for a licence granted under section 19(4A) of the Act that authorises the taking of bêche-de-mer in the bêche-de-mer fishery without the use of a boat (pursuant to changes being made to the s17 declaration). Although there are currently no licences granted under subsection 19(4A) of the Act, this will cover any future scenarios in which such licences are granted. This approach is consistent with both the TRL Management Instrument[2] and the TRL Management Plan[3].
    d. remove subclauses 8.1(a)(b) and (c) of the previous instrument as all persons engaged in commercial or community fishing in the bêche-de-mer fishery require a licence granted under sections 19(2), 19(3) or 19(4A) to take, process or carry bêche-de-mer in the area of the bêche-de-mer fishery.
    e. remove existing exemptions for traditional fishing in the BDM Fishery. As advised out-of-session in July 2018, the PZJA does not have jurisdiction to regulate traditional fishing (see s 4(1) of the *Arrangement between the Commonwealth and the State of Queensland under section 31 of the Torres Strait Fisheries Act 1984* (the Arrangement)). Given the operation of s 4(1) of the Arrangement, the Instrument cannot apply to traditional fishing.

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[1] Section 16 instruments impose a general prohibition on the take, processing and carrying of specified species, and then provide a series of exemptions to the prohibitions relating to licence types, minimum size limits, season dates, the use of certain gear and methods.
[2] *Torres Strait Fisheries (Tropical Rock Lobster) Management Instrument 2018*
[3] *Torres Strait Fisheries (Quotas for Tropical Rock Lobster (Kaiar)) Management Plan 2018*

f. no longer prescribe a cessation date (referred to as an application date). Consistent with recent PZJA decisions (meeting 39, 27 August 2020) the instrument instead, would be subject to section 63AB(d) of the *Legislation (Exemptions and Other Matters) Regulation 2015* which provides an exemption to sunsetting for a legislative instrument made by or on behalf of the PZJA in the exercise of a power under subsection 35(1) of the Act. AFMA recommends this approach to minimise the administrative burden of needing to remake instruments while noting that these Regulations do not preclude the PZJA from reviewing legislative instruments at any time, subject to need. The current BDM Fishery instrument is set to cease on 31 December 2026.

2. As well as the above it is proposed to update the instrument to meet current legislative drafting styles.

3. A copy of the current management instrument is at **Attachment A**. The proposed new instrument is at **Attachment B** together with a draft Explanatory Statement at **Attachment C.**

4. Advice from the HCWG will be considered by the PZJA when it meets in November 2021 to consider repealing and making a new management instrument for the BDM Fishery.

INSTRUMENT REGULATING FISHING

Torres Strait Fisheries Act 1984
Section 16
Torres Strait Sea Cucumber Fishery

TORRES STRAIT FISHERIES MANAGEMENT INSTRUMENT NO. 15

The **PROTECTED ZONE JOINT AUTHORITY** exercising jurisdiction under Commonwealth law over commercial fishing in the Protected Zone pursuant to the arrangement between the Commonwealth and the State of Queensland published on 19th March 1999 in the Commonwealth Gazette No. S125 and acting in accordance with the powers conferred on the Authority by paragraph 35(1)(a) of the *Torres Strait Fisheries Act 1984*, under section 16 of the *Torres Strait Fisheries Act 1984,* makes the following Instrument.

Dated 31st March 2017

Senator the Hon. Anne Ruston
Parliamentary Secretary to the Deputy Prime Minister and Minister for Agriculture and Water Resources
Chair of the Torres Strait Protected Zone Joint Authority

Citation

1. This Instrument may be cited as the *Torres Strait Fisheries Management Instrument No. 15*.

Commencement

2. This Instrument commences on the day after it is registered on the Federal Register of Legislative Instruments.

Cessation

3. This Instrument is repealed on 31 December 2026 unless earlier revoked.

Interpretation

4.1 In this Instrument, unless the contrary intention appears "the Act" means the *Torres Strait Fisheries Act 1984*; and

4.2 Terms used but not defined in this Instrument have the same meaning as in the Act and the *Torres Strait Fisheries Regulations 1985*; and

4.3 "**sea cucumber**" means fish of the families Holothuriidae and Stichopodidae; and

4.4 "**underwater breathing apparatus**" means any apparatus that delivers air or other breathing gas to a person.

Prohibitions

5. Pursuant to paragraph 16(1)(a) of the Act, the taking, processing or carrying of sea cucumber in the area of the Torres Strait Sea Cucumber Fishery is prohibited.

Size limits

6. Pursuant to paragraph 16(1)(b) of the Act, it is prohibited to take in the area of the Torres Strait Sea Cucumber Fishery species of the kind referred to in the Schedule that, when measured in their original living form at their longest point, are less than the lengths specified in respect of each species in the Schedule.

SCHEDULE

SPECIES	LENGTH IN MILLIMETRES
Sandfish (*Holothuria scabra)*	180
Lollyfish (*Holothuria atra*)	150
Black teatfish (*Holothuria whitmaei*)	250
White teatfish (*Holothuria fuscogilva*)	320
Deepwater redfish (*Actinopyga echinites*)	120
Prickly redfish (*Thelenota ananas*)	300
Elephant's trunk fish (*Holothuria fuscopunctata*)	240
Surf redfish (*Actinopyga mauritiana*)	220
Blackfish (*Actinopyga miliaris*)	220
Curry fish (*Stichopus variegatus*)	270

Gear restrictions

7 Pursuant to paragraph 16(1)(c) of the Act, the taking of sea cucumber in the area of the Torres Strait Sea Cucumber Fishery with the use of any underwater breathing apparatus or by any method other than collection by hand, is prohibited.

Exemption from the prohibitions

8.1 Pursuant to paragraph 16(1A)(d) of the Act, a person is exempt from the prohibition in paragraph 5 if:

a) where the person takes or carries sea cucumbers without the use of a boat – the number of sea cucumber in that person's possession does not exceed three; or

b) where the person takes or carries sea cucumbers with the use of a boat, or by diving from a boat, and no other person is in the boat – the number of sea cucumbers in the boat does not exceed three; or

c) where the person takes or carries sea cucumbers with the use of a boat, or by diving from a boat, and there is at least one other person in the boat – the number of sea cucumber in the boat does not exceed six.

8.2. Pursuant to paragraph 16(1A)(d) of the Act, a person is exempt from the prohibition in paragraph 5 if the person holds a licence granted under subsections 19(2) or 19(3) of the Act that entitles that person to take, process or carry sea cucumber.

8.3 Pursuant to paragraph 16(1A)(d) of the Act, a person is exempt from the prohibition in paragraph 5 if the person takes, processes or carries sea cucumber in the course of traditional fishing.

Revocation of previous instrument

9.1 This Instrument revokes the *Torres Strait Fisheries Management Notice No. 64* dated 24th December 2002 from the date of commencement of this Instrument.

9.2 In accordance with s16(7A) , notwithstanding the revocation of the *Torres Strait Fisheries Management Notice No. 64,* any entry previously made under s21(1) of the Act in an existing licence granted under s19(2) or (3) or treaty endorsement granted for engaging in activities that were prohibited in that revoked instrument, such entry shall continue to operate as if it referred to the prohibition in this instrument.

Torres Strait Fisheries (Bêche-de-mer) Management Instrument 2021

The Protected Zone Joint Authority, acting in accordance with the powers conferred on the Authority by paragraph 35(1)(a) of the *Torres Strait Fisheries Act 1984*, makes the following instrument under section 16, and in accordance with section 40, of the *Torres Strait Fisheries Act 1984*.

Dated November 2021

DRAFT ONLY—NOT FOR SIGNATURE

Senator the Hon Jonathon Duniam

Assistant Minister for Forestry and Fisheries
Assistant Minister for Industry Development
Chair, Protected Zone Joint Authority

Contents

1 Name

This instrument is the *Torres Strait Fisheries (Bêche-de-mer) Management Instrument 2021*.

2 Commencement

(1) Each provision of this instrument specified in column 1 of the table commences, or is taken to have commenced, in accordance with column 2 of the table. Any other statement in column 2 has effect according to its terms.

Commencement information		
Column 1	**Column 2**	**Column 3**
Provisions	**Commencement**	**Date/Details**
1. The whole of this instrument	1 January 2022	1 January 2022

Note 1: This table relates only to the provisions of this instrument as originally made. It will not be amended to deal with any later amendments of this instrument.

(2) Any information in column 3 of the table is not part of this instrument. Information may be inserted in this column, or information in it may be edited, in any published version of this instrument.

3 Authority

This instrument is made under section 16 of the Act.

4 Definitions

Note: A number of expressions used in this instrument are defined in section 3 of the Act, including the following:
(a) community fishing
(b) fish
(c) traditional inhabitant
(d) traditional fishing.

In this instrument:

Act means the *Torres Strait Fisheries Act 1984*.

bêche-de-mer means fish of the families Holothuriidae and Stichopodidae.

bêche-de-mer fishery means the area of the bêche-de-mer fishery prescribed in item 1 of Schedule 2 to the *Torres Strait Fisheries Regulations 1985*.

bêche-de-mer licenced person means a person who has been granted a licence under subsection 19(2), 19(3) or 19(4A) of the Act that authorises the taking, processing or carrying of bêche-de-mer in the bêche-de-mer fishery.

hookah gear means equipment to enable a person to breathe underwater where the air is supplied from either an air compressor or one or more air cylinders above the surface of the water, and includes equipment which may be described as surface supplied breathing equipment or surface supplied breathing apparatus.

PZJA Arrangement means the document titled "*Arrangement between the Commonwealth and the State of Queensland under section 31 of the Torres Strait Fisheries Act 1984*" dated 17 March 1999 and published on the Federal Register of Legislation, as that document exists at the commencement of this instrument.

Note: The PZJA Arrangement could be viewed on the website of the Federal Register of Legislation on **insert date* at: https://www.legislation.gov.au/Details/F2008B00750.

Regulations means the *Torres Strait Fisheries Regulations 1985*.

underwater breathing apparatus includes ***hookah gear*** and self-contained underwater breathing apparatus (known as SCUBA).

5 Schedules

Each instrument that is specified in a Schedule to this instrument is amended or repealed as set out in the applicable items in the Schedule concerned, and any other item in a Schedule to this instrument has effect according to its terms.

6 Prohibition on taking, processing or carrying bêche-de-mer

(1) The taking, processing or carrying of bêche-de-mer in the area of the bêche-de-mer fishery is prohibited.

Note: This prohibition does not apply to traditional inhabitants engaged in traditional fishing due to the application of the PZJA Arrangement.

(2) A person is exempt from the prohibition in subsection (1) where:

(a) the person is a bêche-de-mer licenced person.

7 Prohibition on taking, processing or carrying of undersize bêche-de-mer

The taking, processing or carrying of bêche-de-mer of a species listed in an item in column 1 of the table is prohibited where, in their original living form at their longest point, the length of bêche-de-mer is shorter in length than the minimum length specified in column 2 of the table.

Note: This prohibition does not apply to traditional inhabitants engaged in traditional fishing due to application of the PZJA Arrangement.

Item	Column 1 Species of bêche-de-mer	Column 2 Minimum length (centimetres)
1	Black teatfish (*Holothuria whitmaei*)	25
2	Brown sandfish (*Bohadschia vitiensis*)	25
3	Burrowing blackfish (*Actinopyga spinea*)	22
4	Curryfish (common) (*Stichopus herrmanni*)	31
5	Curryfish (vastus) (*Stichopus vastus*)	15
6	Deepwater blackfish (*Actinopyga palauensis*)	22

Item	Column 1 Species of bêche-de-mer	Column 2 Minimum length (centimetres)
7	Deepwater redfish (*Actinopyga echinites*)	20
8	Elephant trunkfish (*Holothuria fuscopunctata*)	24
9	Golden sandfish (*Holothuria lessoni*)	22
10	Hairy blackfish (*Actinopyga miliaris*)	22
11	Leopardfish (*Bohadschia argus*)	30
12	Lollyfish (*Holothuria atra*)	15
13	Prickly redfish (*Thelenota ananas*)	35
14	Sandfish (*Holothuria scabra*)	18
15	Surf redfish (*Actinopyga mauritiana*)	22
16	White teatfish (*Holothuria fuscogilva*)	32

8 Prohibition on the use of certain methods

(1) The taking, processing or carrying of bêche-de-mer in the bêche-de-mer fishery using methods to which subsection (2) applies is prohibited.

Note: This prohibition does not apply to traditional inhabitants engaged in traditional fishing due to the application of the PZJA Arrangement.

(2) This subsection applies to all fishing methods apart from collection by hand.

9 Prohibition on the use of certain equipment

(1) The taking, processing or carrying of bêche-de-mer in the bêche-de-mer fishery with the use of equipment to which subsection (2) applies is prohibited.

Note: This prohibition does not apply to traditional inhabitants engaged in traditional fishing due to the application of the PZJA Arrangement.

(2) This subsection applies to:

(a) any kind of mechanical equipment that provides for underwater propulsion; and

(b) Any kind of underwater breathing apparatus.

10 Prohibition on the use, possession or control of underwater breathing apparatus

A person is prohibited from using, from having in his or her possession, or from having under his or her control, on a boat in the area of the bêche-de-mer fishery, any quantity of underwater breathing apparatus, where a person is also carrying bêche-de-mer on a boat in the area of the bêche-de-mer fishery.

Note: This prohibition does not apply to traditional inhabitants engaged in traditional fishing due to the application of the PZJA Arrangement.

Schedule 1—Repeals

Torres Strait Fisheries Management Instrument No. 15

F2017L00370

1 The whole of the instrument

Repeal the instrument

EXPLANATORY STATEMENT

Issued by the authority of the Protected Zone Joint Authority

Torres Strait Fisheries Act 1984

Torres Strait Fisheries (Bêche-de-mer) Management Instrument 2021

Purpose

The *Torres Strait Fisheries (Bêche-de-mer) Management Instrument 2021* (the Instrument) repeals and replaces the *Torres Strait Fisheries Management Instrument No. 15* (the Previous Instrument) to update the drafting style regulation, provide an exemption to the prohibitions for a person who holds a licence issued under section 19(4A) of the *Torres Strait Fisheries Act 1984* (the Act) that authorises the taking, processing or carrying of bêche-de-mer in the area of the bêche-de-mer fishery and to streamline rules relating to the use, possession and control of underwater breathing apparatus.

The Fishery

The Torres Strait Sea Cucumber (bêche-de-mer) Fishery has a history that dates back to at least the 19th century. The fishery is now accessed only by traditional inhabitants and it forms an important source of income for Torres Strait traditional inhabitants.

The life-history of sea cucumbers and the fact that they are easily collected make them vulnerable to overfishing, which has occurred in the Torres Strait in the past. It is critical that commercial fishing for sea cucumbers is appropriately regulated to prevent overfishing. Sea cucumbers are mainly collected by hand by free-divers from dinghies or by people walking along reefs at low tide.

Legislative Authority

Subsection 16(1) of the Act provides for the Minister to regulate fishing through a legislative instrument. Subsection 35(1) of the Act provides for the Protected Zone Joint Authority (PZJA) to exercise the powers of the Minister under subsection 16(1) of the Act in respect of a 'Protected Zone Joint Authority fishery'.

Subsection 28(1) of the Act provides that a 'Protected Zone Joint Authority fishery' is a fishery in respect of which an arrangement under Part V of the Act is in place. The *Arrangement between the Commonwealth and the State of Queensland under section 31 of the Torres Strait Fisheries Act 1984* dated 17 March 1999 (the PZJA Arrangement[1]), made under Part V of the Act, provides that the PZJA is to have management of the fishery for the purposes of commercial fishing in the areas described in section 4 of the Arrangement. The bêche-de-mer fishery, which is defined in section 4 of the Instrument by reference to the 'area of the bêche-de-mer fishery' described in item 1 of the

---

[1] PZJA Arrangement means the document titled "*Arrangement between the Commonwealth and the State of Queensland under section 31 of the Torres Strait Fisheries Act 1984*" dated 17 March 1999 and published on the Federal Register of Legislation, as that document exists at the commencement of this Instrument.

Note: The PZJA Arrangement could be viewed on the website of the Federal Register of Legislation on **insert date* at: https://www.legislation.gov.au/Details/F2008B00750.

table in Schedule 2 to the *Torres Strait Fisheries Regulations 1985* (the Regulations), is within the area described in section 4 of the PZJA Arrangement. It follows that commercial fishing for bêche-de-mer in the area of the bêche-de-mer fishery would come under the definition of being a 'Protected Zone Joint Authority fishery' for the purpose of subsection 28(1) of the Act and the PZJA can therefore exercise the power of the Minister under subsection 16(1) of the Act in relation to commercial fishing within the bêche-de-mer fishery.

The PZJA is established under section 30 of the Act and consists of the Minister administering the Act, the Queensland Minister administering the laws of Queensland relating to marine fishing in the Protected Zone and the Chairperson of the Torres Strait Regional Authority (TSRA), which is the Commonwealth agency established under the *Aboriginal and Torres Strait Islander Act 2005* that represents the interests of Torres Strait Islanders.

Details of the Instrument

The Instrument repeals and replaces the Previous Instrument. The key features of the Previous Instrument that are retained in the Instrument are:

- a general prohibition for the taking, processing or carrying of bêche-de-mer (subsection 6(1) of the Instrument, clause 5 of the Previous Instrument), subject to an exemption for a person who holds a licence to take, process or carry bêche-de-mer under subsection 19(2), 19(3) or 19(4A) of the Act (subsection 6(2) of the Instrument, subclause 8(2) of the Previous Instrument);

- prohibitions on the use of certain fishing methods other than collection by hand (see section 8 of the Instrument, clause 7 of the Previous Instrument) and prohibitions on the use of any equipment that provides for breathing underwater (see section 9 of the Instrument, clause 7 of the Previous Instrument).

The Instrument retains prohibitions on taking, processing or carrying undersize bêche-de-mer (see subsection 7(1) of the Instrument, clause 6 of the Previous Instrument), including the method for measuring bêche-de-mer for these purposes (subsection 7(2) of the Instrument, clause 6 of the Previous Instrument. The Instrument additionally provides for increases for some individual minimum size limits to align with the updated size limits set out in the *Torres Strait Bêche-de-mer Fishery Harvest Strategy*[2], agreed to by the PZJA in November 2019 and implemented from 1 January 2020 for the commencement of the 2020 fishing season.

The Instrument also provides a section (see section 10) in relation to a prohibition on the use, possession or control of hookah gear on a boat, in the area of the bêche-de-mer fishery (see section 10 of the Instrument) where a person also carries bêche-de-mer on a boat, in the area of the bêche-de-mer fishery. This section intends to clarify any ambiguity that may arise in relation to whether bêche-de-mer was taken with the use of prohibited equipment. It is also intended to maintain the integrity of equipment prohibitions in the bêche-de-mer fishery under the Previous Instrument.

Subclauses 8.1(a)(b) and (c) of the Previous Instrument have been removed from the Instrument, as

[2] The *Torres Strait Bêche-de-mer Fishery Harvest Strategy* is subject to periodic review and is made publicly available on the PZJA website at https://www.pzja.gov.au/the-fisheries/torres-strait-beche-de-mer-fishery.

all persons engaged in commercial or community fishing in the bêche-de-mer fishery require a licence granted under sections 19(2), 19(3) or 19(4A) to take, process or carry bêche-de-mer in the area of the bêche-de-mer fishery.

Exemptions to persons engaged in traditional fishing (see subclause 8.3 of the Previous Instrument) have also been removed. The PZJA does not have jurisdiction in relation to 'traditional fishing' conducted by 'traditional inhabitants' (as defined in section 3 of the Act by reference to the Torres Strait Treaty[3]). This is because subsection 4(1) of the PZJA Arrangement specifies that the PZJA is to have jurisdiction over the management of commercial fishing in the Torres Strait. A note to the prohibitions is provided in the Instrument.

Subclauses 9.1 and 9.2 of the Previous Instrument have been removed, as the Instrument is repealing and replacing the Previous Instrument.

Details on the provisions of the Instrument are included at **Attachment A**.

Publication and Commencement

Subsection 16(9) of the Act provides that the PZJA, by way of section 35, must publish or broadcast the contents of an instrument made under section 16 a manner prescribed by sections 3 or 4 of the Regulations. Section 3 of the Regulations states that, for the purpose of subsection 16(9) of the Act, the manner of publication is by publication in such a newspaper as in the opinion of the PZJA is appropriate having regard to the nature of the contents of the notice.

In making the decision to make the Instrument, the PZJA has considered the nature and the contents of the Instrument and have determined that it would be appropriate for the Instrument to be published in the *Torres News*, which is the local newspaper in circulation across the islands of the Torres Strait and Cape York. The *Torres News* also has some circulation in Cairns where some licence holders are based. The PZJA also authorised staff members of the Australian Fisheries Management Authority (AFMA) to register the Instrument on the Federal Register of Legislation.

Subsection 16(4) of the Act provides that a prohibition in an instrument made under section 16(1) comes into force on the day it is published under subsection 16(9), or a later day as specified in the instrument. It follows that the Instrument will come into force on the day specified in section 2 of the Instrument.

Consultation

The PZJA and AFMA, which is delegated responsibility for the day-to-day management of Torres Strait fisheries under paragraph 38(1)(b) of the Act, are advised through a number of advisory committees established under subsection 40(7) of the Act, that incorporate advice from traditional inhabitants of the Torres Strait. The PZJA committees generally consist of an independent Chair and representatives from the government (Fisheries Queensland, AFMA and TSRA), scientific experts, economists, traditional inhabitant fishing industry and, where applicable, non-traditional

[3] The Torres Strait Treaty is the Treaty between Australia and the Independent State of Papua New Guinea concerning Sovereignty and Maritime Boundaries in the area between the two Countries, including the area known as Torres Strait, and Related Matters, signed at Sydney on 18 December 1978 and ratified by Australia on 15 February 1985.

inhabitant fishing industry. In addition, the Chairperson of the *Malu Lamar (Torres Strait Islander) Corporation RNTBC*, which is a Registered Native Title Body Corporate (RNTBC) and representatives from the Papua New Guinea National Fisheries Authority also have standing invitation to attend meetings as an observer.

The Hand Collectables Working Group (HCWG) considered and provided advice on making the Instrument at their meeting on 28-29 October 2021. Having regard to HCWG advice, the PZJA *[to be updated]*.

Disallowance and sunsetting

The Instrument is a legislative instrument for the purpose of the *Legislation Act 2003* (the Legislation Act) and is:

- not subject to disallowance, by application of subsection 44(1) of the Legislation Act, as the PZJA in making this Instrument is an intergovernmental body involving the Commonwealth and the State of Queensland; and

- not subject to sunsetting by application of subsection 54(1) and paragraph 54(2)(b) of the Legislation Act, read together with item 63AB of the table in section 12 of the *Legislation (Exemptions and Other Matters) Regulation 2015*.

Native Title

The making of the Instrument is a future act for the purposes of the *Native Title Act 1993* (the Native Title Act). In particular, sections 24HA and 24OA of the Native Title Act relevantly provides that the making of legislation in relation the management or regulation of living aquatic resources, such as the Instrument, is a valid future act insofar as it impacts upon native title rights and interests.

Statement of compatibility with human rights

As the Instrument is exempt from disallowance through the process of parliamentary scrutiny, by application of subsection 44(1) of the Legislation Act, a statement of compatibility with human rights does not have to be prepared for the purposes of Part 3 of the *Human Rights (Parliamentary Scrutiny) Act 2011*.

Regulation Impact Statement

The Office of Best Practice Regulation (OBPR) advised that a Regulation Impact Statement was not required for the Instrument (OBPR ID 44181).

Attachment A

Details of the *Torres Strait Fisheries (Bêche-de-mer) Management Instrument 2021*

Section 1 - Name

This section provides that this instrument is the *Torres Strait Fisheries (Bêche-de-mer) Management Instrument 2021* (the Instrument).

Section 2 – Commencement

This section provides for the commencement of the Instrument. As outlined above, subsection 16(4) of the Act provides that any prohibition contained within an instrument made under subsection 16(1) of the Act does not take effect inter alia until the instrument is published in accordance with subsection 16(9) of the Act and section 3 of the Regulations. The PZJA authorised AFMA to publish the Instrument in the *Torres News* and register it on the Federal Register of Legislation. It follows that the commencement of the Instrument is the day specified in section 2.

Section 3 – Authority

Provides that the Instrument is made under section 16 of the Act.

Section 4 – Definitions

This section outlines relevant definitions for the purpose of the Instrument, which provide as follows:

> ***Act*** means the *Torres Strait Fisheries Act 1984.*
>
> ***bêche-de-mer*** means fish of the families Holothuriidae and Stichopodidae
>
> ***bêche-de-mer fishery*** means the 'area of the bêche-de-mer fishery' prescribed in item 1 of Schedule 2 to the the Regulations.
>
> ***bêche-de-mer licensed person*** means a person who has been granted a licence under subsection 19(2), 19(3) or 19(4A) of the Act that authorises the taking, processing or carrying of bêche-de-mer. This definition is included for the purposes of the exemption in subparagraph 6(2) of the Instrument.
>
> This definition has been expanded to include persons who have been granted a licence that authorises the taking of bêche-de-mer without the use of a boat under subsection 19(4A) of the Act.
>
> It is intended that this definition cover all operators in the bêche-de-mer fishery, including people originally granted a licence under subsections 19(2) or 19(3). Although there are currently no licences granted under subsection 19(4A) of the Act, this definition will cover any future scenarios in which such licences are granted.
>
> ***hookah gear*** means equipment to enable a person to breathe underwater where the air is supplied from either an air compressor or one or more air cylinders above the surface of the water, and includes equipment which may be described as surface supplied breathing equipment or surface supplied breathing apparatus.
>
> ***PZJA Arrangement*** means the document titled "*Arrangement between the Commonwealth and the State of Queensland under section 31 of the Torres Strait*

Fisheries Act 1984" dated 17 March 1999 and published on the Federal Register of Legislation (ref: F2008B00750), as that document exists at the commencement of this Instrument.

Regulations means the *Torres Strait Fisheries Regulations 1985.*

underwater breathing apparatus includes ***hookah gear*** and self-contained underwater breathing apparatus (known as SCUBA).

Section 5 – Schedules

This section provides authority for Schedule 1 to the Instrument, which repeals the *Torres Strait Fisheries Management Notice No. 15.*

Section 6 – Prohibition on taking, processing or carrying bêche-de-mer

Paragraph 16(1)(a) of the Act relevantly provides that the PZJA may, by legislative instrument, prohibit the taking, processing or carrying of a class of fish specified in the instrument. Section 6 of the Instrument is made for this purpose.

Subsection 6(1) provides that the taking, processing or carrying of bêche-de-mer, in the area of the bêche-de-mer fishery is prohibited. This general prohibition restricts persons, other than the persons that fall within the exception listed in subsection (2) of this section, from engaging in commercial fishing for bêche-de-mer in the area of the bêche-de-mer fishery.

Subsection 6(2) outlines one exemption from the prohibition in subsection (1). Those exceptions apply where the person is a bêche-de-mer licenced person (as defined in section 4 above).

Section 7 - **Prohibition on taking, processing or carrying of undersize bêche-de-mer**

Subparagraphs 16(1)(b)(ii) and (v) of the Act relevantly provide that the PZJA may, by legislative instrument, prohibit the taking, processing or carrying of fish included in a specified class that have a dimension less or greater than a dimension specified in the instrument respectively. Section 7 of the Instrument is made for this purpose. The minimum lengths specified in this section have been implemented consistent with recommendations made from the PZJA Hand Collectables Working Group.

Under subsection 7, it is prohibited for a person in the bêche-de-mer fishery to take, carry or process bêche-de-mer that are less than the dimensions specified in the Instrument.

Section 7 specifies these dimensions and the way in which bêche-de-mer are to be measured.

It is noted at this section that the prohibition in section 7 does not apply to traditional inhabitants engaged in traditional fishing. This is because the PZJA, the body making the Instrument, does not have jurisdiction to regulate traditional fishing under the PZJA Arrangement.

Section 8 – Prohibition on the use of certain methods

Paragraph 16(1)(c) of the Act relevantly provides that the PZJA may, by legislative instrument, prohibit the taking, processing or carrying of fish included in a class of fish by a method specified in the instrument. Section 8 of the Instrument is made for this purpose, by providing that the taking, processing or carrying of bêche-de-mer by a person in the bêche-de-mer fishery by all methods other than collection by hand is prohibited.

It is noted at this section that the prohibition in section 8 does not apply to traditional inhabitants engaged in traditional fishing. This is because the PZJA, the body making the Instrument, does not have jurisdiction to regulate traditional fishing under the PZJA Arrangement.

Section 9 – Prohibition on the use of certain equipment

Paragraph 16(1)(c) of the Act relevantly provides that the PZJA may, by legislative instrument, prohibit the taking, processing or carrying of fish included in a class of fish with the use of equipment specified in the instrument. Section 9 of the Instrument is made for this purpose, by providing that the taking of bêche-de-mer by a person in the bêche-de-mer fishery using any kind of equipment that provides for mechanical propulsion or any kind of underwater breathing apparatus is prohibited.

It is noted at this section that the prohibition in section 9 does not apply to traditional inhabitants engaged in traditional fishing. This is because the PZJA, the body making the Instrument, does not have jurisdiction to regulate traditional fishing under the PZJA Arrangement.

Section 10 – Prohibition on the use, possession or control of underwater breathing apparatus

This section provides a person is prohibited from having bêche-de-mer as well as having in his or her possession, or under his or her control, on a boat, any quantity of underwater breathing apparatus. This section is made under subparagraph 16(1)(f) of the Act and intends to clarify any ambiguity that may arise in relation to whether bêche-de-mer was taken with the use of prohibited equipment. It is also intended to maintain the integrity of existing equipment prohibitions in the bêche-de-mer fishery.

It is noted at this section that the prohibition in section 10 does not apply to traditional inhabitants engaged in traditional fishing. This is because the PZJA, the body making the Instrument, does not have jurisdiction to regulate traditional fishing under the PZJA Arrangement.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
ECOLOGICAL RISK ASSESSMENT FOR THE BDM FISHERY (CSIRO)	Agenda Item 5.3 FOR NOTING

RECOMMENDATIONS

1. That the Working Group (WG):

   a. **NOTE** the CSIRO have completed a draft Ecological Risk Assessment for the Effects of Fishing (ERA) process for the BDM Fishery (**Attachment A**);

   b. **NOTE** that the draft ERA was considered by the Hand Collectable Resource Assessment Group (HCRAG) at its meeting on 6-8 October 2021;

   c. **NOTE** that all the assessed direct and indirect impacts to and of the BDM Fishery were assessed as having either minor or negligible scores; and

   d. **NOTE** the final assessment report will be provided to the HCWG once available.

KEY ISSUES

2. CSIRO are undertaking an ERA for the Torres Strait BDM Fishery to address an assessment priority and export approval condition for the fishery, which currently requires an ERA to be completed by 1 January 2022[1]. Stakeholder consultation is an important feature of the ERA especially in the Scoping and Level 1 phases to improve the assessment, increase the chance of uptake of results and to identify suitable management responses. Accordingly, the draft ERA was tabled and considered by the HCRAG at its meeting on 6-8 October 2021.
3. The HCRAG provided some comments for the ERA project team to consider when finalising the ERA. In doing so the assessment outcomes are not expected to change.
4. The draft ERA has assessed all direct and indirect impacts to and of the BDM Fishery as having either minor or negligible scores and the overall risk for the ecological impacts for the effects of fishing and external activities is low. The assessment outcome is based on the scale and nature of the fishery as well as available survey data. The assessment concluded that '*Fishing for sea cucumbers is very selective as done by hand collection and no by-catch or by products result from fishing. The direct ecological impact on the benthos from harvesting their species is low*'.
5. Noting that the draft ERA did not identify any moderate-high risks, all ecological components were eliminated at Level 1 and no specific ecological risk management strategy is required.
6. The final ERA assessment report will be provided to the HCWG once available.

BACKGROUND

7. The ERA framework was initially developed in 2007 by CSIRO in collaboration with AFMA to help AFMA meet its ecologically sustainable development (ESD) objective[2] by managing the impacts of commercial fisheries on commercial species, by-product species, bycatch species, protected species, and habitats and communities. The framework also addresses the need to

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[1] Torres Strait Bech de mer Fishery WTO Condition 5: The Protected Zone Joint Authority must complete an ecological risk assessment of the Torres Strait Beche-de-mer Fishery by 1 January 2022 and develop an associated risk management strategy to address any risks identified in this assessment.

[2] Under the *Fisheries Management 1991*

assist in evaluating impacts of fishing for strategic assessments under the *Environment Protection and Biodiversity Conservation Act 1999*.

8. Since its development, the framework has been successfully applied to several fisheries in Australia and internationally. The framework has been reviewed and refined since its implementation to ensure that it is credible, cost effective and adaptable enough to consider new information, species, reference points, methods/tools or adaptation to new standards and policy developments.

9. The framework consists of a set of risk assessment methodologies that are used to assess the impact of fishing across five ecological components of the marine environment (commercial species, by-product species, bycatch species, protected species, and habitats and communities). The methodologies start off as qualitative and becomes more quantitative as the fishery progresses through the different assessment levels.

10. Once the ERA is finalised, any ecological components with a moderate-high risk score at Level 1 are escalated to the next level of ERA assessment (Level 2 semi-quantitative-quantitative methods) and an Ecological Risk Management strategy is developed to address, manage and monitor those risks.

11. More information on the ERA and ERM process is available on the AFMA website and the Guide to AFMA's Ecological Risk Management.

www.csiro.au

Ecological Risk Assessment for the Effects of Fishing

Draft Report for the Torres Strait Fishery: Bêche-de-mer Fishery 2016-2020

Authors

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July 2021

DRAFT Report for the Australian Fisheries Management Authority

CSIRO Oceans & Atmosphere

Castray Esplanade Hobart 7001

Citation

Dutra, L.X.C., Sporcic, M, and Murphy, N. (2021). Ecological Risk Assessment for the Effects of Fishing. Report for Torres Strait Fishery: Bêche-de-mer Fishery 2016- 2020. Report for the Australian Fisheries Management Authority. 117 pp.

Copyright

Important disclaimer

<u>Notes to this document:</u>

This fishery ERA Report document contains figures and tables with numbers that correspond to the full methodology document for the ERAEF method:

> Hobday, A. J., A. Smith, H. Webb, R. Daley, S. Wayte, C. Bulman, J. Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, T. Walker. (2007). Ecological Risk Assessment for the Effects of Fishing: Methodology. Report R04/1072 for the Australian Fisheries Management Authority, Canberra

Thus, table and figure numbers within the fishery ERA Report document are not sequential as not all are relevant to the fishery ERA Report results.

Additional details on the rationale and the background to the methods development are contained in the ERAEF Final Report:

> Smith, A., A. Hobday, H. Webb, R. Daley, S. Wayte, C. Bulman, J. Dowdney, A. Williams, M. Sporcic, J. Dambacher, M. Fuller, D. Furlani, T. Walker. (2007). Ecological Risk Assessment for the Effects of Fishing: Final Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

This document also reflects some changes in methods that are detailed in AFMA's ERA guide (2017).

> Australian Fisheries Management Authority (2017). Guide to AFMA's Ecological Risk Management. 130 pp. (Commonwealth of Australia, Canberra).

Contents

Figures

Tables

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We would like to thank Dr Eva Plaganyi (CSIRO), Selina Stoute (AFMA), Danait Ghebrezgabhier and Natalie Couchman (AFMA) for their valuable insights, comments and inputs to this document.

Executive summary

The "Ecological Risk Assessment for Effect of Fishing" ERAEF was developed jointly by CSIRO Marine and Atmospheric Research and the Australian Fisheries Management Authority [1, 2]. This assessment of the ecological impacts of the Torres Strait Bêche-de-mer Fishery was undertaken using the ERAEF method version 9.2, with some additional modifications currently in final stages of development with AFMA [3]. This revised ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five new ecological components –key commercial and secondary commercial species; byproduct and bycatch species; protected species; habitats; and (ecological) communities [3].

ERAEF proceeds through four stages of analysis: scoping; an expert judgement-based Level 1 analysis (SICA – Scale Intensity Consequence Analysis); an empirically based Level 2 analysis (PSA – Productivity Susceptibility Analysis); and a model-based Level 3 analysis. This hierarchical approach provides a cost-efficient way of screening hazards, with increasing time and attention paid only to those hazards that are not eliminated at lower levels in the analysis. Risk management responses may be identified at any level in the analysis.

Application of the ERAEF methods to a fishery represents a set of screening or prioritization steps that work towards a full quantitative ecological risk assessment. At the start of the process, all components are assumed to be at risk. Each step, or Level, potentially screens out issues that are of low concern. The Scoping stage screens out activities that do not occur in the specific fishery. Level 1 screens out activities that are judged to have low impact, and potentially screens out components with all low impact scores. Level 2 is a screening or prioritization process for individual species, habitats and communities at risk from direct impacts of fishing, using either PSA or the Sustainability Assessment for Fishing Effect (SAFE) methods. The Level 2 methods do not provide absolute measures of risk. Instead, they combine information on productivity and exposure to fishing to assess potential risk – the term used at Level 2 is risk. Because of the precautionary approach to uncertainty, there will be more false positives than false negatives at Level 2, and the list of high-risk species or habitats should not be interpreted as all being at high risk from fishing. Level 2 is a screening process to identify species or habitats that require further investigation. Some of these may require only a little further investigation to identify them as a false positive; for some of them managers and industry may decide to implement a management response; others will require further analysis using Level 3 methods, which do assess absolute levels of risk.

This 2016-2020 assessment of the Torres Strait Bêche-de-mer Fishery (TSBDMF) consists of the following:

- Scoping
- Level 1 results for the Key/Secondary commercial species, Habitat and Community components

Fishery Description

Method:	hand collectable
Area:	16,844 km^2
Depth range:	0-10 m
Fleet size:	~88 vessels
Effort:	Traditional Inhabitant Boat (TIB) licence holders reporting catch: 40 (2019)
Landings:	36 t (2019); 32 t (2020)
Discard rate:	2.7% (1 t of Curryfish had spoiled; discarded in 2018)
Commercial species (ERA classification):	16
Management:	Competitive total allowable catches (TACs).
Observer program:	There is no observer program currently in the Torres Strait.

Ecological Units Assessed

Table ES1.1. Ecological units assessed in 2021.

ECOLOGICAL COMPONENT	2021
Key/secondary commercial species	**2 key; 13 secondary**
Byproduct and bycatch species	**0 byproduct; 0 bycatch**
Protected species	**0**
Habitats	**4 demersal, 1 pelagic**
Communities	**5 demersal, 2 pelagic**

A total of 16 species across the three ecological components were assessed in this ERAEF (Table ES1.1).

Level 1 Results and Summary

All ecological components were eliminated at Level 1 (i.e. no components with risk scores of 3 – moderate – or above). Fishing for sea cucumbers is very selective as done by hand collection and no by-catch or by products result from fishing. The direct ecological impact on the benthos from harvesting these species is low. Also, no interaction with Protected species have been reported. As a result, the 'Bycatch, byproduct', and 'Protected species' ecological components were not assessed.

All hazards (fishing activities and external) were considered as low risk and eliminated at Level 1 (i.e. no components with risk scores of 3 – moderate – or above). The highest risk scores (2; with high confidence level) were reported for as part of direct fishing activity on key/secondary species, habitats and communities. The main reason is that fishing for sea cucumbers involves walking/trampling and diving on coral reefs, which may affect species directly and also break or damage benthic communities and coral reef structures. As a result, the most vulnerable habitats subject to physical damage were the shallow reef top and forereef zone habitats.

Although still considered a 'low risk' hazard, coastal development was the highest scored risk (risk score = 2) to key/secondary species, habitats and communities because of localised pollution in some Islands and sediment runoff from coastal developments in the Fly river (PNG). Sediments can smother sessiles species like corals and increased turbidity and reduction in light penetration can negatively affect spcies that depend on light, such as corals, algae and seagrasses. Confidence is low because impacts from Fly river are still poorly understood and there is a lack of data on water quality issues and recovery times of species and habitats. All of the assessed direct and indirect impacts to the TSBDMF were either low or negligible based on scale and nature of the fishery as well as available survey data.

Table ES1.2. Outcomes of assessments for ecological components conducted in 2021.

ECOLOGICAL COMPONENT	2021
Key/secondary commercial species	**Level 1**
Byproduct and bycatch species	Not required*
Protected species	Not required*
Habitats	**Level 1**
Communities	**Level 1**

*: there are no byproduct, bycatch or protected species in this sub-fishery

Table ES1.3. Key and secondary commercial species stock status, assessment and tier status, and ERA classification for Torres Strait bêche-de-mer sub-fishery. NSTOF: Not subject to overfishing; NOF: Not overfished; OF: Overfished; UNC: uncertain. Primary: C1; Secondary: C2. ^: based on ABARES classification. ^^ based on stock assessment.

COMMON NAME	SPECIES NAME	ERA CLASSIFICATION	BIOMASS^	STATUS^^	REFERENCES	YEAR LAST ASSESSED
Prickly redfish	*Thelenota ananas*	Key	NSTOF / NOF possible fishing decline but still within TAC		[4-7]	2009
Curryfish Herrmanni or Common	*Stichopus herrmanni*	Key	2019/20 survey results indicate possible fishing decline but still within TAC		[4, 7]	
White Teatfish	*Holothuria (Microthele) fuscogilva*	Secondary	NSTOF / NOF		[4-7]	2009
Deepwater redfish	*Actinopyga echinites*	Secondary			[4, 5, 7]	2009
Elephant's Trunkfish	*Holothuria (Microthele) fuscopunctata*	Secondary			[4, 7]	
Stonefish	*Actinopyga lecanora*	Secondary			[4, 7]	
Greenflsh	*Stichopus chloronotus*	Secondary			[4, 7]	
Blackfish - AKA Hairy blackfish	*Actinopyga miliaris*	Secondary			[4-7]	2009
Lollyfish	*Holothuria (Halodeima) atra*	Secondary			[4, 7]	
Burrowing Blackfish	*Actinopyga spinea*	Secondary	status remains relatively unknown		[4, 7]	
Brown Sandfish	*Bohadschia vitiensis*	Secondary			[4, 7]	
Golden Sandfish	*Holothuria (Metriatyla) lessoni*	Secondary				
Curryfish Vastus	*Stichopus vastus*	Secondary	2019/20 survey results indicate possible fishing decline but still within TAC		[4, 7]	
Leopardfish	*Bohadschia argus*	Secondary	n/a			
Deepwater Blackfish	*Actinopyga palauensis*	Secondary	status still remains relatively unknown		[4, 7]	
Sandfish	*Holothuria (Metriatyla) scabra*	Was a key species when	NSTOF / OF Sandfish were not surveyed and the species therefore		[4-7]	2009

COMMON NAME	SPECIES NAME	ERA CLASSIFICATION	BIOMASS^	STATUS^^	REFERENCES	YEAR LAST ASSESSED
		assessed but is currently closed	remains closed in accordance with the TSBDMHS			
Black Teatfish	*Holothuria (Microthele) whitmaei*	Was a key species when assessed but is currently closed	NSTOF / NOF Population is at near natural (unfished) densities		[4-7]	2009
Surf redfish	*Actinopyga mauritiana*		Recent survey in 2019/20 shows that Surf redfish is showing signs of recovery,but biomass is low and current densities are low in comparison to 2002 survey		[4, 5, 7]	2009

1 Overview

1.1 Ecological Risk Assessment for the Effects of Fishing (ERAEF) Framework

1.1.1 The Hierarchical Approach

The Ecological Risk Assessment for the Effects of Fishing (ERAEF) framework involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of risk at Level 1, through a more focused and semi-quantitative approach at Level 2, to a highly focused and fully quantitative “model-based” approach at Level 3 (Figure 1.1). This approach is efficient because many potential risks are screened out at Level 1, so that the more intensive and quantitative analyses at Level 2 (and ultimately at Level 3) are limited to a subset of the higher risk activities associated with fishing. It also leads to rapid identification of high-risk activities, which in turn can lead to immediate remedial action (risk management response). The ERAEF approach is also precautionary, in the sense that risks will be scored high in the absence of information, evidence or logical argument to the contrary.

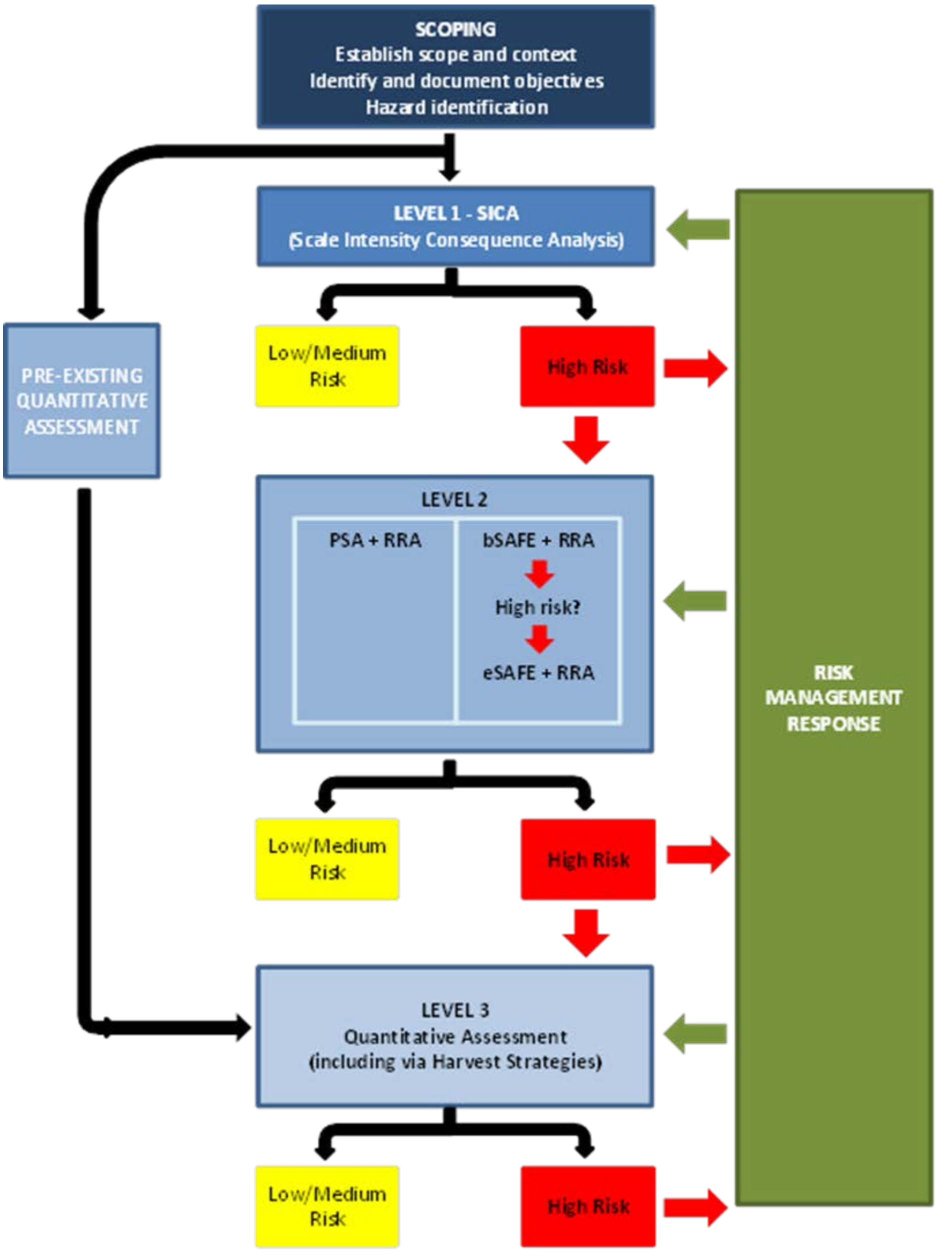


Figure 1.0.1. Structure of the 3 level hierarchical ERAEF methodology. SICA – Scale Intensity Consequence Analysis; PSA – Productivity Susceptibility Analysis; SAFE – Sustainability Assessment for Fishing Effects; RRA – Residual Risk Analysis. T1 – Tier 1. eSAFE may be used for species classified as high risk by bSAFE.

Conceptual Model

The approach makes use of a general conceptual model of how fishing impacts on ecological systems, which is used as the basis for the risk assessment evaluations at each level of analysis (Levels 1-3). For the ERAEF approach, five general ecological components are evaluated, corresponding to five areas of focus in evaluating impacts of fishing for strategic assessment under EPBC legislation. The five revised *components* are:

- Key commercial species and secondary commercial species

- Byproduct and bycatch species
- protected[1] species (formerly referred to as threatened, endangered and Protected[2] species or TEPs)
- Habitats
- Ecological communities

This conceptual model (Figure 1.2) progresses from *fishery characteristics* of the fishery or sub-fishery, → *fishing activities* associated with fishing and *external activities*, which may impact the five ecological components (target, byproduct and bycatch species, protected species, habitats, and communities); → *effects of fishing and external activities* which are the direct impacts of fishing and external activities; → *natural processes and resources* that are affected by the impacts of fishing and external activities; → *sub-components* which are affected by impacts to natural processes and resources; → *components*, which are affected by impacts to the sub-components. Impacts to the sub-components and components in turn affect achievement of management objectives.

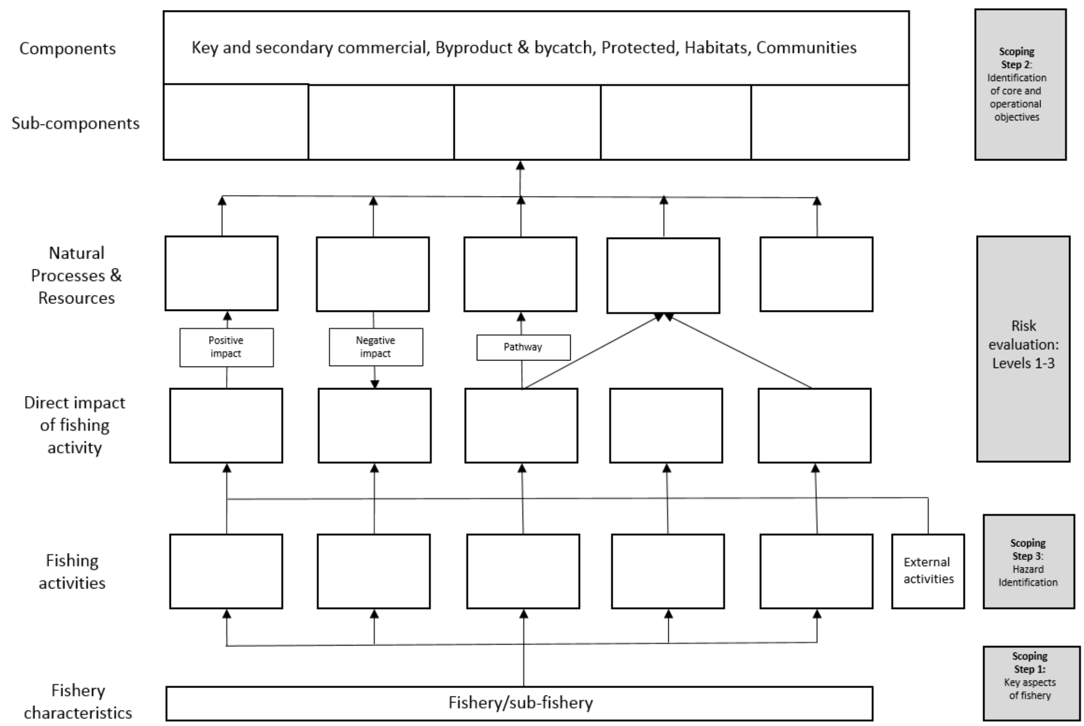


Figure 1.0.2. Generic conceptual model used in ERAEF.

[1] The term "protected species" refers to species listed under [Part 13] of the EPBC Act (1999) and replaces the term "Threatened, endangered and protected species (TEPs)" commonly used in past Commonwealth (including AFMA) documents.

[2] Note "protected" (with small "p") refers to all species covered by the EPBC Act (1999) while "Protected" (capital P) refers only to those protected species that are threatened (vulnerable, endangered or critically endangered).

The external activities that may impact the fishery objectives are also identified at the Scoping stage and evaluated at Level 1. This provides information on the additional impacts on the ecological components being evaluated, even though management of the external activities is outside the scope of management for that fishery.

The assessment of risk at each level takes into account current management strategies and arrangements. A crucial process in the risk assessment framework is to document the rationale behind assessments and decisions at each step in the analysis. The decision to proceed to subsequent levels depends on

- Estimated risk at the previous level
- Availability of data to proceed to the next level
- Management response (e.g. if the risk is high but immediate changes to management regulations or fishing practices will reduce the risk, then analysis at the next level may be unnecessary).

1.1.2 ERAEF stakeholder engagement process

A recognized part of conventional risk assessment is the inclusion of stakeholders involved in the activities being assessed. Stakeholders can make an important contribution by providing expert judgment, fishery-specific and ecological knowledge, and process and outcome ownership. The ERAEF method also relies on stakeholder involvement at each stage in the process, as outlined below. All stakeholder interactions are recorded in the process. This ERA will be presented and discussed with stakeholders as part of Hand Collectables Resource Assessment Group meeting to be held in Thursday Island 21-23 July 2021. Input from HCRAG will be incorporated to the ERA after the meeting.

1.1.3 Scoping

In the first instance, scoping is based on review of existing documents and information, with much of it collected and completed to a draft stage prior to full stakeholder involvement. This provides all the stakeholders with information on the relevant background issues. Three key outputs are produced from the scoping exercise, each requiring stakeholder input.

1. <u>Identification of units of analysis</u> (species, habitats and communities) potentially impacted by fishery activities (Section 2.2.2; Scoping Documents S2A, S2B1, S2B2 and S2C1, S2C2).
2. <u>Selection of objectives</u> (Section 2.2.3; Scoping Document S3). The primary objective to be pursued for species assessed under ERAEF is that of ensuring populations are maintained at biomass levels above which recruitment failure is likely, as stated in Chapter 2 (ERM Guide [3]). This is consistent with current legislation and fisheries policies and represents a change from when the ERAEF was first developed and there was less policy or legislation-based guidance on sustainability objectives, with stakeholders able to choose from a range of “sustainability” objectives (e.g.: tables 5A-C in [1]).

3. Selection of activities (hazards) (Section 2.2.4; Scoping Document S4) that occur in the sub-fishery is made using a checklist of potential activities provided. The checklist was developed following extensive review, and allows repeatability between fisheries. Additional activities raised by the stakeholders can be included in this checklist (and would feed back into the original checklist). The background information and consultation with the stakeholders is used to finalize the set of activities. Many activities will be self-evident (e.g. fishing, which obviously occurs), but for others, expert or anecdotal evidence may be required.

1.1.4 Level 1. SICA (Scale, Intensity, Consequence Analysis)

The SICA analysis evaluates the risk to ecological components resulting from the stakeholder-agreed set of activities. Evaluation of the temporal and spatial scale, intensity, sub-component, unit of analysis, and credible scenario (consequence for a sub-component) should be prepared by the draft fishery ERAEF report author and reviewed at an appropriate stakeholder meeting (e.g. Resource Assessment Group meeting). Due to the number of activities (up to 24) in each of five components (resulting in up to 120 SICA elements), preparation before involving the full set of stakeholders may allow time and attention to be focused on the uncertain or controversial or high-risk elements. Documenting the rationale for each SICA element ahead of time for the straw-man scenarios is crucial to allow the workshop debate to focus on the right portions of the logical progression that resulted in the consequence score.

SICA elements are scored on a scale of 1 to 6 (negligible to extreme) using a “plausible worst case” approach (see ERAEF Methods Document for details [1, 8]). Level 1 analysis potentially result in the elimination of activities (hazards) and in some cases whole components. Any SICA element that scores 2 or less is documented, but not considered further for analysis or management response.

1.1.5 Level 2. PSA and SAFE (semi-quantitative and quantitative methods)

When the risk of an activity at Level 1 (SICA) on a species component is moderate or higher and no planned management interventions that would remove this risk are identified, an assessment is required at Level 2 (to determine if the risk is real and provide further information on the risk). The tools used to assess risk at Level 2 allow units (e.g. all individual species) within any of the ecological species components (e.g. key/secondary commercial, byproduct/bycatch, and protected species) to be effectively and comprehensively screened for risk. The analysis units are identified at the scoping stage. To date, Level 2 tools have been designed to measure risk from direct impacts of fishing only (i.e. risk of overfishing, leading to an overfished fishery), which in all assessments to date have been the hazard with the greatest risks identified at Level 1[3].

In the period since the first ERAEF was implemented across Commonwealth fisheries, much of the management focus has been on the assessment results associated with Level 2 and Level

[3] Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

2.5 or 3 risk assessment methods, which comprise semi-quantitative or rapid simple quantitative methods (e.g. PSA and SAFE). This level has been subject to the greatest level of change and improvement which are discussed in the following sections. Additional improvements are being developed for implementation in the near future (see Chapter 4.13 of AFMA ERM Guide in [3]).

Level 2 was originally designed to rely on a single risk assessment methodology, the Productivity-Susceptibility Analysis (PSA) (see Chapter 4.8.3 of AFMA ERM Guide in [3]), however a more quantitative method called the Sustainability Assessment for Fishing Effects (SAFE) (see Chapter 4.8.4 of AFMA ERM Guide in [3]) was developed early in the implementation of the ERAEF and classed as a Level 2.5 or Level 3 tool.

Under the revised ERAEF:

- bSAFE has now been reclassified as the preferred Level 2 method (over PSA) where sufficient spatial and biological data (to support bSAFE) are available. Typically, this has been used for teleost and chondricthyan species.
- Species estimated to be at high risk under bSAFE may then be assessed under eSAFE which may provide reduced estimates of uncertainty pertaining to the actual risk.
- Where either the data or species biological characteristics are insufficient to support bSAFE analyses, it is recommended that PSA be applied instead. This will be the case for many protected species, invertebrate bycatch species and some other species.
- At Level 2, either PSA or SAFE methods should be applied to any given species, not both.
- For high risk species it is a management choice whether to progress to eSAFE, pursue a Level 3 fully quantitative stock assessment, or to take more immediate management action to reduce the risk. The types of considerations required in making that choice (ie: moving up the ERAEF assessment hierarchy or taking direct management action) are outlined in Chapter 5.5 of the AFMA ERM Guide [3].

It is also recognised that a number of additional tools, including some of the “data poor” assessment tools that are used to inform harvest strategies, could potentially be included within the Level 2 toolkit. They are distinguished from Level 3 quantitative tools (i.e. stock assessment models) that are more data rich and able to more precisely quantify uncertainty.

PSA (Productivity Susceptibility Analysis)

Details of the PSA method are described in the accompanying ERAEF Methods Document and also summarised in Section 4.8.3 of the AFMA ERM Guide [3]. Stakeholders can provide input and suggestions on appropriate attributes, including novel ones, for evaluating risk in the specific fishery. Attribute values for many of the units (e.g. age at maturity, depth range, mean trophic level) can be obtained from published literature and other resources (e.g. scientific experts) without initial stakeholder involvement. Stakeholder input is required after preliminary attribute values are obtained. In particular, where information is missing, expert opinion can be used to derive the most “reasonable” conservative estimate. For example, if species attribute values for annual fecundity have been categorized as low, medium or high on the set (<5, 5-500, >500), estimates for species with no data can still be made. Also, estimated fecundity of a broadcast-spawning fish species with unknown fecundity is still likely to be greater than the high fecundity category (>500). Susceptibility attribute estimates, such as “fraction alive when landed”, can also be made based on input from experts such as scientific observers. Feedback to stakeholders regarding comments received during the preliminary PSA consultations is considered crucial. The final PSA is completed by scientists and results are presented to the relevant stakeholder group (e.g. RAG and/or MAC) before decisions regarding Level 3 analysis are considered. The stakeholder group may also decide on priorities for analysis at Level 3.

Residual Risk Analysis

There were several limitations due to the semi-quantitative nature of a Level 2 PSA assessment. For example, certain management arrangements which mitigate the risks posed by a fishery, as well as additional information concerning levels of direct mortality, may not be easily taken into account in assessments. To overcome this, Residual risk analyses (RRA) are used to consider additional information, particularly mitigating effects of management arrangements that were not explicitly included in the ERAs or introduced after the ERA process commenced. Priority for this process has typically been focused on those species attributed a high-risk rating (those likely to be most at risk from fishing activities). It could in theory be used to also determine if some species have been incorrectly classified as low risk.

Recently revised Residual risk guidelines have been developed (see below) to assist in making accurate judgments of residual risk consistently across all fisheries. At the moment, they are applied to species and not applicable to habitats or communities.

These guidelines are not seen as a definitive guide on the determination of residual risk and it is expected they may not apply in a small number of cases. Care must also be taken when applying them to ensure residual risk results are appropriate in a practical sense. There are a number of conditions which underpin the residual risk guidelines and should be understood before the guidelines are applied:

- All assessments and management measures used within the residual risk assessment must be implemented prior to the assessment with sufficient data to demonstrate the effect. Any planned or proposed measures can be referred to in the assessment but cannot be used to revise the risk score.
- When applied, the guidelines generally result in changes to particular "attribute" scores for a particular species. Only after all of the guidelines have been applied to a particular species, should the overall risk category be re-calculated. This will ensure consistency, as well as facilitating the application of multiple guidelines.
- Unless there is clear and substantiated information to support applying an individual guideline, then the attribute and residual risk score should remain unchanged. All supporting information considered in applying these Guidelines must be clearly documented and referenced where applicable. This is consistent with the precautionary approach applied in ERAs, with residual risk remaining high unless there is evidence to the contrary ensuring a transparent process is applied.

The results (including supporting information and justifications) from residual risk analyses must be documented in “Residual Risk Reports” for each fishery (or can be integrated into the Level 2 risk assessment report). These will be publically available documents.

SAFE (Sustainability Assessment for Fishing Effects)

The SAFE method developed is split into two categories: base SAFE (bSAFE) and an enhanced SAFE (eSAFE). eSAFE has greater data processing requirements and is recommended to only be used to assess species estimated to be at high risk via the bSAFE. It is also able to more appropriately model spatial availability aspects when sufficient data are available.

bSAFE

Relative to the PSA approach, the bSAFE approach [9, 10] (Zhou and Griffiths, 2008; Zhou et al. 2011):

- is a more quantitative approach (analogous to stock assessment) that is able to provide absolute measures of risk by estimating fishing mortality rates relative to fishing mortality rate reference points (based on life history parameters),
- requires less productivity data than the PSA,
- is able to account for cumulative risk and
- potentially out performs PSA in several areas, including strength of relationship to Tier 1 assessment classifications [11].

Like PSA, the bSAFE method is a transparent, relatively rapid and cost effective process for screening large numbers of species for risk, and is far less demanding of data and much simpler to apply than a typical quantitative stock assessment.

As such it is recommended that bSAFE be used as the preferred Level 2 assessment tool for all fish species and some invertebrates and reptiles (eg: some sea snakes) with sufficient data.

In estimating fishing mortality, bSAFE utilises much of the same information as the PSA, to estimate:

- Spatial overlap between species distribution and fishing effort distribution,
- Catchability resulting from the probability of encountering the gear and size-dependent selectivity and
- Post-capture mortality.

The fishing mortality is essentially the fraction of overlap between fished area and the species distribution area within the jurisdiction, adjusted by catchability and post-capture mortality. Uncertainty around the estimated fishing mortality is estimated by including variances in encounterability, selectivity, survival rate and fishing effort between years.

The three biological reference points are based on a simple surplus production model:

- **F_{MSY}** – instantaneous fishing mortality rate that corresponds to the maximum number of fish in the population that can be killed by fishing in the long term. The latter is the maximum sustainable fishing mortality (MSM) at B_{MSM}, similar to target species MSY.

- F_{LIM} – instantaneous fishing mortality rate that corresponds to the limit biomass B_{LIM} where B_{LIM} is a assumed to be half of the biomass that supports a maximum sustainable fishing mortality ($0.5B_{MSM}$)
- F_{CRASH} – minimum unsustainable instantaneous fishing mortality rate that, in theory, will lead to population extinction in the long term.

This methodology produces quantified indicators of performance against fishing mortality based reference points and as such does allow calibration with other stock assessment and risk assessment tools that measure fishing mortality. It allows the risk of overfishing to be determined, via the score relative to the reference line. Uncertainty (error bars) are related to the variation in the estimation of the scores for each axis.

It is recommended that species assessed as being potentially at high risk under bSAFE are then progressed to analysis by eSAFE which is able to narrow uncertainties around the risk (but is more time and resource intensive than bSAFE).

Assumptions and issues to be aware of:

- Comparisons of PSA and SAFE analyses for the same fisheries and species support the claim that the PSA method generally avoids false negatives but can result in many false positives. Limited testing of SAFE results against full quantitative stock assessments suggest that there is less “bias” in the method, but that both false negatives and false positives can arise.
- SAFE analyses retain some of the key precautionary elements of the PSA method, including assumptions that fisheries are impacting local stocks (within the jurisdictional area of the fishery).
- Although the bSAFE analyses provide direct estimates of uncertainty in both the exploitation rate and associated reference points, they are less explicit about uncertainties arising from key assumptions in the method, including spatial distribution and movement of stocks.
- The method assumes there would be no local depletion effects from repeat trawls at the same location (ie: populations rapidly mix between fished and unfished areas). The fishing mortality will likely be overestimated if this assumption is not satisfied (ERA TWG 2015)[4].
- The method also assumes that the mean fish density does not vary between fished area and non-fished area within their distributional range. Hence, the level of risk would be over-estimated for species found primarily in non-fished habitat, while risk would be under-estimated for species that prefer fished habitat (ERA TWG 2015).
- The SAFE methodology makes greater assumptions than Tier 1 stock assessments in coming to its F estimates (due to a lack of the data relative to that used in a Tier 1 assessment) and it is not capable of measuring risk of a stock being already overfished (so the type of risk it measures relates only to overfishing, which may then lead to

[4] ERA Technical Working Group, September 2015

future overfished state). The limitations of SAFE with respect to measuring overfished risks are the same essentially as for PSA.

eSAFE

Enhanced SAFE (eSAFE) appears, based on calibration with Level 3 assessments, to provide improved estimates of fishing mortality relative to the base SAFE (bSAFE) method. The eSAFE requires more spatially explicit data and takes more analysis time than bSAFE, and so might only be used to further assess species that were identified as at high risk using bSAFE (and which have not had further direct management action taken). The eSAFE enhances the bSAFE method by estimating varying fish density across their distribution range as well as species- and gear-specific catch efficiency for each species.

1.1.6 Level 3

This stage of the risk assessment is fully-quantitative and relies on in-depth scientific studies on the units identified as at medium or greater risk in the Level 2. It will be both time and data-intensive. Individual stakeholders are engaged as required in a more intensive and directed fashion. Results are presented to the stakeholder group and feedback incorporated, but live modification is not considered likely.

1.1.7 Conclusion and final risk assessment report

The results presented in this document are based on desktop review and inputs from AFMA according to the ERAEF methods. These results are preliminary as yet to be considered by stakheolders during Hand Collectables RAG 21-23 July 2021. It is envisaged that the completed assessment will be finalised after adequate stakeholder consultation process, which involves presentation to and inputs from HCRAG. It is expected that the final risk assessment report will be adopted by the fishery management group and used by AFMA for a range of management purposes, including to address the requirements of the Wildlife Trade Operation approval for the fishery under the EPBC Act as evaluated by Department of Agriculture, Water and the Environment.

1.1.8 Subsequent risk assessment iterations for a fishery

The frequency at which each fishery must revise and update the risk assessment is not fully prescribed. As new information arises or management changes occur, the risks can be re-evaluated, and documented as before. The fishery management group or AFMA may take ownership of this process, or scientific consultants may be engaged. In any case the ERAEF should again be based on the input of the full set of stakeholders and reviewed by independent experts familiar with the process.

Fishery re-assessments for byproduct and bycatch species under the ERAEF will be undertaken every five years[5] or sooner if triggered by re-assessment triggers. The five-year timeframe is based on a number of factors including:

- The time it takes to implement risk management measures; for populations to respond to those measures to a degree detectable by monitoring processes; and to collect sufficient data to determine the effectiveness of those measures.
- Alignment with other management and accreditation processes.
- The cost of re-assessments.
- The review period for Fisheries Management Strategy (FMS).

For byproduct and bycatch species, in the periods between scheduled five-year ERA reviews[6], AFMA will develop and monitor a set of fishery indicators and triggers, on an annual basis, so as to detect any changes (increase or decrease) in the level of risk posed by the fishery to any species. Where indicators exceed specified trigger levels, AFMA will investigate the causes and provide opportunity for RAG to comment and advice during that process. Pending outcomes of that review, and RAG advice, AFMA can, if necessary, request a species specific or full fishery re-assessment (i.e. prior to the scheduled re-assessment dates).

The ERA Technical Working Group (TWG) (September 2015)[5] identified five key indicators upon which such triggers could be based, these being changes in:

- Gear type/use
- Mitigation measures (use or type)
- Area fished
- Catch or interaction rate
- Fishing effort

Where possible, the triggers should look to take into account additional sources of risk from interacting with non-Commonwealth fisheries. In addition, if a major management change is planned for a fishery, such as a move from input to output controls, the fishery will need to be reassessed prior to that management change coming into effect. In considering each indicator and trigger level, the RAG should consider the following:

- The data upon which the indicator is based must be sufficiently representative of actual changes in catch, effort, area, gear or mitigation methods. Consideration should be given to the level of uncertainty associated with the data underpinning any prospective indicator.

[5] Based on a recommendation by the ERA Technical Working Group, September 2015.

[6] In contrast to key and secondary commercial species managed via catch/effort limits under Harvest Strategies, which depending on species and Harvest Strategy, can be re-assessed any time between 1 and 5 years.

- The trigger level chosen should not be overly sensitive to the normal inter-annual variance that is typical of the indicator and independent of fishing pressure, assuming such variance is unlikely to relate to a significant change in the risk posed by the fishery to any or all species.
- The trigger level should equate to the minimum level of change that the RAG (by its expert opinion) considers might potentially represent a significant change in the risk posed by the fishery.
- The trigger level could represent an absolute change (number/level) in an indicator or a percentage change in an indicator.
- The RAG should consider whether a “temporal” condition should be placed on the trigger (i.e. the trigger is breached 2 years in a row) to further reduce the likelihood of natural population variance or data errors triggering a re-assessment unnecessarily.

The final set of indicators and triggers will be developed for each fishery by AFMA in consultation with its fishery RAG (or for fisheries lacking a RAG, the ERA TWG), in association with the next planned re-assessment (see Table 8 in AFMA ERM Guide in [3]). A RAG may choose a subset of these indicators and triggers, or include an additional indicator/trigger(s), based on consideration of the availability and reliability of data upon which to base any of the above indicators/triggers, however justification of this must be provided.

Research is currently underway to develop specific guidance for RAG to aid in the selection of appropriate triggers, which will in the meantime be determined using RAG expert opinion. In the longer term it may be possible to refine indicators and triggers using the existing PSA and SAFE methods to test which attributes the end risk scores are most sensitive to (ERA TWG 2015)[7]. The RAG will record both the final set of indicators and triggers chosen, and a justification for those, in the RAG minutes. Once the final set of indicators and triggers is determined for a fishery, they will require implementation within the FMS and a monitoring and review process.

[7] ERA TWG recommendation, September 2015

2 Results

The focus of analysis is the fishery as identified by the responsible management authority. The assessment area is defined by the fishery management jurisdiction within the Australian Fisheries Zone (AFZ). The fishery may also be divided into sub-fisheries on the basis of fishing method and/or spatial coverage. These sub-fisheries should be clearly identified and described during the scoping stage. Portions of the scoping and analysis at Level 1 and beyond are specific to a particular sub-fishery. The fishery is a group of people carrying out certain activities as defined under a management plan. Depending on the jurisdiction, the fishery/sub-fishery may include any combination of commercial, recreational, and/or indigenous fishers.

The results presented below are for the Torres Strait Bêche-de-mer sub-fishery. A full description of the ERAEF method is provided in the methodology document [1, 2]. This fishery report contains figures and tables with numbers that correspond to this methodology document. Thus, table and figure numbers within this fishery ERAEF report are not sequential, as not all figures and tables are relevant to the fishery risk assessment results.

2.1 Stakeholder Engagement

This BDM ERA report considered inputs provided by AFMA and scientists. Enaggement and consultation with industry and other stakeholders is planned as part of the upcoming Hand Collectables RAG to be held on Thursday Island 23-24 August 2021. Inputs from stakeholders will be added to Table 2.1below and used to revise the ERA where appropriate.

Table 2.1. Summary Document SD1. Summary of stakeholder involvement for Torres Strait fishery, bêche-de-mer sub-fishery.

FISHERY ERA REPORT STAGE	TYPE OF STAKEHOLDER INTERACTION	DATE OF STAKEHOLDER INTERACTION	COMPOSITION OF STAKEHOLDER GROUP (NAMES OR ROLES)	SUMMARY OF OUTCOME
Scoping	MS TEAMS meeting, Phone calls and emails	Various	Danait Ghebrezgabhier (AFMA), Selina Stoute (AFMA), E. Plaganyi (CSIRO)	Discussions about catch data, protected species, traditional catches, key/secondary commercial species, fishing methods and areas fished. Black teatfish work in sub-fishery
Draft report	Submitted draft report	25 June 2021	Danait Ghebrezgabhier (AFMA), Selina Stoute (AFMA) and Natalie Couchman (AFMA)	
Draft report	Submitted draft report	30 June 2021	Danait Ghebrezgabhier (AFMA), Selina Stoute (AFMA) and Natalie Couchman (AFMA)	Report submitted incorporating comments from AFMA
Draft report	Submitted draft report	Add date xx July 2021	Danait Ghebrezgabhier (AFMA), Selina Stoute (AFMA) and Natalie Couchman (AFMA)	Report submitted incorporating comments from AFMA
Draft report	Presentation of results	24, 25 August 2021	TSWG members, scientists, AFMA	Presented overall ERA Level 1 results

2.2 Scoping

The aim in the Scoping stage is to develop a profile of the fishery being assessed. This provides information needed at stakeholder meetings and to complete Levels 1 and 2. The focus of analysis is the fishery, which may be divided into sub-fisheries on the basis of fishing method and/or spatial coverage. Scoping involves six steps:

Step 1. Document the general fishery characteristics
Step 2. Generating "unit of analysis" lists (species, habitat types, communities)
Step 3. Selection of objectives
Step 4. Hazard identification
Step 5. Bibliography
Step 6. Decision rules to move to Level 1

2.2.1 General Fishery Characteristics (Step 1).

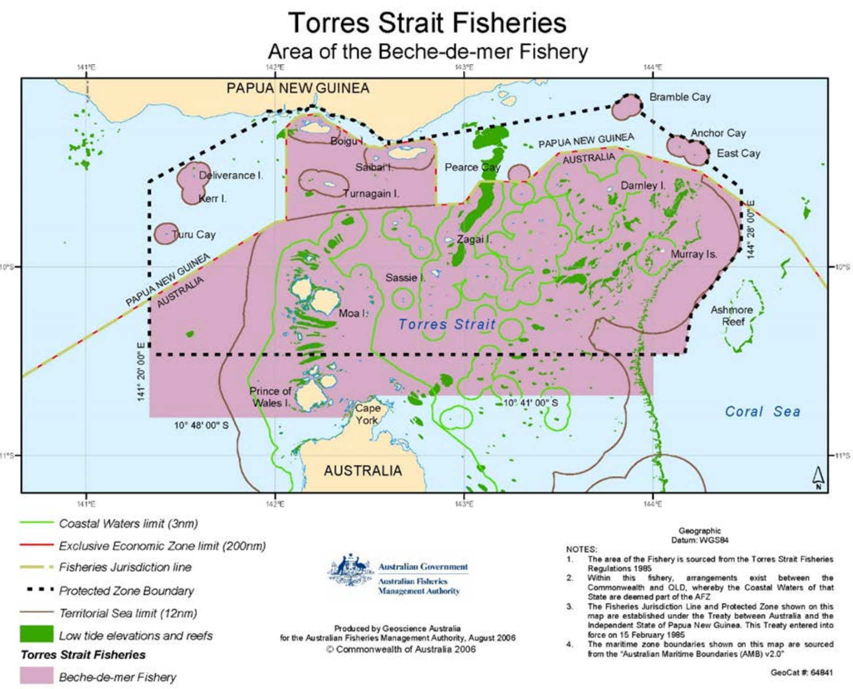
The information used to complete this step came from a range of documents such as Survey and Assessment Reports, and any other relevant background documents.

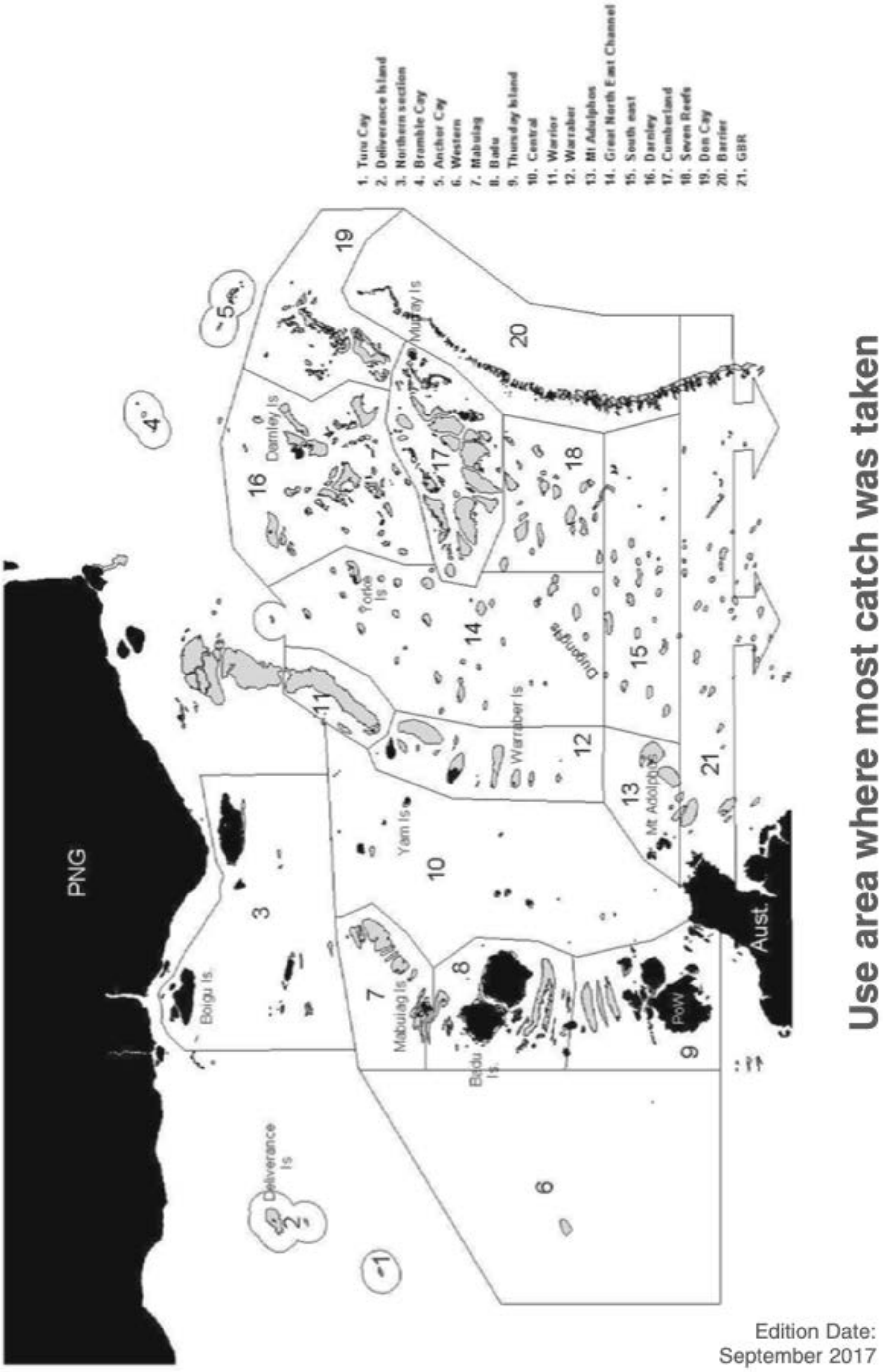
Scoping Document S1 General Fishery Characteristics

Fishery Name: Torres Strait Bêche-de-mer Fishery
Assessment date: May 2020
Assessor: AFMA and authors of this report

Table 2.2. General fishery characteristics

GENERAL FISHERY CHARACTERISTICS	
Fishery Name	Torres Strait Bêche-de-mer Fishery
Sub-fisheries	There are no sub-fisheries within this fishery but targeting of certain Sea cucumber species within the fishery is prohibited outside of specific trial openings (e.g. Black teatfish openings in 2014 and 2015). Currently, Black teatfish, Surf redfish and Sandfish have a zero t TAC.
Sub-fisheries assessed	No sea cucumber species in the TSBDMF have undergone an ecological risk assessment.
Start date/ history	The Torres Strait Sea Cucumber (Bêche-de-mer) Fishery has a history that dates back to at least the 19th century. In 1916-17 558 tons (567 tonnes) of Bêche-de-mer was exported from Thursday Island with 124 boats registered to collect it. The fishery is now accessed only by Traditional Inhabitants and is wholly commercial and export only). It forms an important source of income for some Torres Strait traditional inhabitants in East Torres Strait, where the Tropical Rock Lobster Fishery is less acitive.
Geographic extent of fishery	The TSBDMF area covers 16,844 km^2 of Torres Strait, situated at its eastern extreme which includes the Australian side of the Torres Strait Protected Zone east of Warrior Reef. The TSBDMF comprises tidal waters within the Torres Strait Protected Zone (TSPZ) and the area declared under the TSF Act to be 'outside but near' the TSPZ for commercial fishing for sea cucumber. For the TSBDMF, the outside but near area extends to waters just south of Prince of Wales Island to the west and to due east of Cape York Peninsula [12]. The area contains about 1,388 km^2 of shallow reefs, which accounts for about 64 % of all the reefs in Torres Strait [4]. The area of the Bêche-de-mer Fishery is the area consisting of: (a) the area of waters in the Protected Zone to the south of the Seabed Jurisdiction Line; and

	(b) the area of waters (excluding any waters within the limits of Queensland) bounded by a line beginning at the point of latitude 10° 48’ 00” south, longitude 141° 20’ 00” east and running progressively: • north along the meridian of longitude 141° 20’ 00” east to its intersection with the parallel of latitude 10° 28’ 00” south; • east along that parallel to its intersection with the meridian of longitude 144° 00’ 00” east; • south along that meridian to its intersection with the parallel of latitude 10° 41’ 00” south; • west along that parallel to its intersection with the meridian of longitude 142° 31’ 49” east; • south along that meridian to its northernmost intersection with the coastline of Cape York Peninsula at low water; • generally south-westerly along the western coastline of Cape York Peninsula, that is along the low water line on that coast and across any river mouth, to its intersection with the parallel of latitude 10° 48’ 00” south; • west along that parallel to the point where the line began; and (c) the territorial sea of Australia north of the Seabed Jurisdiction Line Source: Schedule 2 (1) Torres Strait Fisheries Regulations 1985 **https://www.legislation.gov.au/Details/F2016C00633**  **Area of the Torres Strait Beche-de-mer fishery.** **Source:** **https://www.pzja.gov.au/sites/default/files/content/uploads/2011/05/beche_map.gif?acsf_files_redirect**

Regions or Zones within the fishery	There are 21 areas in the fishery for the Catch Disposal Record and they are reflected in the catch database as well.  Twenty one fishing areas for the catch disposal record of the Torres Strait Beche-de-mer fishery. Source: https://www.afma.gov.au/sites/default/files/uploads/2018/07/2.2a-catch-disposal-record-TDB02.pdf?acsf_files_redirect
Fishing season	1 January – 30 December
Key/secondary commercial species and stock status	This fishery targets a range of sea cucumber species. Historically, the main species of sea cucumber harvested in the Torres Strait have been Black teatfish (*Holothuria whitmaei*), Prickly redfish (*Thelenota ananas*), Sandfish (*Holothuria scabra*), White teatfish (*H. fuscogilva*), Surf redfish (*Actinopyga mauritiana*), Deepwater redfish (*A. echinites*) and other Blackfish species (*Actinopyga* spp.)[12]. In recent years, market demand and fishing effort for Curryfish species (*Stichopus* spp.) and Prickly redfish have increased significantly [4, 5, 12].

Fishing for Sandfish ceased in 1998 due to sustainability concerns following a considerable decline in abundance. This was followed by the closure of fishing for Black teatfish and Surf redfish in 2003. There have been two trial openings of fishing for black teatfish in 2014, and 2015.

Currently (2020), fishing is mainly focused on Prickly redfish (*Thelenota ananas*), White teatfish (*H. fuscogilva*), Deep-water blackfish (mostly *A. palauensis*), Deep-water redfish (*A. echinites*) and since 2018, Curryfish (*Stichopus herrmanni* and *S. vastus*) [4]. The key and secondary commercial species are presented in the table below.

Table A. Species list and their roles (key, secondary) in the fishery. Key species comprise > 20% of the average catches between 2016-2020. Secondary species comprise < 20% of average catches between 2016-2020. Stock status information from [4, 5].

COMMON NAME	SCIENTIFIC NAME	STATUS	ROLE
Prickly redfish (Sea Cucumber)	*Thelenota ananas*	not subject to overfishing / not overfished 2019/20 survey results indicate possible fishing decline but still within TAC [4]	Key
Curryfish Herrmanni (Sea Cucumber) - AKA Curryfish (common)	*Stichopus herrmanni*	2019/20 survey results indicate possible fishing decline but still within TAC [4]	Key
White Teatfish (Sea Cucumber)	*Holothuria (Microthele) fuscogilva*	not subject to overfishing / not overfished	Secondary
Deepwater redfish	*Actinopyga echinites*	status still remains relatively unknown [4]	Secondary
Elephant's Trunkfish (Sea Cucumber)	*Holothuria (Microthele) fuscopunctata*	not subject to overfishing / not overfished	Secondary
Stonefish (Sea Cucumber)	*Actinopyga lecanora*	status still remains relatively unknown [4]	Secondary
Greenfish (Sea Cucumber)	*Stichopus chloronotus*	not subject to overfishing / not overfished	Secondary
Blackfish (Sea Cucumber) - AKA Hairy blackfish	*Actinopyga miliaris*	status still remains relatively unknown [4]	Secondary
Lollyfish (Sea Cucumber)	*Holothuria (Halodeima) atra*	not subject to overfishing / not overfished	Secondary
Burrowing Blackfish (Sea Cucumber)	*Actinopyga spinea*	status still remains relatively unknown [4]	Secondary
Brown Sandfish (Sea Cucumber)	*Bohadschia vitiensis*	status still remains relatively unknown [4]	Secondary
Golden Sandfish (Sea Cucumber)	*Holothuria (Metriatyla) lessoni*	status still remains relatively unknown [4]	Secondary
Curryfish Vastus (Sea Cucumber)	*Stichopus vastus*	2019/20 survey results indicate possible fishing decline but still within TAC [4]	Secondary
Leopardfish (Sea Cucumber)	*Bohadschia argus*	not subject to overfishing / not overfished	Secondary

Deepwater Blackfish (Sea Cucumber)	*Actinopyga palauensis*	status still remains relatively unknown [4]	Secondary
Sandfish (Sea Cucumber)	*Holothuria (Metriatyla) scabra*	not subject to overfishing / overfished Sandfish were not surveyed and the species therefore remains closed in accordance with the TSBDMHS [4]	Was a key species when assessed but is currently closed
Black Teatfish (Sea Cucumber)	*Holothuria (Microthele) whitmaei*	not subject to overfishing / not overfished Black teatfish stock is determined to be above limit reference point level from the use of high-quality survey data from 2019/20 survey. Population is at near natural (unfished) densities [4]	Was a key species when assessed but is currently closed
Surf redfish (Sea Cucumber)	*Actinopyga mauritiana*	recent survey in 2019/20 shows that Surf redfish is showing signs of recovery, but biomass is low and current densities are low in comparison to 2002 survey [4]	

The harvest strategy for the fishery outlines the species categories as at November 2019. https://www.pzja.gov.au/sites/default/files/bdm_harvest_strategy_adopted_nov_2019.pdf

The species i.d. guide, which also provides an indication of the relative value of these species: https://www.pzja.gov.au/sites/default/files/torres_strait_bdm_id_guide_2019_web_version.pdf

Comprehensive Information on the status of the stocks can be found on the ABARES Fishery Status Reports 2020 [5]: https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status/torres-strait-beche-de-mer-trochus-fisheries

Bait collection and usage	This is a hand collection fishery and does not require the use and/or collection of bait.
Current entitlements	The TSBDMF can only be accessed by Traditional Inhabitant (as defined by the Torres Strait Treaty[8]) fishers. There is no limit on the number of Traditional Inhabitants that can participate commercially in the fishery. However, they are required to hold a current Traditional Inhabitant Boat (TIB) licence with a specific endorsement to be able to fish for BDM. Total TIB licences area generally around 130. The level of participation in the BDM Fishery has increased in recent years although the number of active TIB fishing licences tends to fluctuate from year to year [12]. For information on current licences please refer to the publically available licence register available at: https://www.afma.gov.au/fisheries-services/concession-holders-conditions

[8] a traditional inhabitant is:

1) A Torres Strait Islander who lives in the Protected Zone or adjacent coastal area of Australia and is an Australian citizen who maintains traditional customary associations with the area in relation to subsistence or livelihood or social, cultural or religious activities; or

2) An Aboriginal traditional inhabitant of the Torres Strait or the Northern Peninsula Area as defined under the Torres Strait Treaty and who is resident in that area; or

3) A Papua New Guinea traditional inhabitant from the PNG area of jurisdiction of the Protected Zone who is now an Australian citizen and resides in the Protected Zone or adjacent coastal area of Australia and who was granted permanent residency status under the 1978/79 Immigration Taskforce Amnesty List. Or is a descendent of such a person.

Non-traditional inhabitants have fished for BDM historically but the last non-traditional inhabitant licence was taken out of the fishery in 2014 and held in trust by the Torres Strait Regional Authority (TSRA).

Current and recent TACs, quota trends by method

As of 1 January 2020, the Total Allowable Catch (TAC) that apply to the target species in the TSBDMF are as follows:

SPECIES OR GROUP (SCIENTIFIC NAME)	2020 TAC (t) (WET WEIGHT OF GUTTED FISH)	2016-2019 TAC (t) [12]
Prickly redfish (*Theleonata ananas*)	15	15
White teatfish (*Holothuria fuscogilva*)	15	15
Deepwater redfish *(Actinopyga echinites)*	5	Part of 80 t combined TAC (basket)
Hairy blackfish (*Actinopyga miliaris*)	5	Part of 80 t combined TAC (basket)
Greenfish (*Stichopus chloronotus)*	40	Part of 80 t combined TAC (basket)
Curryfish species (*Stichopus herrmanni, S. vastus and S. occellatus*)	60 t combined TAC (basket)	Part of 80 t combined TAC (basket)
Black teatfish (*Holothuria whitmaei*)	0	0
Surf redfish (*Actinopyga mauritania*)	0	0
Sandfish (*Holothuria scabra*)	0	0
All other BDM species (inc. those in the families Holothuridae and Stichopidae)	50 t combined TAC	Part of 80 t combined TAC (basket)

There are no quota allocations in the TSBDMF, i.e. TACs are competitive.

TACs are also outlined in the Harvest Strategy for the fishery which was adopted by the PZJA in November 2019 https://www.pzja.gov.au/sites/default/files/bdm_harvest_strategy_adopted_nov_2019.pdf

Species that are overfished have been closed to commercial fishing (zero TAC; see table above).

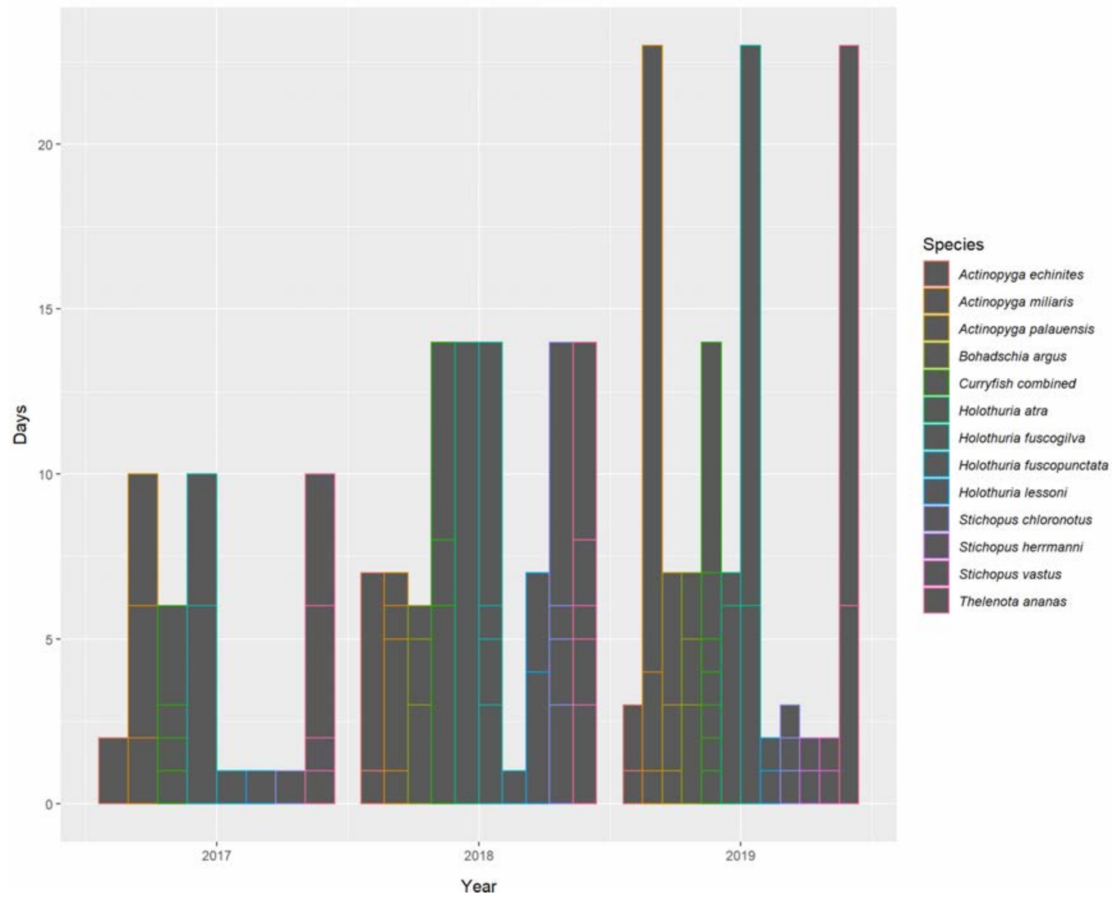
Current and recent fishery effort trends by method

Effort information for the Fishery is provided in the data summary in Attachment 2. Fishing method is hand collection only.

The fish receiver data also provides useful information on effort. Data from 2017-19 shows that the majority of fishing trips last between 1-3 days (~80%). The number of trips lasting between 3 and 6 days have increased in 2018-19 compared to 2017 and trips can last up to 21 days.

YEAR	FISHING TRIP LENGTH (DAYS)	FREQUENCY	%
2017	1	64	63.4%
	2	10	9.9%
	3	4	4.0%
	4	5	5.0%
	5	8	7.9%
	6	7	6.9%
	10	3	3.0%
	Total:	**101**	**100%**
2018	1	157	58.1%
	2	14	5.2%
	3	30	11.1%
	4	12	4.4%
	5	16	5.9%
	6	24	8.9%
	7	8	3.0%
	8	2	0.7%
	14	7	2.6%
	Total:	**270**	**100%**
2019	1	167	61.2%
	2	26	9.5%
	3	31	11.4%
	4	13	4.8%
	5	11	4.0%
	6	16	5.9%
	7	6	2.2%
	14	1	0.4%
	21	2	0.7%
	Total:	**273**	**100%**

The figure below shows a 'fishing trip length' with regard to the catch data. Segments on the bars are roughly equal (data was auto binned in R). Data shows how reporting has improved at the species level, with Curryfish species – *Stichopus herrmanni* and *S. vastus* being identified in the catch in 2019, as opposed to 2017 and 2018.



Current and recent fishery catch trends by method

Catch data from the TSBDMF improved in recent years as a result of a concerted effort by the Australian Fisheries Management Authority (AFMA) in 2017 to follow up on unreported catch and implement a fish receiver system. This process resulted in substantially higher catches being reported for some sea cucumber species in some years [5].

Catch reports of BDM for the last season and a half are available on the PZJA website through the links provided below. A summary of the historical catches in the fishery (2005-2020) is also provided in Appendix A.

Fishery catch watch reports: https://www.pzja.gov.au/fishery-catch-watch-reports

end of season catch report for 2019:
https://pzja.govcms.gov.au/sites/default/files/torres_strait_beche-de-mer_bdm_fishery_catch_watch_report_18_february_2020.pdf

2020 catch reports as at December:
https://www.pzja.gov.au/sites/default/files/bdm_catch_watch_31_dec_2020_final.pdf

Current and recent value of fishery ($)

There are currently no available estimates of GVP for this fishery. ABARES is aiming to calcultate GVP for the next ERAEF assessment.

The latest Torres Strait Bêche-de-mer (Sea cucumber) species ID guide [13] provides some indication of the relative value for the species that are found in the TSBDMF:

COMMON NAME	SCIENTIFIC NAME	VALUE (HIGH (H), MEDIUM (M), LOW (L)) [13]
Amberfish (Sea Cucumber)	*Thelenota anax*	L
Surf redfish (Sea Cucumber)	*Actinopyga mauritiana*	H
Sandfish (Sea Cucumber)	*Holothuria (Metriatyla) scabra*	H

White Teatfish (Sea Cucumber)	*Holothuria (Microthele) fuscogilva*	M
Black Teatfish (Sea Cucumber)	*Holothuria (Microthele) whitmaei*	H
Deepwater redfish	*Actinopyga echinites*	M
Elephant's Trunkfish (Sea Cucumber)	*Holothuria (Microthele) fuscopunctata*	L
Stonefish (Sea Cucumber)	*Actinopyga lecanora*	M
Greenflsh (Sea Cucumber)	*Stichopus chloronotus*	M
Blackfish (Sea Cucumber) - AKA Hairy blackfish	*Actinopyga miliaris*	M
Lollyfish (Sea Cucumber)	*Holothuria (Halodeima) atra*	L
Prickly redfish (Sea Cucumber)	*Thelenota ananas*	M
Burrowing Blackfish (Sea Cucumber)	*Actinopyga spinea*	M
Brown Sandfish (Sea Cucumber)	*Bohadschia vitiensis*	M
Golden Sandfish (Sea Cucumber)	*Holothuria (Metriatyla) lessoni*	H
Curryfish Herrmanni (Sea Cucumber) - AKA Curryfish (common)	*Stichopus herrmanni*	M
Curryfish Vastus (Sea Cucumber)	*Stichopus vastus*	M
Leopardfish (Sea Cucumber)	*Bohadschia argus*	M
Deepwater Blackfish (Sea Cucumber)	*Actinopyga palauensis*	M

Relationship with other fisheries	Traditional Inhabitant Boat (TIB) fishers in the TSBDMF can also get endorsement to operate in other Torres Strait Fisheries such as the Torres Strait Rock Lobster (TRL) Fishery. This information can be found on the public licence register on the AFMA website: https://www.afma.gov.au/fisheries-services/concession-holders-conditions. No overlap with the TRL Fishery which is hand collection only. No overlap with the Finfish fishery which is a line only fishery. No overlap with Prawn Fishery, which is a trawl fishery [4, 14]
GEAR	
Fishing methods and gear	The TSBDMF operates in tidal waters within the Torres Strait Protected Zone (TSPZ) and south of the TSPZ, in the waters defined as the 'outside but near area' [5] (see fishing area shown on map above). Bêche-de-mer (sea cucumber) has historically been harvested in the eastern parts of Torres Strait, with most of the catch typically taken from the Great North East Channel, Don Cay, Darnley Island, Cumberland Channel and Barrier regions. Western Torres Strait is included in the fishery, but is documented as having naturally low abundance of sea cucumbers [5].

	Fishing for Bêche-de-mer in the Torres Strait is by hand collection, mainly by free diving from dinghies crewed by two or three fishers, or by walking along reef tops and edges at low tide. Most (60%) of the fishing trips last for 1 day but they can last up to 21 days (2017-2019 fish receiver data). When working on boats, two fishers can be towed on snorkel to search for species of interest (see photo below). Fishers can also walk dragging bins full of sea water (tied by rope), that are filled with species that are hand collected. Catches are stored on boats either on bilges or nally bins filled with sea water. Fishers sometimes camp closer to fishing locations. The depth ranges of the most frequently sought species occur in a range of 0 – 20 m but a combined hookah (surface-supplied underwater breathing apparatus)/SCUBA ban means that most fishing occurs within 0-10m.  **Two fishers towed on snorkel in search of sea cucumbers. Photo: Mike Passi, TO Murray Island** Following collection, Sea cucumbers are processed for market; typically, this involves gutting, grading, cleaning, boiling and salting. A few operators also dry the product before sending it to market.
Fishing gear restrictions	The taking of Sea cucumbers in the area of the TSBDMF with the use of any underwater breathing apparatus or by any method other than collection by hand, is prohibited (legislative instrument). There is a maximum of 7 m boat length limit in the fishery (policy-based restriction).
Selectivity of fishing methods	Highly selective fishing method as it is hand collection only.
Spatial gear zone set	Hand collection only method applies to the entire fishery.
Depth range gear set	It is estimated that most fishing occurs within 0 – 10 m due to the ban on hookah/SCUBA gear.
How gear set	n/a as hand collection fishery.
Area of gear impact per set or shot	unknown
Capacity of gear	n/a

Effort per annum all boats	ABARES reports effort in the fishery measured by number of active TIB fishers reporting catch and has increased in 2019 compared to 2018 [5]: Effort (# of sellers) 2018: 34 Effort (# of sellers) 2019: 40
Lost gear and ghost fishing	n/a as this is currently a hand-collection only fishery.
ISSUES	
Key/second-ary commercial species issues and Interactions	n/a as this is a primarily sea cucumber fishery but there is a value differential among the various sea cucumber species that are available for harvest in the fishery. The fishery is unlikely to have an unsustainable ecological impact in the last three years [15]. Participation in the fishery is restricted to Traditional Inhabitants and (as of 1 December 2017) all commercial fishers are required to unload their catch to licensed fish receivers. The BDM Fishery is a wholly commercial fishery and catches by the recreational and traditional sectors are considered to be negligible. Black and white teatfish are both no-take species for the recreational sector managed by the Queensland Government. AFMA understands that there is no traditional fishing for sea cucumbers based on advice from stakeholders [12]. Overall, survey data from 2019/20 show the TSBDMF is healthy and can support moderate long-term income to local Islander communities, with some fishers reporting decreased catch rates (may indicate localised depletion) for Prickly redfish and Curryfish [4]. The data gathered during the 2019/20 survey showed that Black teatfish, a previously depleted high value species closed to fishing in 2003, has continued to recover. High densities observed in preferred Black teatfish habitats and observations shared by Traditional Inhabitants with long-term fishing experience, indicate the population is likely near virgin biomass levels [4]. The maximum size recorded for the 2019/20 survey was 325 mm and the average size was 219 mm, which was lower than the 2009 survey but larger than historical (1995/96) surveys. This indicates that full size adults are present in the population, with average size Black teatfish above common size and almost at size at maturity - determined as 220-260 mm [4].
Byproduct and bycatch issues and interactions	Due to the high selectivity of fishing methods used to catch Bêche-de-mer (i.e. hand collection) there is likely to be no byproduct or bycatch caught or retained: “No bycatch usually occurs in hand collection fisheries and risks are likely to be low” [15].
Protected species issues and interactions	There are no bycatch or protected species issues reported in the fishery. Interactions with protected species is highly unlikely because the fishery is highly selective (collected by hand). Some fishers may hunt (Turtles and Dugongs) on the same trip but this would be classified as traditional fishing and not fishing within the TSBDMF (AFMA 2021, pers. Comms.). Risks to protected species (Turtles and Dugongs) are likely to be relatively low, but may include impacts such as boat strikes, anchoring or trampling [15]. Dugongs spend much of their time in depths between five to 20 metres, so may be less at risk of boat strike than Turtles which spend more time around reef habitats in waters less than five metres deep. Large carrier boats which supply fishing boats and sometimes transport the catches in wharves, typically anchor in sheltered areas and not over reef [15]. Anchoring of large commercial boats in channels adjacent to Dugong feeding grounds was identified as a potential concern in a study on Western and Central Torres Strait [16], but as BDM fishing occurs mostly in eastern Torres Strait, this risk of boat strikes is very small. AFMA requires interactions with Threatened, Endangered or Protected (TEP) species to be recorded in logbooks. There have been no interactions with TEP species reported in this fishery to date, and the risks are likely to be relatively low [15]. No interactions with EPBC Act listed [17] species have been reported in the fishery [15, 18].
Habitat issues and interactions	Results from the 2019/20 survey suggest that the surveyed reef habitats within the TSBDMF appear to be in very good condition [4]. Sea cucumbers are caught by hand and the direct ecological impact on the benthos from harvesting these speciesis likely to be low based on the scale and nature of the fishery [15]. Although direct impacts from fishing have not been measured or reported, there is

	significant concern related to potential physical damage to coral reef structures from walking during collection at low tide [5]. AFMA considered that indirect impacts of the fishery on the ecosystem may include: over-exploitation of target species; translocation of species via hull and anchor fouling; and impacts of anchoring/mooring and other anthropogenic activities such as treading and walking on reef top habitat [15]. Results from the 2019/20 survey [4] showed Hard and Soft coral have declined since 2002, which was also the same for Sponges, with Giant clams down from 2009 (but higher than previous years). By contrast, seagrass cover increased, compared to previous years, where lower seagrass cover was recorded. Crown of thorn numbers were low with no suggestion of an outbreak and Trochus numbers were lower, but considered stable as Trochus specific habitat was not surveyed. The decline of Corals and other biota (Sponges) is of concern as they represent key ecosystem roles and habitat, and may indicate a wider and ongoing environmental and physical effect occurring for Torres Strait.
Community issues **and interactions**	n/a
Discarding	Due to the high selectivity of fishing method used to catch Bêche-de-mer (i.e. hand collection) there is likely to be minimal discarding and limited to the disposal of unmarketable product or illegal catch. In 2019, AFMA confiscated some illegal catch of sea cucumber (229 kg of White teatfish, 27 kg of Prickly redfish and 6 kg of Deepwater black fish) from unlicensed fishers, or because the fish did not go through licensed receivers. In addition, approximately 1 t of Curryfish,(a more difficult species to process)had spoiled and was rejected by receivers in 2018 [5].
MANAGEMENT: PLANNED AND THOSE IMPLEMENTED	
Management **objectives**	The TSBDMF is managed by the PZJA that consists of the Australian Government (represented by the Minister responsible for fisheries, as the Chair of the PZJA), the Queensland Government (represented by the Minister responsible for fisheries) and the Torres Strait Regional Authority (TSRA) (represented by the TSRA Chair). The Australian Fisheries Management Authority (AFMA) coordinates and delivers fisheries management and now also delivers compliance programs in the Torres Strait on behalf of the PZJA and in accordance with the *Torres Strait Fisheries Act 1984* (TSF Act). Management objectives for the fishery, with regard to the the rights and obligations conferred on Australia by the *Torres Strait Treaty 1984* (the Treaty) and the objectives to be pursued under the TSF Act, are: a) to acknowledge and protect the traditional way of life and livelihood of traditional inhabitants, including their rights in relation to traditional fishing[9]; b) to protect and preserve the marine environment and indigenous fauna and flora in and in the vicinity of the Protected Zone; c) to adopt conservation measures necessary for the conservation of a species in such a way as to minimise any restrictive effects of the measures on traditional fishing; d) to manage the fishery for optimum utilisation; e) to have regard, in developing and implementing licensing policy, to the desirability of promoting economic development in the Torres Strait area and employment opportunities for traditional inhabitants. Licences are granted under either subsection 19(2) or 19(3) of the TSF Act that entitles that person to take, process or carry trochus.

[9] Traditional fishing means non-commercial fishing as defined in the TSF Act.

<table>
<tr><td></td><td>https://www.legislation.gov.au/Details/C2016C00677</td></tr>
<tr><td>Fishery management plan</td><td>n/a

There is no formal management plan for the fishery, but management arrangements [15] are outlined below:

• A guide to management arrangements for Torres Strait Fisheries, June 2004

• Community Fishing Notice No. 1 (pdf copy on PZJA website but not found on legislation.gov.au)

• Torres Strait Fisheries Management Instrument No. 15

• Fisheries Management Notice No. 47

The management regime is likely to achieve the objective of maintaining ecologically viable stock levels [15].</td></tr>
<tr><td>Input controls</td><td>• Hand collection only, maximum 7 m boat length limits
• Traditional Inhabitant Boat (TIB) licence and BDM endorsement required
• Prohibition of hooka and scuba gear [5].</td></tr>
<tr><td>Output controls</td><td>Zero Total Allowable Catches (TAC) for Sandfish, Black teatfish and Surf redfish; and TAC's (Appendix B) for selected species,and combined (basket) sea cucumber species, minimum size limits on 10 species (see table below showing Sea cucumber species revised as part of the Harvest Strategy), conversion ratios used to convert processed product to whole weight (wet gutted whole weight) [5]. TACs are listed above, conversion ratios are in the Harvest Strategy document. Minimum (?) size limits are shown in the -table below. These will be updated to reflect the revised and recommended size limits in the Harvest Strategy.
<table>
<tr><th>COMMON NAME - SCIENTIFIC NAME</th><th>PREVIOUS SIZE LIMIT (CM)</th><th>REVISED HARVEST STRATEGY SIZE LIMIT (CM)</th></tr>
<tr><td>Deepwater redfish – A. echinites</td><td>12</td><td>20</td></tr>
<tr><td>Stonefish – A. lecanora</td><td></td><td>15</td></tr>
<tr><td>Surf redfish – A. mauritiana</td><td>22</td><td>22</td></tr>
<tr><td>Hairy blackfish – A. miliaris</td><td>22</td><td>15</td></tr>
<tr><td>Deepwater blackfish – A. palauensis</td><td>22</td><td>22</td></tr>
<tr><td>Burrowing blackfish – A. spinea</td><td>22</td><td>22</td></tr>
<tr><td>Leopardfish – B. argus</td><td></td><td>30</td></tr>
<tr><td>Brown sandfish – B. vitiensis</td><td></td><td>25</td></tr>
<tr><td>Lollyfish – H. atra</td><td>15</td><td>20</td></tr>
<tr><td>Elephant trunkfish – H. fuscopunctata</td><td>24</td><td>35</td></tr>
<tr><td>White teatfish – H. fuscogilva</td><td>32</td><td>32</td></tr>
<tr><td>Golden sandfish – H. lessoni</td><td>18</td><td>22</td></tr>
<tr><td>Sandfish – H. scabra</td><td>18</td><td>20</td></tr>
<tr><td>Black teatfish – H. whitmaei</td><td>25</td><td>25</td></tr>
<tr><td>Greenfish – S. chloronotus</td><td></td><td>20</td></tr>
<tr><td>Curryfish (common) – S. herrmanni</td><td>27</td><td>31</td></tr>
<tr><td>Curryfish (vastus) – S. vastus</td><td></td><td>20</td></tr>
<tr><td>Prickly redfish – T. ananas</td><td>30</td><td>35</td></tr>
</table></td></tr>
<tr><td>Technical measures</td><td>n/a</td></tr>
<tr><td>Regulations</td><td>1. Fisheries Management Instruments (FMIs) and Fisheries Management Notices (FMNs) are issued under the TSF Act and give effect to the regulations in place for each of the Torres Strait fisheries.</td></tr>
</table>

	<u>Torres Strait Fisheries Management Instrument No. 15 (Torres Strait Sea Cucumber Fishery)</u> Prohibitions: • Prohibition on the taking, processing or carrying of Bêche-de-mer. Exemptions from the prohibitions: • A person holding a licence to take, process or carry Bêche-de-mer; • where a person takes or carries sea cucumbers without the use of a boat – the number of sea cucumber in that person's possession does not exceed three; or • where a person takes or carries sea cucumbers with the use of a boat, or by diving from a boat, and no other person is in the boat – the number of sea cucumbers in the boat does not exceed three; or • where the person takes or carries sea cucumbers with the use of a boat, or by diving from a boat, and there is at least one other person in the boat – the number of sea cucumbers in the boat does not exceed six; and • A person who takes, processes or carries Bêche-de-mer in the course of traditional fishing. Size Limit: • minimum size limits apply. Gear restrictions: • the taking of sea cucumber in the area of the Torres Strait Sea Cucumber Fishery with the use of any underwater breathing apparatus or by any method other than collection by hand, is prohibited. • https://www.legislation.gov.au/Details/F2017L00370 2. Licensing arrangements Fishing is limited to traditional inhabitants only (as of 1 December 2017) in the commercial BDM fishery. Traditional inhabitants can enter this fishery by obtaining a Traditional Inhabitant Boat (TIB) fishing licence with a Bêche-de-mer (BD) endorsement. The Australian Fisheries Management Authority (AFMA) assesses and issues licences on behalf of the PZJA. 3. Licence conditions Implemented by way of licence conditions, boat lengths are limited to a maximum of seven metres in the fishery, which does not apply to processor/carrier boats.
Initiatives, strategies and incentives	• **HARVEST STRATEGY**: In November 2019 the PZJA endorsed the implementation of a Harvest Strategy in the TSBDMF which was implemented for the 2020 fishing season starting on 1 January [18]. • **FISH RECEIVER SYSTEM:** The Torres Strait Fish Receiver System was implemented on 1 December 2017. This is a requirement for all commercial fishers to unload their catch to licensed fish receivers. Fish receivers can only receive catch from licenced fishers and are required to weigh all catch and return the associated paperwork to AFMA within three days of receiving the catch. This allows AFMA to better monitor and manage catches than was possible under the voluntary reporting arrangements [15]. There is still however, limited information available to assess the status of fishery populations, with incomplete catch and effort time series data available prior to 2017 [4]. The fish receiver system provides an incentive for fishers to collect data which will feed into the Harvest Strategy. The Strategy specifies the data that are needed to effectively manage the fishery and how these data will be used to adjust catch limits and manage the fishery to meet biological, social and economic objectives [18].
Enabling processes	Data available for the TSBDMF is described below. The PZJA has an advisory committee for the Fishery, the Hand Collectables Working Group and has established a Resource Assessment Group for the Fishery with inaugural meeting to be held on Thursday Island 23-25 August 2021.

Other initiatives or agreements	The PZJA continues to engage Papua New Guinea including issues related to illegal PNG fishing of stocks on Warrior Reef. Illegal catch taken by PNG nationals has been reported in previous years, but no such reports have been received since the 2017 to 2018 fishing season [5, 12]. The PZJA has been supportive of the closure to the Bêche-de-mer fishery in PNG since 2009 and has continued to encourage PNG to continue the moratorium. However, the PNG Government's recent decision to lift the Bêche-de-mer moratorium is cause for concern, in relation to the management of Australian stocks and risks of illegal fishing by PNG licenced boats. Australia has offered assistance in conducting surveys of BDM stocks on the PNG area of Warrior Reef, to assist PNG in monitoring the impact of the fishery closure. PNG NFA are members of the Torres Strait Scientific Advisory Committee. The aim of this forum is to facilitate a collaborative approach to research.
DATA	
Logbook data	Logbook reporting is voluntary in the TSBDMF, however there is some historical data from logbooks and docket books used in the fishery. As a result, very limited historical fishery-dependent monitoring data are available as catch reporting was only made compulsory in December 2017. It is anticipated that there will be some time before reliable catch and effort data are available for analysis [18].
Observer data	nil
Scientific data	A number of Sea cucumber fishery-independent surveys were conducted in Torres Strait since 1995, across representative habitats [4]. Number of zones (equivalent to TSBDMF logbook areas) surveyed and number of survey sites in each habitat, are shown in the table below (from [4]):

YEAR	ZONES	REEF TOP	REEF TOP BUFFER	REEF EDGE	DEEP WATER^	Total
1995/96	14	1089	164	365	0	1618
2002	6	136	139	159	0	434
2005	5	35	52	40	0	127
2009	5	33	25	45	0	103
2019/20	6	88	86	70	53	297

^: defined as the the deep (>20 m) outer reef edge and deep reef lagoon habitats.

The *Torres Strait Hand Collectables, 2009 survey: Sea cucumber* (Skewes *et al.* 2010 [6]) completed in March 2009 was not by definition a stock assessment analysis, however, provided some insight into stock status.

Formal analysis of stock recovery strategies (prohibition of the take of overfished species and increased foreign compliance capabilities), has not been undertaken for the fishery. However, results from the 2009 and 2010 surveys indicate recovery for some species (Black teatfish and Surf redfish), as a result of a zero TAC since 2003.

http://pzja.gov.au/wp-content/uploads/2011/06/tshcwg-meeting-4-27-28-july-2010_attachment-2.2a-torres-stra.pdf

Other data	Catch disposal record data: a fish receiver system was implemented in 1 December 2017 and has led to increased availability of catch data for the fishery. Catch reports are available at: https://www.pzja.gov.au/fishery-catch-watch-reports Harvest strategy: https://pzja.govcms.gov.au/sites/default/files/bdm_harvest_strategy_adopted_nov_2019_070421.pdf BDM surveys: 1995/96, 2002, 2005, 2009, 2019/20 [4, 6, 19-22]

	Submission for a further export approval for the Torres Strait Bêche-de-mer Fishery under the EPBC Act 1999 [12] See reference list
Legislative instruments and directions	See previous section
Management plans	n/a

2.2.2 Unit of Analysis Lists (Step 2)

The units of analysis for the sub-fishery are listed by component:

- Species Components (key commercial and secondary commercial; byproduct/bycatch and protected species components). [Scoping document S2A Species]
- Habitat Component: habitat types. [Scoping document S2B1 and S2B2 Habitats]
- Community Component: community types. [Scoping document S2C1 and S2C2 Communities]

Ecological Units Assessed

Key commercial and secondary species:	2 (C1); 13 (C2)
Byproduct and bycatch species:	0
Protected species:	0
Habitats:	4 demersal; 1 pelagic
Communities:	7 (5 demersal, 2 pelagic)

Scoping Document S2A. Species

Each species identified during the scoping is added to the ERAEF database used to run the Level 2 analyses. A CAAB code (Code for Australian Aquatic Biota) is required to input the information. The CAAB codes for each species may be found at http://www.marine.csiro.au/caab/

Key commercial/secondary commercial species

- *Key commercial species* – defined in the Harvest Strategy Policy (HSP) Guidelines as a species that is, or has been, specifically targeted and is, or has been, a significant component of a fishery.
- *Secondary commercial species* – commercial species that, while not specifically targeted, are commonly caught and generally retained, and comprise a significant component of a fishery's catch and economic return. These can include quota species in some fisheries.

For the purpose of this ERA, species need to have TAC greater than zero to be considered as key or secondary commercial species. Key commercial species are defined as the species that comprised more than 20 % of the average catch between 2016-2020, while secondary commercial species comprised less than 20 % of average catch between 2016-2020.

Table 2.3. Key commercial (C1) and secondary commercial (C2) species list for the Torres Strait Bêche-de-mer Fishery.

ROLE IN FISHERY	TAXA NAME	FAMILY NAME	CAAB CODE	SCIENTIFIC NAME	COMMON NAME	SOURCE
C1	Holothuroidea	Stichopodidae	25417003	*Thelenota ananas*	Prickly redfish (Sea cucumber)	[7, 13, 23]
C1	Holothuroidea	Stichopodidae	25417006	*Stichopus herrmanni*	Curryfish herrmanni (Sea Cucumber) - AKA Curryfish (common)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416006	*Holothuria (Microthele) fuscogilva*	White teatfish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416001	*Actinopyga echinites*	Deepwater redfish (Sea cucumber)	[7, 13, 23]

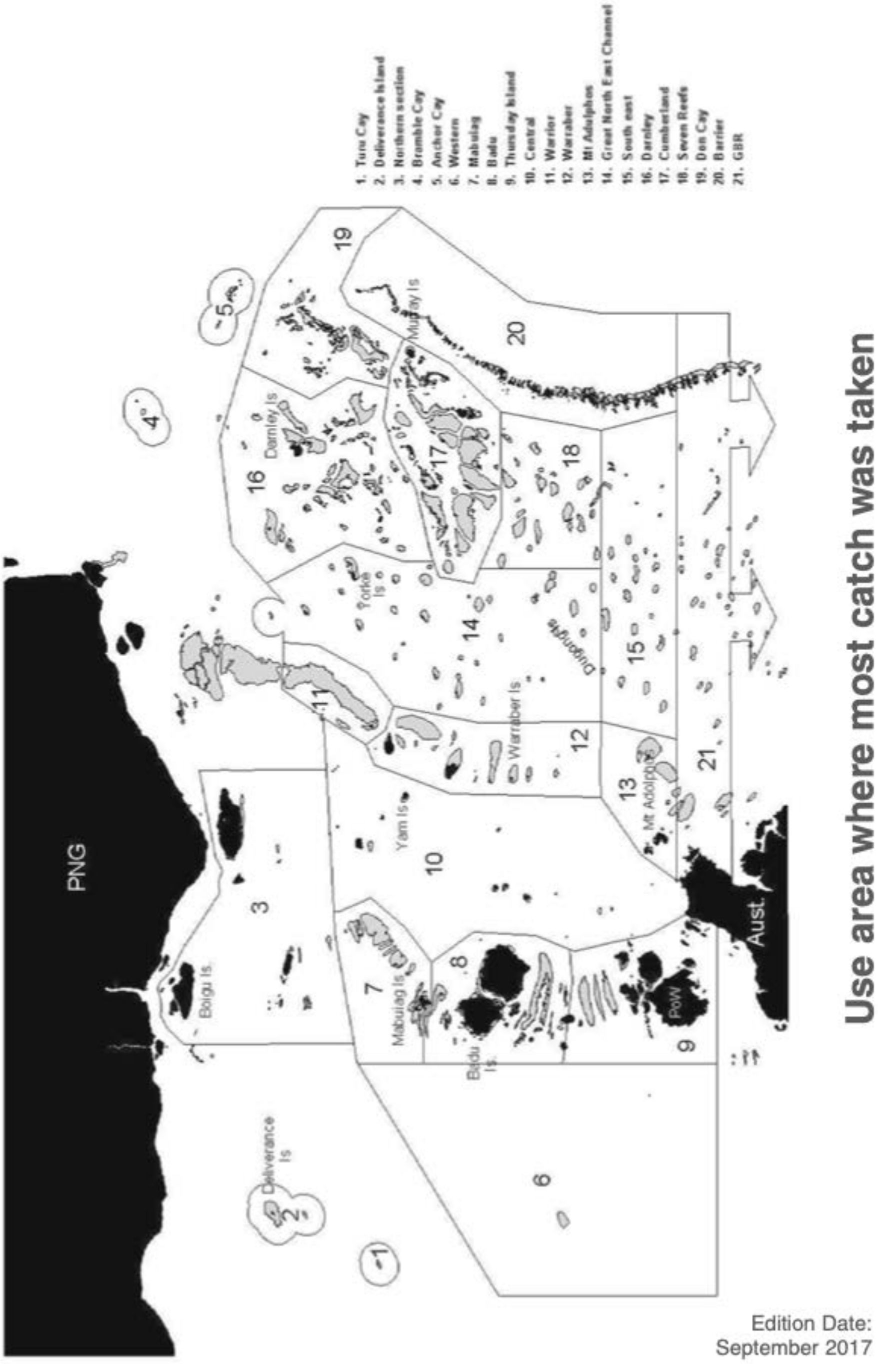
ROLE IN FISHERY	TAXA NAME	FAMILY NAME	CAAB CODE	SCIENTIFIC NAME	COMMON NAME	SOURCE
C2	Holothuroidea	Holothuriidae	25416032	*Holothuria (Microthele) fuscopunctata*	Elephant's trunkfish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416009	*Actinopyga lecanora*	Stonefish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Stichopodidae	25417001	*Stichopus chloronotus*	Greenflsh (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416007	*Actinopyga miliaris*	Blackfish (Sea cucumber) - AKA Hairy blackfish	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416003	*Holothuria (Halodeima) atra*	Lollyfish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416064	*Actinopyga spinea*	Burrowing blackfish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416065	*Bohadschia vitiensis*	Brown sandfish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416031	*Holothuria (Metriatyla) lessoni*	Golden sandfish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Stichopodidae	25417012	*Stichopus vastus*	Curryfish vastus (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416013	*Bohadschia argus*	Leopardfish (Sea cucumber)	[7, 13, 23]
C2	Holothuroidea	Holothuriidae	25416070	*Actinopyga palauensis*	Deepwater Blackfish (Sea Cucumber)	
The following three species were key species when previously assessed, but are are currently closed to fishing:						
	Holothuroidea	Holothuriidae	25416004	*Holothuria (Metriatyla) scabra*	Sandfish (Sea cucumber)	[7, 13, 23]
	Holothuroidea	Holothuriidae	25416033	*Holothuria (Microthele) whitmaei*	Black teatfish (Sea cucumber)	[7, 13, 23]
	Holothuroidea	Holothuriidae	25416002	*Actinopyga mauritiana*	Surf redfish (Sea cucumber)	[7, 13, 23]

Scoping Document S2B1. Benthic Habitats

Risk assessment for benthic habitats considers both the seafloor structure and its attached invertebrate fauna. Because data on the types and distributions of benthic habitat in Australia's Commonwealth fisheries are generally sparse, and because there is no universally accepted benthic classification scheme, the ERAEF methodology has used the most widely available type of data – seabed imagery – classified in a similar manner to that used in bioregionalisation and deep seabed mapping in Australian Commonwealth waters. Using this imagery, benthic habitats are classified based on an SGF score, using sediment, geomorphology, and fauna. Where seabed imagery is not available, a second method (Method 2) is used to develop an inferred list of potential habitat types for the fishery. For details of both methods, see [1].

The TSBDMF area covers 16,844 km^2 of Torres Strait, but Sea cucumbers have been historically harvested on coral reefs in eastern Torres Strait, with most of the catch (and effort) typically taken from the Great North East Channel (zone 14 in Figure 2.2), Don Cay (zone 19), Darnley Island (zone 16), Cumberland Channel (zone 17) and Barrier (zone 20) regions. Western Torres Strait is included in the fishery, but is documented as having naturally low abundance of Sea cucumbers [5]. The area with most catch contains about 1,388 km^2 of shallow reefs, which accounts for about 64 % of all reefs in Torres Strait (Figure 2.2) [20].

Recent surveys in Torres Strait have documented 275 coral species, of which approximately 75 are new records for the region. Corals build reef structures that provide habitat for the Sea cucumbers. The reefs are in good to excellent condition with high coral cover, presence of the major taxonomic and functional groups and minimal incidence of coral disease [24]. Torres Strait coral reefs have the highest diversity of fungiid corals (mushroom corals) in the eastern coast of Australia [25]. For both corals and reef fishes, the communities from central sites differ from those in eastern sites, reflecting a gradient in turbidity and wave exposure, where water is more turbid and energy is lower from west to east [26].

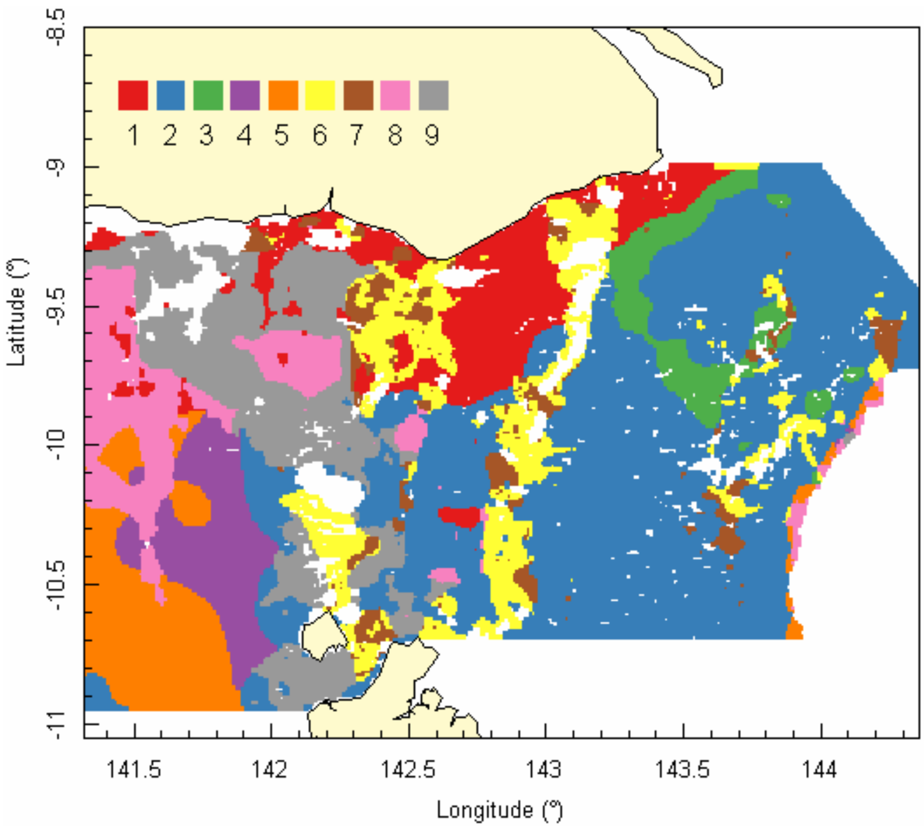


Source: https://www.afma.gov.au/sites/default/files/uploads/2018/07/2.2a-catch-disposal-record-TDB02.pdf?acsf_files_redirect.

Figure 2.1. Twenty one fishing areas for the Catch Disposal Record of the Torres Strait Bêche-de-mer fishery.

Seabed imagery was used to characterise key biotic and physical attributes of the Torres Strait inter-reefal ecosystems [14, 27]. Murphy et al.[4] reviewed these datasets and found that "[…]the inter-reefal seabed data does not indicate a significant population of high value commercial species in the inter-reefal seabed areas of Torres Strait (apart from *S. horrens*, a commercial but not currently targeted species), such as White teatfish and Prickly redfish. Nor does it indicate the existence of significant populations of Burrowing blackfish (*Actinopyga* *spinea*) that now forms the largest single species on the Qeensland east coast (GBR) Sea cucumber fishery."

As discussed above, the commercial species in Torres Strait are harvested on coral reefs, mostly on reef tops and reef edges [4], with species having preferences to different reef habitats (Table 2.4). Therefore, instead of relying solely on seabed imagery, we also used survey data to create the habitat categories used in this report. The relevant broad inter-reefal benthic habitats and assemblages (Figure 2.2) were grouped into a single category (inter-reefal habitats). The habitats 'reef flat', 'forereef zone', 'deep reef' and 'seagrass beds' habitats were created based on habitat preferences of commercially caught species (Table 2.4) according to historical Sea cucumber surveys [4, 6, 13, 19-22, 28, 29] and summarised in [13]. The revised habitat types and their descriptions are provided in Table 2.5.



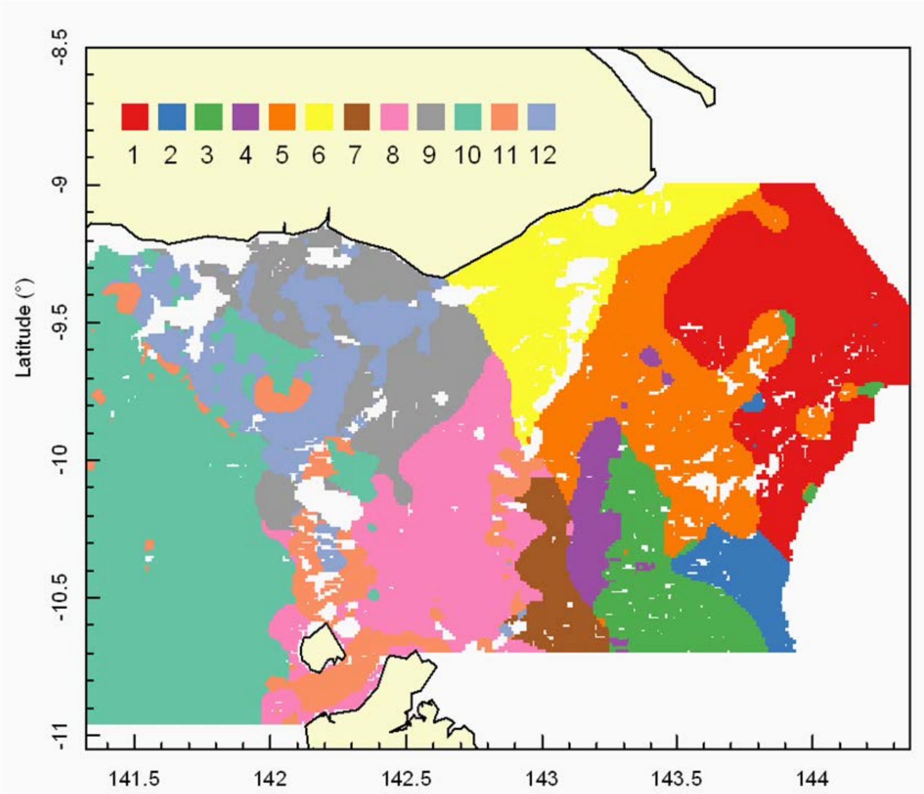


Figure 2.2. Map of the Torres Strait bêche-de-mer sub-fishery showing the nine inter-reefal habitats (top) and 12 inter-reefal assemblages (bottom) derived from [14, 27].

Table 2.4. Commercial Sea cucumber species, their preferred habitats and respective characterisation [based on 13, 14, 27].

SPECIES	BROAD HABITAT PREFERENCE [13]	DETAILED HABITAT PREFERENCE [13]	WHERE FOUND
Deepwater redfish	Reef flat Seagrass beds	**Unconsolidated substrate**. Coastal reefs in rubble, seagrass beds and sand between corals	Moa Island, Orman reefs, Darnley Island, Murray Island, Campbell Island, Aureed Island, Hannah bank, Warrior reef, Auwamaza Reef
Surf redfish	Forereef zone	**Consolidated substrate.** Surf zone on outer reefs	Murray Island, Don Cay
Hairy blackfish	Reef flat	**Unconsolidated substrate.** Sandy lagoons and reef flats	Warrior Reef, Campbell Island
Deepwater blackfish	Forereef zone	**Consolidated substrate.** Forereef pavement and reef passes	Very uncommon
Burrowing blackfish	Reef flats	**Unconsolidated substrate.** Lagoons and reef flats	Western side of Warrior reef
Stonefish	Reef flats Forereef zone	**Unconsolidated or consolidated substrate.** Deeper seabed in areas with live coral, coral rocks and reef ledge	Reasonably uncommon, found in deeper seabed from Warrior and western Torres Strait. Also at Orman Reeef, Mabuiag Island, Bet Reef, Buru Island, Tudu Island, Nagai Island
Leopardfish	Reef flats Forereef zone Inter-reef seabed	**Unconsolidated substrate.** Sand base of reef slopes or on reef flats and lagoons	Widespread. Commonly on sand at base of reef slopes or on reef flats and in lagoons

SPECIES	BROAD HABITAT PREFERENCE [13]	DETAILED HABITAT PREFERENCE [13]	WHERE FOUND
Brown sandfish	Reef flats	**Unconsolidated substrate.** Lagoons and inner reef flats with soft sediments	Calm water of coastal lagoons and inner reef flats with soft sediments eg. sand
Lollyfish	Reef flats	**Unconsolidated substrate.** Sandy lagoons and reef flats	Widespread. Sand lagoons and reef flat
White teatfish	Reef flats Inter-reef seabed Deep reef	**Consolidated or unconsolidated substrate.** Lagoons, reef passes on pavement or sand	Widespread, but more common in north eastern Torres Strait
Elephant trunkfish	Reef flats	**Unconsolidated substrate.** Rubble sandy lagoons and reef flats	Widespread. Rubble sand lagoons and reef flats
Golden sandfish	Reef flats	**Unconsolidated substrate.** Sandy reef flats and lagoons	Sandy reef flats and lagoons. Very restricted distribution in western Torres Strait
Sandfish	Reef flats Seagrass beds	**Unconsolidated substrate.** Muddy-sand seagrass beds and reef flats	Warrior Reef, Dungeness Reef
Black teatfish	Reef flats Forereef zone Inter-reef seabed	**Unconsolidated or consolidated substrate.** Sandy reef flats, reef fronts and between reefs	Widespread throughout Torres Strait
Greenfish	Reef flat Forereeef zone	**Unconsolidated or consolidated substrate.** Reef flats and upper slopes	Widespread throughout Torres Strait
Curryfish (common)	Reef flat	**Unconsolidated substrate.** Reef flats and lagoons in rubble and muddy-sand bottoms	Widespread. Coastal reefs and lagoons in rubble and muddy-sand bottoms
Curryfish (vastus)	Forereef zone	**Unconsolidated substrate.** Inshore reef edges on sand, coral rubble or muddy-sand in shallow waters	Widespread. Inshore reefs edges on sand, coral rubble or muddy sand in shallow waters
Prickly redfish	Reef flat	**Unconsolidated substrate.** Lagoons, in areas with rubble and passes	Widespread. Lagoons, in areas with rubble and passes

Table 2.5. Habitats and corresponding faunal assesmblages in the Torres Strait Bêche-de-mer Fishery.

HABITAT (BASED ON [13])	RELEVANT HABITAT TYPES [14, 27]	DESCRIPTION	ASSEMBLAGE
Inter-reef seabed	1	Habitat Type 1 was among the most barren seabed types, almost entirely bare and/or bioturbated with very little biohabitat — distributed in low current stress, low salinity, muddy–sandy areas adjacent to the PNG coast and extending south behind the Warrior Reefs.	6. occurred in areas of low variability in temperature and salinity with high turbidity, distributed primarily in the lee of the Warrior Reefs to the PNG coast and northeast towards the Fly River delta. At the species level, a few species had moderately strong affinities for assemblage#6; those most aligned were: Actinopterygii: *Torquigener whitleyi*, *Apogon fasciatus*; Crustacea: *Phalangipus filiformis*, *Thalamita sima*. [14]
	2	somewhat similar to habitat types 1 and 3, being also very barren with little epibenthos or algae, though sandier and much less bioturbated — distributed in low current stress, high salinity, low phosphate, low silicate variability, sandy areas located over most of eastern TSPZ including the trawl grounds and open areas of southern central TSPZ.	1. occurred in areas of low variability in temperature and salinity with sediment carbonate <85%, distributed primarily in the northeast outer shelf of the TSPZ. Several species had very strong affinities for assemblage#1; those most aligned were Actinopterygii: *Fistularia petimba*, *Rogadius pristiger*, *Paramonacanthus filicauda*, *Upeneus* cf sp. 1 (Sainsbury), *Suggrundus macracanthus*, *Nemipterus* sp juv/unident, *Apogon septemstriatus*, *Onigocia* sp b; Crustacea: *Paguristes* sp2358-2, *Trachypenaeus curvirostris*, *Penaeus longistylus*; Asteroidea: *Luidia hardwicki*. [14]

HABITAT (BASED ON [13])	RELEVANT HABITAT TYPES [14, 27]	DESCRIPTION	ASSEMBLAGE
			3. occurred in areas of low variability in temperature and salinity with low turbidity and chlorophyll and low trawl effort, distributed primarily in southeast TSPZ in a mid-shelf position. Some of the most barren habitats occurred in some of these areas, although the sled and trawl revealed significant biodiversity. Few individual species had strong affinities for assemblage#3; those most aligned were: Crustacea: *Portunus tenuipes*, Actinopterygii: *Rhynchostracion nasus*, *Sorsogona tuberculata*. [14]
			4. occurred in areas of low variability in temperature and salinity with low turbidity and chlorophyll and high trawl effort, distributed primarily in southern-central eastern TSPZ, corresponding with a large part of the trawl grounds. Again, few individual species had strong affinities for assemblage#4; those most aligned were: Actinopterygii: *Scolopsis taeniopterus*, *Paramonacanthus choiro/otisensis*, *Priacanthus tayenus*, *Cynoglossus maculipinnis*, *Euristhmus nudiceps*. [14]
			5. occurred in areas of low variability in temperature and salinity with low turbidity and high chlorophyll, distributed primarily in the Great Northeast Channel straddling the trawl grounds from the Warrior Reefs to the Hibernia Reef matrix in central eastern TSPZ. At the species level, a relatively large number of species showed moderately strong affinities for assemblage#5; those most aligned were: Actinopterygii: *Grammatobothus polyophthalmus*, *Pseudorhombus elevatus*, *Nemipterus peronii*, *Nemipterus hexodon*, *Repomucenus belcheri*, *Priacanthus tayenus*, *Saurida grandi/undosquamis*, *Pegasus volitans*, *Leiognathus leuciscus*, *Apistus carinatus*, *Pentaprion longimanus*, *Apogon truncatus*; Crustacea: *Portunus gracilimanus, Portunus hastatoides*, *Charybdis truncata*, *Scyllarus demani*, *Penaeus esculentus*; Bivalvia: *Placamen calophyllum*, *Amusium pleuronectes* cf; Cephalopoda: *Sepia elliptica*. [14]
	3	very similar to habitat type 1, being also very barren with very little epibenthos or algae, though sandier with less bioturbation — distributed in low current stress, high salinity, low phosphate, high silicate variability, muddy-sand areas located across and along the Great Northeast Channel in north-eastern TSPZ and spanning part of the northern trawl grounds.	5 [14]
	6	mostly rubbly with ~30% cover of sponge and other epibenthos gardens interspersed with ~15% cover of mixed algae and ~45% bare areas — distributed in high current stress, low	6. (see above)
			8. occurred in areas of high variability in temperature, low current stress, intermediate phosphate and low variability in salinity, distributed primarily in south central TSPZ between the lines of

HABITAT (BASED ON [13])	RELEVANT HABITAT TYPES [14, 27]	DESCRIPTION	ASSEMBLAGE
		phosphate, low sand, rubbly areas located along the western and Warrior lines of reefs and islands, and some inter-reef area of eastern TSPZ.	the western reefs and islands and the Warrior line of reefs. A few individual species had moderately weak affinities for assemblage#8; those most aligned were: Anthozoa: *Dichotella* sp1; Gastropoda: *Murex brevispina*; Actinopterygii: *Stolephorus* sp juv/unidentified; Gymnolaemata: *Parasmittina* spp. [14]
	7	similar to 6 though sandier with coarse sand and with ~45% cover of sponge and other epibenthos gardens interspersed with ~15% cover of mixed algae and ~40% bare areas — distributed in high current stress, low phosphate, high sand areas located along the western and Warrior lines of reefs and islands, and some inter-reef area of eastern TSPZ.	1. (see above) 5. (see above)
Reef flat (reef top and reef top buffer)	-	**Consolidated and unconsolidated substrate** in low-moderate energy environnments in lagoons and inner reef flats	13. Live coral cover between 1-4%; <1% soft coral cover; <1% seagrass cover; algae cover > 5% sponges. Crinoids, hydroids and sea urchins are the most common species groups [4]
Forereef zone (reef edge)	-	**Consolidated or unconsolidated substrate** located at high energy environments at reef edges, upper reef slopes and reef ledge < 20m deep	14. >5% coral live cover; >2% soft corals; algae cover <2%. Gorgonians and whip corals and crinoids are the most abundant species groups; fungiid corals are most abundant in this area (~0.5% cover) [4]
Deep reef	-	**Consolidated or unconsolidated substrate** located at deep (>20 m) outer reef edge and deep-reef lagoon.	15. Substrate is mostly barren. Filter feeders (whip corals, sponges and gorgonians) are the most frequently organisms found. Some corals, soft corals, algae and seagrass found but their percentage cover is low. < 1% coral cover, <1% soft coral cover; <0.5% seagrass cover; algae cover <2% whips, sponges and gorgonians are the most abundant species groups [4]

Scoping Document S2B2. Pelagic Habitats

Table 2.6. Pelagic habitats for the Torres Strait Bêche-de-mer Fishery. Shading denotes habitats occurring within the jurisdictional boundary of the fishery. Bolded text refers to pelagic habitats where fishing effort has occurred.

ERAEF PELAGIC HABITAT NO.	PELAGIC HABITAT TYPE	DEPTH (M)	SOURCE
P1	Eastern Pelagic Province - Coastal	0 – 200	ERA pelagic habitat database based on pelagic communities definitions
P2	Eastern Pelagic Province - Oceanic	0 – > 600	ERA pelagic habitat database based on pelagic communities definitions

ERAEF PELAGIC HABITAT NO.	PELAGIC HABITAT TYPE	DEPTH (M)	SOURCE
P3	Heard/ McDonald Islands Pelagic Provinces - Oceanic	0 - >1000	ERA pelagic habitat database based on pelagic communities definitions
P4	North Eastern Pelagic Province - Oceanic	0 – > 600	ERA pelagic habitat database based on pelagic communities definitions
P5	**Northern Pelagic Province - Coastal**	**0 – 200**	**ERA pelagic habitat database based on pelagic communities definitions**
P6	North Western Pelagic Province - Oceanic	0 – > 800	ERA pelagic habitat database based on pelagic communities definitions
P7	Southern Pelagic Province - Coastal	0 – 200	ERA pelagic habitat database based on pelagic communities definitions
P8	Southern Pelagic Province - Oceanic	0 – > 600	ERA pelagic habitat database based on pelagic communities definitions
P9	Southern Pelagic Province - Seamount Oceanic	0 – > 600	ERA pelagic habitat database based on pelagic communities definitions
P10	Western Pelagic Province - Coastal	0 – 200	ERA pelagic habitat database based on pelagic communities definitions
P11	Western Pelagic Province - Oceanic	0 – > 400	ERA pelagic habitat database based on pelagic communities definitions
P12	Eastern Pelagic Province - Seamount Oceanic	0 – > 600	ERA pelagic habitat database based on pelagic communities definitions
P13	Heard/ McDonald Islands Pelagic Provinces - Plateau	0 -1000	ERA pelagic habitat database based on pelagic communities definitions
P14	North Eastern Pelagic Province - Coastal	0 – 200	ERA pelagic habitat database based on pelagic communities definitions
P15	North Eastern Pelagic Province - Plateau	0 – > 600	ERA pelagic habitat database based on pelagic communities definitions
P16	North Eastern Pelagic Province - Seamount Oceanic	0 – > 600	ERA pelagic habitat database based on pelagic communities definitions
P17	Macquarie Island Pelagic Province - Oceanic	0 – 250	ERA pelagic habitat database based on pelagic communities definitions
P18	Macquarie Island Pelagic Province - Coastal	0 - > 1500	ERA pelagic habitat database based on pelagic communities definitions

Scoping Document S2C1. Demersal Communities

In ERAEF, communities are defined as the set of species assemblages that occupy the large-scale provinces and biomes identified from national bioregionalisation studies. The biota includes mobile fauna, both vertebrate and invertebrate, but excludes sessile organisms such as corals that are largely structural and are used to identify benthic habitats. The same community lists are used for all fisheries, with those selected as relevant for a particular fishery being identified on the basis of spatial overlap with effort in the fishery. The spatial boundaries for demersal communities are based on IMCRA boundaries for the shelf, and on slope bioregionalisations for the slope [30, 31]. The spatial boundaries for the pelagic communities are based on pelagic bioregionalisations and on oceanography [32, 33]. Fishery and region-specific modifications to these boundaries are described in detail in [1] and briefly outlined in the footnotes to the community Tables below.

The area of the TSBDMF encompasses inner shelf and reef (0-110 m) North Eastern and Timor Transitions demersal communities. However, most of the catch and effort (Scoping Document S2B1) occurs on reefs in the North East Transition. The assemblages/communities described on the bioregionalisation [30, 31] were predominately focussed on fish assemblages/communities (not on invertebrates).

Table 2.7. Demersal communities in which fishing activity occurred in the Torres Strait bêche-de-mer Fishery (x). Shaded cells indicate all communities within the province.

DEMERSAL COMMUNITY	CAPE	NORTH EASTERN TRANSITION	NORTH EASTERN	CENTRAL EASTERN TRANSITION	CENTRAL EASTERN	SOUTH EASTERN TRANSITION	CENTRAL BASS	TASMANIAN	WESTERN TAS TRANSITION	SOUTHERN	SOUTH WESTERN TRANSITION	CENTRAL WESTERN	CENTRAL WESTERN TRANSITION	NORTH WESTERN	NORTH WESTERN TRANSITION	TIMOR	TIMOR TRANSITION ARAFURA	TIMOR TRANSITION GROOTE	TIMOR TRANSITION CAPE YORK	TIMOR TRANSITION G. OF CARPENTARIA	HEARD & MCDONALD IS	MACQUARIE IS
Inner Shelf 0 – 110m [1,2]		X																	X	X		
Outer Shelf 110 – 250m [1,2,]																						
Upper Slope 250 – 565m [3]																						
Mid–Upper Slope 565 – 820m[3]																						
Mid Slope 820 – 1100m[3]																						
Lower slope/ Abyssal > 1100m[6]																						
Reef 0 -110m[7, 8]		X															X					
Reef 110-250m[8]																						

DEMERSAL COMMUNITY	CAPE	NORTH EASTERN TRANSITION	NORTH EASTERN	CENTRAL EASTERN TRANSITION	CENTRAL EASTERN	SOUTH EASTERN TRANSITION	CENTRAL BASS	TASMANIAN	WESTERN TAS TRANSITION	SOUTHERN	SOUTH WESTERN TRANSITION	CENTRAL WESTERN	CENTRAL WESTERN TRANSITION	NORTH WESTERN	NORTH WESTERN TRANSITION	TIMOR	TIMOR TRANSITION ARAFURA	TIMOR TRANSITION GROOTE	TIMOR TRANSITION CAPE YORK	TIMOR TRANSITION G. OF CARPENTARIA	HEARD & MCDONALD IS	MACQUARIE IS
Seamount 0 – 110m																						
Seamount 110- 250m																						
Seamount 250 – 565m																						
Seamount 565 – 820m																						
Seamount 820 – 1100m																						
Seamount 1100 – 3000m																						
Plateau 0 – 110m																						
Plateau 110- 250m[4]																						
Plateau 250 – 565m[4]																						
Plateau 565 – 820m[5]																						
Plateau 820 – 1100m[5]																						

[1] Four inner shelf communities occur in the Timor Transition (Arafura, Groote, Cape York and Gulf of Carpentaria) and three inner shelf communities occur in the Southern (Eyre, Eucla and South West Coast). At Macquarie Is: [2]inner & outer shelves (0-250m), and [3]upper and midslope communities combined (250-1100m). At Heard/McDonald Is: [4]outer and upper slope plateau communities combined to form four communities: Shell Bank, inner and outer Heard Plateau (100-500m) and Western Banks (200-500m), [5]mid and upper plateau communities combined into 3 trough (Western, North Eastern and South Eastern), southern slope and North Eastern plateau communities (500-1000m), and [6] 3 groups at Heard Is: Deep Shell Bank (>1000m), Southern and North East Lower slope/abyssal, [7]Great Barrier Reef in the North Eastern Province and Transition and [8] Rowley Shoals in North Western Transition.

Scoping Document S2C2. Pelagic Communities

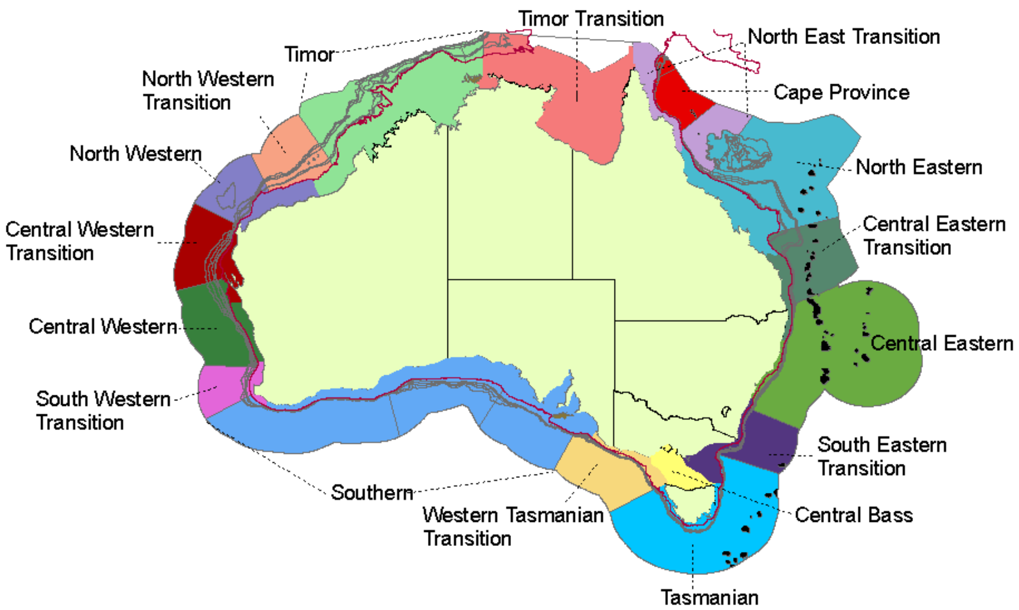
The fishery does not interact with pelagic communities, but the area of the TSBDMF encompasses coastal pelagic communities from the Northern Pelagic Province. However, most catch and effort (Scoping Document S2B1) occurs in northern east of Cape York.

Table 2.8. Pelagic communities in which fishing activity occurs in the Torres Strait bêche-de-mer Fishery (x). Shaded cells indicate all communities that exist in the province.

PELAGIC COMMUNITY	NORTHEASTERN	EASTERN	SOUTHERN	WESTERN	NORTHERN NWS	NORTHERN BONAPARTE	NORTHERN ARAFURA	NORTHERN GULF	NORTHERN EAST CAPE YORK	NORTHWESTERN	HEARD AND MCDONALD IS2	MACQUARIE IS
Coastal pelagic 0-200m[1,2]								X	X			
Oceanic (1) 0 – 600m												
Oceanic (2) >600m												
Seamount oceanic (1) 0 – 600m												
Seamount oceanic (2) 600–												
Oceanic (1) 0 – 200m												
Oceanic (2) 200-600m												
Oceanic (3) >600m												
Seamount oceanic (1) 0 – 200m												
Seamount oceanic (2) 200 –												
Seamount oceanic (3) 600–												
Oceanic (1) 0-400m												
Oceanic (2) >400m												
Oceanic (1) 0-800m												
Oceanic (2) >800m												
Plateau (1) 0-600m												
Plateau (2) >600m												
Heard Plateau 0-1000m[3]												
Oceanic (1) 0-1000m												
Oceanic (2) >1000m												
Oceanic (1) 0-1600m												
Oceanic (2) >1600m												

[1] Northern Province has five coastal pelagic zones (NWS, Bonaparte, Arafura, Gulf and East Cape York) and Southern Province has two zones (Tas, GAB). [2] At Macquarie Is: coastal pelagic zone to 250m. [3] At Heard and McDonald Is: coastal pelagic zone broadened to cover entire plateau to maximum of 1000 m.

(a)



(b)

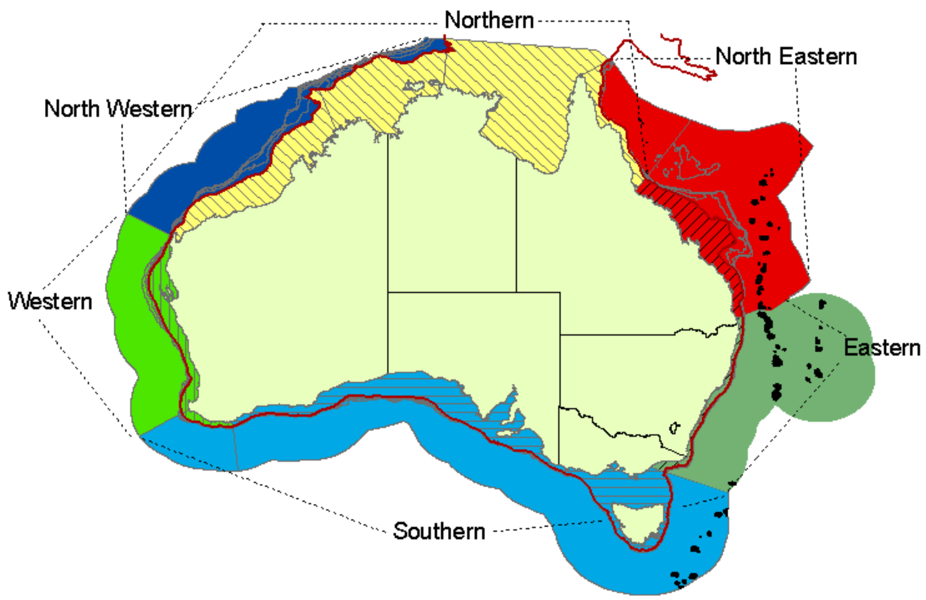


Figure 2.3 (a) Demersal communities around mainland Australia based on bioregionalisation schema [31]. Some inshore (0-110 m) communities comprise more than one community e.g. Timor Transition comprises 4 distinct communities. (b) Australian pelagic provinces. Hatched areas indicate coastal epipelagic zones overlying the shelf. Offshore (oceanic) provinces comprise two or more overlaying pelagic zones as indicated in Table 2.10. Seamounts (black) and plateaux (light green) are illustrated in their demersal or pelagic provinces.

2.2.3 Identification of objectives for components and sub-components (Step 3)

Objectives are identified for each sub-fishery for the five ecological components (target, bycatch/byproduct, protected species, habitats, and communities) and sub-components, and are clearly documented. It is important to identify objectives that managers, the fishing industry, and other stakeholders can agree on, and that scientists can quantify and assess. The criteria for selecting ecological operational objectives for risk assessment are that they:

- be biologically relevant;
- have an unambiguous operational definition;
- be accessible to prediction and measurement; and
- that the quantities they relate to be exposed to the hazards.

For fisheries that have completed Ecological Sustainable Development (ESD) reports, use can be made of the operational objectives stated in those reports.

Each 'operational objective' is matched to example indicators. **Scoping Document S3** provides suggested examples of operational objectives and indicators. Where operational objectives are already agreed for a fishery (Existing Management Objectives; EMOs), those should be used (e.g. Strategic Assessment Reports). The objectives need not be exactly specified, with regard to numbers or fractions of removal/impact, but should indicate that an impact in the sub-component is of concern/interest to the sub-fishery. The rationale for including or discarding an operational objective is a crucial part of the table and must explain why the particular objective has or has not been selected for in the (sub) fishery. Only the operational objectives selected for inclusion in the (sub) fishery are used for Level 1 analysis (**Level 1 SICA Document L1.1**).

Scoping Document S3. Components and sub-components identification of objectives

Table 2.9. Components and sub-components identification of operational objectives and rationale. Operational objectives that are eliminated are shaded out. EMO: Existing Management Objective; AMO: Existing AFMA Objective. Cells that are not relevant to this ERA are coloured in grey.

COMPONENT	CORE OBJECTIVE	SUB-COMPONENT	EXAMPLE OPERATIONAL OBJECTIVES	EXAMPLE INDICATORS	RATIONALE
	What is the general goal?		*"What you are specifically trying to achieve"?*	*"What you are going to use to measure performance?*	*Rationale flagged as 'EMO' where Existing Management Objective in place, or 'AMO' where there is an existing AFMA Management Objective in place for other Commonwealth fisheries (assumed that squid fishery will fall into line).*
Key Commercial and secondary commercial species	All objectives of the TSF Act are relevant: a) to acknowledge and protect the traditional way of life and livelihood of traditional inhabitants, including their rights in relation to traditional fishing[10]; b) to protect and preserve the marine environment and indigenous fauna and flora in and in the vicinity of the Protected Zone; c) to adopt conservation	1. Population size	1.1 No trend in biomass 1.2 Maintain biomass above a specified level 1.3 Maintain catch at specified level 1.4 Species do not approach extinction or become extinct	Biomass, numbers, density, CPUE, yield	1.1 Increases in biomass of the key/secondary commcerical species would be acceptable. 1.2. To ensure that population at acceptable level by the assessment. 1.3. TAC levels are specified. 1.4. Additional objectives with regards to this addressed by the EPBC Act – inc expectation for CITES listed species such as black and white teatfish. In general these objectives underlie the sustainable management of the Fishery.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across the known distribution range	2.1 this is monitored to a certain extent through a time series of fishery independent surveys.
		3. Genetic structure	3.1 Genetic diversity does not change outside	Frequency of genotypes in the population, effective	3.1 Studies of the genetic structure of Sandfish in the Northern Territory (NT) showed

[10] Traditional fishing means non-commercial fishing as defined in the TSF Act.

COMPONENT	CORE OBJECTIVE	SUB-COMPONENT	EXAMPLE OPERATIONAL OBJECTIVES	EXAMPLE INDICATORS	RATIONALE
	measures necessary for the conservation of a species in such a way as to minimise any restrictive effects of the measures on traditional fishing; d) to manage the fishery for optimum utilisation; e) to have regard, in developing and implementing licensing policy, to the desirability of promoting economic development in the Torres Strait area and employment opportunities for traditional inhabitants These management objectives can be grouped into the following objectives: Avoid recruitment failure of the key/secondary commcercial species Avoid negative consequences for species		acceptable bounds	population size (N_e), number of spawning units	two distinct populations occurring in the Arafura Sea and the Gulf of Carpentaria, with results also indicating limited larval dispersal [34]. Another study for Black teatfish on the Great Barrier Reef showed no significant genetic structure [35]. Given differences at a regional scale for the NT and little difference across the whole GBR, the genetic structure of sea cucumber species in Torres Strait is likely to be one stock.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Covered in general by 1.2. Overall, survey data show a healthy fishery with the potential to provide moderate long-term income to local Islander communities [4]
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) 5.2 Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 Covered by 1.2.Reproductive capacity in terms of egg production may be easier to monitor via changes in Age/size/sex structure. 5.2 Covered by 1.2. May be easier to monitor via changes in Age/size/sex structure in the fishery.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population	6.1. Changes behavior that are deleterious to the species and populations are to be avoided. Covered by 1.2.

COMPONENT	CORE OBJECTIVE	SUB-COMPONENT	EXAMPLE OPERATIONAL OBJECTIVES	EXAMPLE INDICATORS	RATIONALE
	or population sub-components			(e.g. attraction to lights)	
Byproduct and Bycatch	TSF Act objectives: a-c Avoid recruitment failure of the byproduct and bycatch species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Species do not approach extinction or become extinct 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 Increases in biomass of the key/secondary commcerical species would be acceptable. 1.2. To ensure that population at acceptable level by the assessment. 1.3. TAC levels are specified. 1.4. Maintaining bycatch / byproduct levels is not a specific objective but an indirect one related to TSF Act objective b.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space	2.1 Not currently monitored. No specific management objective based on the geographic range of byproduct/bycatch species. No specific management objective based on the geographic range of bycatch/byproduct species as no bycatch/byproduct in the fishery.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Not currently monitored. No reference levels established. No specific management objective based on the genetic structure of bycatch species. no bycatch/byproduct in the fishery.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1Not relevant to TSBDMF as no bycatch/byproduct in the fishery.

COMPONENT	CORE OBJECTIVE	SUB-COMPONENT	EXAMPLE OPERATIONAL OBJECTIVES	EXAMPLE INDICATORS	RATIONALE
		5 Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1. 1Not relevant to TSBDMF as no bycatch/byproduct in the fishery
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Not relevant to TSBDMF as no bycatch/byproduct in the fishery.
Protected species	TSF Act objectives: a-e Avoid recruitment failure of protected species Avoid negative consequences for protected species or population sub-components Avoid negative impacts on the population from fishing	1. Population size	1.1 Species do not further approach extinction or become extinct 1.2 No trend in biomass 1.3 Maintain biomass above a specified level 1.4 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	1.1 The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species. 1.2 A positive trend in biomass is desirable for protected species. 1.3 Maintenance of protected species biomass above specified levels not currently a fishery operational objective. 1.4 Not currently a fishery operational objective.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space, i.e. the Southern Ocean	2.1 Change in geographic range of protected species may have serious consequences e.g. population fragmentation and/or forcing species into sub-optimal areas.
		3. Genetic structure	3.1 Genetic diversity does not change outside	Frequency of genotypes in the population, effective population size	3.1 Because population size of protected species is often small, protected species are sensitive to loss of genetic diversity.

COMPONENT	CORE OBJECTIVE	SUB-COMPONENT	EXAMPLE OPERATIONAL OBJECTIVES	EXAMPLE INDICATORS	RATIONALE
			acceptable bounds	(N_e), number of spawning units	Genetic monitoring may be an effective approach to measure possible fishery impacts.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Monitoring the age/size/sex structure of protected species populations is a useful management tool allowing the identification of possible fishery impacts and that cross-section of the population most at risk.
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 The reproductive capacity of protected species is not of concern to this fishery because potential fishery induced changes in reproductive ability (e.g. reduction in prey items may critically affect seabird brooding success) may have immediate impact on the population size of protected species.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 BDM fishin operations are very unlikely to alter behaviour and movement patterns of protected species (Turtles and Dugongs) because boats are small, Dugongs are more frequent on the Western size (where fishery is minimal).
		7. Interactions with fishery	7.1 Survival after interactions is maximised 7.2 Interactions do not affect the viability of the population or its ability to recover	Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1, 7.2 The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species. Fishery is by hand collection, waste, and discards are minimal and not relevant to protected species of interest. Interactions with protected species are therefore minimal

COMPONENT	CORE OBJECTIVE	SUB-COMPONENT	EXAMPLE OPERATIONA L OBJECTIVES	EXAMPLE INDICATORS	RATIONALE
					and attraction of the vessel is null.
Habitats	TSF Act objectives: a-c Avoid negative impacts on quality of environment Avoid reduction in the amount and quality of habitat	1. Water quality	1.1 Water quality does not change outside acceptable bounds	Water chemistry, noise levels, debris levels, turbidity levels, pollutant concentrations, light pollution from artificial light	1.1 EMO control the discharge or discarding of waste and limit lighting on the vessels. MARPOL regulations prohibit discharge of oils, discarding of plastics.
		2. Air quality	2.1 Air quality does not change outside acceptable bounds	Air chemistry, noise levels, visual pollution, pollutant concentrations, light pollution from artificial light	2.1 Not currently perceived as an important habitat sub-component, seining operations not believed to strongly influence air quality.
		3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1 The scale of operation of the fishery is small, with boats <7m using outboard engines. Skippers would try as much as possible to minimise impacts on benthic habitats due to risk of damage to vessels. Accidental interaction with benthic habitats may occur but scale of impacts would be very small and localised.
		4. Habitat types	4.1 Relative abundance of habitat types does not vary outside acceptable bounds	Extent and area of habitat types, % cover, spatial pattern, landscape scale	4.1 Although sea cucumbers are hand collected and direct impacts of tis likely to be minimal, the fishing activity also involves walking over reef areas and snorkeling, which may result in changes to the local habitat types on fishing grounds.
		5. Habitat structure and function	5.1 Size, shape and condition of habitat types does not vary outside acceptable bounds	Size structure, species composition and morphology of biotic habitats	5.1 Although sea cucumbers are hand collected and direct impacts of tis likely to be minimal, the fishing activity also involves walking over reef areas and snorkeling, which may result in local disruption to benthic processes.

COMPONENT	CORE OBJECTIVE	SUB-COMPONENT	EXAMPLE OPERATIONAL OBJECTIVES	EXAMPLE INDICATORS	RATIONALE
Communities	TSF Act objectives: a-c Avoid negative impacts on the composition/ function/distribution/structure of the community	1. Species composition	1.1 Species composition of communities does not vary outside acceptable bounds	Species presence/absence, species numbers or biomass (relative or absolute) Richness Diversity indices Evenness indices	1.1 The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally.
		2. Functional group composition	2.1 Functional group composition does not change outside acceptable bounds	Number of functional groups, species per functional group (e.g. autotrophs, filter feeders, herbivores, omnivores, carnivores)	2.1 The presence/abundance of 'functional group' members may fluctuate widely, however in terms of maintenance of ecosystem processes it is important that the aggregate effect of a functional group is maintained.
		3. Distribution of the community	3.1 Community range does not vary outside acceptable bounds	Geographic range of the community, continuity of range, patchiness	3.1 Although sea cucumbers are hand collected and direct impacts of tis likely to be minimal, the fishing activity also involves walking over reef areas and snorkeling, which impacts on the benthos in the fishing grounds. The current MPA and conservation areas reserve large areas of the known habitat types from fishing disturbance.
		4. Trophic/size structure	4.1 Community size spectra/trophic structure does not vary outside acceptable bounds	Size spectra of the community Number of octaves, Biomass/number in each size class Mean trophic level Number of trophic levels	4.1 Fishing for key/secondary commercial species have the potential to remove a significant component of the detritivore functional group with unknown consequences in the food web and. other trophic groups.
		5. Bio- and geo-chemical cycles	5.1 Cycles do not vary outside acceptable bounds	Indicators of cycles, salinity, carbon, nitrogen, phosphorus flux	5.1 Sea cucumbers play an important role in nutrient recycling. Over-explitation of sea cucumbers is know to reduce nutrient recycling, thus affecting biogeochemical cycles.

2.2.4 Hazard Identification (Step 4)

Hazards are the activities undertaken in the process of fishing, and any external activities, which have the potential to lead to harm.

The effects of fishery/sub-fishery specific hazards are identified under the following categories:

- capture
- direct impact without capture
- addition/movement of biological material
- addition of non biological material
- disturbance of physical processes
- external hazards

These fishing and external activities are scored on a presence/absence basis for each fishery/sub-fishery. An activity is scored as a zero if it does not occur and as a one if it does occur. The rationale for the scoring is also documented in detail and must include if/how the activity occurs and how the hazard may impact on organisms/habitat.

Scoping Document S4. Hazard Identification Scoring Sheet

This table is completed once. Table 2.11 provides a set of examples of fishing activities for the effects of fishing to be used as a guide to assist in scoring the hazards.

Fishery name: Torres Strait Bêche-de-mer Fishery

Date completed: June 2021

Table 2.10. Hazard identification, score and rationale(s) for the Torres Strait Bêche-de-mer Fishery.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	SCORE (0/1)	DOCUMENTATION OF RATIONALE
Capture	Bait collection	0	Not required by this fishery method.
	Fishing	1	Most of the fishing occurs at the Great North East Channel, Don Cay, Darnley Island, Cumberland Channel and Great Barrier Reef regions, which maximum diagonal in the area is ~90NM so in the 10-100 miles range (3), but there may be occasional longer trips as the maximum diagonal for the whole fishing area is ~200NM so used (4) (100-500nm). In terms of temporal scale of fishing activity, the data from 2017-19 suggests this is a daily activity. Although there are overlapping fishing days among fishers s (i.e. total days fishing for the period (1558)/ yearly average (519) > 365 days), it seems fishing happens quite often. Therefore, we assume this is a 'daily' activity (score 6) and revise if additional temporal data is available.
	Incidental behaviour	1	Sea cucumbers are not used traditionally but are exported - traditional / subsistence fishing of non sea cucumber species may occur. For example, fishers may catch finfish or other species during BDM fishing trips for personal consumption (considered as traditional fishing).
	Bait collection	0	Does not occur

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	SCORE (0/1)	DOCUMENTATION OF RATIONALE
Direct impact without capture	Fishing	1	Fishing occurs mostly on coral reef shallow (0-10m) waters, resulting on impacts on benthic orghanisms via trampling or movement underwater.
	Incidental behaviour	1	Sea cucumbers are not used traditionally but are exported - traditional / subsistence fishing of non sea cucumber species may occur as fishers may catch some marine species for personal consumption or subsistence during BDM fishing trips (considered as traditional fishing).
	Gear loss	0	Species are harvested by hand.
	Anchoring/ mooring	1	Fishing involves the use of small (<7 m) boats operating at shallow waters (0-10). Anchors are therefore small and intensity of impacts is minor as restricted to areas where fishing is more intense but detectability is difficult due to small size of boats.
	Navigation/steaming	1	As fishing occurs in shallow coral reef areas (0-10 m), steaming/navigation to fishing grounds may result in collisions with benthos (e.g. seagrasses, sponges, coral reefs, macrolage) and species such as turtles and, to a lesser extent, dugongs (because they are mostly found on central and western parts of Torres Strait and fisheries occurs mostly on the East. intensity is negligible as boat skippers will try to avoid damage to hull of boats as much as possible and therefore, very difficult to detect at any scale.
Addition/ movement of biological material	Translocation of species	0	Translocation via hull and anchor fouling unlikely as boats operate locally within same fishery area and no aquaculutre in the region that could introduce new species.
	On board processing	0	No onboard processing. Fishers catch sea cucumbers alive and keep them in bilges, tanks or nally bins onboard until they can be processed at facilities.
	Discarding catch	1	Discarding is uncommon, mostly associated with autotomy (e.g. evisceration / falling apart) which makes it difficult to process.
	Stock enhancement	0	None occurs
	Provisioning	0	None occurs
	Organic waste disposal	1	Some food (uncontaminated) may be discharged into the sea while fishers are fishing, on camps, or in transit. MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits food waste if contaminated by any other garbage types.
Addition of non-biological material	Debris	0	MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits rubbish generated during general fishing vessel operations to be discharged at sea. Rubbish must be collected onboard and disposed of ashore. No evidence of disposal of marine debris found.
	Chemical pollution	1	MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits domestic and operational waste discharge from vessels. Leakage of substances such as fuel, oil, bilge discharges, natural decay of antifouling agents may occur in normal course of operations.
	Exhaust	1	Vessels introduce exhaust into the environment resulting in noise and impact air quality within shallow reef areas.
	Gear loss	0	No gear used for fishing sea cucumbers so accidental gear losses is extremely unlikely.
	Navigation/ steaming	1	Navigation to and from fishing grounds introduces noise and visual stimuli into the environment. Depth sounders have potential to disturb sea cucumbers and other species like corals, fish, dugongs and turtles.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	SCORE (0/1)	DOCUMENTATION OF RATIONALE
	Activity/ presence on water	1	Fishing for sea cucumbers involves diving in shallow waters. Vessels and divers introduce noise and visual stimuli in the environment which may result in changes in behaviour of sea cucumbers and interfere with biological processes of coral reef organisms, such as corals, fish and algae. Sea cucumbers can detect sound [36].
Disturb physical processes	Bait collection	0	Bait not required by fishery.
	Fishing	1	Fishing is by hand collection and involves diving and walking on coral reefs (lagoons, hard substrates and passes). Trampling and movement of hands / flippers underwater may disturb seabed sediments and break corals, and damage seagrass beds, sponges and algae.
	Boat launching	1	Some boats used in the fishery are stored on beaches / out of the water and dragged into the water when needed. Movement of the boat in and out of the water can break corals, and damage seagrass beds, sponges, algae and other benthic organisms.
	Anchoring/ mooring	0	Anchors used in the fishery are relatively small as used in boats <7 m long and unlikely to affect the physical processes in the area.
	Navigation/ steaming	1	Navigation /steaming may affect the physical processes on the benthos by turbulent action of propellers or wake formation on shallow waters. The fishery uses relative small (<7 m) boats and engines.
External Hazards	Other capture fishery methods	1	Other Torres Strait fisheries may operate on same fishing grounds (e.g. finfish, Rock Lobster). Fishers (divers), gear (e.g., line, hook, spearguns) and boat operation may accidentally interact with sea cucumbers.
	Aquaculture	0	None happening at this stage that would have any kind of impact on the TSBDMF due to the extremely low and localised nature of farms.
	Coastal development	1	Coastal development has caused localised pollution (e.g. oil spills, sewage contamination) in some Islands (e.g. Boigu, Iama), and caused increase in sediment runoff from coastal developments in the Fly river (Saibai, Dauan and Boigu). These impacts can affect coral reef and seagrass habitats via smothering, increased turbidity and reduction in light penetration. Sewage contamination can also facilitate growth of algae which may outcompete corals for space.
	Other extractive activities	0	No oil and gas extractive activities in Torres Strait.
	Other non-extractive activities	1	Major shipping activity in Torres Strait, which produce noise, which can affect sea cucumbers and coral reef organisms. There is also the potential leakage of contaminants from antifouling paints.
	Other anthropogenic activities	1	Charter boats can introduce noise and pollution (oil) into the environment. Oil contamination can negatively affect sea cucumbers directly and their habitats.

Table 2.11. Examples of fishing activities (modified from Fletcher et al. 2002).

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	EXAMPLES OF ACTIVITIES INCLUDE
Capture		Activities that result in the capture or removal of organisms. This includes cryptic mortality due to organisms being caught but dropping out prior to the gear's retrieval (i.e. They are caught but not landed).
	Bait collection	Capture of organisms due to bait gear deployment, retrieval and bait fishing. This includes organisms caught but not landed.
	Fishing	Capture of organisms due to gear deployment, retrieval and actual fishing. This includes organisms caught but not landed.
	Incidental behaviour	Capture of organisms due to crew behaviour incidental to primary fishing activities, possible in the crew's down time; e.g. crew may line or spear fish while anchored, or perform other harvesting activities, including any land-based harvesting that occurs when crew are camping in their down time.
Direct impact, without capture		This includes any activities that may result in direct impacts (damage or mortality) to organisms without actual capture.
	Bait collection	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with bait gear during deployment, retrieval and bait fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but aren't caught.
	Fishing	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with fishing gear during deployment, retrieval and fishing. This includes: damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but are not caught.
	Incidental behaviour	Direct impacts (damage or mortality) without capture, to organisms due to behaviour incidental to primary fishing activities, possibly in the crew's down time; e.g. the use of firearms on scavenging species, damage/mortality to organisms through contact with the gear that the crew use to fish during their down time. This does not include impacts on predator species of removing their prey through fishing.
	Gear loss	Direct impacts (damage or mortality), without capture on organisms due to gear that has been lost from the fishing boat. This includes damage/mortality to species when the lost gear contacts them or if species swallow the lost gear.
	Anchoring/ mooring	Direct impact (damage or mortality) that occurs and when anchoring or mooring. This includes damage/mortality due to physical contact of the anchor, chain or rope with organisms, e.g. An anchor damaging live coral.
	Navigation/ steaming	Direct impact (damage or mortality) without capture may occur while vessels are navigating or steaming. This includes collisions with marine organisms or birds.
Addition/ movement of biological material		Any activities that result in the addition or movement of biological material to the ecosystem of the fishery.
	Translocation of species (boat movements, reballasting)	The translocation and introduction of species to the area of the fishery, through transportation of any life stage. This transport can occur through movement on boat hulls or in ballast water as boats move throughout the fishery or from outside areas into the fishery.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	EXAMPLES OF ACTIVITIES INCLUDE
	On board processing	The discarding of unwanted sections of target after on board processing introduces or moves biological material, e.g. heading and gutting, retaining fins but discarding trunks.
	Discarding catch	The discarding of unwanted organisms from the catch can introduce or move biological material. This includes individuals of target and byproduct species due to damage (e.g. shark or marine mammal predation), size, high grading and catch limits. Also includes discarding of all non-retained bycatch species. This also includes discarding of catch resulting from incidental fishing by the crew. The discards could be alive or dead.
	Stock enhancement	The addition of larvae, juveniles or adults to the fishery or ecosystem to increase the stock or catches.
	Provisioning	The use of bait or berley in the fishery.
	Organic waste disposal	The disposal of organic wastes (e.g. food scraps, sewage) from the boats.
Addition of non-biological material		Any activities that result in non-biological material being added to the ecosystem of the fishery, this includes physical debris, chemicals (in the air and water), lost gear, noise and visual stimuli.
	Debris	Non-biological material may be introduced in the form of debris from fishing vessels or mother ships. This includes debris from the fishing process: e.g. cardboard thrown over from bait boxes, straps and netting bags lost. Debris from non-fishing activities can also contribute to this e.g. Crew rubbish – discarding plastics or other rubbish. Discarding at sea is regulated by MARPOL, which forbids the discarding of plastics.
	Chemical pollution	Chemicals can be introduced to water, sediment and atmosphere through: oil spills, detergents other cleaning agents, any chemicals used during processing or fishing activities.
	Exhaust	Exhaust can be introduced to the atmosphere and water through operation of fishing vessels.
	Gear loss	The loss of gear will result in the addition of non-biological material, this includes hooks, line, sinkers, nets, otter boards, light sticks, buoys etc.
	Navigation /steaming	The navigation and steaming of vessels will introduce noise and visual stimuli into the environment. Boat collisions and/or sinking of vessels. Echo-sounding may introduce noise that may disrupt some species (e.g. whales, orange roughy)
	Activity /presence on water	The activity or presence of fishing vessels on the water will noise and visual stimuli into the environment.
Disturb physical processes		Any activities that will disturb physical processes, particularly processes related to water movement or sediment and hard substrate (e.g. boulders, rocky reef) processes.
	Bait collection	Bait collection may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Fishing	Fishing activities may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	EXAMPLES OF ACTIVITIES INCLUDE
	Boat launching	Boat launching may disturb physical processes, particularly in the intertidal regions, if dredging is required, or the boats are dragged across substrate. This would also include foreshore impacts where fishers drive along beaches to reach fishing locations and launch boats. Impacts of boat launching that occurs within established marinas are outside the scope of this assessment.
	Anchoring /mooring	Anchoring/mooring may affect the physical processes in the area that anchors and anchor chains contact the seafloor.
	Navigation /steaming	Navigation /steaming may affect the physical processes on the benthos and the pelagic by turbulent action of propellers or wake formation.
External hazards		Any outside activities that will result in an impact on the component in the same location and period that the fishery operates. The particular activity as well as the mechanism for external hazards should be specified.
	Other capture fishery methods	Take or habitat impact by other commercial, indigenous or recreational fisheries operating in the same region as the fishery under examination.
	Aquaculture	Capture of feed species for aquaculture. Impacts of cages on the benthos in the region.
	Coastal development	Sewage discharge, ocean dumping, agricultural runoff.
	Other extractive activities	Oil and gas pipelines, drilling, seismic activity.
	Other non-extractive activities	Defense, shipping lanes, dumping of munitions, submarine cables.
	Other anthropogenic activities	Recreational activities, such as scuba diving leading to coral damage, power boats colliding with whales, dugongs, turtles. Shipping, oil spills.

2.2.5 Bibliography (Step 5)

All references used in the scoping assessment are included in the References section.

Key documents can be found on the PZJA web page at https://www.pzja.gov.au and include the following:

- The Harvest Strategy for the fishery outlines the species categories as at November 2019. https://www.pzja.gov.au/sites/default/files/bdm_harvest_strategy_adopted_nov_2019.pdf
- Sea cucumber surveys (2009)
- Bycatch Action Plans and implementation reports
- Bêche-de-mer catch watch reports: https://www.pzja.gov.au/fishery-catch-watch-reports
- Relevant legislation

Other publications that provided information include

- ABARES Fishery Status Reports [5]
- Assessment of the Torres Strait Bêche-de-mer fishery [37]
- The species i.d. guide [4], which also provides an indication of the relative value of these species: https://www.pzja.gov.au/sites/default/files/torres_strait_bdm_id_guide_2019_web_version.pdf

2.2.6 Decision rules to move to Level 1 (Step 6)

Any hazards that are identified at Step 4 Hazard Identification as occurring in the fishery are carried forward for analysis at Level 1. In this case, 19 out of 26 possible internal activities were identified as occurring in this fishery. Four external scenarios were also identified. Thus, a total of 23 activity-component scenarios will be considered at Level 1. This results in 69 (i.e., excluding bycatch, byproduct, and protected species x direct impact by capture activity) total scenarios (of 160 possible) to be developed and evaluated using the unit lists (key commercial/secondary, habitats, communities).

2.3 Level 1 Scale, Intensity and Consequence Analysis (SICA)

Level 1 aims to identify which hazards lead to a significant impact on any species, habitat or community. Analysis at Level 1 is for whole components (key/secondary commercial; bycatch and byproduct; protected species; habitat; and communities), not individual sub-components. Since Level 1 is used mainly as a rapid screening tool, a "worst case" approach is used to ensure that elements screened out as low risk (either activities or components) are genuinely low risk. Analysis at Level 1 for each component is accomplished by considering the most vulnerable sub-component and the most vulnerable unit of analysis (e.g. most vulnerable species, habitat type or community). This is known as credible scenario evaluation (Richard Stocklosa e-systems Pty Ltd (March 2003) Review of CSIRO Risk Assessment Methodology: ecological risk assessment for the effects of fishing) in conventional risk assessment. In addition, where judgments about risk are uncertain, the highest level of risk that is still regarded as plausible is chosen. For this reason, the measures of risk produced at Level 1 cannot be regarded as absolute.

At Level 1 each fishery/sub-fishery is assessed using a scale, intensity and consequence analysis (SICA). SICA is applied to the component as a whole by choosing the most vulnerable sub-component (linked to an operational objective) and most vulnerable unit of analysis. The rationale for these choices must be documented in detail. These steps are outlined below. Scale, intensity, and consequence analysis (SICA) consists of thirteen steps. The first ten steps are performed for each activity and component, and correspond to the columns of the SICA table. The final three steps summarise the results for each component.

Step1. Record the hazard identification score (absence (0) presence (1) scores) identified at Step 3 at the scoping level (Scoping Document S3) onto the SICA table

Step 2. Score spatial scale of the activity

Step 3. Score temporal scale of the activity

Step 4. Choose the sub-component most likely to be affected by activity

Step 5. Choose the most vulnerable unit of analysis for the component e.g. species, habitat type or community assemblage

Step 6. Select the most appropriate operational objective

Step 7. Score the intensity of the activity for that sub-component

Step 8. Score the consequence resulting from the intensity for that sub component

Step 9. Record confidence/uncertainty for the consequence scores

Step 10. Document rationale for each of the above steps

Step 11. Summary of SICA results

Step 12. Evaluation/discussion of Level 1

Step 13. Components to be examined at Level 2

2.3.1 Record the hazard identification score (absence (0) presence (1) scores) identified at step 3 in the scoping level onto the SICA Document (Step 1)

Record the hazard identification score absence (0) presence (1) identified at Step 3 at the scoping level onto the SICA sheet. A separate sheet will be required for each component (key/secondary commercial, bycatch and byproduct, and protected species, habitat and communities). Only those activities that scored a 1 (presence) will be analysed at Level 1.

2.3.2 Score spatial scale of activity (Step 2)

The greatest spatial extent must be used for determining the spatial scale score for each identified hazard. For example, if fishing (e.g. capture by longline) takes place within an area of 200 nm by 300 nm, then the spatial scale is scored as 4. The score is then recorded onto the SICA Document and the rationale documented.

Table 2.12. Spatial scale score of activity.

<1 NM	1-10 NM	10-100 NM	100-500 NM	500-1000 NM	>1000 NM
1	2	3	4	5	6

Maps and graphs may be used to supplement the information (e.g. sketches of the distribution of the activity relative to the distribution of the component) and additional notes describing the nature of the activity should be provided. The spatial scale score at Step 2 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to spatial scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column of the SICA spreadsheet.

2.3.3 Score temporal scale of activity (Step 3)

The highest frequency must be used for determining the temporal scale score for each identified hazard. If the fishing activity occurs daily, the temporal scale is scored as 6. If oil spillage occurs about once per year, then the temporal scale of that hazard scores a 3. The score is then recorded onto the SICA Document and the rationale documented.

Table 2.13. Temporal scale score of activity.

DECADAL (1 DAY EVERY 10 YEARS OR SO)	EVERY SEVERAL YEARS (1 DAY EVERY SEVERAL YEARS)	ANNUAL (1-100 DAYS PER YEAR)	QUARTERLY (100-200 DAYS PER YEAR)	WEEKLY (200-300 DAYS PER YEAR)	DAILY (300-365 DAYS PER YEAR)
1	2	3	4	5	6

It may be more logical for some activities to consider the aggregate number of days that an activity occurs. For example, if the activity “fishing” was undertaken by 10 boats during the same 150 days of the year, the score is 4. If the same 10 boats each spend 30 non-overlapping days fishing, the temporal scale of the activity is a sum of 300 days, indicating that a score of 6 is appropriate. In the case where the activity occurs over many days, but only every 10 years, the number of days by the number of years in the cycle is used to determine the score. For example, 100 days of an activity every 10 years averages to 10 days every year, so that a score of 3 is appropriate.

The temporal scale score at Step 3 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to temporal scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column.

2.3.4 Choose the sub-component most likely to be affected by activity (Step 4)

The most vulnerable sub-component must be used for analysis of each identified hazard. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity' combination, and recorded in the 'sub-component' column of the SICA Document. The justification is recorded in the rationale column.

2.3.5 Choose the unit of analysis most likely to be affected by activity and to have highest consequence score (Step 5)

The most vulnerable 'unit of analysis' (i.e. most vulnerable species, habitat type or community) must be used for analysis of each identified hazard. The species, habitats, or communities (depending on which component is being analysed) are selected from **Scoping Document S2 (A – C)**. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity' combination, and recorded in the 'unit of analysis' column of the SICA Document. The justification is recorded in the rationale column.

2.3.6 Select the most appropriate operational objective (Step 6)

To provide linkage between the SICA consequence score and the management objectives, the most appropriate operational objective for each sub-component is chosen. The most relevant operational objective code from **Scoping Document S3** is recorded in the 'operational objective' column in the SICA document. Note that SICA can only be performed on operational objectives agreed as important for the (sub) fishery during scoping and contained in **Scoping Document S3**. If the SICA process identifies reasons to include sub-components or operational objectives that were previously not included/eliminated then these sub-components or operational objectives must be re-instated.

2.3.7 Score the intensity of the activity for the component (Step 7)

The score for intensity of an activity considers the direct impacts in line with the categories shown in the conceptual model (Figure 1.2) (capture, direct impact without capture, addition/movement of biological material, addition of non-biological material, disturbance to physical processes, external hazards). The intensity of the activity is judged based on the scale of the activity, its nature and extent. Activities are scored as per intensity scores below.

Table 2.14. Intensity score of activity (modified from [38]).

LEVEL	SCORE	DESCRIPTION
Negligible	1	remote likelihood of detection at any spatial or temporal scale
Minor	2	occurs rarely or in few restricted locations and detectability even at these scales is rare
Moderate	3	moderate at broader spatial scale, or severe but local
Major	4	severe and occurs reasonably often at broad spatial scale
Severe	5	occasional but very severe and localized or less severe but widespread and frequent
Catastrophic	6	local to regional severity or continual and widespread

This score is then recorded on the **Level 1 (SICA) Document** and the rationale documented.

2.3.8 Score the consequence of intensity for that component (Step 8)

The consequence of the activity is a measure of the likelihood of not achieving the operational objective for the selected sub-component and unit of analysis. It considers the flow on effects of the direct impacts from Step 7 for the relevant indicator (e.g. decline in biomass below the selected threshold due to direct capture). Activities are scored as per consequence scores defined below. A more detailed description of the consequences at each level for each component (key/secondary commercial, bycatch and byproduct, protected species, habitats, and communities) is provided as a guide for scoring the consequences of the activities in the description of consequences table (Table 2.15).

Table 2.15. Consequence score for ERAEF activities (modified from [38]).

LEVEL	SCORE	DESCRIPTION
Negligible	1	Impact unlikely to be detectable at the scale of the stock/habitat/community
Minor	2	Minimal impact on stock/habitat/community structure or dynamics
Moderate	3	Maximum impact that still meets an objective (e.g. sustainable level of impact such as full exploitation rate for a target species)
Major	4	Wider and longer term impacts (e.g. long-term decline in CPUE)
Severe	5	Very serious impacts now occurring, with relatively long time period likely to be needed to restore to an acceptable level (e.g. serious decline in spawning biomass limiting population increase)
Intolerable	6	Widespread and permanent/irreversible damage or loss will occur-unlikely to ever be fixed (e.g. extinction)

The score should be based on existing information and/or the expertise of the risk assessment group. The rationale for assigning each consequence score must be documented. The conceptual model may be used to link impact to consequence by showing the pathway that was considered. In the absence of agreement or information, the highest score (worst case scenario) considered plausible is applied to the activity.

2.3.9 Record confidence/uncertainty for the consequence scores (Step 9)

The information used at this level is qualitative and each step is based on expert (fishers, managers, conservationists, scientists) judgment. The confidence rating for the consequence score is rated as 1 (low confidence) or 2 (high confidence) for the activity/component. The score is recorded on the SICA Document and the rationale documented. The confidence will reflect the levels of uncertainty for each score at steps 2, 3, 7 and 8 (see description; Table 2.16).

Table 2.16. Description of Confidence scores for Consequences. The confidence score appropriate to the rationale is used, and documented on the SICA Document.

CONFIDENCE	SCORE	RATIONALE FOR THE CONFIDENCE SCORE
Low	1	Data exists, but is considered poor or conflicting
		No data exists
		Disagreement between experts
High	2	Data exists and is considered sound
		Consensus between experts
		Consequence is constrained by logical consideration

2.3.10 Document rationale for each of the above steps (Step 10)

The rationale forms a logical pathway to the consequence score. It is provided for each choice at each step of the SICA analysis.

SICA steps 1-10. Tables of descriptions of consequences for each component and each sub component provide a guide for scoring the level of consequence (see Table above)

Level 1 (SICA) Document L1.1 Key commercial/secondary commercial species.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Capture	Bait collection	0									
	Fishing	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	3	2	2	Removal of sea cucumbers will affect population size. Catches for Prickly redfish have increased during the assessment period. Catch data shows that Prickly redfish is the species mostly caught (37% for the period between 2016-2020) in the fishery. The 2019 survey data for Prickly redfish [4] indicate a possible fishing decline compared to the previous survey in 2009, with some fishers reporting declining catch rates, which can indicate localised overfishing). However, survey estimates suggest that current catch limits are sustainable. Intensity: moderate, as can be severe but local which increased catches during the assessment period (e.g. from about 11 t in 2016 to about 15 t in 2020). Consequence:minor as has caused minimal impact (sustainable catches) on the species Confidence: high, as survey data gives us strong confidence on score.
	Incidental behaviour	1	4	6	Population size	Prickly redfish	1.2	1	1	2	Incidental behaviour (traditional / subsistence fishing) of non sea cucumber species may occur. For example, fishers may catch finfish or other species during BDM fishing trips for personal consumption (considered as traditional fishing) [12]. Spatial and

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						(*Thelenota ananas*)					temporal scales are similar for fishing activity (see comments on 'fishing' above). Intensity: negligible as unlikely to be detected at any spatial or temporal scale as subsistence catches are low due to small size of boats and number of fishers (boats <7 m with 2-3 fishers). Consequence: negligible, as unlikely to be detectable at the scale of the stock. Confidence: high, via logical consideration.
Direct impact without capture	Bait collection	0									
	Fishing	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	2	1	2	Fishing for Prickly redfish occurs on coral reef lagoons, reef edge and passes at depths <10 m. Trampling and free diving may break or damage corals and other benthic orgnisms. Intensity: minor, as occurs in few restricted locations where fishing occurs more frequently. Consequence: negligible, as very difficult to be detected at the scale of the stock. Confidence: high via logical consideration.
	Incidental behaviour	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	1	1	2	Incidental behaviour (catch of traditional / subsistence species while fishing for sea cucumbers) may affect benthic species (corals, sponges, seagrass and algae) via trampling or free diving (e.g. flippers). This may occur in a few restricted locations where fishers may catch for subsistence while they fish for sea cucumbers. Intensity: negligible, as unlikely to be detected at any spatial or temporal scale as subsistence catches are low due to small size of boats and number of fishers (boats <7 m with 2-3 fishers). Consequence: negligible, as unlikely to be detectable at the scale of the stock. Confidence: high via logical consideration.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Gear loss	0									
	Anchoring/ mooring	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	2	1	2	Anchoring / mooring may break, kill or damage sponges, corals, seagrasses and other benthic species. Intensity is negligible as this impact can occur in specific locations where fishing activity is high but difficult to be detected due to size of anchors/moorings required for 7 m long boats. Consequence: negligilble, as impact is unlikely to be detected at the scale of the stock. Confidence: high via logical consideration.
	Navigation/ steaming	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	1	1	1	Navigation to and from fishing grounds introduces noise and visual stimuli into the environment. Depth sounders also emit sound, which can disturb sea cucumbers as they are able to detect noise [36]. The fishery uses small boats with outboard engines, which are equipped with depth sounders and one of the fishing techniques includes towing fishers in search of sea cucumbers, producing noise. Intensity: minor, as impacts are restricted to some fishing grounds and are difficult to detect. Consequence: negligible, because it is very difficult to detect. Confidence: low as little is known about impacts of noise on sea cucumbers.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Discarding catch	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.1	1	1	2	Discarding is uncommon, mostly associated with autotomy (e.g. evisceration / falling apart) which makes it difficult to process. Spatial and temporal scales are similar for fishing activity (see comments on 'fishing' above). Intensity and consequence are negligible as impacts of discards are very difficult to detect at any scale because it is uncommon. Confidence is high via logical consideration.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.1	1	1	2	Some food (uncontaminated) may be discharged into the sea while fishers are fishing, on camps, or in transit. MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits food waste if contaminated by any other garbage types. As a detritivorous species, prickly redfish can benefit from disposal of uncontaminated food into the sea. Spatial and temporal scales are similar for fishing activity (see comments on 'fishing' above). Intensity: negligible, as impacts of discharge of food scraps are very difficult to detect at any scale because of scale of operations (small boat <7m long and 2-3 crew). The consequence is also negligible as very difficult to detect. Confidence: high, via logical consideration.
	Debris	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Addition of non-biological material	Chemical pollution	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	4.1	2	1	1	Leakage of substances such as fuel, oil, bilge discharges, natural decay of antifouling agents may occur in normal course of fishing operations. For example, oil and fuel leakages from engines and accidental spills during refuelling operations may occur. Given small size of boats (and engines) operating in the fishery discharges and accidental leaks likely disperse relatively fast and impact on fishery is difficult to detect. Intensity:minor, as can occur at specific locations such as refuelling ports on Islands. Consequence: negligible as very difficult to detect at the scale of the stock. Confidence: low, due to lack of data on contamination and impacts on species in Torres Strait.
	Exhaust	1	4	6	Behaviour / movement	Prickly redfish (*Thelenota ananas*)	6.1	1	1	1	Vessels introduce exhaust into the environment resulting in noise and impact air quality within shallow reef areas. There is some evidence (from laboratory studies) that sea cucumbers can distinguish the pitch of sound [36] and may move in response to noise. Intensity: negligible, as the lieklihood of detection is very small given size of boats. Consequence:negligible as impact unlikely to be detectable at the scale of the stock. Confidence:low, as study was done in the laboratry using a species that does not occur in the Torres Strait (*Apostichopus japonicus*). Little is known about impacts of sound on sea cucumbers.
	Gear loss	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Navigation/ steaming	1	4	6	Behaviour / movement	Prickly redfish (*Thelenota ananas*)	6.1	2	1	1	Navigation to and from fishing grounds introduces noise and visual stimuli into the environment. The fishery uses small boats with outboard engines that are equipped with depth sounders, producing noise; one of the fishing techniques include towing fishers in search of sea cucumbers. Sea cucumbers can distinguish the pitch of sound and as a result can respond to noise [36]. Intensity: minor as impacts are restricted to some fishing grounds and difficult to detect. Consequence:negligible, as impact unlikely to be detectable at the scale of the stock. Confidence: low, as little is known about impacts of sound on the behaviour/movement of sea cucumbers. The study was done in the laboratory using a species that does not occur in Torres Strait (*Apostichopus japonicus*).
	Activity/ presence on water	1	4	6	Behaviour / movement	Prickly redfish (*Thelenota ananas*)	6.1	2	1	2	Fishing for sea cucumbers involves diving in shallow waters. Vessels and divers introduce may visual stimulli in the environment which may result in changes in behaviour. Intensity: minor, as impacts are restricted to some fishing grounds and difficult to detect. Consequence: negligible, as impact unlikely to be detectable at the scale of the stock. Confidence: high via logical consideration, as scale of activity (i.e. number of divers) is low and any visual impacts most likely to be very minimal.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	6	Population size	Prickly redfish	1.2	2	1	2	Fishing involves diving and walking on coral reef areas (lagoons, hard substrates and passes). Trampling and movement of hands

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						(*Thelenota ananas*)					/ flippers underwater may disturb and resuspend seabed sediments. Intensity: minor, as this occurs in few restricted locations where fishing is more intense. Consequence: negligible, as the scale of impact is quite small (2-3 fishers per boat <7 m) and detectability is very difficult and impact is unlikely to be detectable at scale of the stock [1]. Confidence: high, via logical consideration.
	Boat launching	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	2	1	2	Some boats used in the fishery are stored on beaches / out of the water and dragged into the water when needed. Movement of the boat in and out of the water can affect sea cucumbers directly as they move very slowly. Intensity: minor, as this impact occurs at specific locations and is difficult to detect. Consequence: negligible, as the impact of boat launching on sea cucumbers are very difficult to detect. Confidence: high, via logical consideration.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	6	Behaviour / movement	Prickly redfish (*Thelenota ananas*)	6.1	1	1	2	Navigation /steaming may affect the physical processes on the benthos by turbulent action of propellers or wake formation resulting in sea cucumbers moving to other places. Intensity: negligible, as the fishery uses relative small (<7 m) boats and engines and impacts are unlikely to be detectable at any scale. Consequence: negligible, as unlikely to be detectable at the scale of the stock. Confidence: high, via logical consideration - boats are relatively small.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
External Impacts	Other fisheries (TS-Rock lobster; TS-finfish)	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	1	1	2	Other Torres Strait fisheries may operate on same fishing grounds (e.g. finfish, Rock Lobster). Fishers (divers), gear (.e.g line, hook, spearguns) and boat operation may accidentally interact with sea cucumbers. Intensity: negligible, as unlikely to be detectable at any scale. Consequence: negligible: impact is very difficult to detect at the scale of the stock. Confidence: high, via logical consideration - interaction with other fisheries are unlikely.
	Aquaculture	0									
	Coastal development	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	3	2	1	Localised pollution (e.g. oil spills, sewage contamination) in some Islands at boat ramps and ports (Boigu, Iama), as well as sediment runoff from coastal developments in the Fly river (Saibai, Dauan and Boigu) [39] could affect sea cucumbers directly and also their habitats (i.e. cause declines on corals, and impact seagrasses, sponges and algae). These impacts are localised and although inside the sea cucumber fishery, these Islands are not inside the zones of high fishing effort. Intensity: moderate as can be severe at Islands. Consequence: minor, as likely to cause minimal impacts to the stock due to scale of impacts. Confidence: low, as no data about effects of sewage and sediment runoff on sea cucumbers in Torres Strait is available.
	Other extractive activities	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Other non extractive activities	1	4	6	Behaviour/ movement	Prickly redfish (*Thelenota ananas*)	6.1	1	1	1	Major shipping activity occurs in Torres Strait which produces noise, that can affect sea cucumbers as they can detect sound [36]. Intensity: negligible, as impacts are very difficult to detect. Consequence: negligible as very difficult to detect at the scale of the stock. Confidence: low as no data on impacts of noise on sea cucumbers found in Torres Strait (especially Prickly redfish).
	Other anthropogenic activities	1	4	6	Population size	Prickly redfish (*Thelenota ananas*)	1.2	2	2	1	Charter boats can introduce noise and pollution (oil) into the environment. Oil contamination can negatively affect sea cucumber populations and decline spawning biomass. There is evidence (from elsewhere in the world) of absence of sea cucumbers in benthic communities after impacted by oil spills (see deepwater horizon oil spill). Intensity: minor, restricted to boat loading facilities [39]. Consequence: minor, as causes minimal impacts on sea cucumbers close to boat loading facilities. Confidence: low, as no data on effects of noise / oil pollution (and recovery time from impacts) on the population size of this species exist for Torres Strait.

Level 1 (SICA) Document L1.4 - Habitat Component (demersal)

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Capture	Bait collection	0									
	Fishing	1	4	6	Habitat structure and function	Reef flat	5.1	3	2	1	Fishing for Bêche-de-mer in the Torres Strait is by hand collection, mainly by free diving from dinghies crewed by two or three fishers at depths < 10 m, or by walking along reef tops and edges at low tide. Most damage should occur while walking on reef top although snorkeling can also damage or break corals, algae, sponges and other benthic species associated with coral reefs as a result of fishing. Intensity: moderate with localised impacts. Consequence: minor, as regeneration of corals may take between months to years but area of impact is relatively small. Confidence: low because it is not known what proportion of the vulnerable habitat types are damaged, and recovery time is not known.
	Incidental behaviour	1	4	6	Habitat structure and function	Reef flat	5.1	1	2	1	Fishers may catch other species for traditional / subsistence purposes while fishing for BDM (considered as traditional fishing) [12].This may involve fishing from the boat with hand line or opportunistic catch by hand. Intensity: negligible, as very difficult to detect the impact at any scale (scale of impact is liley to be small and unliley to be detactable). Consequence: minor as likely to have miminal impact on the habitat structure and

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											function. Corals and other invertebrates may take months to years to recover but scale of impact is relatively small as concentrated in some areas. Confidence: low, as the exact proportion of vulnerable damaged habitat and recovery time are both unknown.
Direct impact without capture	Bait collection	0									
	Fishing	1	4	6	Habitat structure and function	Reef flat	5.1	2	2	1	Fishing for Bêche-de-mer in the Torres Strait is by hand collection, mainly by free diving from dinghies crewed by two or three fishers at depths < 10 m, or by walking along reef tops and edges at low tide. Damage or breakage of corals, algae, sponges and other coral reef species may occur even without capture. Intensity: minor with localised impacts that are difficult to detect. Consequence: minor due to minimal impact on stock because area of impact is relatively small although regeneration of corals may take between months to years. Confidence: low because it is not known what proportion of the vulnerable habitat types are damaged, and recovery time is not known.
	Incidental behaviour	1	4	6	Habitat structure and function	Reef flat	5.1	1	1	1	Incidental behaviour (catch of traditional / subsistence species while fishing for sea cucumbers) may affect benthic species such as corals, sponges, seagrass and algae, which are most abundant on the reef flat habitat, via trampling or free diving (e.g. flippers and hands breaking reef structures). Intensity: negligible as remote likelihood of detection of impact at any spatial or temporal scale as subsistence catches are low due to small size of boats and number of fishers (boats <7m with 2-3 fishers).

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											Consequence: negligible, as impact on stock unlikely to be detectable. Confidence: low, because the recovery time after impact is unknown.
	Gear loss	0									
	Anchoring/ mooring	1	4	6	Habitat structure and function	Reef flat	5.1	2	2	1	Anchoring on lagoons and reef flat may break corals, damage gardens of sponges, soft corals alge and seagrasses. Although anchors and moorings required for the boats used in the fishery are relatively small (boats are less than 7 m long), it can cause localised impacts. Intensity: minor as occurs in a few locations and detectability is difficult due to small size of anchors. Consequence: minor, as it can cause small impacts on specific locations on the reef or seagrass areas. Confidence: low because recovery time is unknown.
	Navigation/ steaming	1	4	6	Habitat structure and function	Reef flat	5.1	1	1	2	Fishing often occurs close to coral reefs in shallow waters and there is a risk of accidental strikes of hull and properller to corals, soft corals, sponges and other reef organisms. Intensity: negligible as although it can happen, skippers will try to avoid this as much as possible to maintain boat and there is a remote likelihood of detection at any scale. Consequence: negligible because such impacts are unlikely to be detectable at the scale of the habitat. Confidence: high, logical considerations given size of boats and scale of habitat.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	6	Substrate quality	Reef flat	3.1	1	1	2	Discarding occurs rarely in the fishery mostly due to autotomy (evisceration). Scavengers would quickly take up discarded species causing bioturbation but any impacts unlikely to be detectable beause of small amount of discards that would be quickly consumed by fish and scavengers and dispersed. Intensity: negligible because discards are rare and there is a remote likelihood of detection at any scale. Consequence: negligible because unlikely to be detectable at the scale of the habitat. Confidence: high via logical consideration as reported discards are low.
	Stock enhancement	0									
	Provisioning	0									
	Organic waste disposal	1	4	6	Water quality	Reef flat	1.1	1	1	2	Discharge of organic waste (e.g. uncontaminated food waste) likely to occur daily although relatively small amounts because of scale of operation (2-3 fishers / small boat). Intensity: negligible as very small amounts disposed. Consequence: negligible, volume likely to be small and quickly dispersed through the water column. Confidence: high via logical

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											consideration as increases in nutrient not expected to adversely affect water column.
Addition of non-biological material	Debris	0									
	Chemical pollution	1	4	6	Water quality	Forereef zone	1.1	2	2	2	Small amounts of fuel may spill/leak during refuelling as boats use outboard engines. Oil contamination likely to impact sensitive coral species which are more abundant on forereef zone. Spills are likely small due to size of boats and amount of fuel that can be carried, but can cause death and affect growth and reproduction of corals [40]. Intensity: minor, as restricted to some locations and difficult to detect. Consequence: minor, as can cause minimal impacts on habitat. Confidence: low, as data on impacts and recovery times do not exist for Torres Strait.
	Exhaust	1	4	6	Air quality	Reef flat	2.1	1	1	2	Exhaust from running engines may impact the air quality within shallow areas fo the reef flat. Intensity: negligible because although the hazard occurs over a larger range/scale, impact area is only within metres of the vessel. Consequence: negligible, due to rapid dispersal of pollutants in winds, and likely to be physically undetectable over very short time frames. Confidence: high, via logical consideration because effect of exhaust was considered to be very localised.
	Gear loss	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Navigation/ steaming	1	4	6	Water quality	Reef flat	1.1	2	1	2	Steaming/navigation to fishing grounds may result in disruption of water quality from introduction noise, light and changes to water chemistry or turbidity due to boats navigating at shallow waters. Intensity: minor, as localised and difficult to detect due to size of boats. Consequence: negligible, impacts unlikely to be detectable at the scale of the habitat. Confidence: high, logical consideration.
	Activity/ presence on water	1	4	6	Water quality	Forereef zone	1.1	2	2	1	Boats and divers can introduce noise into the environment. Boat noise can interfere with the biological processes of coral reef organisms, such as corals and fish [41]. This may occur in specific locations where boat traffic is more intense but very difficult to be detected given the scale of the operations (boats < 7 m). Consequence: minor, as can cause minimal localised impact on areas of heavy boat traffic. Confidence: low, because of lack of data and knowledge about noise pollution on corals in Torres Strait.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	6	Water quality	Reef flat	1.1	2	1	2	Fishing involves diving and walking on coral reef areas (lagoons, hard substrates and passes). Trampling and movement of hands / flippers underwater may disturb and resuspend seabed sediments, smothering corals and obliterating light, affecting corals and seagrasses. This occurs in few restricted locations where fishing is more intense, but still the scale is quite small (2-3 fishers per boat <7m). Intensity: minor, as impacts are localised and difficult to detect [2]. Consequence: negligible, due

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											to scale of impacts on habitat (unlikely to be detectable at the scale of the habitat). Confidence: high, based on logical consideration.
	Boat launching	1	4	6	Habitat structure and function	Shallow Reef flat	5.1	2	2	2	Vessels in fishery are small (<7m) and some may be stored on beaches / out of the water and dragged into the water when needed. Movement of the boat in and out of the water can break corals, damage seagrass beds, sponges, algae and other benthic organisms on the shallow Reef flat. Intensity: minor, as impact happens at specific locations. Consequence: minor, as impacts are minimal, constrained to specific locations. Confidence: high via logical conseideration.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	6	Water quality	Reef flat	1.1	1	1	2	Navigation /steaming may affect the physical processes on the benthos by turbulent action of propellers or wake formation as boats move on shallow areas in the Reef flat, causing sedimentat re-suspension and increase turbidity, which can negatively affect species like corals and seagrasses. Intensity: negligible as the fishery uses relative small (<7m) boats and engines, so impacts are very difficult to detect at any scale. Consequence: negligible as unlikely to be detectable at the scale of the habitat. Confidence: high, via logical consideration - scale of boats is relatively small.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
External Impacts	Other fisheries (Torres Strait Tropical Rock Lobster; Torres Strait finfish)	1	4	6	Habitat type, structure and function	Forereef zone	5.1	1	2	2	Other Torres Strait fisheries, including traditional, may operate on same fishing grounds (e.g. finfish, Rock Lobster). Fishers (divers), gear (.e.g line, hook, spearguns) and boat operation may accidentally interact with coral reef habitats. Intensity: negligible, as this happens at very specific locations and impacts are very difficult to detect. Consequence: minor, as minimal impact on habitat. Confidence: high, via logical consideration.
	Aquaculture	0									
	Coastal development	1	4	6	Water quality, substrate quality	Forereef zone	1.1, 3.1	3	2	1	Localised pollution (e.g. oil spills, sewage contamination) in some Islands at boat ramps and ports (Boigu, L (?) ama), as well as sediment runoff from coastal developments in the Fly river (Saibai, Dauan and Boigu) [39] could affect nearby coral reef and seagrass habitats via smothering, increased turbidity and reduction in light penetration [25]. Sewage contamination can also facilitate growth of algae which may outcompete corals for space. Intensity: moderate, as can be severe at specific locations (islands). Consequence: minor, as impacts are restricted to some islands. Confidence: low, due to impacts from Fly river are poorly understood and lack of data on water quality issues and recovery times [42, 43].
	Other extractive activities	0									
	Other non extractive activities	1	4	6	Water quality	Forereef zone	1.1	1	1	1	Major shipping activity in Torres Strait, produce noise and potential leakage of contaminants (oil, chemicals). Intensity: minor, as restricted to shipping lanes. Consequence: negligible,

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											as impacts are very difficult to detect. Confidence: low, due to little information on effects of shipping in the region.
	Other anthropogenic activities	1	4	6	Water quality	Reef flat; Forereef zone	1.1	2	1	1	Charter boats can introduce noise and pollution (oil) into the environment. Oil contamination can negatively affect reef flat, forereef zone and seagrass habitats. Intensity: minor, restricted to boat loading facilities in some islands [39]. Consequence: negligible, as unlikely to be detectable at scale of the stock. Confidence:low, as no data exists on impacts and recovery times in the region.

Level 1 (SICA) Document L1.5 - Community Component.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Capture	Bait collection	0									
	Fishing	1	4	6	Species composition	Reef communities at Northeastern Transition	1.1	3	2	1	The removal of sea cucumbers can reduce the capacity of sediments to buffer organic matter pulses, impeding the function and productivity of shallow coastal ecosystems **[44]**. Intensity: moderate with localised impacts (e.g. Prickly redfish). Consequence: minor, as area of impact is relatively small. Confidence: low, because recovery time to rebuild population is unknown.
	Incidental behaviour	1	4	6	Species composition	Reef communities at Northeastern Transition	1.1	1	2	1	Fishers may catch other species for traditional / subsistence purposes while fishing for BDM (considered as traditional fishing)**[12]**. This may involve fishing from the boat with hand line, spearfishing or opportunistic catch by hand, which may affect species composition and abundance. Intensity: negligible, as very difficult to detect the impact at any scale due to scale of operations. Consequence: minor, as minimal impacts on corals and other invertebrates scale of impact is relatively small, but it may take months to years to recover. Confidence: low as we don't know exactly the proportion of the vulnerable communities damaged and recovery times.
	Bait collection	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Direct impact without capture	Fishing	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	2	2	1	Direct hand collection therefore no post-capture mortality but possible some cucumbers are handled for identification before rejection. Intensity: minor and difficult to detect. Consequence: minor. Confidence: low, because the proportion of the vulnerable damaged community types , and recovery time are unknown.
	Incidental behaviour	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	1	2	1	Fishers may catch other species for traditional / subsistence purposes while fishing for BDM (considered as traditional fishing) **[12]**. This may involve fishing from the boat with hand line, spearfishing or opportunistic catch by hand, which may affect species composition and abundance. Intensity: negligible, as very difficult to detect the impact at any scale due to scale of operations. Consequence: minor, as minimal impacts on corals and other invertebrates scale of impact is relatively small, but it may take months to years to recover. Confidence: low, because the proportion of the vulnerable damaged community types , and recovery time are unknown.
	Gear loss	0									
	Anchoring/ mooring	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	2	2	1	Anchoring on lagoons and reef flat may damage benthic sessile communities (e.g. crinoids, sea cucumbers, crabs, seastars) causing changes in species composition and abundance with potential impact on food chains. Anchors used on boats in the fishery are relatively small and cause relatively small damage. Intensity: minor, as occurs in a few locations and detectability is difficult due to small size of anchors. Consequence: minor, as it can cause small impacts

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											on specific locations. Confidence: low, because recovery time after impact is unknown.
	Navigation/ steaming	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	1	1	2	Fishing often occurs close to coral reefs in shallow waters and there is a risk of accidental strikes of hull and properller on benthic communities (e.g. crinoids, sea cucumbers, crabs, seastars) causing changes in species composition and abundance with potential impact on food chains. Intensity: negligible as remote likelihood of detection. Consequence: negligible because impact is very difficult to detect at the scale of communities. Confidence: high, logical considerations given size of boats and scale of habitat.
Addition/ movement of biological material	Translocation of species	0									
	On board processing	0									
	Discarding catch	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	1	1	2	Discarding occurs rarely in the fishery mostly due to autotomy (evisceration). Scavengers would quickly take up discarded species causing bioturbation which can affect filter feeders and species that depend on light (e.g. corals and seagrass). Intensity: negligible because discards are rare. Consequence: negligible because unlikely to be detectable at the scale of the habitat. Confidence: high, via logical considerations and reported discards are low.
	Stock enhancement	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Provisioning	0									
	Organic waste disposal	1	4	6	Functional group composition	Reef communities in Northeastern Transition	2.1	1	1	2	Some food (uncontaminated) may be discharged into the sea while fishers are fishing, on camps, or in transit. If uncontaminated, food wastes may be discharged into the sea while the fishing vessel is in transit, if the waste is discharged subject to location-specific conditions. MARPOL regulations via Protection of the Sea (Prevention of Pollution from Ships) Act 1983 prohibits food waste if contaminated by any other garbage types. Discharge of organic waste (e.g. uncontaminated food waste) likely to occur daily although relatively small amounts because of scale of operation (2-3 fishers / small boat). Intensity: can benefit grazers such as sea urchins via increase in organic matter with associated increase in algae cover. Intensity: negligible, as very small amounts disposed due to scale of operations. Consequence: negligible, volume likely to be small and quickly dispersed through the water column. Confidence: high via logical considerations - little disposal of organic matter with negligible increases in nutrient in the water column.
Addition of non-biological material	Debris	0									
	Chemical pollution	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	2	2	2	Small amounts of fuel may spill/leak during refuelling as boats use outboard engines. Oil contamination likely to impact mobile benthic and demersal species. Spills are likely small due to size of boats and amount of fuel that can be carried, but can cause death and affect growth and reproduction of organisms **[40]**. Intensity:minor as

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											restricted to some locations and difficult to detect. Consequence: minor, as can cause minimal impacts on communities at specific locations. Confidence:high, given scale of fishing operation and no reports of major leaks in the region.
	Exhaust	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	1	1	2	Exhaust from running engines cause noise and pollution especially in shallow areas of the reef flat and forereef zone. Intensity: negligible because although the hazard occurs over a larger range/scale, impact area is only within metres of the vessel. Consequence: negligible due to rapid dispersal of pollutants in winds, and likely to be physically undetectable over very short time frames. Confidence: high, via logical consideration because effect of exhaust is considered to be very localised.
	Gear loss	0									
	Navigation/ steaming	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	2	1	1	Steaming/navigation to fishing grounds may result in disruption of water quality from introduction noise, light and changes to water chemistry or turbidity due to boats navigating at shallow waters. This can cause negative impacts on fish and invertebrates **[41, 45]**. Intensity: minor, as localised and difficult to detect due to size of boats and associated impact. Consequence: negligible because it is unlikely that this impact would be detectable on communities at reef flat or forereef zone. Confidence: low as little is know about impacts of noise and changes in water quality on benthic

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											communities in Torres Strait. Also, litttle is known about recovery times after impacts.
	Activity/ presence on water	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	2	2	1	Boats and divers can introduce noise into the environment. Boat noise can interfere with the biological processes of coral reef organisms, such as corals and reef fish **[41]**. This is may happen in specific locations where boat traffic is higher but very difficult to be detected given the scale of the operations (boats < 7m). Consequence: minor, as can cause minimal localised impact on areas of heavy boat traffic. Confidence: low, as little is known about long-term effects of noise pollution on coral reef communities.
Disturb physical processes	Bait collection	0									
	Fishing	1	4	6	Species composition	Reef communities -in Northeastern Transition	1.1	2	1	2	Fishing involves diving and walking on coral reef areas (lagoons, hard substrates and passes). Trampling and movement of hands / flippers underwater may disturb habitats and resuspend seabed sediments while fishing. This occurs in few restricted locations where fishing is more intense, but the scale of fishing operation is quite small (2-3 fishers per boat <7m). Intensity: minor, as impacts are localised and difficult to detect [2]. Consequence: negligible, due to scale of impacts on habitat (unlikely to be detectable at scale of communities). Confidence: high, based on logical consideration.
	Boat launching	1	4	6	Species composition	Reef communities in	1.1	2	2	2	Vessels in fishery are small (<7m) and some may be stored on beaches / out of the water and dragged into the water when needed. Movement of the boat in and out of the water can kill or

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Northeastern Transition					damage benthic communities. Intensity: minor, as impact happens at specific locations. Consequence: minor, as minimal impacts on distribution of community. Confidence is high via logical conseideration.
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	1	1	2	Navigation /steaming may affect the physical processes on the benthos by turbulent action of propellers or wake formation as boats move on shallow areas, causing sedimentat re-suspension and increase turbidity affecting habitats and communities. Intensity: negligible, as the fishery uses relatively small (<7m) boats and engines, so impacts are very difficult to detect. The consequence is negligible as impact is unlikely to be detectable at community level. Confidence: high, as scale of boats is relatively small; hence consequence is constrained by logical consideration.
External Impacts	Other fisheries (TS-finfish, TS-Tropical Rock Lobster)	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	1	1	2	Other Torres Strait fisheries, including traditional, may operate on same fishing grounds (e.g. finfish, Rock Lobster). Fishers (divers), gear (e.g. line, hook, spearguns) and boat operation may accidentally interact with habitatas and communities. Intensity: negligible, as this may happen at very specific locations and impacts would be very difficult to detect. Consequence: negligibile, as impact unlikely to be detectable as the scale of the community. Confidence: high, via logical consideration.
	Aquaculture	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Coastal development	1	4	6	Functional group composition	Inner shelf and reef communities in Northeastern Transition	2.1	3	2	1	Localised pollution (e.g. oil spills, sewage contamination) in some Islands at boat ramps and ports (Boigu, Iama), as well as sediment runoff from coastal developments in the Fly river (Saibai, Dauan and Boigu) could affect coral reef habitat and communities via reduction of light, sediment smothering, and algae overgrowth due to increase in nutrients **[39]**. Intensity: moderate, as can be severe at specific locations (islands) and locations nearby Fy River mouth. Consequence: minor, as it can cause some impacts at specific lcoations. Confidence: low, because impacts from Fly river as poorly understood and lack of data on water quality issues and recovery times **[42, 43]**.
	Other extractive activities	0									
	Other non-extractive activities	1	4	6	Species composition	Reef communities in Northeastern Transition	1.1	2	1	1	Major shipping activity in TS, which produce noise and potential leakage of contaminants (oil, chemicals) with potential negative impacts on coral reef invertebrates and fish. Intensity is minor as restricted to shipping lanes. Consequence is negligible as impacts are very difficult to detect at any scale. Confidence is low because there is little information on effects of shipping in the region.
	Other anthropogenic activities	1	4	6	Species composition	Reef communities in	1.1	2	1	1	Charter boats can introduce noise and pollution (oil) into the environment. Oil contamination can negativelly affect communities. Intensity is minor, restricted to boat loading facilities in some islands [25]. Consequence is negligible as changes in community

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Northeastern Transition					dynamics are unlikely to be detectable. Confidence is low as no data exists on impacts and recovery times in the region.

2.3.11 Summary of SICA results

The preliminary summary results of SICA, which are yet to include input from stakeholders, are presented in the table below. No results are presented for byproduct and bycatch species and protected species because a) this is a highly selective hand collectable fishery and there are no bycatch or byproduct species there are no protected species interactions.

Table 2.17. Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations. Those in bold have high confidence. * existing stock assessment – assessment not required. Note: external hazards are not considered at Level 2.

DIRECT IMPACT	ACTIVITY	KEY/SECONDARY COMMERCIAL SPECIES	BYPRODUCT & BYCATCH SPECIES	PROTECTED SPECIES	HABITATS	COMMUNITIES
Capture	Bait collection	0	-	-	0	0
	Fishing	**2**	-	-	**2**	**2**
	Incidental behaviour	**1**	-	-	2	2
Direct impact without capture	Bait collection	0	-	-	0	0
	Fishing	**1**	-	-	**2**	**2**
	Incidental behaviour	1	-	-	1	2
	Gear loss	0	-	-	0	0
	Anchoring/ mooring	1	-	-	2	2
	Navigation/ steaming	1	-	-	1	1
Addition/ movement of biological material	Translocation of species	0	-	-	0	0
	On board processing	0	-	-	0	0
	Discarding catch	1	-	-	1	1
	Stock enhancement	0	-	-	0	0
	Provisioning	0	-	-	0	0
	Organic waste disposal	1	-	-	1	1
Addition of non-biological material	Debris	0	-	-	0	0
	Chemical pollution	1	-	-	2	2
	Exhaust	1	-	-	1	1
	Gear loss	0	-	-	0	0
	Navigation/ steaming	1	-	-	1	1
	Activity/ presence on water	1	-	-	2	2
Disturb physical processes	Bait collection	0	-	-	0	0
	Fishing	1	-	-	**1**	1
	Boat launching	1	-	-	2	2
	Anchoring/mooring	0	-	-	0	0
	Navigation/ steaming	1	-	-	1	1
External Impacts	Other fisheries	**1**	-	-	**2**	**1**
	Aquaculture	0	-	-	0	0
	Coastal development	2	-	-	2	2
	Other extractive activities	0	-	-	0	0
	Other non-extractive activities	1	-	-	1	1
	Other anthropogenic activities	2	-	-	1	1

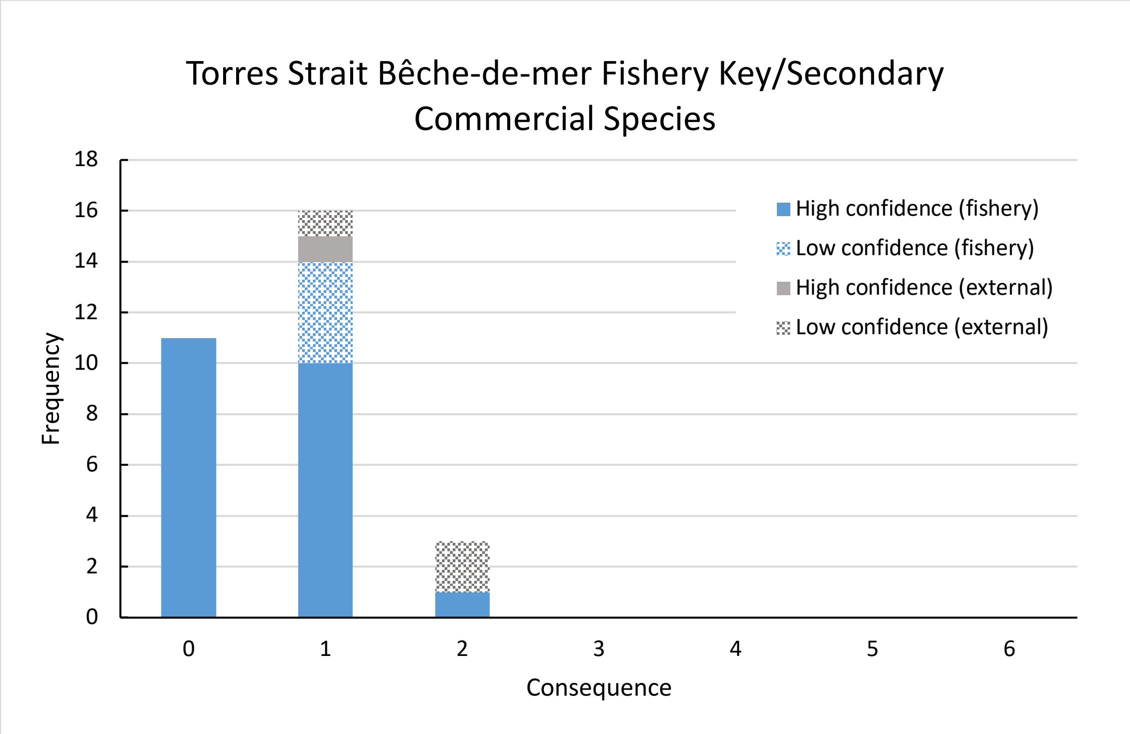


Figure 2.4. Key/secondary commercial species: Frequency of consequence score by high and low confidence.

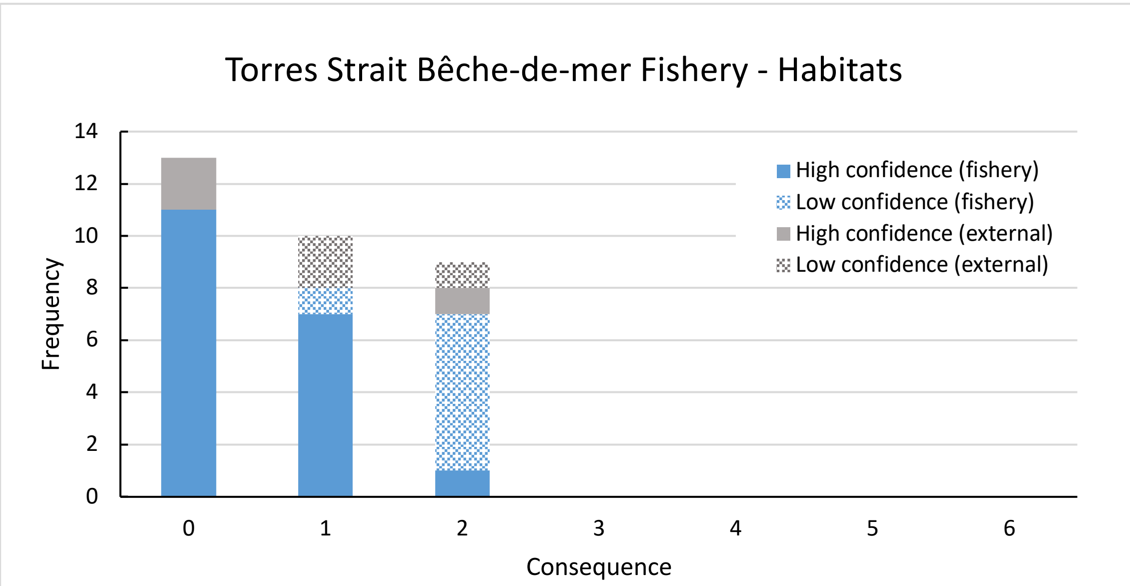


Figure 2.5. Habitat: Frequency of consequence score by high and low confidence.

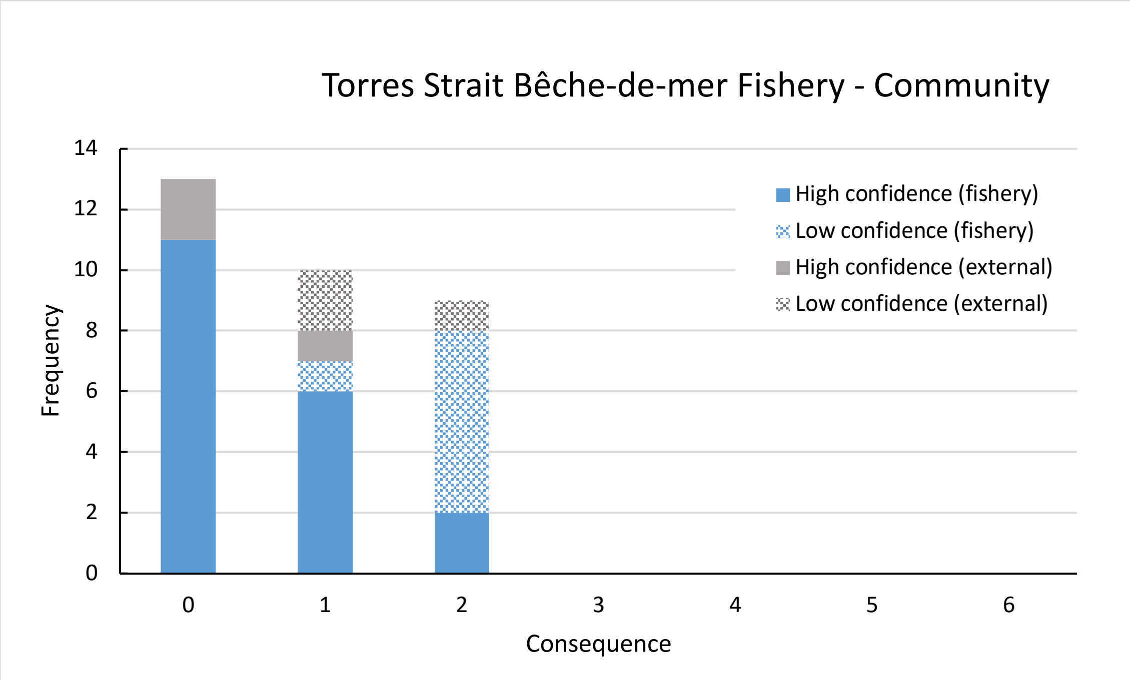


Figure 2.6. Communities: Frequency of consequence score by high and low confidence.

2.3.12 Evaluation/discussion of Level 1

All ecological components were eliminated at Level 1 (i.e. no components with risk scores of 3 – moderate – or above; Table 2.17). Fishing for sea cucumbers is very selective as collected by hand and no by-catch or byproducts result from fishing [15]. Also, no interactions with Protected species have been reported [18]. As a result, the 'Bycatch, byproduct', and 'Protected species' ecological components were not assessed.

All hazards (fishing activities and external) were considered as low risk and eliminated at Level 1 (i.e. no components with risk scores of 3 – moderate – or above). The highest risk scores (2; with high confidence level) were reported for as part of direct fishing activity on key/secondary species, habitats and communities. The main reason is that fishing for sea cucumbers involves walking/trampling and diving on coral reefs, which may affect species directly and also break or damage benthic communities and coral reef structures.

Although still considered a 'low risk' hazard, coastal development was the highest scored risk (risk score = 2) to key/secondary species, habitats and communities because of localised pollution in some Islands and sediment runoff from coastal developments in the Fly river (PNG) [39]. Sediments can smother sessiles species like corals [45] and increased turbidity and reduction in light penetration can negatively affect spcies that depend on light, such as corals, algae and seagrasses. Confidence is low because impacts from Fly river likely restricted to Northern Islands in the Torres Strait Protected Zone and are still poorly understood and there is a lack of data on water quality issues and recovery times of species and habitats [42, 43].

2.3.13 Components to be examined at Level 2

As a result of the preliminary SICA analysis, no components are to be examined at Level 2.

3 General discussion and research implications

3.1 Level 1

In this case, 19 out of 32 possible internal activities were identified as occurring in this sub-fishery. Four external scenarios were also identified. Thus, a total of 23 activity-component scenarios were considered at Level 1. This resulted in 69 (excluding the Bycatch, byproduct and Protected species x direct impact by capture activity because these activities are not applicable to the fishery) scenarios (of 160 possible) that were evaluated using the unit lists (Key commercial/secondary, habitats, communities).

3.2 Level 2

3.2.1 Species at risk

A Level 2 analysis was not triggered, as all risk (consequence) scores were < 3 in the Level 1 SICA analysis.

Appendix A: TAC (t) and annual recorded catch[11] (t) by species for the Torres Strait Bêche-de-mer Fishery since 2005

COMMON NAME	Pre-2020 TAC	2005	2007	2010	2011	2012	2013	2014	2015	2016	2017[12]	2018[13]	2019	2020
Black teatfish	0 (15[14])				75	2.001	0.138	16.624	23.303					
Prickly redfish	15 (20[15])	5.564	0.128	0.146	11.056	1.255	5.888	9.173	28.110	11.211	12.185	14.741	11.765	15.654
Sandfish	0			0.005	0.031	2.152	0.026	0.006				0.018		
Surf Redfish	0	0.734					0.052	0.001			0.747			0.199
White teatfish	15	0.186			3.179	13.924	12.633	16.341	4.200	0.990		1.774	1.556	1.767
Blackfish	80 basket		0.128		0.507	0.073	0.216	1.960	3.596	1.098	11.118	1.368	3.475	1.399
Burrowing blackfish													0.003	0.003

[11] No catch reported in 2006, 2008, 2009

[12] Total catch for 2017 is converted weight- (47 kg unknown), based on recorded catch through tax invoices and logbook data(HC01, TDB01) and Catch Disposal Records (CDR; TBD02). Potential duplicate records were removed.

[13] Data is reported through CDR (TDB02) only and converted to wet weight gutted using CSIRO recommended conversion factors.

[14] 15 t TAC was available in 2014 and 2015 only

[15] 20 t TAC was available until the end of 2017.

Annual catch that exceeds TAC are highlighted in yellow.

COMMON NAME	Pre-2020 TAC	2005	2007	2010	2011	2012	2013	2014	2015	2016	2017[12]	2018[13]	2019	2020
Curryfish – mixed					1.118				6.099	1.085	0.597	42.392	12.212	10.549
Curryfish common													1.093	0.621
Curryfish vastus													0.215	0.153
Deepwater redfish				0.007			5.024	4.229	5.546		0.160	0.172	0.050	0.050
Elephant trunkfish					0.004	0.028	0.002		0.133			0.190		
Golden sandfish							0.052	0.351	0.055			0.008	0.032	0.032
Greenfish							0.001	0.001	0.014		0.063	1.013	0.271	0.015
Stonefish				0.459							0.006			
Leopardfish											6.876	2.322	0.958	0.958
Brown sandfish												0.030	0.204	0.204
Lollyfish													3.997	3.997
Unidentified BDM												0.067		
'Basket total'		**0.186**	**0.256**	**0.466**	**1.629**	**0.101**	**5.295**	**6.541**	**15.443**	**2.183**	**19.831**	**47.761**	**22.686**	
	TOTAL:	**6.484**	**0.256**	**0.617**	**15.970**	**18.803**	**24.032**	**48.686**	**71.056**	**14.384**	**32.764**	**64.300**	**36.006**	**32.000**

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Glossary of Terms

Assemblage	A subset of the species in the community that can be easily recognized and studied. For example, the set of sharks and rays in a community is the Chondricythian assemblage.
Attribute	A general term for a set of properties relating to the productivity or susceptibility of a particular unit of analysis.
Bycatch species	A non-target species captured in a fishery, usually of low value and often discarded (see also Byproduct).
Byproduct species	A non-target species captured in a fishery, but it may have value to the fisher and be retained for sale.
Community	A complete set of interacting species.
Component	A major area of relevance to fisheries with regard to ecological risk assessment (e.g. target species, bycatch and byproduct species, threatened and endangered species, habitats, and communities).
Component model	A conceptual description of the impacts of fishing activities (hazards) on components and sub-components, linked through the processes and resources that determine the level of a component.
Consequence	The effect of an activity on achieving the operational objective for a sub-component.
Core objective	The overall aim of management for a component.
End point	A term used in risk assessment to denote the object of the assessment; equivalent to component or sub-component in ERAEF
Ecosystem	The spatially explicit association of abiotic and biotic elements within which there is a flow of resources, such as nutrients, biomass or energy (Crooks, 2002).
External factor	Factors other than fishing that affect achievement of operational objectives for components and sub-components.
Fishery method	A technique or set of equipment used to harvest fish in a fishery (e.g. long-lining, purse-seining, trawling).
Fishery	A related set of fish harvesting activities regulated by an authority (e.g. Southern and Eastern Scalefish and Shark Fishery).
F_MSM	Maximum sustainable fishing mortality
F_Lim	Limit fishing mortality which is half of the maximum sustainable fishing mortality
F_Crash	Minimum unsustainable fishing mortality rate that may lead to population extinction in the longer term
Habitat	The place where fauna or flora complete all or a portion of their life cycle.
Hazard identification	The identification of activities (hazards) that may impact the components of interest.

Indicator	Used to monitor the effect of an activity on a sub-component. An indicator is something that can be measured, such as biomass or abundance.
Likelihood	The chance that a sub-component will be affected by an activity.
Operational objective	A measurable objective for a component or sub-component (typically expressed as “the level of X does not fall outside acceptable bounds”)
Precautionary approach	The approach whereby, if there is uncertainty about the outcome of an action, the benefit of the doubt should be given to the biological entity (such as species, habitat or community).
PSA	Productivity-Susceptibility Analysis. Used at Level 2 in the ERAEF methodology.
Scoping	A general step in an ERA or the first step in the ERAEF involving the identification of the fishery history, management, methods, scope and activities.
SICA	Scale, Impact, Consequence Analysis. Used at Level 1 in the ERAEF methodology.
Sub-component	A more detailed aspect of a component. For example, within the target species component, the sub-components include the population size, geographic range, and the age/size/sex structure.
Sub-fishery	A subdivision of the fishery on the basis of the gear or areal extent of the fishery. Ecological risk is assessed separately for each sub-fishery within a fishery.
Sustainability	Ability to be maintained indefinitely
Target species	A species or group of species whose capture is the goal of a fishery, sub-fishery, or fishing operation.
Trophic position	Location of an individual organism or species within a foodweb.
Unit of analysis	The entities for which attributes are scored in the Level 2 analysis. For example, the units of analysis for the Target Species component are individual “species”, while for Habitats, they are “biotypes”, and for Communities the units are “assemblages”.

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TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No.18 28-29 October 2021
RESEARCH PRIORITIES	Agenda Item 6 FOR DISCUSSION & ADVICE

RECOMMENDATIONS

1. That the Working Group:

    a. **NOTE** the current status of identified research priorities and needs for the Torres Strait Beche-de-mer Fishery (BDM Fishery) as advised by the Hand Collectables Resource Assessment Group (HCRAG) (**Table 1)**;

    b. **NOTE** that at present (i.e. in the absence of securing further funding) expected AFMA and TSRA research funding available in the 2022/23 financial year is around $100 000; and

    c. Having considered the above, **DISCUSS** and **PROVIDE ADVICE** on research priorities for a rolling five-year research plan 2022/23 - 2026/27 for Hand Collectable Fisheries (**Attachment A**) including advice on the feasibility, timing and indicative costing of essential, unfunded research project(s) to inform the Torres Strait Scientific Advisory Committee's (TSSAC) annual call for research funding proposals.

KEY ISSUES

Research priorities for Hand Collectable Fisheries

2. The HCRAG met on 6-7 October 2021 and provided advice on research priorities for the BDM Fishery. Draft advice from the HCRAG is provided in **Table 1**. Please note however, that the meeting record for the HCRAG meeting is currently with members for comment. As necessary, AFMA will advised the Working Group of any updates to Table 1 in finalising the HCRAG01 meeting record.

3. The HCRAG consideration of priorities was informed not only by consideration of research outcomes and assessment needs discussed at the meeting but also a summary of previous HCWG advice on research priorities.

4. The most recent Working Group advice on research priorities was provided at its video conference meeting held on 12 October 2020. The Working Group recommended that:

    a. the highest research and data needs for the BDM Fishery are the analysis of new catch data collected during the trial reopening of black teatfish to inform future openings and any follow up work from the stock survey. The exact scope of this work will be more evident once the stock survey project is finalised and after the black teatfish trial opening and advised that this did not require a dedicated research project to be identified at that point.

    b. that the newly established RAG would/should engage industry upfront to refine identified research priorities for the BDM Fishery and seek funding in the following

(2022-23) TSSAC research round. This would also provide time to talk to industry, including Traditional Owners on Tudu about progressing future Sandfish stock surveys.

c. it is important that research in the BDM Fishery is informed through a two-way exchange of knowledge between industry and researchers and this is anticipated to be achieved through the RAG.

d. in making the recommendations above, the HCWG considered members advice on the research needs for the fishery as being (not in order of priority):
   - Development of curryfish conversion ratios.
   - Exploring sea ranching/re-seeding opportunities.
   - Outstanding stock survey of Sandfish at Warrior Reef.
   - Socio-economic priorities.

5. Further detail on the research funding cycle is provided in the Background section. The purpose of this agenda item is to get Working Group advice on priorities for the hand collectables fisheries for the next five years (2022-27).

Broader research priorities for Torres Strait Fisheries

6. The TSSAC also funds projects that are applicable across Torres Strait Fisheries. Two such projects that were funded in 2019-20 are the *Climate variability and change relevant to key fisheries resources in the Torres Strait – a scoping study)* and *Measuring non-commercial fishing (indigenous subsistence fishing and recreational fishing) in the Torres Strait in order to improve fisheries management and promote sustainable livelihoods*.

7. The Working Group is invited to provide feedback to the TSSAC on the outcomes of the projects, in particular recommendations from the projects for future research. The project outcomes and recommendations were considered by TSSAC at its meeting on 9-10 June 2021. Below provides a brief overview of the projects.

Climate variability and change relevant to key fisheries resources in the Torres Strait – a scoping study)

8. The need to better understand the species-specific effects of climate change and variability on Torres Strait Fisheries was initially identified as a research priority by TSSAC in December 2018 (meeting 71). TSSAC agreed that as a starting point, a scoping study should be undertaken on the possible methods and resources needed to build an information framework that can evaluate the implications of future climate variability and change scenarios on fisheries to better allow fisheries managers and industry to respond and adapt to any changes.

9. The project was funded by AFMA and finalised on 31 January 2020. A summary of the suggested components and estimated costs for a full climate modelling project are outlined in **Table 2**. A copy of the report is provided as **Attachment B**.

10. The project builds on a literature review of the main climate change drivers in Torres Strait affecting tropical rock lobster, bêche-de-mer (sea cucumber), finfish, prawns, turtles and dugongs to provide detailed specification and costings for a future project that will produce the over-arching data framework at the appropriate spatial scales, as required to address future climate variability and change scenarios for Torres Strait fisheries. The report also includes detailed information about data availability, and specifications on data storage, management and data accessibility issues.

11. The TSSAC considered the project's outcomes and recommendations at their 79th meeting on 9-10 June 2021 and agreed that if the project was to progress beyond this scoping phase, it would provide a range of information that is of value to fisheries management, including:

    - Understanding interactions between fisheries and ecosystems.
    - Understanding impacts that different climate change scenarios could have on fisheries/ species.
    - Understanding impacts of changes in catchment conditions and rainfall.
    - Understanding impacts of incidences.
    - Assisting fisheries managers and communities with preparation for adaptation, where possible.
    - Providing predictions of changes in abundance, growth, reproductive capacity and distribution.
    - Helping to differentiate between the relative effects of fishing and environmental (climate) change on marine resources.
    - Use existing, and new data to be collected, to generate information of value to other sectors beyond fisheries, e.g. water circulation, winds, predicted sea level rise, rainfall and wind speed.

12. Given the limited annual research budget, the TSSAC agreed that other funding sources need to be explored including the Fisheries Research and Development Corporation (FRDC) and other agencies such as councils and state environment agencies.

Developing an approach for measuring non-commercial fishing in Torres Strait in order to improve fisheries management and promote sustainable livelihood

13. This scoping study was funded to quantify the subsistence and recreational (i.e. non-commercial) take of key commercial species and to gauge interest from Torres Strait communities in collecting information on the subsistence take of other non-commercial species, to identify the most culturally significant and important species to communities (including contribution to health and livelihoods)
14. The research need was identified the TSRA Finfish Fishery leasing quota committee. A committee at the time, comprising TSRA Board members and traditional inhabitant representatives from eastern island communities. Members identified the need to improve estimates of non-commercial catch of commercial species to inform stock assessment, the setting of sustainable catch levels and to determine the how much of the available catch needs to be reserved for traditional fishing.

15. The project found self-reporting using an app (or web-based approach indistinguishable from an app) was likely to be the best approach to monitoring non-commercial fishing, paired with a data validation method of conducting household surveys. The project undertook consultation with stakeholders on this monitoring approach which would need to continue should the project recommendation proceed. This would ensure communities are on board with this approach and identify risks and concerns that would need to be managed around it.

16. The TSSAC considered the project's recommendations at its 79th meeting on 9-10 June 2021 and agreed that if the project proceeds beyond the scoping stage, it should do so in a phased approach as follows:

a. Phase 1:
    i. Community consultation and sign on (re engaging community regarding the suggested monitoring method to gauge support).

    ii. App design and development options (including data collection and storage options, and what data may be collected beyond non-commercial catch of commercial species (such as other species, environmental etc)). This process should be through co-design with communities and Government to meet stakeholder needs).

b. Phase 2:

    iii. Develop App, database and data flow infrastructure

    iv. Community rollout – pilot (on some communities).

    v. Community rollout – full-scale (to all communities).

17. Although, as AFMA understands it, there is no non-commercial catch of sea cucumbers, it may still be relevant for the Working Group to provide feedback to TSSAC on the outcomes and recommendations from this project. This is because the project relates to developing a catch data collection method for the region.

BACKGROUND

TSSAC Research Funding Process

1. 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

2. PZJA fisheries research is generally funded by AFMA. The AFMA research budget is generally set at around $420 000 each year. In additional to the AFMA research funding, however TSRA has recently committed in-principle to contributing $150,000 each year for PZJA fisheries research. This allows around $570 000 annually for Torres Strait research. Additional funding can also be sought from other bodies such as the Fisheries Research and Development Corporation, when needed, and when projects align with FRDC objectives

3. Assuming no change to available AFMA and TSRA funding, considering expected research commitments and in the absence of securing further funding, research funding across all Torres Strait Fisheries in the 2022/23 financial year will be around $100 000.

TSSAC Fisheries Strategic Research Plan 2018-2023 and rolling five-year fishery-specific research plans

4. TSSAC operates under a Strategic Research Plan (SRP) which guides priority setting for research in Torres Strait fisheries over a five-year period. The SRP specifies the research priorities and strategies summarised in **Table 3** 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.

5. There are 3 research themes within the SRP, under which the HCRAG and HCWG could identify research priorities for Hand Collectable fisheries. 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.

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

7. The TSSAC has an annual research cycle, which fits with the AFMA budgeting cycle.

Table colour key	Completed	Scoped and/or costed	Not scoped/not costed

Table 1. Overview and status update of research needs identified or discussed for Hand Collectable Fisheries at previous HCWG meetings and the rolling five-year research plan including HCRAG's recommendations and assigned priorities from its meeting on 6-7 October 2021.

	Research activity	Detail	Status	Comments/questions	HCRAG priority
1	Status of BDM stocks in relation to harvest strategy reference points	Consistent with the BDM harvest strategy and where there is sufficient information available, a tactical research project is needed to determine the current status of sea cucumber stocks in relation to the harvest strategy reference points, noting that the first step is to define the reference points for the species for which it may be possible.	Not scoped/not costed		**High priority**
2	White teatfish modelling	Additional analysis on white teatfish to develop a rationale on the status of the stock in relation to harvest strategy reference points and modelling analysis on a sustainable TAC increase.	Not scoped/not costed		**High priority**
3	Black teatfish sampling	Representative sampling to collect size and weight frequencies during the black teatfish openings.	Not scoped/not costed		**High priority**
4	Development of curryfish conversion ratios	Project to develop conversion ratios for curryfish with industry undertaking the sampling process.	Scoped and costed $12,000	Full proposal developed and allocated funding in 2019/20 but did not proceed due to COVID-19.	**High priority**
5	Sandfish stock survey	Outstanding stock survey of Sandfish at Warrior Reef to better understand its status	Not scoped/not costed	Identified as a research need for the fishery by HCWG17 at its meeting 12 October 2020. Was part of the 2019-20 stock survey but did not proceed.	**High priority** subject to confirmation of support from Iama and Tudu Island PBC, GBK, Traditional Owners and fishers.

	Research activity	Detail	Status	Comments/questions	HCRAG priority
6	Black and white teatfish follow up surveys	Follow up black and white teatfish surveys focusing on specific areas and potentially including areas not surveyed previously such as south east TSPZ, barrier and deep-water strata.	Not scoped/not costed	The RAG will initially need to determine what is required, other than an independent survey, to meet the WTO requirement to provide a revised population estimate.	**Medium term priority**
7	Socio-economic	Collecting data on socioeconomic indicators for the fishery through recall surveys.	Not scoped/not costed	Identified as a research need for the fishery by HCWG17 members. Research scope and survey design and development to be: • Informed by AFMA's review of CDR participation data to date and by social science expertise • further considered by the HCRAG	**Medium term priority** and update the current wording to reflect RAG advice.
8	Management Strategy Evaluation (MSE) of the Beche-de-mer Harvest Strategy	1. Collate all data and biological information; 2. Update and extend the spatial multispecies TS BDM operating model developed earlier (or construct a new model); 3. Use MSE to evaluate how well the HS achieves the pre-specified objectives; 4. In consultation with stakeholders, use the MSE framework to investigate ways to improve the current HS.	Not scoped Est cost – $130k	Identified as an essential research priority by HCWG in the rolling five-year research plan for Hand Collectable Fisheries. Requires 3-5 years of BDM HS implementation.	**Medium priority** and to be held off until the harvest strategy has been in place for a few years.

	Research activity	Detail	Status	Comments/questions	HCRAG priority
9	Supply chain	Better understanding of the supply chains as per other fisheries to better understand vulnerabilities and help develop an industry that is resilient to fluctuating export market conditions.	Not scoped/not costed		**Not prioritised**
10	Exploring sea ranching/re-seeding opportunities		Not scoped/not costed	Identified as a key research need for the fishery by HCWG Traditional Inhabitant members. Industry initiated pilot project currently underway on Ugar.	**To be removed from the research plan** - Aquaculture falls outside the remit of the PZJA. PZJA can provide support through provision of information and permitting collection of broodstock. With regarding to Sandfish aquaculture, the PZJA will initially want to establish the status of the sandfish stock on Warrior reef.
11	Ecological Risk Assessment (ERA) – Torres Strait Pearl Shell Fishery	Conduct an ERA for the Torres Strait Pearl Shell (TSPF) Fishery	Not scoped Est cost - $20,400	Identified as an essential research priority by HCWG in the rolling five-year research plan for Hand Collectable Fisheries	**To be remove from the research plan** as there is no fishing activity and therefore no immediate ecological risk.
12	Understanding biological parameters of BDM species, including growth, mortality, size and breeding seasonality	Identifying gaps in knowledge of biological parameters of BDM species and investigating options for collaborative research	Not scoped/not costed	Identified as an essential research priority by HCWG in the rolling five-year research plan for Hand Collectable Fisheries Requires further scientific advice.	Low priority and proposed that it be addressed as the need arises.
13	Stock Status Survey	To undertake a stock survey of all Torres Strait beche-de-mer species with a focus on deeper water species	Completed in 2019 - 2020	Final report identified research needs that the HCRAG may want to consider further	N/A

	Research activity	Detail	Status	Comments/questions	HCRAG priority
14	Ecological Risk Assessment (ERA)	Conduct an ERA for the TSBDM Fishery	Draft completed on 30 June 2021.	Needs to be completed by January 2022 to meet WTO condition 5 for the fishery.	N/A
15	Climate Change impacts and vulnerability	Scoping study across all Torres Strait	Completed	Final report made recommendations for further research	N/A
16	Data analysis	Further analysis of catch data collected during the 2021 trial reopening of black teatfish to inform future openings and follow up work from the stock survey.	Completed	HCWG identified this as the highest research need for the BDM Fishery. CSIRO completed the black teatfish catch data analysis from the 2021 opening and updated the modelling to inform future opening and TAC.	Completed

Table 2. Summary of the main outcomes and recommendations of the project *Climate variability and change relevant to key fisheries resources in the Torres Strait — a scoping study*

Main outcomes/ recommendations	Estimated cost
1. Prioritise physical data collection and further strengthen and expand a large-scale monitoring program for Torres Strait that would support the identification of long-term trends and improve understanding about local and regional processes affecting habitats, species and fisheries, and to support the development of models.	Unknown. It is difficult to estimate costings for data collection programs, as some data is already being collected across fisheries. This issue can be discussed at the meeting. The PI will provide some estimates of cost associated with collecting hydrodynamic information.
2. Staged approach in the development of an integrated ecosystem modelling framework to investigate the impacts of climate and local changes on fisheries in Torres Strait, via coupling together:	
a) Development and implementation of data framework to support future modelling efforts in Torres Strait – approx. cost	Approximately 0.4-0.5 FTE for 1 year or rough estimate of A$130k
b) Development of integrated ecological or socio-ecological models capable of integration with a regional hydrodynamic model:	
i. For example, combining existing data and models (Tropical Rock Lobster, beche-de-mer, and dugongs) into an integrated spatial MICE, which will form the basis for a hybrid MICE-ATLANTIS ecosystem model;	Approximately 0.5-0.7 FTE over each of 2 years, or rough estimate of $460k.
ii. Dedicated regional hydrodynamic model, including physics and biogeochemistry for Torres Strait, for example similar to eReefs. Include the key findings – recommendations from each project, and the costs.	Approximately 0.3-0.5FTE over each of 2 years, or rough estimate of $350k
Total estimated costs for costed components of project (this excludes data collection components)	**$940k**

Table 3. Torres Strait fisheries strategic research themes, strategies and research activities

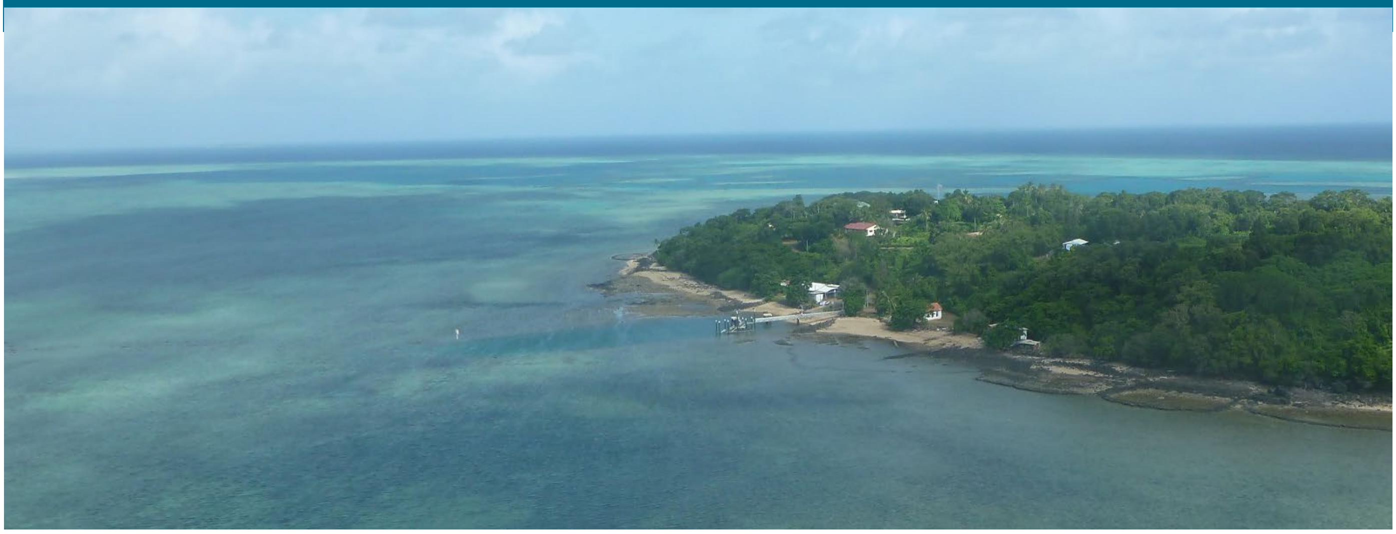
<table>
<tr><th colspan="2">Theme 1: Protecting the Torres Strait marine environment for the benefit of Traditional Inhabitants</th></tr>
<tr><td colspan="2">Aim: Effective management of fishery stocks based on understanding species and their biology and ecological dependencies so it can support Traditional Inhabitant social and economic needs.</td></tr>
<tr><td>Strategy 1a - Fishery stocks, biology and marine environment</td><td>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.</td></tr>
<tr><td>Strategy 1b – Catch sharing with Papua New Guinea</td><td>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.</td></tr>
<tr><th colspan="2">Theme 2: Social and Economic Benefits</th></tr>
<tr><td colspan="2">Aim: Increase social and economic benefits to Traditional Inhabitants from Torres Strait Fisheries.</td></tr>
<tr><td>Strategy 2a - Promoting social benefits and economic development in the Torres Strait, including employment opportunities for Traditional Inhabitants</td><td>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.</td></tr>
<tr><th colspan="2">Theme 3: Technology and Innovation</th></tr>
<tr><td colspan="2">Aim: To have policies and technology that promote economic, environmental and social benefits from the fishing sector.</td></tr>
<tr><td>Strategy 3a – Develop technology to support the management of Torres Strait fisheries.</td><td>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.</td></tr>
</table>

Australian Government | TSRA www.tsra.gov.au | Australian Government Department of Agriculture | Australian Government Australian Fisheries Management Authority | Queensland Government | TORRES STRAIT PZJA PROTECTED ZONE JOINT AUTHORITY

Five-year Research Plan 2022/23 – 2026/27 (DRAFT)

Torres Strait Hand Collectable Fisheries

Beche-de-mer
Pearl shell
Crab
Trochus



COMPILED BY THE HAND COLLECTABLES WORKING GROUP

October 2020

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 2021/22 to 2025/26. 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.

Table 1. Research priorities for Torres Strait Hand Collectable Fisheries for 2022/23 – 2026/27.

Proposed Project	Objectives and component tasks	Year project to be carried out and indicative cost				Other funding bodies		Evaluation		
		2022/23	2023/24	2024/25	2025/26	Notes on project timings		Priority essential /desirable	Priority ranking (1-5)	Theme
Understanding critical uncertainties for Torres Strait Beche-de-mer species and processing methods	Undertake field sampling of curryfish species (*Stichopus herrmanni and S. vastus*) to develop conversion ratios for boiled and salted weight to gutted weight.	$12,000						Essential	1	1
Management Strategy Evaluation (MSE) of the Beche-de-mer Harvest Strategy	1. Collate all data and biological information; 2. Update and extend the spatial multispecies TS BDM operating model developed earlier (or construct a new model); 3. Use MSE to evaluate how well the HS achieves the pre-specified objectives; 4. In consultation with stakeholders, use the MSE framework to investigate ways to improve the current HS.		$130k ^[1]			Will require 3-5 years of BDM HS implementation before MSE testing is achievable. However, can be undertaken sooner if external pressure requires (e.g. CITES Appendix II listing)		Essential	2	1
Ecological Risk Assessment (ERA)	Conduct an ERA for the Torres Strait Pearl Shell (TSPF) Fishery	$20,400			Nil		CSIRO (in-kind)	Desirable	5	1
Understanding biological parameters of BDM species, including growth, mortality, size and breeding seasonality	Identifying gaps in knowledge of biological parameters of BDM species and investigating options for collaborative research	Not costed – pending further scientific advice						Desirable	5	1

[1] Advice from CSIRO: Rough costing takes into account time needed to collate all fishery-dependent and fishery-independent data, develop and refine existing operating model and MSE framework, costs of attending at least 2 meetings to consult with stakeholders

Australia's National
Science Agency

Scoping a future project to address impacts from climate variability and change on key Torres Strait Fisheries

Leo X.C. Dutra, Éva E. Plagányi, Rob Kenyon, Trevor Hutton, Nicole Murphy, Laura K. Blamey, Steven Edgar and Christian Moeseneder

Final Report for Project Climate variability and change relevant to key fisheries resources in the Torres Strait to Australian Fisheries Management Authority

31/01/2020 FINAL REPORT

Contents

Executive Summary

Fishing is a critical activity in Torres Strait supporting both Indigenous and non-indigenous sectors through commercial, subsistence and traditional activities. Pressures on fisheries resources can be localised (e.g. overfishing, increased runoff and turbidity due to land-use changes and extreme rainfall events) and also related to climate change (e.g. ocean acidification, increase in sea surface temperature), which operates at larger scales. Localised and climate change pressures can act in isolation or synergistically to influence fishery resources.

The first objective of this report (presented in Parts 1 and 2) is to provide background information about Torres Strait and review previous projects and other relevant literature to identify environmental drivers that affect recruitment, growth, mortality rates, catches and relevant habitats of selected fisheries (tropical rock lobster (TRL), bêche-de-mer (BDM), finfish, prawns, turtles and dugongs), and potential effects of climate change on these environmental drivers. The review informs the second objective of the project, which is to provide a detailed technical specification of the over-arching data framework, and spatial scales for a future project scope that would address future climate variability and change scenarios for Torres Strait fisheries (Part 3).

Torres Strait is a narrow body of water situated between Papua New Guinea, Indonesia and Australia connecting the Gulf of Carpentaria to the Coral Sea via the continental shelf of the Great Barrier Reef and the Gulf of Papua. Its climate is influenced by considerable ocean and climate variability, dominated by the monsoon and El Niño–Southern Oscillation (contributing to year-to-year variability) and extreme weather events, including changes in sea level and marine heatwaves. Cyclones are relatively rare, but the area is influenced by cyclonic-related storms, strong winds, waves, surges and extreme rainfall. Both air and sea surface temperatures do not vary much throughout the year because of the tropical location. Mean annual rainfall is 1,750mm falling mostly between November and February.

The bathymetry and circulation in Torres Strait are complex, mostly shallow (between 5 and 25m deep) and characterised by high energy conditions and strong tidal currents. The region contains productive ecosystems, including coral reefs, sandbanks, and extensive areas of seagrasses and mangroves, supporting a variety of fisheries.

Anthropogenic impacts (other than climate change) in Torres Strait are relatively minor, but exist in specific locations. Torres Strait is, however, relatively highly vulnerable to shipping accidents, with this being recognised by TSRA, and oil spill risk may be important to consider in an ecosystem modelling framework. Local impacts include, localised oil contamination, mangrove cutting, alteration of hydrology, nutrient and sediment runoff, and chemical contamination.

Fishing is an additional anthropogenic impact source. Most marine living resources have been managed sustainably but there are examples of past overharvesting (most notably sandfish and black teatfish) and this needs to be considered.

Climate change is already affecting Torres Strait fisheries and culture. Expected impacts from climate change include higher sea levels and associated coastal erosion, warmer atmospheric and ocean temperatures, more acidic waters, changes in ocean circulation, and more intense rainfall events. Although relatively minor, simultaneous local impacts (e.g. untreated sewage, chemical, sediment and nutrient runoff, oil pollution, overfishing) act together with climate change impacts, such as sea-level rise, ocean warming, acidification, leading to interactive, complex and amplified impacts for species and ecosystems.

These pressures can manifest directly in the form of changes in abundance, growth, reproductive capacity, distribution and phenology (changes in cyclic and seasonal phenomena such as reproduction and migration), and indirectly through changes in habitats. Invertebrates (TRL, prawns, BDM) are likely to be more impacted by climate change than vertebrates (Finfish, turtles and dugongs). This is *inter alia* because although highly productive, their life spans are short, which makes it difficult for them to move out of a certain area severely impacted over many years before significant losses at the population level happen.

Climate change is likely to cause mostly negative direct effects on the fisheries investigated in this report, but some effects may also be positive, especially in the short to medium-term (e.g. relatively small warming may increase growth rates of sea cucumber and lobsters). If climate-related environmental changes exceed certain limits or ranges for species, they will either move when possible, or have their abundance reduced.

The second objective of the report was to produce an over-arching data and modelling framework at the appropriate spatial scales, as required to address future climate variability and change scenarios for Torres Strait fisheries (Part 3). The objectives of the modelling exercise are to simulate future climate scenarios and assess the impacts of these on fisheries and associated habitats and species through quantitative evaluation. It will support the exploration of responses and strategies to manage the selected Torres Strait fisheries, such as the evaluation of:

1) Interactions between different fisheries and broader ecosystem functioning, including consideration of communities that rely on these resources;

2) Impacts of climate change scenarios on the abundance and distribution of selected species;

3) Impacts of current and future river catchment conditions and management scenarios on fisheries;

4) Impacts of incidents (e.g. oil spills, ship groundings) on fisheries;

5) Combined scenarios of 1-4 to develop strategies that are robust across impacts and fisheries; and

6) Evaluation of alternative adaptation options.

In order to address objectives, some of the desirable features of the modelling framework include: 1) Catchment runoff; 2) Hydrodynamics and transport; 3) Physio-chemical water quality constituents; 4) Biogeochemistry, 5) Fisheries dynamics; and 6) Ecological and socio-ecological relationships.

Data requirements to simulate these desirable features include: 1) biological and fisheries data (catches, catch locations, target species, gear, age and size frequency of catches, species distribution, growth rates, reproduction and maturity, mortality and population size); 2) location, area and species of supporting habitats (mangroves, seagrasses and mangroves); and 3) physical and biogeochemical data (currents, turbidity, temperature (air and sea), tides and water level, light penetration, nutrients, salinity, sedimentation, pH, oxygen, grazing, extreme events, waves, moon phase, diseases and parasites).

There is significant information covering Torres Strait fisheries, key marine species, habitats, geology and physiochemical water quality parameters. However, datasets are sparse both in space and time. A large-scale monitoring program for Torres Strait would support the identification of long-term trends and improve understanding about local and regional processes affecting habitats, species and fisheries, including the impacts of climate change on these.

Most of the understanding about physical and biogeochemical cycles and processes (e.g. currents, tides, primary productivity, nutrients) in Torres Strait have been derived from remote sensing and hydrodynamic models developed in the 2000s and in the early 2010s, each with relatively well-known pros and cons. Limited physical long-term observational data is available as these data were collected mostly in the 1990s. It is therefore recommended to prioritise physical data collection to improve our understanding about regional dynamics and potential impacts of climate change on these.

Habitat, fisheries and ecological data are also sparse, but recent mapping of mangroves, seagrasses and coral reefs combined with survey data on substrate and species collected in large-scale BDM and TRL surveys offer valuable information about the location and health status of such habitats, which can support the development of models to explore impacts and adaptation options.

A number of modelling initiatives are already in place in Torres Strait and it would be worth considering capitalising on these efforts. Given issues with hydrodynamic models previously developed for the region it is recommended that a dedicated regional hydrodynamic model, including physics and biogeochemistry be constructed for Torres Strait (supported by appropriate oceanographic data collection), as the effort to re-run previously developed models will likely be similar to deploying an up-to-date state-of-the-art modelling platform such as eReefs, which has been developed for the Great Barrier Reef (GBR) region.

The Torres Strait region will likely need to integrate a mix of modelling approaches that feed into one another, built in a stepwise fashion. A cost-effective approach would be to couple a regional hydrodynamic model that simulates basic physical and biogeochemical processes with an ecological or socio-ecological model. Although complex to develop, if feasible a socio-ecological approach is preferred as it accounts for the human dimension and hence some of the complex socio-cultural relationships between traditional owners and their marine environment. Given there are already assessment models developed for some of the key species (e.g. TRL, BDM, prawns), a useful starting point would be to combine these in an integrated spatial model using models of intermediate complexity for ecosystem assessment (MICE) for the Torres Strait region. This can form the basis of a more complex ecosystem model or help to ground-truth a larger more complex model.

Starting the modelling exercise using MICE approach sooner rather than later would provide a framework to utilise existing datasets and investigate potential climate change impacts on the fisheries and there are sufficient data to start modelling. So, our recommended approach would be to build the models in a stepwise fashion, adding new data and complexity as these become available or necessary. This also allows time to start obtaining feedback from stakeholders on preliminary model results, which allows time to communicate the usefulness of models as well as how to draw on local knowledge to further refine models.

Many ecosystem models involve coupling together different components and this is also how we envisage development of an ecosystem model proceeding – hence the starting point is to extend and link the current biological models of key species (e.g. TRL, BDM, dugongs), add current known environmental drivers (e.g. SST), gradually add other species (e.g. seagrass, finfish, turtles) and link with prelim hydrodynamic models or model outputs to start adding complexity associated with the oceanographic setting. The development of fully integrated couple hydrodynamic model usually takes a few years and is an expensive process so we recommend starting small and gradually expanding.

The proposed data framework identifies how the physio-chemical and ecological data could be managed and delivered to support the development of models. Datasets can be managed on CSIRO IT infrastructure, utilising relational database systems and enterprise file servers. Datasets will be described using geonetwork (www.marlin.csiro.au) and these descriptions can be made public to allow third parties (non-CSIRO) to access data depending on level of permission granted (i.e. licence restrictions). Datasets can be shared using Open Geospatial Consortium (OGC) standards where appropriate, by using a standards-compliant webserver (geoserver) linked to the collated data. This framework is scalable, robust and compliant with open data/metadata standards, allowing a flexible data delivery method.

The following are the key recommendations from this report:

1. Prioritise physical data collection and further strengthen and expand a large-scale monitoring program for Torres Strait that would support the identification of long-term trends and improve understanding about local and regional processes affecting habitats, species and fisheries, and to support the development of models.
2. Staged approach in the development of an integrated ecosystem modelling framework to investigate the impacts of climate and local changes on fisheries in Torres Strait, via coupling together:
    a. Development and implementation of data framework to support future modelling efforts in Torres Strait
    b. Development of integrated ecological or socio-ecological models capable of integration with a regional hydrodynamic model:
        i. For example, start by combining existing data and models (TRL, BDM, and dugongs) into an integrated spatial MICE, which will form the basis for a hybrid MICE-ATLANTIS ecosystem model;
        ii. Dedicated regional hydrodynamic model, including physics and biogeochemistry for Torres Strait, for example similar to eReefs.

Part 1: Background

1 Introduction

Fishing is a critical activity in Torres Strait supporting both Indigenous and non-indigenous sectors through commercial, subsistence (food security) and traditional activities (Busilacchi et al. 2013). Commercial fishing is one of the most economically important activities in the Torres Strait, providing significant opportunities for financial independence, maintenance of traditions and lifestyle for traditional inhabitants of the region (Plaganyi et al. 2013b, van Putten et al. 2013b, Johnson and Welch 2016). Not surprisingly, impacts on Torres Strait fisheries have profound economic and social consequences to traditional and non-traditional inhabitants of the Torres Strait.

Pressures on fisheries resources can be localised (e.g. overfishing, increased runoff and turbidity due land-use changes and extreme rainfall events) and also related to climate change (e.g. ocean acidification, increase in sea surface temperature) (Welch and Johnson 2013). These pressures manifest directly in the form of changes in fish abundance, growth, reproductive capacity, distribution and phenology (changes in cyclic and seasonal phenomena such as reproduction and migrations)(Free et al. 2019)), and indirectly through changes in foodwebs and habitats (Welch and Johnson 2013, Fulton et al. 2018). Localised and climate change pressures can act in isolation or synergistically to influence fishery resources (Abelson 2019).

Localised and climate-change pressures affect Torres Strait habitats and fisheries indirectly via changes in sea level, sea surface temperature and extreme rainfall events (Marsh and Kwan 2008, Babcock et al. 2019, Smale et al. 2019). Some direct pressures include localised habitat destruction, pollution and over-exploitation (Plaganyi et al. 2013a, Duke et al. 2015, Patterson et al. 2018). Such impacts have reduced Torres Strait Islanders' access to target species (Skewes et al. 2006, Plaganyi et al. 2013a) or caused reduction in catches (Marsh and Kwan 2008). Fisheries management and assessments will need to take account of the implications of future variability and change that may affect stocks. These may manifest through effects on recruitment pathways, growth and mortality rates, and critical habitats among other processes.

Anthropogenic impacts in Torres Strait are minimal, but exist in specific locations. The main drivers are the modernisation and urbanisation of Island communities, and need to connect to mainland Australia and markets. These require built infrastructure such as piped water and sewerage facilities, better housing, jetties, roads/air strips, and shipping routes. Land clearing and associated increase in land-based runoff, localised pollution, changes in water flow and oil spills are some of the risks affecting Torres Strait fisheries (Duke et al. 2015).

Climate change also threatens Torres Strait Islands, their people, fisheries and industries. Current and expected impacts from climate change likely to affect Torres Strait fisheries include higher seas, warmer atmospheric and ocean temperatures, more acidic waters, and changes in ocean circulation (CSIRO-BOM 2015). Climate change is expected to substantially influence marine ecosystems and fisheries in Australia (Fulton et al. 2018). There is no single most important factor affecting all of Torres Strait fisheries as they are site- and fishery-specific. Instead, multiple climate and non-climate stressors interact in various ways to impact fisheries and habitats (Bonebrake et al. 2019). Although localised impacts on ecosystems and fisheries are relatively small in Torres Strait (see Part 2), changes in land-use, resource over-exploitation, and pollution interact with climate change to contribute to changes in Torres Strait habitats and fisheries, influencing ecosystem functioning, services, and human well-being (Duce et al. 2010, Pecl et al. 2017).

Climate change is an emerging issue affecting key ecosystem processes and fisheries resources world-wide, with a relatively large and growing knowledge base, but still with important uncertainties and knowledge gaps (Fulton et al. 2018, Free et al. 2019, Johnson et al. 2020) that need to be addressed, hence the climate change focus of this report.

Predicting exactly how climate will change and the effects of these changes in ecosystems and fisheries is very difficult in Torres Strait because the region lacks high-quality, long-running meteorological records (Green et al. 2010) and its ecosystems are highly variable and poorly studied (Harris et al. 2008, Duce et al. 2010) despite recent progress on the understanding of fisheries, environmental and governance regimes (e.g. Wolanski et al. 2017, NESP Earth Systems and Climate Change Hub 2018, Plaganyi et al. 2018c, Butler et al. 2019, Plaganyi et al. 2019c, Rodgers et al. 2019). The lack of full knowledge about how Torres Strait will change in the future does not preclude action. There is likely enough information from studies in Torres Strait to support decision-making in the short term, but information at the appropriate scale is required for longer-term strategic decisions (NESP Earth Systems and Climate Change Hub 2018). The climate change signal is clear (Suppiah et al. 2010, CSIRO-BOM 2015, Cheng et al. 2019, IPCC 2019b) and expected to affect fisheries in Torres Strait (Norman-Lopez et al. 2013, Plaganyi et al. 2013a, Johnson and Welch 2016, Plagányi et al. 2018). Torres Strait fisheries management will require relevant information to support adaptation planning. The first step in this process is to review the literature to understand potential impacts of localised and climate change on fisheries and supporting ecosystems (Part 2).The review offered in Parts 1 and 2 of the report is used in Part 3 to assess data needs and the spatial and temporal scales required to develop a future data and modelling platform to assess potential climate change (and localised) impacts on the selected fisheries. This future study will be an important aspect required for climate adaptation planning in Torres Strait.

1.1 Objectives of this report

This report will build on detailed findings from a literature review of the main climate change drivers in Torres Strait affecting tropical rock lobster, bêche-de-mer (sea cucumber), finfish, prawns, turtles and dugongs (Table 1) to provide detailed specification and costings for a future project that will produce the over-arching data framework at the appropriate spatial scales, as required to address future climate variability and change scenarios for Torres Strait fisheries. The report will also include detailed information about data availability, and specifications on data storage, management and data accessibility issues.

Table 1. Fisheries investigated in this report. Fishery type: C (commercial), S (subsistence), R (recreational) (from: Johnson and Welch 2016), plus additional Holothurians - Prickly redfish and White teatfish given their increasing economic value and harvest.

Fishery	Common name	Scientific name	Fishery type
Tropical Rock Lobster	Tropical Rock Lobster	*Panulirus ornatus*	C, S
Prawns	Brown tiger prawn	*Penaeus esculentus*	C
	Blue endeavour prawn	*Metapenaeus endeavouri*	C
Finfish	Spanish mackerel	*Scomberomorus commerson*	C, S, R
	Common coral trout	*Plectropomus leopardus*	C, S, R
	Barcheek coral trout	*Plectropomus maculatus*	C, S, R
	Passionfruit coral trout	*Plectropomus areolatus*	C, S, R
	Bluespot coral trout	*Plectropomus laevis*	C, S, R
Beche-de-mêr	Sandfish	*Holothuria scabra*	C
	Black teatfish	*Holothuria whitmaei*	C
	Prickly redfish	*Thelenota ananas*	C
	Curryfish	*Stichopus herrmanni* and *S. vastus*	C
	White teatfish	*Holothuria fuscogilva*	C
Turtle	Green Turtle	*Chelonya midas*	S
	Hawksbill Turtle	*Eretmochelys imbricata*	S
Dugong	Dugong	*Dugong dugon*	S

1.2 Why this report is needed

Semi-quantitative fisheries assessments of climate change impacts and vulnerability have been conducted in Torres Strait (Green et al. 2010, Welch and Johnson 2013, Johnson and Welch 2016, Fulton et al. 2018). However, quantitative considerations are still sparse (but see, Plaganyi et al. 2011, Plagányi et al. 2017a) despite being essential for fisheries management to adequately respond and plan for the future.

2 Approach

This report will synthesise results from previous projects about climate implications for Torres Strait and other relevant literature to identify environmental drivers that affect recruitment, growth, mortality rates, catches and relevant habitats for selected fisheries (rock lobsters, prawns, finfish, *bêche-de-mer*, dugongs and turtles).

In 2010, two major reports about climate change observations and predictions, impacts and adaptation for Torres Strait were published (Duce et al. 2010, Suppiah et al. 2010). These were based on IPCC AR5 models. We will provide a synthesis from the literature identifying key advancements in knowledge since the publication of these reports. References were gathered using search in End Note of Web of Science database using the keywords “Torres Strait” and “Climate Change” and also includes a web search on both climate change impacts and fisheries in Torres Strait (e.g. reports from major research programs, such as the National Environmental Research Program (NESP), as well as State and Commonwealth agencies). References selected for review have their abstracts screened based on their relevance to the focus of the report (climate change impacts on fisheries and supporting habitats) and include information about both observations and models related to climate change, potential impacts on physio-chemical, ecological and biological drivers influencing the selected fisheries.

The main source of information for climate change predictions for Torres Strait is web resource ‘Climate Change in Australia’ (CSIRO-BOM 2015), which presents information for the Wet Tropics of Australia. More recent predictions from peer-reviewed sources are used to update climate change predictions when appropriate.

A draft version of this report was presented in a video-conference technical workshop held on the 14th of October 2020 with relevant scientists and managers to get their inputs and feedback for incorporation into the final report.

3 Torres Strait environmental setting

Torres Strait is a narrow body of water lying between Papua New Guinea (PNG; Western Province), Indonesia (Papua Province), and Australia (Queensland) covering an area of approximately 48,000km^2 (Duce et al. 2010, Butler et al. 2019). It connects the Gulf of Carpentaria (GoC) to the Coral Sea via the continental shelf of the Great Barrier Reef (GBR) and the Gulf of Papua (Wolanski et al. 2013) (Figure 1). Its deeper channels form a major shipping route in which a large proportion of goods flow from and to Australia (Duce et al. 2010, Wolanski et al. 2013).

Torres Strait contains productive ecosystems, including about 750 coral reefs, sandbanks, and extensive areas of seagrasses and mangroves, with more than 270 islands in which 17 are inhabited with a total population of about 8,500 people (Harris et al. 2008, Duce et al. 2010, Butler et al. 2019). The region is culturally, ecologically and economically important (Wolanski et al. 2013), supporting traditional and commercial fisheries, including Tropical Rock Lobster, finfish, crab, trochus and *bêche-de-mer*, marine turtles and dugongs (van Putten et al. 2013b, Johnson and Welch 2016).

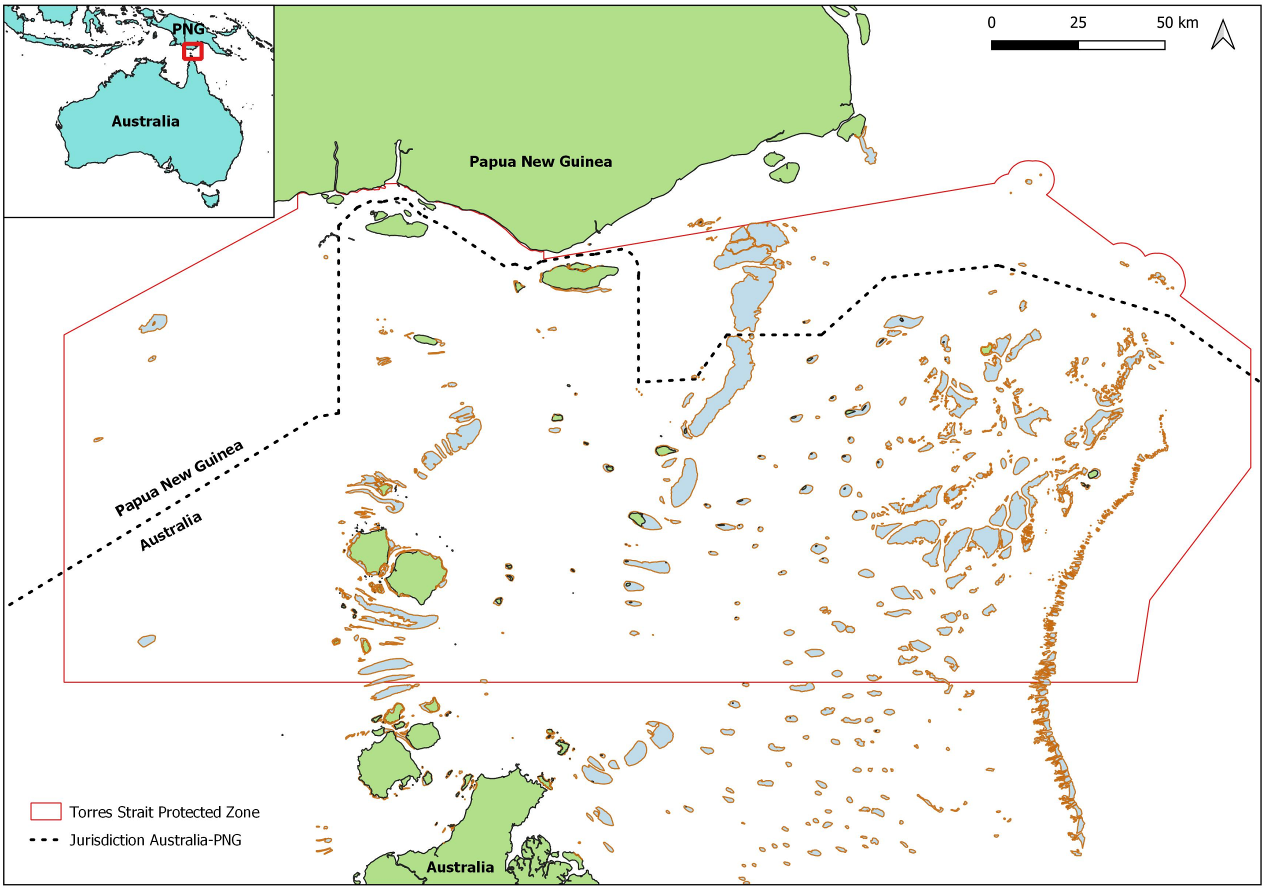


Figure 1. Map of Torres Strait (source: http://www.tsra.gov.au/news-and-resources/annual-reports/annual-report-2016-2017/section-report-of-operations/where-we-operate).

3.1 Climate

The Torres Strait climate is influenced by considerable ocean and climate variability. It is dominated by the monsoon and El Niño–Southern Oscillation (ENSO; contributing to year-to-year variability) and extreme weather events, including changes in sea level, marine heatwaves, tropical storms with associated strong winds, waves and storm surges and extreme rainfall. During ENSO, northern Australia is drier than normal, while during La Niña events it is wetter than normal (NESP Earth Systems and Climate Change Hub 2018).

The Torres Strait climate experiences seasonally reversing winds separated in two seasons: the monsoonal wet season dominated by prevailing north-westerly winds between December and April, and the dry season dominated by prevailing south-easterly winds from May to November (CSIRO-BOM 2015), where north westerlies driven by the monsoon dominate for around 15% of the year (Duce et al. 2010). Winds are stronger in the dry season (April-June), with mean maximum wind speeds up to 15ms^{-1}. Wet season winds are considerably lower with maximum speeds ranging between 10-11 ms^{-1}, while mean wind speeds are less than 4 ms^{-1}(Duce et al. 2010).

Both air and sea surface temperatures do not vary much throughout the year because of the tropical location. Average daily temperatures are 29°C (maximum mean 31.2°C and mean minimum 25.4°C). Wet and dry season mean maximum and (minimum) vary from about 28 (22)°C to 32 (25) °C (Green et al. 2010). Sea surface temperatures range from 29°C (summer) to 25°C (winter). Mean annual rainfall is 1,750mm falling mostly during the wet season between November and February (Duce et al. 2010).

Cyclones are relatively rare in the region because Torres Strait is located north of the main cyclone belt. However, the area receives cyclonic-related storms and strong wind events, which influence surges (Duce et al. 2010, NESP Earth Systems and Climate Change Hub 2018).

3.2 Bathymetry and circulation

The bathymetry and circulation in Torres Strait are complex, mostly shallow (between 5 and 25m deep) – especially along the axis of the western Torres Strait Islands (~142°15'E) – and characterised by high energy conditions and strong tidal currents (Green et al. 2010, Daniell 2015). The region contains productive ecosystems, including coral reefs, sandbanks, and extensive areas of seagrasses and mangroves (Harris et al. 2008, Duce et al. 2010).

The complexity of oceanographic conditions in Torres Strait is often under-estimated. Tides, currents and waves influence sediment transport and larval dispersion, affecting geomorphology and fish stocks (Duce et al. 2010). Currents are the major mechanism connecting ecosystems by facilitating dispersal of larvae, supporting biogeochemical processes, and the propagation of climate features (Wolanski et al. 2013, Johnson et al. 2018). Water circulation is still poorly understood in the region because of its complex bathymetry (Wolanski et al. 2013). The net flow through is determined by the wind and the sea level difference (Figure 2) – mean sea level (MSL) rises by about 0.1m on the Coral Sea with increasing easterly winds; MSL decreases or increases 0.2-0.3m in the Gulf of Carpentaria according to whether southeast winds (decrease in MSL) or monsoonal winds (increase in MSL) prevail (Wolanski et al. 2013). ENSO also plays a strong role in year to year variability of sea level (NESP Earth Systems and Climate Change Hub 2018).

The complex bathymetry steers the net currents to form zones of net through flow, zones of stagnation, and zones of recirculation (Li et al. 2015). During the dry season, southeast trade winds raise MSL in the northwest Coral Sea and the wind and waves on the outer GBR generate a landward flow from the Coral Sea. The wind pushes the incoming Coral Sea water longshore northward on the GBR shelf. At the latitude of Cape York, a fraction of the wind-driven current waters turns westwards to form the Through Torres Strait current, which flows into the GoC (Gulf of Carpentaria). The remaining wind-driven current waters keep flowing northwards to form the Through Great Northeast Channel Current, exiting Torres Strait and entering the Gulf of Papua (Wolanski et al. 2013). Non-linear interactions between wind and tidal currents in shallow coastal waters in the GoC result in the formation of a coastal Boundary layer on the GoC side of the Torres Strait – these waters are ultimately exported from the GoC and is replaced by an inflow of water from the Arafura Sea. The plumes from the Fly River are entrained in the Coral Sea and at least during strong southeast trade winds this forms an eddy in the Gulf of Papua (Figure 2). A small fraction of the Fly River plume is entrained in Torres Strait by the currents of the Great North East Channel (Wolanski et al. 2013). The East-West flowing currents can reach up to 2-4$m.s^{-1}$ within narrow passages during spring tides (Duce et al. 2010, Daniell 2015).

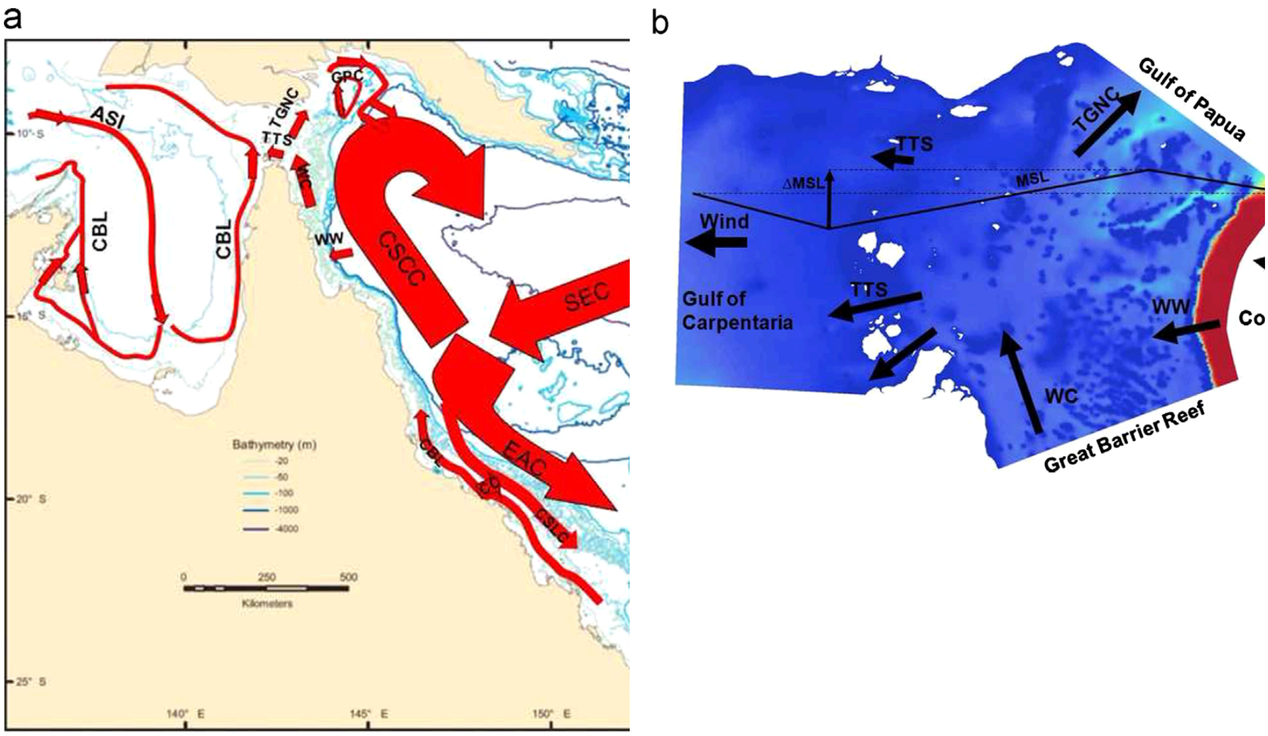


Figure 2. A sketch map of the general surface water circulation during southeast trade winds in (a) the Great Barrier Reef and (b) Torres Strait. MSL (mean sea level; ΔMSL (sea level difference between the Coral Sea and the Gulf of Carpentaria. SEC (South Equatorial Current); EAC (East Australian Current). CSLC (Coral Sea Lagoonal Current) ; CC (Cross Shelf Current as discovered by Andutta et al.(2013); CBL (wind-driven) Coastal Boundary Layer current; CSCC (Coral Sea Coastal Current); WW (inflow from the wind raising these a level in the Coral Sea and wave breaking on the outer reefs); WC (Wind-driven Current). TTS (Through Torres Strait current); TGNC (Through Great North East Channel current; GPC (Gulf of Papua current); ASI (Arafura Sea inflow).The CSCC was the original name given to that current by oceanographers (Andrews and Clegg, 1989) and it is also known as the Hiri current (source: Wolanski et al. 2013).

Tidal regime in Torres Strait is complex and variable because of the combination of strong currents and bathymetry and location of the Strait between two Ocean basins with different tidal regimes (semi-diurnal in the Pacific/Coral Sea and diurnal tides propagating from the Gulf of Carpentaria and the Indian Ocean) (Hemer et al. 2004, Daniell 2015). Tidal range in the Torres Strait depends on location. In the Gulf of Carpentaria it varies between 1.5-6m and in the Coral Sea and Gulf of Papua it varies between 3-7m (Duce et al. 2010).

Part 2: Threats to Torres Strait Fisheries

4 Local threats

Local impacts in Torres Strait include metal pollution from the Fly River (PNG) associated with mining, and construction of future oil and gas facilities, oil palm plantation and associated infrastructure building to support these industries. The required land clearing will increase sediment and pollution runoff, destruction of habitats with impacts on ecosystems and connectivity (Wolanski et al. 2013). Threats to Torres Strait fisheries include oil contamination, ship accidents, mangrove cutting, alteration of hydrology, nutrient and chemical contamination, and over-harvest of marine living resources (detailed below).

4.1 Oil contamination

Ship-and land-based related oil contamination occurs in Torres Strait but seems to be contained to small areas close to boat loading facilities (Duke et al. 2015). Major oil spills have occurred in the past (e.g. 'Oceanic Grandeur' oil spill in 1970) and have the potential to occur again in the region especially because of increased traffic since then.

4.2 Ship accidents

In addition to the risk from oil spills, the physical impact from ship grounding can cause structural habitat damage (e.g. coral reefs, seagrasses) (Carter et al. 2018). Antifouling paint (AFP) scrapped from hulls of grounded vessels (as smears and flakes) is also known to pose a significant risk for marine life. For instance, the exposure of marine life to contaminants present in AFP can cause: a) extensive mortality of resident communities (e.g. corals (Smith et al. 2003)); b) decrease in growth rates of molluscs (Alzieu 1998), corals (Smith et al. 2003), fish (Triebskorn et al. 1994, Shimasaki et al. 2003) and microalgae (Beaumont and Newman 1986); c) negative effects on reproduction, such as inhibition of reproduction in molluscs (Alzieu 1998), reduced sperm counts in fish (Haubruge et al. 2000), reduced coral fertilisation (Reichelt-Brushett and Harrison 1999), larval survival (Negri and Heyward 2001), larval settlement (Negri et al. 2002), larval metamorphosis (Reichelt-Brushett and Harrison 1999, Negri and Heyward 2001, Negri et al. 2002), induced sex reversal (increased masculinisation) in fish (Shimasaki et al. 2003) and molluscs (Horiguchi et al. 1998); and d) hampered recovery of adult populations from other stresses (Smith et al. 2003).

4.3 Mangrove cutting

Mangrove cutting affects a large proportion of mangroves on Boigu, Dauan and Mabuiag and seems to be mostly restricted to these islands. Mangroves are mostly harvested for timber resources (firewood, building material and for carving) (Duke et al. 2015: 71).

4.4 Alteration of hydrology

This is a relatively minor issue associated with the building of infrastructure (mainly air strips, dams and roads), which restrict natural freshwater, overland, and tidal flow into coastal ecosystems such as mangroves, causing localised die-offs (Duke et al. 2015:72).

4.5 Nutrient and sediment runoff and chemical contamination

Sewage treatment plants in Torres Strait have been upgraded in the early 2010s but it has been reported that despite the upgrades they still experience frequent maintenance issues resulting in leaks and untreated sewage discharge, negatively affecting nearby ecosystems (Waterhouse et al. 2013, Duke et al. 2015). The Islands mainly affected by nutrient contamination from sewage treatment plants are Boigu and Iama (Duke et al. 2015).

Chemical leachate in Torres Strait is associated with landfills often located within or directly adjacent to tidal wetland habitats and subjected to tidal inundation during king tides and runoff from heavy rainfall events. Evidence of chemical leachate (albino mangrove propagules) has been found in Saibai and Boigu Islands. Dauan, Boigu, Saibai and Iama Islands have landfills in close proximity of mangroves (Duke et al. 2015).

There is ongoing concern over the implications of sediment-related pollution originating from the Fly River. Saibai, Dauan and Boigu are most affected, though results are currently inconclusive and some species may be more sensitive to impacts from Fly River plumes than others (Waterhouse et al. 2018). Future research is needed to investigate common food sources for metal contamination as well as work to determine historical levels of metals in sediment and corals (NESP Earth Systems and Climate Change Hub 2018).

4.6 Over-harvest of marine living resources

While most fishery stocks in Torres Strait have not been overfished or subject to overfishing (Patterson et al. 2020), unsustainably high harvest levels have occurred in at least two stocks.

Sandfish (*Holothuria scabra*): Catch levels peaked in 1995 but were unsustainable leading to fishing closure (Skewes et al. 2006, Plaganyi et al. 2013a). The fishery is still closed but classified as “not subject to overfishing”, because there were no reports of illegal fishing in 2017 (Patterson et al. 2018, Patterson et al. 2020) (see chapter 7.4).

Sea turtles (Chapter 7.5): Hawksbill turtle nesting population in Torres Strait is in severe decline mostly due overharvest in neighbouring nations and potential overharvest of eggs in Torres Strait and in neighbouring nations (NESP Earth Systems and Climate Change Hub 2018). Similarly, Northern Great Barrier Reef stock of Green turtles which utilise Torres Strait is likely to decline due to failing hatchling production at key index sites at Raine Island and Moulter Cay. Targeting of adult females for harvest and overharvest of eggs in some locations in PNG, Solomon Islands and Torres Strait are also primary contributors (NESP Earth Systems and Climate Change Hub 2018).

5 Climate change

The planet is clearly warming (Cheng et al. 2019). Global concentrations of greenhouse gases in the atmosphere continue to increase mainly due to emissions from fossil fuels, and are unlikely to be drastically reduced in the short term because of the inertia of governments (Climate Transparency 2018). Greenhouse gas emissions have increased on average 1.5 percent per year in the last 10 years (United Nations Environment Programme 2019). The opposite was expected if the world is to achieve the Paris agreement goal of limiting warming below 2°C and pursuing efforts to limit warming to 1.5 °C above pre-industrial levels.

The planet has warmed by over 1 °C since records began in 1850, resulting in mass loss from ice sheets and glaciers and sea level rise (over 20 cm since 1880), with the rate of sea level rise accelerating in recent decades (Commonwealth of Australia 2018, IPCC 2019b). A major contributor of global sea level rise is the melting of the Greenland Ice Sheet, driven by oceanographic and atmospheric warming. Greenland Ice sheets are melting seven times faster now than in 1992, with the rate of melting expected to increase due to global warming, on track to reach IPCC's predicted rates for high-end climate warming scenario (Shepherd et al. 2019). As the frozen soil starts to thaw, it releases more organic carbon than what summer plants can sequestrate. This carbon is converted into carbon dioxide and methane (greenhouse gases) further exacerbating climate change (Schuur 2019).

Not surprisingly, long-term observations show that the last 5 years (2015-2019) were the hottest on record and climate change projections made in the last 10 years appear to be conservative as climate is changing faster and stronger and expected to continue this strong warming path, reaching 3-5°C by 2100 (World Meteorological Organization 2019), despite the Paris agreement to limit warming to below 2°C (Lenton et al. 2019). Recent advances in climate science are reducing uncertainties about ice melting in Antarctica and Greenland, and are pointing to faster rates of ice melting compared to predictions in the IPCC 5th Assessment Report (AR5; IPCC 2014) with strong implications to the ice contribution of sea level rise (Shepherd et al. 2018). For example, between 1984 and 2018, sea ice coverage in the Arctic Ocean has declined by one third (Moore et al. 2019) and there appears to be a redistribution of heat from the Earth's atmosphere into the ocean interiors (up to 2,000m deep) (Cheng et al. 2019). Ocean warming appears to be increasing the energy of ocean currents in the last 25 years (Hu et al. 2020).

The future is uncertain but models and observations depict a future in which climate will continue to change, interact with climate variability and non-climate drivers affecting the interactions between oceans, cryosphere and atmosphere, ecosystem goods and services, and people (Commonwealth of Australia 2018, Coffey et al. 2019, IPCC 2019b). Changes in climate and ecosystems are already affecting fisheries worldwide (Pecl et al. 2014, Pecl et al. 2017, Lindegren and Brander 2018). Although some species will benefit from climate change–especially with warming waters– the majority of species will be negatively affected through changes in growth, abundance and distribution (Free et al. 2019).

5.1 Climate Change in Australia

Climate is changing much faster in Australia than in most of the world's oceans (Fulton et al. 2018). Since 1910, air temperatures have risen on average by about 1°C, with most warming post 1950. This has resulted in more extreme events such as heat waves, extreme rainfall events and cyclones (CSIRO-BOM 2015, Frolicher et al. 2018, Babcock et al. 2019, Smale et al. 2019). Natural climate variability in Australia's Tropical Pacific Ocean region is associated with El Niño and La Niña events, which now occurs on top of the warming trend with the potential to modify climate-ocean interactions with flow-on effects on Australia's climate (CSIRO-BOM 2015).

Since 1900 there has been a general increasing trend in rainfall during the northern wet season. There is evidence that heavy rainfall (rainfall extremes) are becoming more extreme, with a higher proportion of total annual rainfall coming from heavy rain days (Commonwealth of Australia 2018). Extreme rainfall events are expected to become more intense because of the relationship between increase in temperature and the water holding capacity of the atmosphere. Total rainfall in heavy rain days is expected to increase by around 7% per degree of warming. For short-duration, hourly, extreme rainfall events, observations in Australia generally show a larger than 7% increase. Short-duration rain extremes are often associated with flash flooding (Commonwealth of Australia 2018).

As a result of climate change, Australian marine ecosystems are already experiencing poleward redistributions of species across taxa and throughout latitudes worldwide (Hobday et al. 2016, Marzloff et al. 2016, Pecl et al. 2017, Fulton et al. 2018).

5.2 Climate change in Torres Strait

Climate change expresses in Torres Strait via extreme events, such as extreme high tides and sea surface temperature (T. Skewes, D. Brewer and J. Rainbird pers. observations). Climate change is impacting fisheries and cultural sites, impacting the exchange of cultural knowledge (Nursey-Bray et al. 2019). Given the current unprecedented emissions and trends (see Chapter 5), we are likely in a high emission scenario path (i.e. in line with IPCC representative impact pathway (RCP) 8.5). We therefore present results for RCP8.5 noting that if trends change it is possible to explore predictions for low and mid-range emission scenarios in the existing tools used in this review (CSIRO-BOM 2015, BOM-CSIRO 2018) (Table 2).

Table 2. Current and future climate change projections for Australia Wet Tropics for RCP 8.5 (CSIRO-BOM 2015). Climate data for Present conditions are for Horn Island station (http://www.bom.gov.au/climate/averages/tables/cw_027058.shtml)

Climate Change Attributes	Present (Period)	Prediction 2030	Prediction 2070	Prediction 2090	Recent updates
Annual Mean Surface Temperature (1995-2019)	27.6°C	0.8±0.2°C	2.3±0.5°C	3.2±0.6°C	

Mean Surface Temperature (Wet – Nov-Apr)	32°C	0.8±0.2°C	2.3±0.5°C	3.1±0.7°C	
Mean Surface Temperature (Dry – May-Oct)	28°C	0.8±0.2°C	2.3±0.4°C	3.2±0.7°C	
Annual Rainfall (1995-2019)	1,791mm	0% (-3.2±7.2)	0% (-2.0±14.0)	0% (-5.6±17)	
Mean Rainfall (wet) (1995-2019)	1645mm	0% (-3.2±8.2)	0% (-2.1±14.6)	0% (-3±17.3)	
Mean Rainfall (dry)	114mm	0% (-5.5±13.7)	0% (-5.5±26.6)	0% (-5.6±17.0)	
Wind Speed (Mean Annual) (1995-2010)	6.18m/s	1 – 3.09% (1.0±2.2)	> 3.09% (2.1±4.4)	>3.09%	
Wind Speed (Wet) (1995-2010)	5m/s	0% (0.6±3.7)	0% (0.9±7.5)	>3.09% (2.4±5.4)	
Wind Speed (Dry) (1995-2010)	7.4m/s	1 – 3.09% (1.3±1.7)	> 3.09 (2.9±2.9)	>3.09% (2.4±5.4)	
Maximum Daily Temperature (Annual)(1995-2019)	37.9°C	0.5 – 1.5°C (0.8±0.2)	1.5 – 3°C (2.2±0.5)	1.5 – 3°C (2.9±0.7)	
Maximum Daily Temperature (Wet) (1995-2019)	37.9°C	0.5 – 1.5°C (0.8±0.2)	1.5 – 3°C (2.2±0.6)	1.5 – 3°C (2.9±0.8)	
Maximum Daily Temperature (Dry) (1995-2019)	35.8 °C	0.5 – 1.5°C (0.8±0.2)	1.5 – 3°C (2.2±0.4)	1.5 – 3°C (2.9±0.6)	
Sea Level Rise	0	0.12m (0.06 – 0.18m)		0.61m (0.41 – 0.84)	0.84m (0.61-1.1m) by 2100 (IPCC 2019a)
Sea Surface Temperature (Annual)		0.7 °C (0.5-1°C)		2.6°C (2.3 – 3.6)	
Sea Surface Salinity		0.05 g/kg (-0.12 – 0.96g/kg)		-0.28g/kg (-0.81 – 0.89)	
Ocean pH		-0.07 (-0.08 – -0.06)		-0.31 (-0.31 – -0.26)	
Aragonite Saturation		-0.41 (-0.45 – -0.24)		-1.57 (-1.67 – -1.19)	

5.2.1 Air Temperature

Temperatures have increased by around 1.1°C over the past century (1910-2013) in the Wet Tropics, with the rate of warming increasing since 1960 (CSIRO-BOM 2015). Temperatures are expected to continue to rise in Torres Strait, increasing about 1°C by 2030, 2.3 °C by 2070 and >3 °C by 2100 (CSIRO-BOM 2015).

5.2.2 Sea surface temperature

Late in the 21st century warming of the Wet Tropics coastal waters poses a significant threat to the marine environment through biological changes in marine species, including local abundance, community structure, and enhanced coral bleaching risk. Sea surface temperature is projected to increase in the range of 2.2 to 3.6 °C by the end of the century (RCP8.5; Table 2) (CSIRO-BOM 2015).

5.2.3 Rainfall

In the early 20th century the Wet Tropics of Australia experienced prolonged periods of extensive drying, but annual long-term rainfall shows no long-term trend between 1910-2013 (CSIRO-BOM 2015). Since 1998, despite a general increase in rainfall in northern Australia during the dry season, no changes in rainfall have occurred in Torres Strait. During the wet season, however, Torres Strait has experienced an increase in rainfall in the last 20 years (Commonwealth of Australia 2018).

Future rainfall predictions are highly variable. The high variability in rainfall predictions suggest that little change in mean annual rainfall is expected, but more variable and extreme rainfall events are expected to intensify (CSIRO-BOM 2015, NESP Earth Systems and Climate Change Hub 2018) (Table 2).

The high variability in rainfall projections means that fisheries models need to consider the risk of both increase and decrease in rainfall in the region (CSIRO-BOM 2015).

5.2.4 Extreme Climate Events

These are characterised as statistically rare or unusual climate periods that alter ecosystem function or structure outside normal variability (Smith 2011). In this sense, Torres Strait may be affected by temperature-related and cyclone-related extreme climate events.

Heat Waves

Climate change is likely to bring more hot days and warm spells to the Wet tropics region (CSIRO-BOM 2015). Extreme temperatures are expected to rise at the same pace as mean temperatures. In addition to an increase in mean temperature, changes in seasonal temperature patterns are also expected as well as an increase in the number of hot days (days with temperatures over 35°C) – which can triple in the region by the end of the century (CSIRO-BOM 2015).

Heavy rainfall

The intensity of extreme rainfall events is expected to increase despite the high uncertainty in future rainfall projections for the region. The magnitude of the increases therefore, cannot be confidently calculated (CSIRO-BOM 2015).

Cyclones

Tropical cyclones are projected to become less frequent, but the proportion of the most intense storms is projected to increase (CSIRO-BOM 2015).

5.2.5 Sea level rise

The dominant cause of sea level rise (SLR) since 1970 is Anthropogenic (IPCC 2019a). SLR is driven by a combination of a decrease in land-water storage, thermal expansion of the oceans, melting of glaciers and Greenland and Antarctic Ice sheets (Church et al. 2013, Clark et al. 2016). Global sea level has risen by over 0.20 m since 1880, and the rate has been accelerating in recent decades (IPCC 2019a). The rate of SLR is not uniform across the globe. For example, in Groote Eylandt in Northern Australia, the rate of sea level rise measured between 1993 and 2011 was 9mm/yr-^{1} (NTC 2011), which is consistent, but higher than global trends in accelerating sea levels since 1993 (3.2mm.yr-^{1} between 1993-2015) (Church and White 2006, 2011, IPCC 2019a). In Torres Strait, the rate of SLR is 6mm.yr^{-1} (1993-2010), twice the global average (Suppiah et al. 2010)

Predicting future sea level change is difficult because these drivers respond to climate change at different timescales, ranging from decades to centuries for glacier melting to centuries to millennia for thermal expansion and ice sheets (Clark et al. 2016). The speed of melting of ice has led to alterations in the Earth's gravitational field resulting in regional sea level fluctuations as the land rises with ice melts (Carlson et al. 2008, Church et al. 2013). Other factors that make future sea level projections complex are the effects of the dynamic variations of physical parameters in the water column associated with variations in wind change, changes in atmospheric pressure and oceanic circulation, and associated differences in water density and rates of thermal expansion on the relative sea level, resulting in large-scale temporal and spatial variability in of sea level (Zhang and Church 2012). Therefore, sea level rise depends not only on the complex ocean-atmosphere interactions and time-delays associated with these interactions, but also on the combination of past, present and future greenhouse gas emissions (Nauels et al. 2019). Despite all complexities in predicting future sea levels, confidence in sea level projections have been increasing (Church et al. 2013, IPCC 2019a).

By 2030, the projected range of sea-level rise for the Torres Strait region is 0.06 to 0.18 m above the 1986–2005 level, with only minor differences between emission scenarios (CSIRO-BOM 2015). Between 2031 and 2050, global mean sea level is expected to rise 0.2m (0.15-0.26m under high emission scenario RCP8.5) (IPCC 2019a, Kulp and Strauss 2019 and references within). Beyond 2050, uncertainty in model predictions increases substantially because of uncertainties in emission scenarios and Antarctic ice sheet responses (IPCC 2019a).

Predictions from AR5 suggest that by 2090 sea level will rise 0.40 to 0.87m (RCP8.5), with higher seas expected under certain circumstances (CSIRO-BOM 2015).However, under a high emission scenario (RCP8.5), sea level rise will be greater than in AR5 by 0.1m due to a larger contribution from the Antarctic Ice sheet (IPCC 2019a). In this recent IPCC report, global mean sea level by 2100 is expected to rise 0.84m (0.61-1.1m under high emission scenario RCP8.5) (IPCC 2019a). Sea level rise predictions for 2100 can diverge even more, with some authors estimating the range from 0.7-1m (RCP4.5) and 1-1.80m (RCP 8.5) (Kulp and Strauss 2019, and references within) and other authors proposing a sea level rise exceeding 2m at the end of the century when incorporating Antarctic and Greenland ice sheet melting (Foster and Rohling 2013, Steffen and Hughes 2013, Kopp et al. 2017, Le Bars et al. 2017).

5.2.6 Ocean acidification

Ocean acidification is the increase of partial pressure of CO_2 and associated decline in seawater pH (Enochs et al. 2016). Ocean acidification can affect organisms that secrete calcium carbonate as it decreases the concentration of carbonate ions (CO_3^{2-}) (Evenhuis et al. 2015). Impacts of ocean acidification on fisheries may be direct or indirect. There is already evidence that ocean acidification is directly impacting important fisheries through carapace dissolution (Bednaršek et al. 2020). However, contrary to what has been previously postulated, it has negligible effects on important behaviours of coral reef fishes (Clark et al. 2020a).

Indirect responses are associated with changes in habitats, for example through negative effects of acidification on coral skeletons. Several laboratory studies suggest that more acidified waters impair calcification and accelerate the dissolution of coral skeletons thus weakening coral skeletons, and triggering stress-response mechanisms, which affect the rates of tissue repair, feeding rate, reproduction, and early life-stage survival (Fabry et al. 2008, Kroeker et al. 2010, D'Angelo et al. 2012, Enochs et al. 2015). Possible responses of reef building corals to reduced calcification include a) decreased linear extension rate and skeletal density (Cooper et al. 2008), b) the maintenance of physical extension rate, but reduced skeletal density, leading to greater erosion (Szmant and Gassman 1990), and c) maintenance of linear extension and density but greater investment of energy diverting resources from other processes such as reproduction (Szmant and Gassman 1990, Albright and Mason 2013). By the end of the century the waters of Torres Strait are expected to become more acidic, with acidification proportional to emissions growth (CSIRO-BOM 2015).

6 Critical habitats and identified Impacts

Mangroves, seagrasses and coral reefs support the selected fisheries examined in this report. These three ecosystems are intrinsically connected and impacts on one of them will have consequences to the other two ecosystems (Guannel et al. 2016). In this section we describe each of these ecosystems, focusing in Torres Strait and looking at the fisheries they support, their spatial distribution, current status, impacts and trends.

6.1 Seagrasses

Seagrasses are highly dynamic, responding to a complex suite of physical environmental factors including tides, currents, turbidity, temperature, light, nutrient (N and P), salinity, exposure, and substrate availability that affect the quality and quantity of light reaching seagrass communities (Campbell et al. 2008, Rasheed et al. 2008, Collier et al. 2011, Griffiths et al. 2020). Both day length and maximum air temperature are positively correlated with the monthly seagrass standing crop (Rasheed et al. 2008). However, extreme temperatures and reduced light availability negatively affect photosynthesis, nutrient uptake, flowering and germination (Duarte 2002, Poloczanska et al. 2007). Decrease in salinity due to large flood events has been associated with a decline in seagrasses (Carruthers et al. 2002). Excessive nitrogen loading from terrestrial sources such as sewerage and agricultural run-off can inhibit seagrass growth and survival through direct physiological response and by stimulating growth of epiphytes, phytoplankton and macroalgae leading to reduction of light (Schaffelke et al. 2005, Sheppard et al. 2008) and nutrient fluxes to the seagrass leaf blades, reducing seagrass productivity, density and above- and below-ground biomass (Richardson 2006, Brodersen et al. 2015, Green et al. 2015).

Torres Strait extensive seagrass meadows represent about one quarter of Australia's seagrass area (Carter et al. 2018). These habitats are dynamic, varying seasonally and annually spreading from between 13,425 km^2 and 17,500 km^2 (Carter et al. 2014, Marsh et al. 2015).

Twelve seagrass species from 3 families occur in intertidal and subtidal meadows in Torres Strait (Carter et al. 2014). Seagrass flora include species that are highly adapted to high-light conditions (*Syringodium isoetifolium* and *Cymodocea serrulate*) and low-light conditions (*Halophila ovalis* and *H. decipiens* and *Halodule uninervis*) (Campbell et al. 2008). Species adapted to low-light conditions tend to be opportunistic, colonizing new substrate after disturbances, nutritious and less fibrous and preferred by marine herbivores such as dugongs and turtles (see Chapters 7.5 and 7.6). Taller species that are adapted to high-light conditions are unable to maintain biomass and survive in low-light conditions. These characteristics optimize survival of smaller species during periods of reduced light penetration (e.g. due to strong rainfall events associated with sediment and nutrient runoff) (Campbell et al. 2008), benefiting herbivores such as turtles and dugongs (Campbell et al. 2008).

Torres Strait seagrasses are influenced by sporadic environmental stress (strong currents, tidal exposure, extreme rainfall affecting salinity) and herbivory (e.g. dugongs and turtles) (Bridges et al. 1982). Their abundance seems to increase during the north-west monsoon, possibly a consequence of elevated nutrients, lower tidal exposure times, less wind, and higher air temperatures. Their abundance diminishes during the dry season, which coincides with the presence of greater winds and longer periods of exposure at low tides (Mellors et al. 2008).

Seagrass and algae dominate the epibenthos of Western Torres Strait and are commonly found in less than 10m deep in sandy substrate (Haywood et al. 2008). Regions containing high seagrass biomass include the Warrior Reefs, the eastern edge of the Dugong Sanctuary subtidal meadow, and reef top meadows and surrounding islands between Prince of Wales Island and Orman Reefs, while very little is known about seagrasses in the North of the Dugong Sanctuary, Prince of Wales Island to western Cape York, and Eastern Cape York and south east Torres Strait (Carter et al. 2014).

6.1.1 Key fisheries

- Dugongs
- Turtles
- Bêche-de-mer
- Prawns
- Tropical Rock Lobster

6.1.2 Total Area

13,425 km^2 - 17,500 km^2

6.1.3 Ecosystem services

Seagrasses provide the following key ecosystem services in Torres Strait (Carter et al. 2014):

1. Food for herbivores like dugongs and sea turtles
2. Cycling of nutrients
3. Stabilisation of sediments
4. Improving water quality
5. Marine carbon sinks
6. Provision of critical habitats and food sources for commercial and traditional fisheries in Torres Strait such as globally significant populations of green turtles (*Chelonya midas*), largest dugong (*Dugong dugon*) population in the world, bêche-de-mer, prawns and tropical rock lobster (Carter et al. 2014, Marsh et al. 2015, Carter et al. 2018).
7. Cultural and spiritual links
8. Food and income: Torres Strait Islanders rely on seagrasses as they support subsistence, commercial and traditional fisheries and income and have also strong cultural and spiritual links with them (Carter et al. 2018).

6.1.4 Current status and impacts

Torres Strait seagrasses are generally in very good condition (Carter et al. 2014, Marsh et al. 2015, Carter et al. 2018). Substantial diebacks of seagrasses have occurred in Torres Strait in the early 1970s, 1991-1992, and 1999-2000. The cause of the first dieback was never confirmed, but likely to be associated with overgrazing by an unusually large number of dugongs and green turtles (Marsh and Kwan 2008). The last two dieback episodes were associated with high turbidity and reduced light penetration resulting from increased rainfall and sediment runoff from rivers in Papua New Guinea coincident with an El Niño Southern Oscillation (ENSO) (Long et al. 1997, Marsh et al. 2004). Turbidity-related light stress and reduced salinity due to excessive rainfall and river flow has been identified as a major driver of seagrass habitat structure in northern Australia (Campbell et al. 2008, Carter et al. 2018). Such diebacks are believed to be natural (Marsh and Kwan 2008), known to have increased local dugong mortality (Marsh et al. 2004) and were also associated with dramatic declines in tropical rock lobster abundance in Torres Strait in 1991 and 1992 (Long et al. 1997).

Epiphytes benefit from increased nutrient inputs, which can negatively impact seagrasses. Nutrients also increase primary productivity and phytoplankton, thus reducing light availability with negative effects on seagrasses. In most cases, epiphytes do not seem to cause any harm to the seagrass host. However, increased nutrient enrichment can cause phytoplankton, macroalgae and epiphyte 'blooms', reducing light and nutrient fluxes to the seagrass leaf blades, reducing seagrass productivity, density and above- and below-ground biomass (Richardson 2006, Brodersen et al. 2015, Green et al. 2015). Threats to seagrasses in Torres Strait include ship-related oil spills and structural habitat damage, climate change and diebacks (Carter et al. 2018).

6.1.5 Climate change implications

Reduction in the extent of seagrasses meadows or diebacks are expected as temperature increases and sea level rises due to climate change. Sea level rise will increase coastal erosion and turbidity, which will negatively affect seagrasses due to reduction in light penetration. Increase in water depth may also open up new areas for seagrass colonisation, but the increased turbidity associated with coastal erosion can prevent seagrass expansion to new areas.

Seagrass loss is expected to adversely affect life history and reproductive rate of female dugongs, the effect of which cannot be separated from a possible density-dependent response to changes in dugong population size (Marsh and Kwan 2008).

Climate change effects such as increase in intensity of extreme rainfall events (see Chapter 5.2.4) will affect river discharge volumes. In the GBR, six consecutive very wet years 2007-2012 where annual discharges were ~65% higher than normal have negatively affected seagrass communities because the impacts of prolonged (multi-year) and associated continuous resuspended material within the coastal zone obliterates light penetration thereby shrinking seagrass meadow areas. The prolonged reduction in water clarity reduces the capacity of seagrass to build energy storage which negatively affects reproduction and seed production. With a healthy seedbank and adequate light seagrass meadows recovery time ranges from 1-2 years (dominated by *Halophila* spp.), however, recovery times are less predictable when seedbanks and adult populations are lost (Wooldridge 2017).

6.2 Mangroves

Mangroves are the most common vegetation community in the Torres Strait (Stanton et al. 2008). They cover an area of 26,054 ha (in 2014), represented by 35 mangrove species from 18 genera, 14 families, including 2 varieties and 2 hybrids (Duke et al. 2015). This is considered as 'high diversity for a numerically small plant habitat assemblage' (Duke et al. 2015). The description of mangroves presented below is based on Duke et al. (2015) unless otherwise stated.

Boigu, Saibai, Sassie, Zagai and Buru are the five predominantly 'mangrove' islands in Torres Strait, with dense and tall (>20 m height) mangrove forests, which have developed on shallow sandy substrate deposited on, and adjacent to, exposed coral reef flat, providing important habitat and breeding grounds for fish and mud crabs, shorebirds, bats, reptiles, Torres Strait Pigeon, Saltwater Crocodile and Turtles (Sassie Island – a mangrove Island– is the world's largest Hawksbill Turtle rookery).

Mangroves are influenced by wind, waves and tidal currents, type and size of sediments, nutrients, sedimentation, and chemical pollution. They are threatened by direct human impacts in Torres Strait including pollution (e.g. nutrients from sewage treatment plants and septic tanks and chemical leachate from poorly located refuse sites), urban development (land clearing to accommodate air strips and roads), mangrove cutting (for firewood, building material and traditional carving) and alteration of coastal zone hydrology. Other factors influencing mangroves in the region include feral animal, root burial, fire, vehicle damage, and sea level rise (Duke et al. 2015). They are also linked with Torres Strait Island culture and are a strong component of the Islanders identity.

6.2.1 Key fisheries

Mangroves sustain a variety of fisheries, such as crabs and a variety of fish species. However, no direct link has been found with the key fisheries investigated in this report, apart from Sassie Island (mangrove Island) being the world's largest Hawksbill Turtle rookery (Duke et al. 2015) and that king prawns may be more abundant in sparse seagrasses close to mangroves (Skilleter et al. 2005)

6.2.2 Total Area

26,054 ha

6.2.3 Ecosystem services

Mangroves provide the following ecosystem services to Torres Strait Islanders (Ewel et al. 1998, Shnukal 2004, Duke et al. 2015 and references within, Himes-Cornell et al. 2018):

1. Fish and wildlife habitats for commercial and traditional species (e.g. Hawksby turtles; prawns, crabs, fish)
2. Provision of food: Biyu sama are slimy balls of cooked mangrove seed-pod pulp, soaked and then cooked in an earth-oven to render it edible
3. Medicinal resources
4. Provision of raw material: timber to make tools, arts and crafts, for firewood and construction
5. Provision of water
6. Erosion control / Shoreline protection: including maintenance of soil fertility / nutrient cycling, moderation of extreme events, regulation of water flow, and trap sediments
7. Regulate air quality
8. Biological control
9. Climate regulation
10. Water quality improvement
11. Carbon storage
12. Support local and genetic biodiversity, coastal productivity and direct connectivity (fringing mangroves) with adjacent terrestrial habitats
13. Maintenance of life cycles of migratory species
14. Aesthetic information
15. Resting places on long sea voyages

16. Information for cognitive development
17. Spiritual experience
18. Opportunities for tourism and recreation

6.2.4 Current status and impacts

Duke et al. (2015) provides a useful summary of current status and impacts on Torres Strait mangroves and is used unless otherwise specified. Mangroves are subjected to high levels of stress (wind and wave activity) and are also very dynamic with some forests expanding (e.g. Erub and Iama Islands) and others retreating (e.g. Gebar Island). About 59% of mangroves in Torres Strait are considered ‘healthy’, while mean shoreline mangrove in ‘poor condition’ is 18%. The proportion of poor condition shoreline mangroves is relatively high given the minimal human environmental modification and influence.

Mangrove expansion likely reflects a recent drop in sea level during the 1980’s and 1990’s and has potentially been facilitated by elevated nutrient loads. Mangroves exposed to excessive nutrients are more susceptible to stem breakage, which reduce their ability to respond to natural wind and wave impacts, sea level rise, cyclones and storm surges, limiting their effectiveness in protecting coastlines because they become more likely to topple. Conversely, nutrient enrichment can assist mangrove accretion in response to elevated sea level and may also improve osmoregulatory function in some species increasing mangrove tolerance to increased salinity from greater tidal exposure.

Mangrove cutting is the most frequent human impact in Torres Strait, mostly for timber resources (firewood, building material and for carving). Mangroves are protected plants under State Fisheries Legislation (Section 54; Queensland Fisheries Act 1994) but in Torres Strait it is unclear whether they fall under similar traditional use exemptions as exists for turtles and dugong (Duke et al. 2015: 71).

Chemical leachate from waste disposal is likely entering mangrove habitat. Dauan Boigu, Saibai and Iama Islands have landfills in close proximity of mangroves and may be contaminated – albino propagules indicate contamination by heavy metals and hydrocarbons and were found in Saibai and Boigu Islands. Chemical leachate is likely to be affecting mangrove fauna and poses a localised threat to human health.

Only a small proportion of mangroves (<1%) are at risk from localized oil and fuel spills due to close proximity to boat loading facilities affecting (e.g. Mua Island). Major oil spills have occurred in the past (e.g. ‘Oceanic Grandeur’ oil spill in 1970) and have the potential to occur again in the region especially because of increased traffic since then. Of concern are the ecologically sensitive and important mangrove areas on Sassie and Zagai Islands and traditional and commercial fisheries that may be affected if a large oil spill occurs in Torres Strait.

Sea level rise may be exacerbating the effects of wind on shoreline mangrove forest, resulting in reduced resilience in Torres Strait (Duke et al. 2015). Mangroves are sensitive and respond rapidly to sea level variations. Sea level affects mangroves both directly (e.g. erosion and accretion of sediments) and indirectly (e.g. changes in salinity and frequency of inundation). Assumed sea level impacts were observed in all mangrove islands in Torres Strait, except Tudu. About 10% of mangroves were observed to be potentially impacted by sea level rise. Root burial may also be associated with sea level rise as transgressive coastlines may deposit sand within the mangrove forest smothering mangrove aerial roots, with the potential to cause death.

The construction of infrastructure (e.g. air strips, dams and roads) is a minor issue affecting mangroves in Torres Strait via the alteration of local hydrology. It restricts natural freshwater, overland, and tidal flow into mangrove channels, causing localised die-offs.

6.2.5 Climate change implications

Duke et al. (2015) found that mangroves have expanded in Torres Strait between 2008 and 2014 by 6% (average annual expansion rate of 2%). This is contrary to global measurements, which show declining mangrove areas on an average rate of 1% per year. Mangrove extension in Torres Strait seems to be associated with i) low level of direct anthropogenic pressure on mangrove habitats, and ii) a localised drop in sea level between 1987 and 1998, which helped establish new mangrove communities. Excess nutrients from sewage treatment plants may have caused a positive impact on the new established mangroves. Sea level rise that has been occurring at a fast rate since the late 1990s is likely to cause the retreat of the newly established mangroves in the coming years, despite localised mangrove expansion observed in some Islands (e.g. Erub and Iama).

The low topographic relief of these islands makes them highly susceptible to sea level rise and their future is uncertain. Mangrove resilience to climate change is dependent on maintaining healthy habitat such that the ecosystem can adequately and effectively respond to change (Duke et al. 2015).

Sea level rise in the Torres Strait may be exacerbating the effects of wind on shoreline mangrove forest, resulting in reduced resilience. Salinity is another important factor likely to be altered with climate change. Improving the understanding of salinity dynamics in mangroves will be important to monitor changes in mangroves low-lying islands (e.g. Boigu and Saibai)(Duke et al. 2015). Rising sea levels may increase mangrove vulnerability to strong winds during the monsoonal season through toppling. The expected increase in the incidence of heat waves (see chapter 5.2.4) may pose a threat to mangroves in Torres Strait.

6.3 Coral Reefs

In Torres Strait there are about 750 coral reefs (Harris et al. 2008) – with 684 reefs larger than 0.15 km^2 – covering an area of 3,972 km^2 (Lawrey and Stewart 2016). These reefs produce about 8.7 million tonnes of $CaCO_3$ per year, which are comparable to those reported at the GBR (Leon and Woodroffe 2013). Recent surveys have documented 275 coral species, of which approximately 75 are new records for the region. The reefs are in good to excellent condition with high coral cover, presence of the major taxonomic and functional groups and minimal incidence of coral disease (Bainbridge et al. 2015). They have the highest diversity of fungiid corals (mushroom corals) in the Eastern Coast of Australia (Hoeksema 2015). For both corals and reef fishes, the communities from central sites differed from those in eastern sites, reflecting a gradient in turbidity and wave exposure (Osborne et al. 2013).

Local morphology and spatial distribution of reef platforms are controlled by the strong tidal currents flowing through Torres Strait, shallow water depth and narrow dimensions of the shelf (Leon and Woodroffe 2013).

Coral reefs are intrinsically linked with mangroves and seagrasses. They form a mosaic of habitats which sustain fish productivity, supporting fishing industries and livelihoods. Healthy coral reefs interconnected with seagrass meadows and mangroves effectively protect the coastline against erosion (Moberg and Folke 1999, Guannel et al. 2016). In Torres Strait, the geological reef structures and hydrodynamic characteristics facilitate the deposition of soft sediments on reef tops and reef flats, often covered by seagrass; while reef edges and slopes are dominated by consolidated substrate and corals (Welch and Johnson 2013:27)

Coral reef distribution is limited by water temperature, pH, light, turbidity/sedimentation, salinity, and water depth (Aronson and Precht 2016), predation (e.g. the Crown-of-Thorns-Starfish (COTS) and *Drupella* spp.; both well-known corallivores (Berthe et al. 2016, Bruckner et al. 2017)), intra and inter-specific competition (e.g. competition between corals and algae, and between different coral species for space), reproductive and regenerative capacity, and their ability to cope with pollutants, nutrients and sediments (Rogers 1990, Kleypas et al. 1999, Guinotte et al. 2003). This means that alterations to any of these factors seriously threaten the existence of corals and their ability to build reefs.

Coral reefs around the world have been declining since the 1970s due to climatic and non-climatic factors. World-wide mass bleaching events are related to above average sea surface temperatures and heat waves (Obura and Mangubhai 2011, Lough 2012, Hughes et al. 2017). Loss of coral reefs is expected with rising sea surface temperatures, owing to interactions between warming, extreme events, ocean acidification, sea level rise and pollution (Barros and Field 2014, Babcock et al. 2019, IPCC 2019a, Lenton et al. 2019). Climate-related events cause mixed effects on coral reefs and adjacent ecosystems upon which corals interact (e.g. seagrasses and mangroves) (Hassenruck et al. 2015, Guannel et al. 2016, Albert et al. 2017), act synergistically with non-climate drivers further impacting reef corals (Wiedenmann et al. 2013, Chazottes et al. 2017, Wooldridge et al. 2017), and are expected to increase due to increased carbon dioxide (CO_2) emissions (causing ocean acidification) and consequent warming of the oceans (Gattuso et al. 2015).

Coral responses to climatic and non-climatic pressures are similar and include bleaching (expulsion of zooxanthellae that live in their tissue (Aronson and Precht 2016, Chazottes et al. 2017)), reproductive and growth impairments (Albright and Mason 2013, Sheridan et al. 2014, Fabricius et al. 2017), and coral-algal phase shifts (from coral-dominated to algae-dominated reefs) (Done 1992, Hughes et al. 2007). The end result of sustained stresses on corals is a simplification of coral community structure and reductions in live coral cover (Bruno and Selig 2007) and species coral trait diversity (Darling et al. 2013), with negative consequences for fisheries that depend on these ecosystems.

6.3.1 Key fisheries

- Bêche-de-mer
- Finfish (coral trout and Spanish mackerel (highly dependent on coral reefs for spawning and feeding)

- TRL
- Prawns
- Dugongs
- Turtles

6.3.2 Total Area

About 750 coral reefs (Harris et al. 2008), occupying an area of 3,972 km^2 (Lawrey and Stewart 2016).

6.3.3 Ecosystem services

Coral reefs provide the following ecosystem goods and services (Moberg and Folke 1999):

1. Provision of renewable resources such as Seafood, Pharmaceutical (anticancer, AIDS-inhibiting, antimicrobial, anti-inflammatory and anticoagulating), agar and carrageenan, manure, mother-of-pearls, souvenirs (red coral), marine aquarium market. Corals were used as bone graft operations. corals were used as bone graft operations.
2. Provision of building materials, production of lime, mortar and cement
3. Provision of physical structure services: protection of the shoreline, wave energy dissipation, creation of favourable conditions to the development of mangroves and seagrasses ecosystems, sediment generation
4. Biotic services: spawning, nursery, breeding and feeding areas for a multitude of organisms, maintenance of biological diversity, genetic library, keystone species that regulate ecosystem processes and functions, provision of species or group of species responsible to keep reef resilience
5. Biotic services between ecosystems: migration back and forth between adjacent ecosystems, such as mangroves and seagrass meadows
6. Biogeochemical services: Nitrogen fixation, carbon dioxide sinker, calcium precipitation
7. Information Services: long-term chemical recorder of temperature, metals, salinity and climate
8. Social/cultural services: recreation, aesthetic values, support of cultural and spiritual values

6.3.4 Current status and impacts

Despite the lack of long-term coral reef data (e.g. composition and abundance of coral species, bleaching, diseases), surveys have shown that Torres Strait reefs are in good to excellent condition (Bainbridge et al. 2015). Resurvey of sites have shown a decline in the abundance of temperature-sensitive corals (e.g. genus *Seriatopora*) (Osborne et al. 2013, Bainbridge et al. 2015).

Extensive coral bleaching was observed for the first time in Torres Strait in 2010 (Bainbridge et al. 2015) and subsequently in 2016 and 2020 (Hughes and Pratchett 2020). Bleaching, outbreaks of

COTS and coral diseases have been observed in the region and are considered the major threats to Torres Strait coral reefs (Osborne et al. 2013, Bainbridge et al. 2015, Hughes and Pratchett 2020).

6.3.5 Climate change implications

Simultaneous climate change drivers, such as sea-level rise, ocean warming, acidification, act together with local drivers (e.g. untreated sewage, chemical, sediment and nutrients runoff, oil pollution, overfishing) leading to interactive, complex and amplified impacts for species and ecosystems (Barros and Field 2014, Valmonte-Santos et al. 2016). For example, calcification rates are affected by both ocean pH and temperature. Current maximum calcification rates are just 2-3 ^{o}C below the maximum temperature corals can withstand before thermal bleaching (Evenhuis et al. 2015). When corals bleach, calcification is further supressed because photosynthetic products from the zooxanthellae are essential for the calcification process (Evenhuis et al. 2015).

Despite the evident negative effect of sea level rise (SLR) on coral reefs (Nurse et al. 2014), it may also provide some opportunities to corals (Saunders et al. 2016). Corals grow vertically and, in principle, additional depth provides extra 'accommodation space', in which corals could expand in intertidal areas and also colonise new inundated areas – provided that suitable substrate is available (Woodroffe and Webster 2014, van Woesik et al. 2015, Saunders et al. 2016) – thus increasing live coral cover (Albert et al. 2017). Some reefs can persist under SLR rates of around 4mm.yr^{-1} (commensurate with RCP 2.6 scenario) (Kench et al. 2018). However, it is unclear whether islands (including in Torres Strait) will continue to maintain their sizes under rising seas of 1.1+m by 2100 (RCP 8.5) (Kench et al. 2018, IPCC 2019a). Under such scenario it is more likely than not that rising seas will inundate coastal areas, destruct mangrove forests (see chapters 5 and 6) and further increase coastal erosion in a positive feedback loop (Barros and Field 2014, Kench et al. 2018), thus increasing turbidity and sedimentation in coastal waters and negatively affecting corals and other reef organisms (De'ath and Fabricius 2010, Brown et al. 2017a, Brown et al. 2017b).

There is high scientific confidence that anthropogenic-induced ocean warming is impacting coral reefs through thermal coral bleaching (Davies et al. 1997, Cumming et al. 2000, Rotmann 2001, Adjeroud et al. 2009, Obura and Mangubhai 2011, Kleypas et al. 2015). During bleaching events, corals stop growing and can die by starvation as it depends on photosynthetic products from an algal symbiont. Coral bleaching affects colony size (favours smaller size corals), the time of coral spawning (Paxton et al. 2016) and reduces coral calcification rates (De'ath et al. 2009, Nurse et al. 2014). Bleaching can also affect coral reproduction as it slows down swimming of coral larvae and reduces the number of viable recruits (Singh 2018), thus influencing mass coral spawning events over large geographical areas (Keith et al. 2016). Higher temperatures also lead to increase in bioerosion (Chaves-Fonnegra et al. 2017), and acts synergistically with nutrients and sediments amplifying bleaching effects and also influencing the recovery period from bleaching (Riegl et al. 2015).

Underwater heatwaves in the summers of 2015/2016 and 2016/17, as part of the longest global coral bleaching event on record, devastated coral reefs worldwide (Hughes et al. 2019). Widespread thermal coral bleaching occurred in the Torres Strait in 2009-2010 (Osborne et al. 2013, Bainbridge and Berkelmans 2014, Bainbridge et al. 2015). Coral loss in Torres Strait can have nuance but important negative consequences to reef fish. For example, it can lead to unstable energetic shifts (Morais et al. 2020), causing negative social-ecological consequences, such as decreased fish catches and coastal protection, and biodiversity loss (Adam et al. 2014). These consequences are very relevant to Torres Strait due to the reliance Islanders have on coastal and marine resources for cultural reasons, income and food (Busilacchi et al. 2013, Plaganyi et al. 2013b, McNamara et al. 2017, Johnson et al. 2018).

Ocean acidification can also negatively impact Torres Strait coral reefs. The most significant consequence of ocean acidification to corals is the decrease in the concentration of carbonate ions (CO_3^{2-}) which decreases calcification rates as coral skeletons are made of calcium carbonate (Pandolfi et al. 2011). Weaker reef systems will be far more susceptible to other pressures including bioerosion, eutrophication, coral disease, intense storms and bleaching because coral skeletons become more fragile (Meissner et al. 2012, van Hooidonk et al. 2014, Nuttall and Veitayaki 2015).

By 2100, Torres Strait coral reef fish and invertebrates communities will be highly vulnerable as they are likely to exceed their upper realised thermal limit (Stuart-Smith et al. 2015). Changes in circulation in Torres Strat (see Chapter 3.2 and also Johnson et al. (2018)) may also affect sediment transport and deposition processes, burying reefs and negatively affecting TRL habitats.

7 Key fisheries and identified impacts

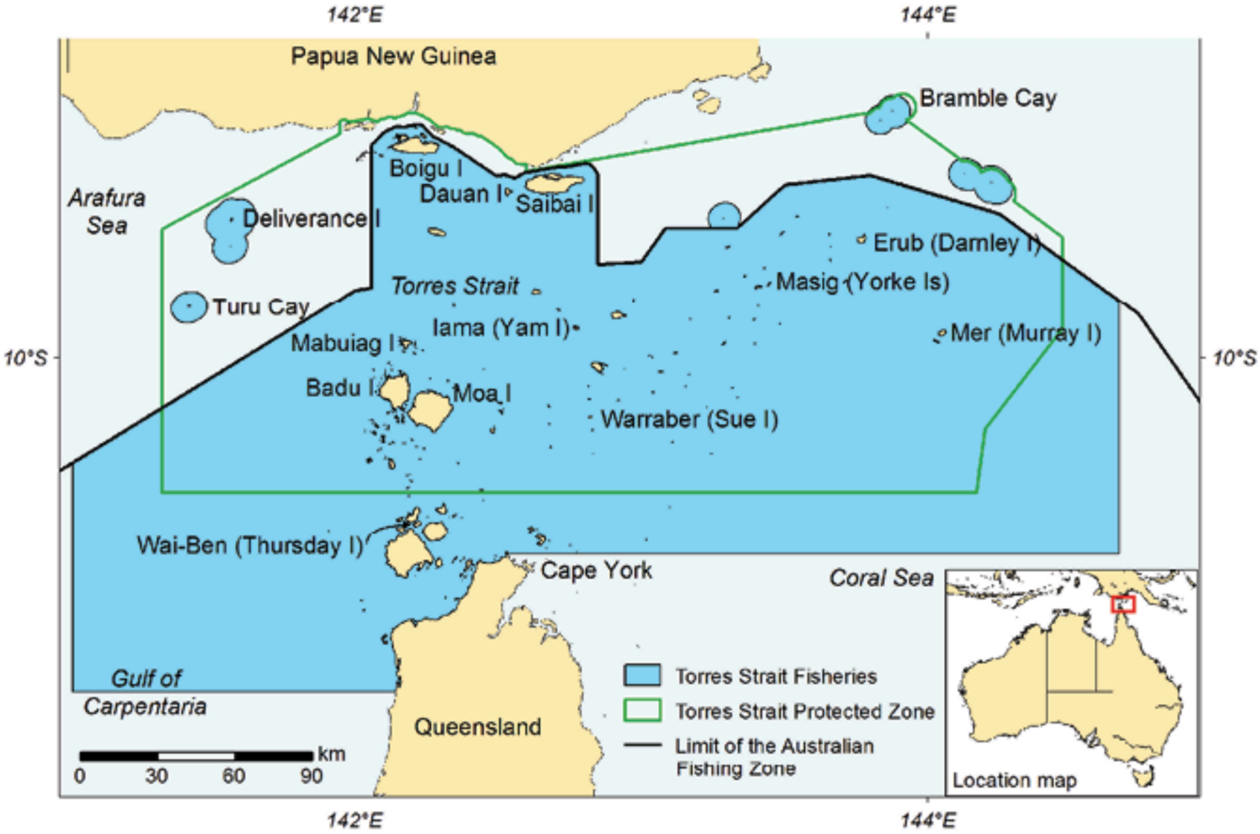


Figure 3 Area of the Torres Strait Fishery (from: Patterson et al. (2018))

7.1 Rock Lobster (*Panulirus ornatus*)

7.1.1 Description

Torres Strait Islanders and Papua and New Guineans have traditionally relied on the tropical rock lobster (TRL) *Panulirus ornatus* for subsistence and cultural uses, and it is currently the region's most economically important fishery. In general, palinurids show significant recruitment variability due to environmental factors, including currents, temperature, winds and moon phase (Plaganyi et al. 2018c). Lobsters are ecologically important in a range of marine habitats, playing a key role in mediating regime shifts, prey on benthic species such as sea urchins, and are prey of larger fish and sharks (see Plaganyi et al. 2018c and references therein).

The TRL fishery is comprised of three sectors; two in Australian waters and a third in PNG. In Australia, the two main Torres Strait fishing sectors are the Traditional Inhabitant Boat (TIB) licence holders, who typically conduct day trips harvesting lobster from dinghies only (van Putten et al. 2013b), and the Transferable Vessel (licence) Holders (TVH) sector consisting mostly of non-indigenous owned commercial vessels (a mother-ship with tenders/dinghies).

As TRL is a shared stock, within Australia it is managed by the Commonwealth. The same species is also fished to the south of Torres Strait, off Queensland's East Coast but is separately managed by the Queensland State Government.

Management recommendations for the past 31 years have been underpinned by scientific surveys of the lobster population and targeted ecological research (Ye et al. 2005, Dennis et al. 2015). The survey and stock assessment methods have been developed through consultation with traditional owners and their representative bodies, in addition to federal and state fisheries managers, independent scientists, non-indigenous fisher representatives and flow-on business stakeholders. Representatives from these groups, and particularly the Tropical Rock Lobster Resource Assessment Group (TRLRAG), have made significant contributions to the development of the fishery-independent surveys, commercial catch and effort monitoring and the integrated fishery model through consultative meetings.

Extensive tagging studies (~20,000 tags) were conducted in Torres Strait and Queensland waters and recaptures showed the 550 km breeding migration that starts in August and September, from Torres Strait to the eastern part of the Gulf of Papua, as well as clear separation of the Torres Strait and Queensland sub-populations (Moore and Macfarlane 1984, Skewes et al. 1997b, Dennis et al. 2001). As a result of the complex life-history comprising a 6 month larval life, the stock is naturally highly variable and the fishery focuses largely on a single 2 year old age-class only.

Recommended Biological Catch (RBC) needs to be set annually in such a way as to ensure biological and economic sustainability consistent with the principles of the Australian Commonwealth Harvest Strategy as well as the TRL fisheries and Protected Zone Joint Authority (PZJA) objectives. An annual pre-season survey of one-year old recruits is conducted as close to the start of the fishing season as possible (November) to inform on the likely biomass of the fishable cohort the next year. The recently implemented empirical (data-based) Harvest Control Rule (eHCR) uses catch, survey indices and CPUE (Catch-Per-Unit-Effort) as inputs (https://pzja.govcms.gov.au/sites/default/files/final_topical_rock_lobster_harvest_strategy_nov_2019.pdf).

7.1.2 Trends and current status

The stock assessment uses an Age Structured Production Model (ASPM) and is an integrated assessment that takes into account all available sources of information (Plaganyi et al. 2019a). The most recent stock assessment was conducted in 2019, and with the switch to use of an eHCR to produce an RBC, stock assessments will be conducted every three years. The stock is naturally highly variable but is considered to have been fluctuating about a high average mean throughout most of the stock's history, with the exception of a concerning downward trend in 2017 and 2018 that has been attributed to anomalous environmental factors (Plaganyi et al. 2019a). However, the 2018 and 2019 preseason surveys recorded high recruitment of 1+ lobsters, resulting in much higher TACs being set for 2019 and 2020.

The most recent stock assessment results indicate that the TRL spawning biomass $B(2019)^{sp}$ is approximately 93% of relative unfished biomass $B(1973)^{sp}$, which is well above the agreed target reference point of 65 per cent unfished biomass under the harvest strategy. The target reference point is relatively higher compared with other Australian fisheries and guidance under the Commonwealth Harvest Strategy Policy. This was deliberately designed to meet the objectives of the TRL fishery and protect the traditional way of life, and livelihoods of traditional inhabitants in Torres Strait. The model estimated a spawning stock biomass $B(2019)^{sp}$ of 4,467 tonnes.

Based on the eHCR, the 2019-20 season RBC is 582 tonnes. Most of the lobsters that are caught are exported live to China, but under travel restrictions imposed in repose to the 2019/2020 coronavirus outbreak, exports have ceased at the time of writing this report and the consequences on this year's fishery catch, economics and livelihood of dependent stakeholders are not currently known.

7.1.3 Value

Most lobsters are now caught live for export to China which has substantially increased the value of the fishery (Plagányi et al. 2017b). The average annual total catch from 2010 to 2019 was 632t. The gross value of production (GVP) of the Australian fishery (not including PNG) fluctuates annually due to the large variability in the stock, with annual estimates ranging from around $12.2 to $20 million.

7.1.4 Issues

Larval circulation models suggest that, depending on the Coral Sea gyre and local currents influencing the broader Coral Sea and Great Barrier Reef regions, some of the larvae may settle off Australia's north-east coast and, similarly, some of the larvae spawned by the East Coast *P. ornatus* component may be advected into Torres Strait due to the predominant northerly direction of the current (Plagányi et al. 2018, Plagányi et al. 2019). The complexity of the oceanographic processes in combination with diverse life histories makes predictions of changes in recruitment success as a function of large-scale oceanographic changes difficult. Using 23 years of continuous survey and climate data, Plaganyi et al. (2019) found no clear relationship between population size and the predictions of the CONNIE3 oceanographic model. However, the BRAN model used is a global model with a daily time step so it does not adequately capture the complex dynamics of the tides in the Torres Strait (http://www.bom.gov.au/australia/tides/about/p4b-torres-strait.shtml) which may influence larval advection in this area. CONNIE3 uses archived currents from oceanographic models and particle tracking techniques to resolve spatial displacement of particles and estimate connectivity statistics from user-specified source regions (or to user-specified sink regions). A range of physical and biological behaviours can be specified including vertical migration, horizontal propulsion or swimming (user-specified random or constant velocity). But the model used cannot be considered reliable in terms of predictions of the exact final distribution of larvae in Torres Strait itself because the model does not resolve tides. Finer resolution oceanographic models are therefore needed to establish relationships between oceanographic processes and recruitment, as a basis for projected changes due to future changes in currents and tides.

Growth in all life history stages (larval, juvenile and adults) have been assessed (Norman-Lopez et al. 2013) as being at high risk due principally to a likely increase in sea temperatures. This effect was assessed as being mostly positive based on experimental studies demonstrating the enhancement of growth by warmer sea surface temperatures up to 30^{o}C (Dennis et al. 1997, Skewes et al. 1997a). Medium risks contained both positive and negative effects. Positive effects were associated with an increase in larval growth due to projected increases in primary production in the Coral Sea (Brown et al. 2010), and faster adult growth and bigger lobsters resulting in an increase in adult reproduction. Negative effects were associated with increased larval and juvenile mortality related to higher sea surface temperatures and detrimental effects on the juvenile lobsters' seagrass habitats. Norman-Lopez et al. (2013) also highlighted that climatic changes to rock lobster catches will have a direct effect on the employment and income (wages and profits) of Islanders (TIB) and non-Islander fishers (TVH), and in turn have a flow on effect to other sectors through changes in demand from these two fishing groups.

More recently, TRL projections to 2050 were run using the same decadal climate projections as the project 'Decadal scale projection of changes in Australian fisheries stocks under climate change.' The projections are available from the CSIRO decadal forecasting project (Matear and Zhang), with international models accessed from the CMIP5 archive. The March 2017 TRL stock assessment model was refitted by linking with climate data available from 1992, and model results suggest strong support for the hypotheses that growth and survival of lobsters are affected by changes in SST (Plagányi et al. 2018). The parameters of the latter functional form were estimated in the model, and used to forward project the lobster spawning biomass to 2050. The model estimated small changes only in lobster mortality over the temperature range 25-29°C, but a fairly steep increase in mortality as SST increased above the likely optimum SST of 29°C. Overall, in the short to medium-term, the TRL spawning biomass is predicted to remain roughly at current levels, with large inter-annual fluctuations as observed in the past, but a decrease is predicted in the longer term (Plagányi et al. 2018). The model fit improved substantially when introducing the hypothesized relationships between SST and growth and mortality, suggesting that changes in SST may already have been influencing TRL dynamics over the recent past, and also that the hypothesized relationships are consistent with available data to date. The model estimated a fairly steep increase in mortality as SST increased above the likely optimum SST of 29°C, although the model relationship was estimated using data up to a maximum of 32°C whereas future SST is predicted to increase to approximately 34°C by the end of the century, and hence is outside the range of current observations (meaning extrapolations are less certain).

However ongoing work will continue to refine these projections. These modelling results incorporate first order effects only, and more work is needed to account for more complex impacts of climate change shifting temperature beyond the thermal envelope for TRL, including moult frequency and increment, timing of larval release and potential mismatch with optimal food conditions and circulation patterns.

Torres Strait waters are expected to increase in acidity in future, with acidification proportional to emissions growth (CSIRO-BOM 2015). Although the exact effects on TRL are not known at present, ocean acidification is considered an important threat to marine species, including crustaceans (Keppel et al. 2012, Green et al. 2014). Negative impacts on lobsters and other crustaceans are increasingly being documented (Whiteley 2011, Agnalt et al. 2013, Bednaršek et al. 2020). A recent study (Bednaršek et al. 2020) demonstrated conclusively using an *in situ* study that increasing ocean acidity is impacting the shells of crab larvae, making them more vulnerable to predation as well as weakening support structures for muscles and possibly leading to loss of important sensory and behavioural functions.

Biophysical understanding is essential for planning responses to climate change but this is not sufficient as the full range of opportunities and threats that will confront fisheries are not limited to biophysical changes at the production phase of fisheries (Hobday et al. 2015). Consideration of the impacts of climate change along seafood supply chains, the steps a product takes from capture to consumer, is thus vital to ensuring the ongoing supply of seafood (Hobday et al. 2015). A quantitative metric for comparing key features and critical elements in wild fisheries and aquaculture supply chains under a changing climate was developed by Plagányi et al. (2014), and applied to case studies including TRL. The Supply Chain Index (SCI) identifies critical elements as those elements with large throughput rates, as well as greater connectivity. Identification of key elements along the supply chain may assist in informing adaptation strategies to reduce anticipated future risks posed by climate change. The SCI identified airports, processors and Chinese consumers as the key elements in lobster supply chains that merit attention to enhance stability and potentially enable growth. For TRL, the SCI identified the Chinese and U.S. markets as key elements, suggesting that the key mechanism for stabilising this supply chain is to reduce uncertainty in supplying these markets. This study underscored that maintaining and strengthening relationships with international markets may thus be key to underpinning the success of this supply chain.

7.1.5 Opportunities

Some environmental factors (eg. temperature) and habitats (eg. hard substrate) have obvious influences on lobster growth and survival and for this reason concurrent qualitative seabed habitat monitoring has been conducted during all lobster population surveys completed since 1989. Data from these surveys have provided insights into the major influencing factors; such as the 1991-1993 seagrass dieback event which impacted the lobster population in north-west Torres Strait (Dennis et al. 2013). However, these data are only collected once or twice a year and the seasonal dynamics of any environmental change are not measured. Since 1994 the habitat monitoring protocol was refined to include a standard set of abiotic and biotic categories so that inter-annual comparisons were consistent.

As an example, fishers operating on the deep Kircaldie fishing grounds have reported the strong influence of shell beds on lobster abundance through aggregation. Hence, the incorporation of influential environmental variables has potential implications for improved management of the TRL stock and improved forecasting of stock abundance for fishers. But the Dennis et al. (2013) and Plaganyi et al. (2018) studies found no strong relationships between the environmental variables recorded and lobster abundance, although percent consolidated rubble and seagrass cover were weakly correlated and more dramatic increases or declines in these variables would impact the lobster population. Likewise, more dramatic increases in water temperature, as forecast due to climate change may influence lobster growth and survival (see for example Norman-Lopez et al. (2013)) and there is evidence from recent anomalously high temperatures that this can impact lobster natural survival rates, capture, and handling mortalities (particularly because of the reduction in available oxygen as water temperatures increase) (Plagányi et al. 2018, Plagányi et al. 2019).

Based on results to date, none of the environmental variables recorded in the survey could be used as covariates in the integrated fishery model to significantly improve the precision of the lobster stock forecasts. This result is perhaps not surprising given that although variable, the densities of recruiting (1+) and fished (2+) lobsters have not trended up or down over long periods during 1989 to at least 2017. Further, the Torres Strait fishery is managed at quite conservative levels thereby eliminating the possibility of cascading effects (as documented in many temperate fisheries due to the lobster/urchin/kelp inter-dependence). Further, in contrast to the relatively simple trophic inter-actions documented in the temperate lobster fisheries it is likely that a multitude of complex environmental factors influence the Torres Strait tropical rock lobster population. The diet of *P. ornatus* for example is broad and opportunistic and lobsters would be capable of compensating for a decline in one component by selecting another. Nevertheless, the observed influence of seasonal shell beds (at least in attracting and aggregating lobsters) and the cause of their seasonal abundance deserve further study. In the past few years anomalously high temperatures have had impacts on the stock and ongoing monitoring will be valuable for future forecasting of impacts on the lobster population.

Changing environmental drivers may also have substantial impacts on the availability of stocks to fishers (and indeed may bias survey results too), such that improved understanding of these complex relationships could assist in improving the stock assessments and methods used to support the sustainable management.

7.2 Prawns

7.2.1 Description

Brown tiger, blue-tailed endeavour and red-spot king prawns are abundant in the Torres Strait region (2009-2018 average annual catch for each species was 338, 98 and 7 t, respectively; average 1960 days fished) (Turnbull and Cocking 2019). However, the ratio of species in the catch and hours fished have changed significantly since the 1990s and early 2000s (1991-2003 average annual catch of the three species was 668, 1044 and 70t, respectively; average 9,699 days fished). The prawns are fished in the inter-reef lagoon, east of the Warrior Reefs in the eastern region of Torres Strait; but west of the myriad of reefs and coral cays and terrigenous islands further east (Watson and Turnbull 1993). Their juvenile phase migrate from the shallow reef-top habitats associated with the Warrior Reefs; both from west and east of the reefs to deeper waters where they are fished (Watson and Turnbull 1993). The nursery source of juvenile king prawns is less well known. The CPUE of endeavour prawns declined significantly over 2005-18, while that of tiger prawns has remained steady, and increased markedly from the 1990s (Turnbull and Cocking 2019).

The Torres Strait Prawn Fishery is an industrial fishery undertaken from mechanised trawlers (~15-20 m length) with significant freezer capacity. They are self-contained for weeks of operation at sea and are serviced by a mothership from Cairns, Queensland. The Torres Strait Protected Zone Joint Authority limits vessel licences to 61. Licences can only be granted to Australian citizens. Fishing capacity is defined by units, which equal boat-days available to be fished (9200 Units). The units are divided as 6,867 Australian Units and 2,333 Papua New Guinea Units.

A feature of all commercial penaeid prawns is ontogenetic habitat shift during their life history (Dall et al. 1990); the juvenile phase inhabits littoral substrates within a range of micro-habitats, the adult phase inhabits shallow coastal water ~10-50 m deep. In Torres Strait, commercial prawn juveniles inhabit shallow reef-top seagrass communities (Blyth et al. 1990, Turnbull and Mellors 1990). The dependence of their juvenile-phase on littoral seagrass habitats renders the prawns vulnerable to Climate Change; particularly as their seagrass community habitats are vulnerable to direct and indirect climate impacts (Duarte 2002, Poloczanska et al. 2007) (see also Chapter 6.1).

Tiger and endeavour prawns are dependent on the refuge structure of seagrass shoots and leaves, which provide them shelter from predators, food, and an ameliorated physical environment (Kenyon et al. 1995, Haywood et al. 1998, Loneragan et al. 1998). Juvenile tiger prawns benefit from large, broad-leaved seagrasses which provide camouflage structures on which to hide and avoid silhouette and capture (Kenyon et al. 1995). The prawn's small, post-settlement stage does not bury to avoid predation; small juveniles are pigmented for camouflage against seagrass leaves (large juveniles and adults do bury)(Wassenberg and Hill 1994, Kenyon et al. 1995). Large juvenile tiger and endeavour prawns and the adult phase bury to avoid predation (Park and Loneragan 1999). In 1999 in Exmouth Gulf, Western Australia, cyclonic disturbance removed the majority of the shallow-inshore seagrass community and created a natural experiment to show the dependence of the tiger prawn population on their inshore seagrass nursery habitats. The loss of the seagrass nurseries deprived the benthic juveniles of critical refuge and forage habitat. Fishery catch declined markedly in 2000 (82 tonnes, down from 450 tonnes in 1999) as a consequence of failure of the juvenile phase due to inshore habitat loss, despite a strong spawning index and likely abundant pelagic larvae the previous year (Loneragan et al. 2013). Over the next three years, the shallow, inshore seagrass community re-established. As the habitat components recolonised the disturbed sediments, the juvenile tiger prawn critical seagrass habitat, the juvenile prawn population, the adult population's recruitment index, and the tiger prawn fishery catch (~200 to 600 tonnes, 2001 to 2006) re-established to pre-cyclonic levels, demonstrating a clear dependency of tiger prawns on seagrass habitat.

Juvenile king prawns inhabit bare substrates and seagrass communities; particularly short, thin-leaved seagrasses, and their distribution preference among bare vs vegetated habitats varies during the day verses the night (Young 1978, Tanner and Deakin 2001, Ochwada-Doyle et al. 2011). Small juvenile king prawns are transparent with speckles, camouflage to be 'invisible' and mimic sand grains on un-vegetated substrates. They bury as small juveniles to avoid predators (Tanner and Deakin 2001) and so vegetated habitats are not critical to them. Although a preference for bare or sparsely vegetated habitats is not consistent in all localities. In Moreton Bay, Skilleter et al. (2005) found eastern king prawns more abundant on dense seagrass than sparse, and sparse seagrass close to mangroves; so microhabitat interactions that affect local density distributions can occur. King prawns can use both bare substrates and (possibly sparse) seagrass habitats and the natural cyclone-induced experiment in Exmouth Gulf (described by Loneragan et al. 2013) did not reduce their local catch immediately after cyclonic disturbances (see Kangas et al. (2015)). Despite inshore seagrass nursery habitats being removed, king prawn catch and hence their population did not decline, demonstrating that their juvenile phase was not critically dependent on vegetated littoral nursery habitat.

In Torres Strait, juvenile tiger and endeavour prawns were found among the seagrass community on the reef-tops of the Warrior Reefs and the York Island reef (Turnbull and Mellors 1990, Turnbull and Watson 1990). Fewer tiger prawns were collected from the sparse seagrass at Yorke Island than the dense seagrasses at Warrior Reef (see Turnbull and Mellors 1990), a carrying-capacity relationship between sparse and dense seagrass identified elsewhere in Australia's tropical coasts (Loneragan et al. 1998).

Information on the habitats of juvenile king prawns is more difficult to determine in Torres Strait. However, Turnbull and Watson (1990) conducted comparisons of beam trawls catch efficiency on both the Warrior Reefs and Yorke Island seagrass communities. Catches from the dense seagrass habitats at Warrior Reefs were comprised of tiger, endeavour and greasyback prawns. In contrast, catches at Yorke Island were comprised of tiger, endeavour and red-spot king prawns. The presence of king prawns at Yorke Island matches the presence of bare substrate or sparse seagrass habitats on the Atoll's reef-top (their Site 111), benthic habitats as reported by Turnbull and Mellors (1990).

7.2.2 Trends and current status

Since 2010, the annual landings of prawns from the Torres Strait fishery have been mostly ≤500 t and comprised of a majority (70-80%) tiger prawns (Turnbull and Cocking 2019). Over the same period, fishing effort has ranged from about 1,000 to 3,000 boat-days a year. By both of these measures, the Torres Strait fishery has recently operated at much reduced levels compared to the 1990–2010 period. From 1990 to 2010, prawn landings were often in the range of 1,500 – 2,000t and the proportion of tiger prawns was 40-50%; the remainder of the catch dominated by endeavour prawns. From 1990 to 2000, annual fishing effort reached 10,000 to 12,000 boat days and was regularly > 6,000 boat days. Fishing effort declined steadily from 2000 to 2010. Since 2010, landings of king prawn were negligible compared to the period 1990-2000. The Torres Strait Prawn Fishery is managed by Total Allowable Effort (TAE), though the effort levels set for 2016-2018 (9200 boat days) were roughly three times actual effort (https://www.pzja.gov.au/the-fisheries/torres-strait-prawn-fishery). The fishery operates under a Management Plan (2009) and a Harvest Strategy (2011) (available from the Torres Strait Protected Zone Joint Authority website; see https://www.pzja.gov.au).

7.2.3 Value

The Torres Strait Prawn Fishery was valued at $4.6 million in 2017-18 (278 t) (Patterson et al. 2018).

7.2.4 Issues

If Torres Strait seagrass communities are impacted by climate change, then the dependence of the juvenile stage of Torres Strait commercial prawns on littoral seagrass habitats exposes them to critical habitat loss. A summary of climate change impacts on prawns is presented in Table 3. Temperature extremes, both air temperature and SST, are likely to affect shallow littoral habitats in Torres Strait by 2030. A surface air temperature increase between 0.5 and 1.5^{o}C, and a sea surface temperature (SST) increase by 1.0^{o}C under emission scenario RCP8.5 are predicted (CSIRO-BOM 2015). By the end of the century, SST increases are predicted in the range of 2.2 to 3.6°C under a high emissions scenario (RCP8.5).

Seagrass growth and survival is influenced by temperature, light, nutrient (N and P), salinity, and substrate availability. Thermal optimum temperature for seagrass ranges from 15 to 33^{o}C (Collier et al. 2011) and SST in Torres Strait reached 30-32 ^{o}C in 2019. By 2090, SST may exceed the upper thermal tolerance of seagrass communities. Extreme temperatures affect photosynthesis, nutrient uptake, flowering and germination in seagrasses (Duarte 2002, Poloczanska et al. 2007). Moreover, regional air-temperature heatwaves and marine heatwaves will elevate shallow sea temperatures for short periods (Frolicher et al. 2018) and cause seagrass community to decline.

In addition, extreme rainfall events are predicted to increase in frequency in the Australian tropics (see Chapter 5.2.4). Decreases in salinity due to large local flood events have been associated with a decline in seagrasses. Hence, the exposure of local reef-top seagrass communities to freshwater pulsed runoff is likely and seagrass community decline is a likely consequence (Carruthers et al. 2002). By 2100, global sea levels are predicted to increase by 1.1m (IPCC 2019a) with subsequent impacts on the average depths of coral reefs that support the seagrass communities; and limiting the light penetration to the then deeper seagrass communities. In addition, cyclones are expected to increase in intensity, which have the capacity to uproot and destroy seagrass communities (Poiner et al. 1993), and hence the juvenile habitats of tiger and endeavour prawns.

The bare-substrate habitats of juvenile king prawns might expand in extent due to the loss of seagrass extent. Greater areas of bare substrate may benefit the juvenile king prawn population in Torres Strait. Cyclonic impact on the prawn community in Exmouth Gulf Western Australia provides a natural 'experiment' to illustrate these benefits (Loneragan et al. 2013). In March 1999 the category 5 Cyclone 'Vance' bisected Exmouth Gulf and removed seagrass habitats that were prolific on the eastern shallows of the Gulf. Prior to 1999, the tiger prawn:king prawn ratio in Exmouth Gulf was 50:50. In 1999, the tiger prawn population remained strong as the 1998/99 juvenile recruitment and inshore growth had occurred prior to cyclonic impact. However, the March 1999 cyclone disturbed the littoral habitats of Exmouth Gulf and by the 1999/2000 juvenile recruitment time window (October to March), their critical seagrass habitats were non-existent (Loneragan et al. 2013). The 2000 and 2001 commercial prawn catches were dominated by king prawns (Kangas et al. 2015) as they had taken advantage of the extensive bare substrates exposed by cyclonic impact (tiger prawn:king prawn ratio was roughly 20:80 in 2000). Over subsequent years, the seagrass habitats re-established in extent, and as they did the population of tiger prawns re-established. By 2005, the tiger prawn:king prawn proportions of the community had returned to similar proportions to what it was in 1995. Hence, if littoral seagrass extent in Torres Strait was to decline, king prawns may benefit and be reflected as increased catches taken over those years.

In addition to the impact of marine heatwaves on the seagrass habitats of commercial prawns, marine heatwaves may impact the postlarval and juvenile phase of the prawns directly. The temperature of shallow sub-littoral waters may exceed the thermal tolerance of pelagic prawn larvae and postlarvae, impeding their development. As the prawns develop to their benthic juvenile phase, they immigrate to shallow nursery habitats and settle from the plankton. Among shallow reef-top seagrass habitats, their exposure to local temperature spikes would continue. Both marine and atmospheric heatwaves are expected to increase in frequency and duration (Coumou and Robinson 2013, Frolicher et al. 2018); the temperature of shallow-water recruitment habitats of juvenile prawns will spike as air temperature spikes. Shallow water temperatures above 40°C would exceed the thermal tolerance of juvenile prawns (Obrien 1994). Torres Strait reef-top waters and shallow inter-reef waters are candidates for localised elevated SST and prawn physiological stress. In 2015 and 2016, shallow water temperatures above 40°C were recorded within *Enhalus acoroides* seagrass beds within the Embley River estuary, Cape York; relatively close by Torres Strait (Skye McKenna, Michael Rasheed; Port of Weipa long-term seagrass monitoring program - 2017, pers. comm.)

A second facet of climate change that may directly impact on the prawn community of Torres Strait would be physiological stress on the larval and juvenile stage of their life histories due to ocean acidity associated with increasing levels of dissolved CO_2. Planktonic prawn larvae feed on phytoplankton and zooplankton and the calcification of the calcareous skeletons of plankton will be impaired interrupting planktonic prawn larval growth under increasingly acidic oceans (Poloczanska et al. 2007). In tank experiments, reduced growth of the larvae of the shrimp *Pandalus borealis* has been measured (Bechmann et al. 2011). In addition, ocean acidification may affect the development of the exoskeleton of juvenile commercial prawns. To date, the characterisation of possible impacts on a prawn's chitinous exoskeleton remains under investigation. Carapace dissolution of crustaceans have been recorded in the West coast of the United States (Bednaršek et al. 2020). However, the exoskeleton of shrimp is dominated by chitin with calcium carbonate impregnation of the chitinous matrix (Taylor et al. 2015). Experimentation reducing seawater pH has shown that calcification increases within the exoskeleton of caridean shrimp in the short term (21 days), but with no effect on moult or growth (Taylor et al. 2015). Body translucency is reduced, which may affect the shrimp's ability to remain cryptic in natural habitat. Changes in circulation in Torres Strait may affect prawn larvae dispersion (Johnson et al. 2018).

Table 3. Observed and expected effects of climate change on prawns.

FISHERY	PHYSICAL DRIVER	CLIMATE CHANGE EFFECT	ECOLOGICAL EFFECT	INDIRECT EFFECTS	FISHERY EFFECT	NOTES	SOURCE
Tiger and endeavour prawns	Sea Temperature	Increase in SST	Extreme temperatures affect photosynthesis, nutrient uptake, flowering and germination in seagrasses	Habitat loss for seagrass-dependent prawns such as tiger and endeavour prawns. Possible increase in habitat for King prawns as they are less dependent on vegetation as juvenile habitat.	Reduction in catch: prawn mortality due to habitat loss/ loss of structured habitat protection from predation; loss of foraging habitat. Tiger and endeavour prawns are a majority of the Torres Strait catch. King prawn catch may be sustained.	Thermal optimum temperature – for seagrass range from 15 to 33°C (Collier et al. 2011)	(Duarte 2002, Poloczanska et al. 2007) Expert opinion http\\www.climatechangeinaustralia.gov.au
Tiger and endeavour prawns	Temperature – marine heat waves (MHW)	High temperature water mass (+2.5°C) moves over Torres Strait	Extreme temperatures affect photosynthesis, nutrient uptake, flowering and germination in seagrasses Seagrass loss – water temperature above seagrass upper thermal tolerance; loss of dynamic ecosystem	Habitat loss for seagrass-dependent prawns such as tiger and endeavour prawns.	Reduction in fishery catch: prawn mortality due to habitat loss/ loss of structured habitat protection from predation; loss of foraging habitat. Catch may be modified depending on the seasonality of MHW impact and regeneration of seagrass.	Marine heatwave impacts evident in Australia.	(Carruthers et al. 2002)
Tiger and endeavour prawns	Air Temperature	Increase in air temperature; exposure of	Extreme temperatures in shallow littoral and tidally-	Habitat loss for seagrass-dependent prawns such as	Reduction in catch: prawn mortality due to habitat loss/ loss	Thermal optimum temperature – for seagrass range from 15 to 33°C	(Duarte 2002, Poloczans

		shallow littoral waters to localised increased temperature and insolation.	exposed seagrass habitats caused elevated air temperature and solar radiation - affects photosynthesis, nutrient uptake, flowering and germination in seagrasses; seagrass mortality	tiger and endeavour prawns. Prawn mortality due to habitat loss.	of structured habitat protection from predation; loss of foraging habitat	(Collier et al. 2011)	ka et al. 2007) Expert opinion http\\www.climatechangeinaustralia.gov.au
King prawns	Sea and air temperature	Increase in sea surface temperature.	Extreme temperatures affect photosynthesis, nutrient uptake, flowering and germination in seagrasses	Possible increase in habitat for King prawns as they are less dependent on vegetation as juvenile habitat.	Sustained king prawn catch perhaps an increase in cath. However, king prawns comprise a small proportion of the catch, so population increase due to habitat would have to be large to be material for fishery catch.	Based on habitat suitability models for Northern Australia	(Carruthers et al. 2002).
Tiger prawns	Ocean acidity	Increase in Ocean acidity due to increased carbon dioxide in solution	Interrupted calcification of phytoplankton and zooplankton – the food of prawn larvae food	Reduction in the quanta of food resources for prawn larvae	Reduction in prawn catch: prawn larval mortality – reduction in postlarval recruitment to juvenile nursery habitats	Based on global oceanographic predictions	(Duarte 2002, Poloczanska et al. 2007) Expert opinion
Tiger prawns	Extreme rainfall events	Decrease in salinity and sedimentation due to large flood events (possibly from Fly River in PNG; Increase in sedimentation and turbidity due to local flood events causing erosion and sediment transport/deposition	Decline in seagrasses abundance and extent due to turbidity; local scale juvenile prawn population loss	Increased turbidity reduces light penetration and photosynthesis . Turbidity impacts seagrass epifloral and fauna.	Reduction in local prawn catch: local juvenile prawn population depletion	Based on climate impact projections for Northern Australia	(Carruthers et al. 2002) http\\www.climatechangeinaustralia.gov.au Expert opinion
Tiger prawns	Sea level rise	Inundation and erosion of coasts increasing sediment transport and deposition; deeper waters over	Deeper reef-top habitats; increase in turbidity; reduction in light penetration and hence the ability of seagrass to photosynthesise.	Habitat loss for seagrass-dependent prawns such as tiger and endeavour prawns.	Reduction in catch: prawn mortality due to habitat loss/ loss of structured habitat protection from predation; loss	Based on climate models and habitat impact models for Northern Australia	(Duarte 2002, Poloczanska et al. 2007) Expert opinion

		reefs and littoral habitats			of foraging habitat.		http\\www.climatechangeinaustralia.gov.au
Tiger prawns	Increase in the frequency of intense cyclones	Inundation and coastal erosion due to cyclone storm surge, Removal of seagrass habitat due to mechanical erosion during cyclonic activity;	Loss of seagrass habitat due to mechanical wave impacts; increase in smothering and turbidity which reduces light penetration and hence photosynthesis.	Habitat loss for seagrass-dependent prawns such as tiger and endeavour prawns.	Reduction in tiger prawn catch; Prawn mortality due to habitat loss/ loss of structured habitat protection from predation; loss of foraging habitat.	Based on climate models for Northern Australia	(Carruthers et al. 2002) http\\www.climatechangeinaustralia.gov.au

7.2.5 Opportunities

As seagrasses photosynthesize, an increase in atmospheric CO_2 may increase community productivity and depth limits. Increased seagrass community productivity may benefit juvenile tiger and endeavour prawns as their habitat potentially could support higher abundances of meiofauna and macrofauna (Poloczanska et al. 2007). However, seagrass communities would be subject to many other stressors associated with climate change (see Chapter 6.1 and also Carruthers et al. (2002)).

If juvenile prawn seagrass nursery habitats declined under a warmer climate, the greater areas of bare shallow substrates that resulted may benefit the juvenile king prawn population in Torres Strait. Greater habitat extent may enhance the abundance of king prawns in the fishery. However, all shallow-water habitats would be subject to extreme events such as marine heatwaves, cyclonic impacts, and extreme rainfall/runoff events.

7.3 Finfish

7.3.1 Description

There are two main finfish fisheries that operate in the eastern Torres Strait: the Torres Strait Reef Line Fishery (TSRLF) and the Torres Strait Spanish Mackerel Fishery (TSSMF) with two commercial sectors participating in the fishery: the Traditional Inhabitant Boat (TIB) and non-TIB sectors (Williams et al. 2020). Coral trout (*Plectropomus* spp.) are the main target species for commercial fishers in the TSRLF. The four species of coral trout harvested in the TSRLF (*Plectropomus leopardus*, *P. maculatus*, *P. areolatus* and *P. laevis*) are currently managed as a single species in Torres Strait, as catch records reported by fishers do not require the catch of individual coral trout species to be recorded. A large number of other reef fish species (see Welch and Johnson (2013) and Williams et al. (2008) are also harvested in the TSRLF. Spanish mackerel (*Scomberomorus commerson*) is the primary target species in the TSSMF fishery, although other mackerel species are occasionally captured. Commercial fishing occurs mostly on the north-eastern side of Torres Strait with a large area to the west currently closed (Williams et al. 2020) (Figure 4).

Fishing methods mostly involves trolling from small boats tendered to larger vessels in the case of Spanish mackerel. Hook-and-line is the predominate method to target species in the TSRLF with common coral trout making up more than 90% of the retained commercial catches (by weight) for both TIB and non-TIB sectors (Williams et al. 2020).

Fishing effort (and catches) has decreased from peaks in the early 2000s due to diverse factors such as the voluntary surrender of Transferable Vessel Holder (TVH) licences and structural adjustments in the fishery (Williams et al. 2020).

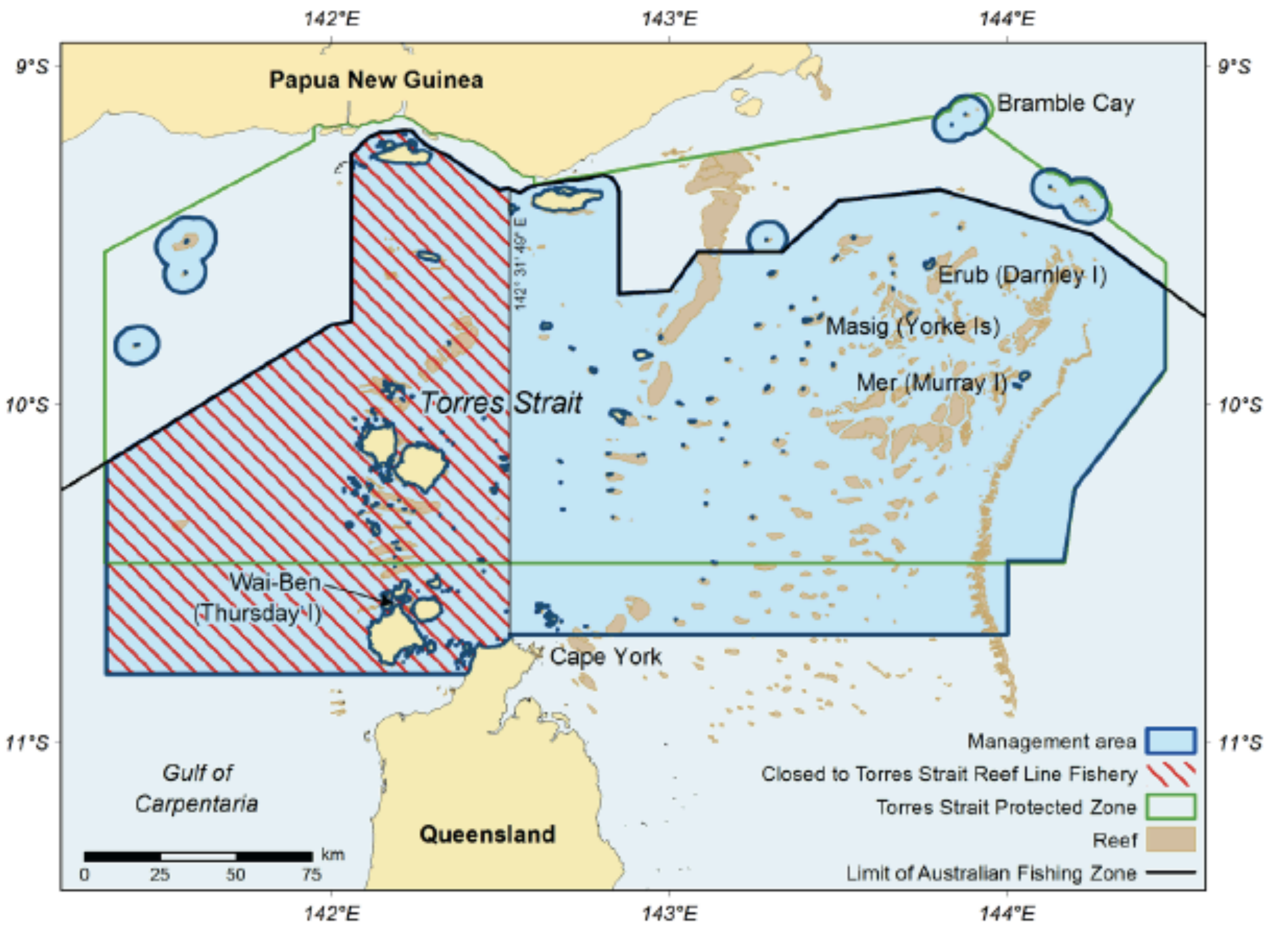


Figure 4. Area of the Torres Strait Finfish Fishery (from: Williams et al. 2020).

The following summary of climate related impacts on the Torres Strait fisheries is based on information from NESP Earth Systems and Climate Change Hub (2018), considering the following assumptions:

1. The Spanish mackerel population in Torres Strait is independent of other populations of Spanish mackerel in Northern Australia, the Gulf of Carpentaria and the East coast of Australia, and potential impacts of climate change are summarised for the Torres Strait population only.
2. Since we are unable to separate the catches of individual coral trout species (as they are not reported in fisheries logbooks), the impact on all coral trout species is assumed to be consistent among species – i.e. the assumption is that all coral trout species will be

impacted approximately the same as common coral trout. This is a high-risk approach, as the other species may be impacted differently, however there is limited information on the other species noting that Williams et al. (2008) offer information on distributions of each species which can potentially be used to identify some of the potential impacts, and

3. All other species of reef fish will be impacted in a similar way. The exception to this is rabbitfish, which form a major part of the food fish for Islanders. Where possible, we will provide reference material on future climate impacts that are specific to that type of fish.

7.3.2 Trends and current status

Spanish mackerel

Spanish mackerel is mostly fished by commercial non-indigenous fishers on the eastern side of Torres Strait (Bramble Cay), where catches are formed mostly by aged 2 to 4 years (Begg et al. 2006). It is assumed that the Spanish mackerel biological stock in Torres Strait is separate from Spanish mackerel in the eastern coast of Queensland and further west across northern Australia. The quota for Spanish mackerel was recently reduced to about 80 tonnes annually, down from 125 tonnes, due to the stock assessment indicating falling biomass levels, driven by a declining CPUE over the 8 years prior to 2018-19. Stock assessments determined that the fishery is classified as 'not overfished' but the Torres Strait Finfish Resource Assessment group recommended biological catch for 2020-21 season to be further reduced to either 56 t (F_{48}) or 71 t(F_{40}) due to model projections falling below limit reference points (Williams et al. 2020).

Coral trout (and food fish)

The peak of commercial catches for TSFRLF was in the 2003-04 fishing season at 132t, before falling to 50t in the 2007-08 season. Although the quotas were set at about 140t in the last 10 years, catches remained below 50t since then and in the 2018-19 fishing season it was 17.3t (Williams et al. 2020).

Catch reporting became mandatory in December 2017. TIB catches are likely to have been under-reported before–because catch-and-effort data reporting was not mandatory for this sector– then and have increased in recent years. Despite the need to closely monitor catch levels, recent research has shown the stock is classified as 'not overfished' and 'not subjected to overfishing' (Williams et al. 2020).

7.3.3 Value

In the 2018-19 fishing season catches for both coral trout and Spanish mackerel declined (by 35,9% and 12.2%, respectively) from catches in 2017-18, resulting in the lowest gross value of production since the 2012-13 fishing season, consistent with falls in catch and effort (Williams et al. 2020). Individual fishery value is not available but total value of the Torres Strait Finfish fishery (2018) was around $1M in the 2017-18 fishing season (Patterson et al. 2018), declining to $0.9M in the 2018-19 fishing season (Williams et al. 2020).

7.3.4 Issues

Spanish Mackerel

The population of Spanish mackerel in Torres Strait is highly vulnerable to climate change. Increases in water temperature could result in a net southward movement of the stock, which would limit access to the stock for Indigenous fishers who cannot move south to follow the stock. Spawning of Spanish mackerel is strongly influenced by sea surface temperatures, with optimal spawning temperatures < 30ºC happening mostly during the wet season (Creighton et al. 2013). South migration of Spanish mackerel in response to increases in water temperatures have been suggested since 2011 (unpublished data cited in Creighton et al. 2013). Evidence of a southward range extension due to increasing water temperature has already been documented for Spanish mackerel in Western Australia (Caputi et al. 2015).

In the last 8 years there has been a significant decline in the standardised catch rate (catch per unit of effort – CPUE) from the commercial fleet in Torres Strait (Williams et al. 2020) which may be linked to a long period of drought in PNG (Tony Vass pers comm. and statements and Finfish RAG meeting). Projections of rainfall are highly variable (see Chapter 5.2.3) and fisheries models need to consider the risk of both increase and decrease in rainfall in the region. Although some downscaled rainfall modelled outputs are available (Katzfey and Rochester 2012), data (flow from Fly River and Rainfall) are generally not available to adequately investigate effects of rainfall and flow on Spanish mackerel (R. Buckworth pers. observation).

Data are currently being collated and a statistical analysis undertaken within a new project (2020 project – Buckworth and O'Neil *pers comm*.) to evaluate potential impacts of environmental variables on Spanish mackerel catch rates. Rainfall and river flow data are not of high quality and there is limited information on prey biomass (baitfish, sardines etc). Recruitment of Spanish mackerel on the Queensland East coast appears to be linked to SST with cooler years positively influencing recruitment, although the causal mechanism for this relationship is unclear (Welch et al. 2014).

The Spanish mackerel stock in the Torres Straits is unique in other regards, as well, in that the collection of age data from commercial fishing harvests in some years since the late 1990s has shown that the 'fishable' biomass of Spanish mackerel in Torres Strait is mostly dependent on only a few year classes (2-5 years), in contrast to the fishery on the Queensland east coast which is largely supported by single strong year classes that occasionally propagate through the population (O'Neill et al. 2018).

Coral trout (and food fish)

Tobin et al. (2010) provide detail on the potential impacts of climate change on coral trout. They provide evidence of declines in CPUE associated with cyclones and resulting changes in SST – an impact that is less likely in Torres Strait because cyclones are rare and not expected to increase in frequency (see chapter 5.2.4). Based on a recent study, it is postulated that heatwaves are likely to decrease biomass and increase catch rates independent of changes in habitat (Brown et al. 2020). Indirect climate change impacts on coral trout include an increase in abundance of prey species (e.g. damselfish) following coral bleaching events due to the dead coral providing additional algae substrate which damselfish eat and decline in coral reefs that provide settlement habitats for *P.*

maculatus (Wen et al. 2013, Wismer et al. 2019). However, in the long-term, species of damselfish are expected to be negatively impacted by warmer waters (Pankhurst and Munday 2011). Such ecological impacts via increased growth and prey dynamics are contradictory. Increasing temperatures lead to faster growth rates of coral trout; however, increased temperatures is also expected to cause direct negative impacts on their prey (Johansen et al. 2015).

Samoilys (1997) found that coral trout spawning aggregations and spawning does not occur below a temperature threshold of 24°C. However, the study did not establish an upper spawning temperature (measuring a maximum of 28°C). Large increases in temperature could decrease spawning potential or change the time of spawning (which may not be in phase with currents for eggs and larvae and out-of-phase with primary productivity)(Pratchett et al. 2013). Other negative impacts on coral trout result from acidification–via an increase in metabolic demand, especially of early larval development, and a decline in coral reef habitats–and temperature, where coral trout is not able to cope with high physical activity at temperatures above 30°C (Munday et al. 2008). Also important to consider are the indirect impacts of climate change on behavioural attributes of the fishes (e.g. activity, feeding rates or escape responses), which will affect catchability. For example, if catchability increases a fishery can maintain CPUE even as biomass declines which can result potentially in a collapse as high catch rates cannot indefinitely be maintained (Brown et al. 2020 and references therein).

7.3.5 Opportunities

As a general point, references to previous scientifically reviewed studies on Spanish mackerel are from overseas work (Hare et al. 2016, Cisneros-Mata et al. 2019); whereas for coral trout (due to its dominance as an iconic species on the Great Barrier Reef) all of our references to previous scientifically reviewed studies on coral trout are from Australia. This is important as it appears the work on Spanish mackerel does not provide a good indication of the possible impacts, and if anything, local research in Australia could provide more in-depth knowledge to the real issues.

Spanish Mackerel

Not all predictions of climate change impacts on Spanish mackerel are likely to be negative. Some learnings from responses of other species of Spanish mackerel may provide useful insights on their potential responses to changes in climate. In a study on fish stocks in the Northeast US continental shelf and using *S. maculatus* as an example although we acknowledge it is a different species, Hare et al. (2016) suggest that while Spanish mackerel 'climate exposure' metric is Very High, their biological sensitivity is Low. They rate Spanish mackerel as a species with High species distribution change and therefore on the basis of this and the fact that they can move and fishers could follow them, a positive directional impact on their productivity and implied fishery catches. However, this is not necessarily the case for the stock in the Torres Straits and considerable uncertainty exists as to likely impacts. In terms of regional studies Nguyen and Nguyena (2017) (using data from Vietnam) correlate sea surface temperature (SST), moon phase, and fishing season against observed Spanish mackerel CPUE. The SST is related to ENSO/La Niña changes during the same time period and the authors admit they have no explanation for the biological linked environmental variables. In summary, Nguyen and Nguyena (2017) found a negative relationship between SST and CPUE indicating that if SST increases, Spanish mackerel biomass will decrease.

Townhill et al. (2019) quote unpublished reports (Creighton et al. 2013) that state Spanish mackerel is resilient to climate change impacts (which is possible if it is a relative metric).

Coral trout

For coral trout, changes in temperatures (including heat waves) pose a serious threat to the fishery. Declining biomass is expected along with increases in catch rates (Brown et al. 2020). The impacts from increased growth and prey dynamics are contradictory. Increasing temperatures lead to faster growth rates of coral trout; however increased temperatures impact negatively on their prey via direct links on these species and indirect links on habitats via coral bleaching. To complicate matters, expected decline in coral reefs will also affect settlement and, although overall impacts will likely be negative to the fishery, it is not known what the outcome will be in these circumstances. Although cyclones occur less frequently in the Torres Strait, where coral bleaching is more common, one could postulate a strong negative impact, yet fishing pressure in the Torres Strait on coral trout is low. There is also deep cooler water to the east. Therefore, a better understanding of impacts of temperature on coral trout growth, and its indirect effects on coral trout abundance and distribution due to changes in habitat will offer useful opportunities in Torres Strait.

Future research

Future research should be focused on the following:

1. For Spanish mackerel – data on rainfall, and river flow in PNG, data on prey abundance, data on cohort strength in Spanish mackerel over a long time period
2. For Coral trout – species-specific catch information and abundance estimates for each species. Data on the status of reefs and changes in the Torres Strait and changes in coral trout prey species over time

Note for both species, the biological-environmental links (that could capture the complex effects of climate change) lead to analyses that will be two stage, first stage – environmental drivers on prey of these predators and then second stage – links between prey abundance and Spanish mackerel and coral trout abundance.

7.4 Bêche-de-mer

7.4.1 Description

In Torres Strait, sea cucumber processed into *bêche-de-mer* (BDM) brings important socio-economic benefits to Torres Strait Islanders (Plaganyi et al. 2013a). Despite being a smaller fishery when compared to other high-value species such as the tropical rock lobster, the BDM fishery is wholly traditionally owned and contributes to regional economic development, improves quality of life and autonomy of Islanders, especially on the Eastern Islands (Skewes et al. 2002).

Sea cucumbers are sessile gonochoric (separate sexes) broadcast spawners (release sperms and eggs in mass events; usually once a year). Therefore, they need to be in close proximity to mates for successful fertilization of gametes; In low-density populations (e.g. a few individuals per ha), they may fail to get close enough to conspecifics in breeding periods, resulting in asynchronous spawning (Purcell et al. 2013). Most of the Torres Strait sea cucumbers spawn during warmer (summer) months, with some (e.g. Black teatfish and Lollyfish) also spawning during colder months (Murphy et al. 2019a). There is increasing evidence showing that sea cucumbers improve the health and resilience of coral reefs, soft-bottom and deep-water habitats (Purcell et al. 2013). They play important roles in ecosystems, most notably due to bioturbation involving ingestion, excretion and burrowing within sediments, thereby cleaning sand and keeping organic matter in check. Other important roles include nutrient cycling, oxygenation, alkalizing water which has a positive effect on coral production, and acting as hosts for a number of other species and as prey for several species such as sea stars and fish (Lee et al. 2018, Murphy et al. 2019b). The conversion of organic detritus into animal tissue and nitrogenous wastes, which can be taken up by algae and seagrasses increasing their productivity, thus producing more available food for herbivores, is highly significant for coral reefs where nutrients may be a limiting factor. Not surprisingly, declines in sea cucumber populations may reduce primary production with cascading effects to food webs and sediment infauna via the reduction of the aerobic layer of sediments (Purcell et al. 2013).

They are easy to harvest and aggregate to reproduce (Marquet et al. 2018). Such characteristics, combined with scattered landing places and wide reach of buyers make the fishery difficult to manage and maintain sustainable yields (Hair et al. 2016a). Overfishing of sea cucumber often results in reduction in their density and biomass (Uthicke and Benzie 2001), which negatively affect reproductive success, with cascading effects on the function and productivity of ecosystems (Lee et al. 2018). In Torres Strait, overfishing led to management responses including fishery closures and minimum catch sizes (Skewes et al. 2006, Murphy et al. 2014, PZJA no date). In addition to overfishing, the fishery is also threatened by climate and environmental change, which pose risks to its future (Lee et al. 2018).

Collected animals are processed to *bêche-de-mer* (ready for market) in a range of ways that may include gutting, salting, boiling and drying. The value and demand for sessile marine resources such as sea cucumber is rising (Purcell et al. 2013) resulting in the general over-exploitation and even high extinction risk for some sea cucumber populations globally (Purcell et al. 2013, Purcell et al. 2014, Purcell et al. 2018), even in seemingly well managed fisheries such as in the Great Barrier Reef Marine Park (Eriksson and Byrne 2013, Plagányi et al. 2015, Plaganyi et al. 2015, Purcell et al. 2015).

Torres Strait has two Hand Collectable Fisheries – trochus and *bêche-de-mer* which have both historically been characterised by boom and bust cycles as the result of resource depletion or price fluctuations. The trochus (*Trochus niloticus*) population in Torres Strait appears to be at least stable at present compared to historical data. A survey in 2009 showed densities were similar to 1995 survey data and healthy populations elsewhere (Murphy et al. 2010).

Historically, Sandfish (*Holothuria scabra*) on Warrior Reef provided the bulk of the early catches for the Torres Strait *bêche-de-mer* fishery (TSBDMF), which peaked at over 1,200 t (wet gutted weight) in 1995. A survey in 1998 (Skewes et al. 2000) found that the population was severely depleted and the sandfish fishery was closed. Subsequent surveys found a small recovery in the population, especially of the breeding cohort, but the current status is unknown (Murphy et al. 2011) and has remained closed. After the closure of sandfish in 1998, the fishery mostly targeted Black teatfish (*H. whitmaei*), Deepwater redfish (*Actinopyga echinites*), Surf redfish (*A. mauritiana*), Blackfish (mostly *A. miliaris*) and White teatfish (*Holothuria fuscogilva*). A stock survey in March 2002 found that Black teatfish and Surf redfish were probably overexploited (Skewes et al. 2003), and a prohibition on the harvest of these species was introduced in January 2003. Further surveys in 2009 found that the density of Black teatfish had recovered to near natural (unfished) densities (Skewes et al. 2010) and it was recommended that this species be reopened to fishing, but with a modest TAC of 25t and community-based harvest strategies to manage the spatial effort of this species (Skewes et al. 2010). Trial openings of the Black teatfish fishery with a maximum catch of 15 tonnes were conducted in 2014 and 2015. However, on both occasions the catch limit was exceeded and the fishery was closed again.

Given concerns regarding the effectiveness of catch monitoring systems, considerable effort has been invested in recent years in establishing a more reliable catch reporting system. As a result, the Torres Strait Fish Receiver System was implemented for the Torres Strait on 1 December 2017. A new harvest strategy for the Torres Strait Bêche-de-mer (sea cucumber) Fishery (TSBDMF) was implemented form 1 January 2020, known as the Torres Strait Bêche-de-mer Harvest Strategy (TSBDMHS) and is a set of pre-agreed rules that provides clear and practical guidance for sustainably managing the fishery, including what data are needed and whether the fishery can be expanded (Plaganyi et al. 2019b). It was put together based on scientific evidence from CSIRO, Australia's national science agency, and in consultation with the Hand Collectables Working Group (HCWG), AFMA, TSRA, Malu Lamar and other stakeholders (https://www.pzja.gov.au/the-fisheries/torres-strait-beche-de-mer-fishery).

7.4.2 Trends and current status

The Eastern part of Torres Strait has been historically associated with the fishery as the Western side of Torres Strait, although included in the fishery, is documented as having naturally low abundance of sea cucumbers (Figure 5) (Skewes et al. 2006, Patterson et al. 2018). Most of the catch is typically taken from the Great North East Channel, Don Cay, Darnley Island, Cumberland Channel and Great Barrier Reef regions (Patterson et al. 2018).

Twenty-three commercial sea cucumber species have been recorded in Torres Strait. There has been a demonstrated change in species fished over the last twenty years (Long et al. 1996, Skewes et al. 2000, Skewes et al. 2004, Skewes et al. 2010), with high value species harvested more regularly than medium and low value species, putting them at risk of overfishing.

In recent years there has been a shift to harvesting medium and low value species due to high value species being closed to fishing or limited TAC. The development of new processing techniques has also seen increased catches of Curryfish and more Greenfish taken.

Current catch records show Curryfish as the most caught species, followed by Prickly redfish, Lollyfish and Blackfish. This is a noticeable change in targeted species since 2018, where Leopardfish and White teatfish were the two most commonly caught species after Curryfish and Prickly redfish.

Having a formal harvest strategy (TSBDMHS) is a key building block for the future of the TSBDMF. It provides certainty to fishers, communities, scientists and managers about how the fishery will be managed. It outlines what data are needed and how the information will be used to adjust total allowable catches. A tiered (or step-wise) approach is used for how fishery data can be used to manage the fishery to reduce the risk to a resource and potentially support higher TACs (Plaganyi et al. 2019b). The HS also specifies the requirements for monitoring, with agreement that a fishery will be closed if no data are provided by fishers and fish receivers. Mixed species/basket catches are managed through the monitoring of as many individual target species as possible. The HS includes rules for re-opening a fishery/species that has been closed. For the Sandfish species that was previously overfished, there are guidelines for supporting species recovery as well as how surveys (either full scale scientific surveys or smaller experimental surveys with local participation) can be used to inform whether the fishery could be re-opened.

The HS also included the introduction of a number of new individual TAC's for species that had been previously managed in the 80 tonne catch 'basket', these included Hairy blackfish, Deepwater redfish, Greenfish and Curryfish (*Stichopus herrmanni* and *Stichopus vastus*). Curryfish and Prickly redfish are of present management concern in Torres Strait, with anecdotal evidence of local depletion reported at fishery meetings.

The implementation of more elaborate management strategies is of timely importance with teatfish species currently being considered for listing under the Convention on International Trade of Endangered Species, due to international exploitation (past and present) for the species (Conand 2018, CITES 2019). Any future international trade would be subject to strict guidelines through export permit authorisation and a non-detriment finding of the source fishery demonstrating measures for species sustainability (Korwin et al. 2019).

Two extensive sea cucumber surveys have been conducted in 2019 and 2020 and will be used to provide an updated assessment of trends and current status of a number of key fished species in Torres Strait.

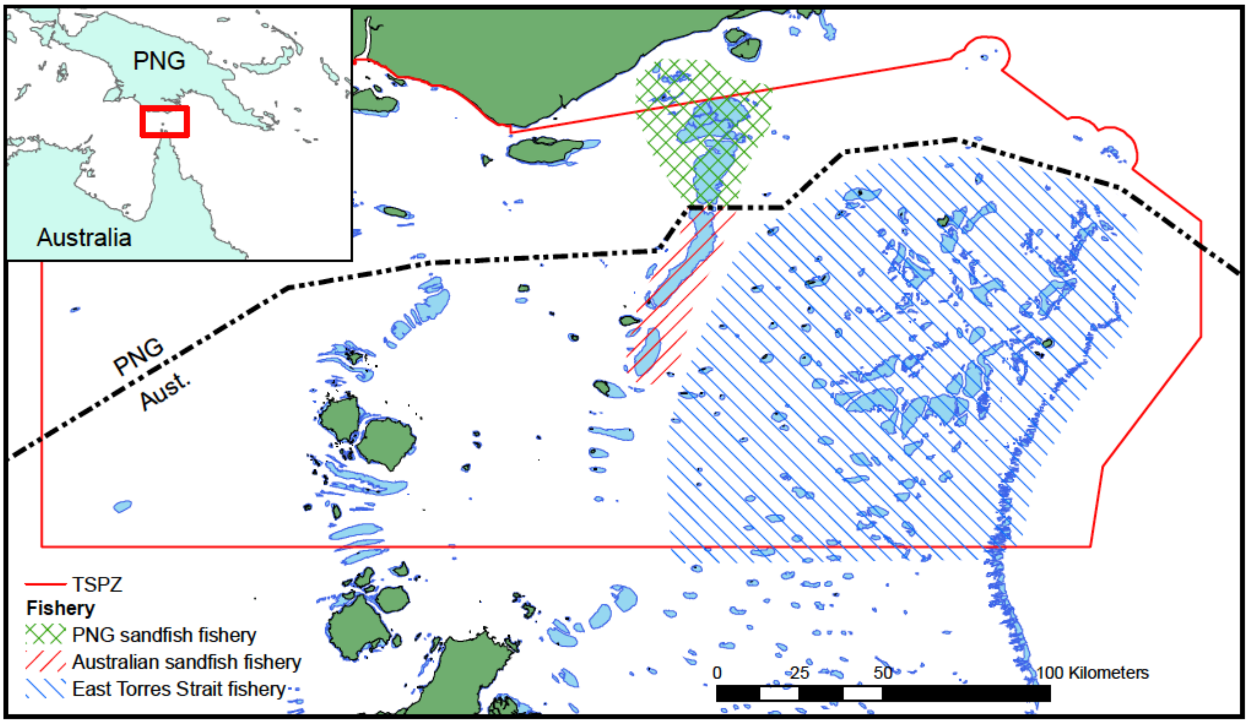


Figure 5. Map of Torres Strait showing approximate locations of sea cucumber fisheries (from (Skewes et al. 2006)

7.4.3 Value

There are no available estimates of net economic returns or gross value of production for the TSBDMF and the value of the catch is not available (Patterson et al. 2018). However, following the recent implementation of the Torres Strait Fish Receiver System as well as new TSBDMHS, these estimates may become available in future.

Most of the product landed in Torres Strait is exported to China, with particularly high retail prices in Hong Kong (Purcell et al. 2018). Prices were also found to be higher for larger animals, particularly for the three high-value species, *Holothuria fuscogilva* (White teatfish), *H. lessoni* (Golden sandfish) and *H. scabra* (Sandfish) (Purcell et al. 2018). Curryfish have only been fished more recently in Torres Strait due to earlier challenges in processing, but catches of Curryfish have been increasing (Plaganyi et al. 2019b) and this species now has a relatively high market value (Purcell et al. 2018).

7.4.4 Issues

Much of the sea cucumber fishing occurs on coral reefs and lagoons, which are under particular threat from global impacts such as climate change and ocean acidification (Purcell et al. 2013). Their calcareous skeletal structures are directly affected by seawater CO_2 concentrations and resulting ocean acidification (Dupont et al. 2010, Yuan et al. 2015). Sea cucumbers are considered to have high vulnerability to climate change (Johnson and Welch 2016, Cochrane et al. 2019), which means that ongoing improvements to harvest strategies will need to ensure that they are climate-smart (Plaganyi et al. 2013a, Punt et al. 2013). Recent studies have shown that considerable uncertainty exists for the potential impacts on sea cucumbers for most combinations of physical and biological variables (Plagányi et al. 2013). Climate change impacts may have both negative and positive effects on sea cucumbers, when they were assessed on the various life history stages of sea cucumber in combination (see Table 4 below), the net effect was slightly more negative for most species (Plagányi et al. 2013). Negative effects were associated with increased larval and juvenile mortality related to higher sea surface temperatures and detrimental effects on the juvenile Sandfish seagrass habitats. Sea level rise was assessed as being mostly positive for shallow water species (e.g. Sandfish, Black teatfish). Climate change is expected to affect distribution and phenology (likely changes in timing of spawning), and to a lesser extent in abundance of Sandfish (Fulton et al. 2018).

Table 4. Summary modified from (Plagányi et al. 2013) on potential changes due to high and medium risks from climate impacts on different life stages of sea cucumber populations in Torres Strait. Values obtained from the literature and expert opinion.

RISK	LIFE STAGE	LIFE HISTORY COMPONENT	SPECIES	EXPLANATION
High	Larvae	Growth	All	Development and growth of invertebrate larvae are generally temperature sensitive. Higher SST will speed growth up to physiological tolerances. Faster growth will mean faster development and larvae ready to metamorphose into settling juveniles quicker. This will likely increase larval supply back to settling habitats.

High	Juvenile/ Adult	Growth	All	Warmer SST generally mean faster growth up to a physiological tolerance. Very little information on the upper limits to growth in the literature, however these species are found in equatorial tropical waters.
High	Larvae	Mortality	All	Higher SST could increase mortality rates due to physiological thresholds, though interactions with other factors (i.e. higher phytoplankton) could ameliorate this impact to some extent.
High	Juvenile/ Adult	Mortality	All	Higher SST, physiological thresholds, disease and parasites may result in higher mortality, though predation pressure will be reduced due to faster growth.
High	Adult	Reproduction	All	Faster growth and bigger sea cucumbers will mean an increased fecundity due to size fecundity relationship. Higher SST could also result in an earlier and longer reproductive season.
Medium	Larvae	Growth/ mortality	All	Projected increases in phytoplankton density in the Coral Sea may influence the Torres Strait and result in faster growth and faster development of sea cucumber larvae. This in turn could increase larval supply.
Medium	Juvenile	Habitat: seagrass	Sandfish	Seagrass habitats may be negatively impacted by increased SST (mostly shallow) and sea level rise (driven by light and species niches) (Connolly, 2009). Settling juvenile sandfish rely on seagrass for habitat.
Medium	Juvenile/ Adult	Carrying capacity	Sandfish, Black teatfish, Surf redfish.	Shallow reef tops may become more available for sea cucumber species that use that habitat (Sandfish, BlackTeat Fish, Surf redfish).

7.4.5 Opportunities

There is a need for new management paradigms and instruments to safeguard reproductive capacity of sea cucumber stocks (Purcell et al. 2013)

It is increasingly important to develop models to link climatic effects over a range of life history components and critical habitats for fisheries (e.g. seagrasses, coral reefs), and quantify the resultant impact on fisheries productivity using alternative emission scenarios (Plaganyi et al. 2013a). This can help identify which kinds of management strategies, monitoring and adaptive feedback are likely to perform best in managing under future climate change. The TSBDMF is a multispecies fishery and the different species have very different distributions, depth preferences and life histories. They will thus be affected differently by climate change drivers, and it's possible that these may have a much smaller impact on deeper water species such as White teatfish.

Management interventions and aquaculture techniques can be used to increase yields of sea cucumber. The foci of management interventions are on minimum sizes, spatial and temporal closures and may also include artificial aggregation of adults to increase the chances of reproductive success. Induced spawning in hatcheries and rearing have become relatively simple (Mazlan and Hashim 2015) and may also be employed to improve wild stocks.

The relative easiness of management initiatives and aquaculture techniques mean that there is potential to establish small or community-based enterprises to cost-effectively enhance stocks in overfished areas (Aalbersberg et al. 2005, Hair et al. 2016b, Han et al. 2016). However, high costs, market access, species choice, inadequate capacity and planning, and poor stakeholder engagement, communication and consultation are some of the barriers reported for small-scale community-based initiatives (Toral-Granda et al. 2008, Hair et al. 2016b). Lack of appropriate monitoring programs to measure effectiveness of initiatives of management and aquaculture techniques for stock enhancement is also common (but see Hair et al. 2016b).

7.5 Turtles

7.5.1 Description

The Torres Strait Turtle Fishery is operated by local Torres Strait residents as an artisanal fishery (Johnson and Welch 2016) that has supplied a large proportion of the daily food intake for Torres Strait islanders for 1000s of years (Hagihara et al. 2016). Turtles are hunted for domestic consumption only. Green Turtles make up ~98% of the catch, with Hawksbill Turtles (~1%) also taken (Harris et al. 1994). The islands of Torres Strait are insignificant nesting locations for both of these species (Limpus et al. 1989). Green Turtles nest in the Great Barrier Reef region (Commonwealth of Australia 2017). However, remote islands in north-west Torres Strait are major nesting sites for the flatback turtle (Limpus et al. 1989), though only their eggs are harvested. The threat of Climate Change is rated as ‘very high’ for Green Turtles in the northern Great Barrier Reef region (Commonwealth of Australia 2017) and Torres Strait is noted as a major foraging habitat for the stock.

In the 1990s, about 5,000 person-days were spent hunting each of turtle and dugong each year. This effort was much less than the ~30,000 person days spent handlining for fish. Other species such as tropical crayfish (*Panulirus ornatus*) were hunted for commercial sale (~9,000 person days y^{-1}). The majority of the turtle catch in Torres Strait is taken between September and February annually (Harris et al. 1994).

7.5.2 Trends and current status

In the 1990s, the number of turtles harvested in Torres Strait was 2,504±358.y^{-1} with a bimodal size distribution (with peaks at 45 and 105 cm carapace length) (Harris et al. 1994). Turtles were the second highest catch by percent composition (26%), only exceeded by dugong (28%) and much higher than finfish, crustaceans and molluscs (18%, 16%, 11%, respectively). The proportion of artisanal catch made up of turtle varies regionally in Torres Strait. In the eastern islands, over 50% of the daily catch is comprised of turtle, while in the central and western Island, turtles comprise about 25% or less of the daily catch. More contemporary data on the fishery taken by species-group composition of the annual resource harvest in Torres Strait are not available, though estimates of a harvest of about 3,000±1,000 turtles.y^{-1} remain reasonable (Hagihara et al. 2016).

7.5.3 Value

Turtle and Dugong fisheries are customary subsistence fisheries whereby only indigenous inhabitants of Torres Strait are allowed access to harvest. Turtles are important to a traditional way of life and provide a major source of protein in the diet of Torres Strait peoples.

7.5.4 Issues

Turtles are particularly vulnerable to the impacts of Climate Change as they are dependent on both the marine and terrestrial environments. A phase of their life history includes terrestrial nesting. Terrestrial sea turtle nests are particularly vulnerable to sea level rise causing erosion, inundation and higher groundwater levels (Fuentes et al. 2010). Elevated temperature is also critical; they and their niche are subject to both air temperature and sea surface temperature increases (both of which are predicted as ambient conditions in Torres Strait through 2050 to 2100). Highly dependent on terrestrial environmental conditions, the temperature of nests is critical to incubation success, sex-structure of the population and hatchling fitness (Booth and Evans 2011, Cavallo et al. 2015, Rivas et al. 2019, Staines et al. 2019). In addition, their nests are subject to coastal and terrestrial large-scale processes such as coastal erosion and extensive rainfall events.

Optimally, turtle nests range in temperature from about 27-30^{o}C over the duration of incubation (about 60 days). However, nest temperature depends on variables such as shaded vs non-shaded location, rainfall incidence and duration, depth of egg burial, and surface vegetation vs bare sand. For example, tree shade can reduce the temperature of nests by 2^{o}C compared to un-shaded nest locations (Booth and Evans 2011, Rivas et al. 2019, Staines et al. 2019). Under current environmental conditions, unshaded turtle nests can reach a sustained 32^{o}C and might reach 34^{o}C for several days. Crucially, the lethal temperature for turtle embryo survival is ~34-36^{o}C (Staines et al. 2019), though reduced incubation success occurs at lower temperatures. Consequently, an ambient temperature rise of 2^{o}C may cause nest temperature to rise to lethal levels; or near-lethal levels that dramatically reduce incubation success and hatchling fitness (Staines et al. 2019).

Nest temperatures ~31^{o}C (compared to 28^{o}C) reduce the incubation period (by ~15%), the percent incubation success (by ~16%), cause the feminisation of the population; and reduce the carapace length of hatchlings (by ~4%), and their crawl speed, self-righting success and swimming speed/thrust (Booth and Evans 2011, Cavallo et al. 2015, Rivas et al. 2019, Staines et al. 2019). Turtles reproduce from October/November to February/March annually in Australia; the hottest season of the year, the late-dry and wet seasons. Climate prediction for tropical Australia suggests that by 2070 and 2100 mean annual temperature, mean 'early-wet' season and 'late-wet' season ambient air temperatures will increase by 3^{o}C, possibly increasing turtle nest temperatures by a significant amount (buried at ~45-50 cm depth). In addition, worldwide heatwave frequency and duration are predicted to increase three- to five-fold by 2100 (Coumou and Robinson 2013), causing prolonged temperature spikes that may impact incubation success, sex-ratios and hatchling fitness.

Green turtles (*Chelonia mydas*), for example, develop into females if the temperature of the nest is higher than 29°C. Recent surveys have found 65-69% of turtles hatching from beaches in the southern Great Barrier Reef female, but 99% of those hatching from northern beaches are female. It seems that the northern rookeries have been producing primarily females for more than two decades, and that complete 'feminisation' of the population may occur in the very near future, with disastrous consequences (Hughes et al. 2019).

Monsinjon et al. (2019) modelled the impacts of climate change (RCP4.5 and 8.5) on key indicators of stable turtle populations across seven nest sites worldwide (using indicators such as incubation success and hatchling fitness). Their model outcomes showed that future climate impacts that would destabilise turtle populations would be crucial at six of the seven nesting sites; from feminisation at RCP4.5 to much reduced incubation success at RCP8.5. The model outcomes implied that a temporal shift in the annual breeding cycle (earlier and cooler) would be required to sustain populations, and questioned the adaptability of turtle populations.

A major indirect impact of rising temperature on turtle populations is the impacts on their food sources, both herbivory and carnivory. In particular, herbivorous turtles (e.g. the Green Turtle) feeds on the extensive seagrass communities that exist in Torres Strait. Herbivorous turtles make up >95% of the turtle harvest as a food resource by Torres Strait human communities and they are dependent on reef-top seagrasses. For example, on the Orman Reefs in Torres Strait, Green Turtles consume both seagrasses (especially *Thalassia hemprichii* and *Enhalus acoroides*) and algae (mainly *Hypnea* spp., *Laurencia* spp. and *Caulerpa* spp.) (Andre et al. 2005).

Higher temperatures will impact turtles indirectly via changes in seagrass abundance given they are close to their temperature tolerance limit (see details in Chapter 6.1). As their food resources reduce, so will the local populations of turtles, either by mortality or movement to more productive seagrass communities (as has been documented for dugongs (see Marsh et al. (2004)).

As well, Torres Strait seagrass communities may suffer sedimentation and deposition impacts due to pulsed nutrient and sediment loads from Papua New Guinea's Fly River associated with extreme rainfall events (Suppiah et al. 2010, Johnson and Welch 2016).

Carnivorous turtles feeding on crustaceans and molluscs will be impacted as warming Sea Surface Temperatures inflict coral bleaching of the reefs of Torres Strait (see Hoegh-Guldberg 1999, Bainbridge et al. 2015, Hughes et al. 2017). Bleached reefs interrupt fundamental nutrient cycles and food webs in coral reef ecosystems and reduce the species richness and abundance of many benthic and demersal fauna, including crustaceans and molluscs (Hoegh-Guldberg 1999). Coral bleaching is a relatively short-term process; it can occur if reefs are exposed to temperature > 30°C for 24-48 hours, increasing in intensity as duration of exposure to above-ambient temperature increases (Hoegh-Guldberg 1999, Hughes et al. 2017). Marine heat waves are predicted to increase in tropical Australia (Frolicher et al. 2018) and short-term air temperature heatwaves are a culprit to induce spikes in littoral waters over 3-5 days. As a consequence, the frequency and extent of coral bleaching is expected to increase across the Australian tropics with broad ecosystem consequences. The abundance of the reef-dependent crustacean and mollusc prey of carnivorous turtles will reduce. As for herbivorous turtles, carnivores will move to locations where reefs are less impacted and their key diet species are more abundant.

Sea turtle populations will also be impacted by sporadic environmental phenomena, the effects of which are less defined both temporally and spatially. Extreme rainfall events are predicted to increase in frequency to 2100 and beyond. In addition, the intensity of tropical cyclones is predicted to increase. These stochastic events can impact both the nests and the adult phase of turtle populations; particularly when they overlay a predicted to increase in sea level by 1.1 m worldwide by 2100 (see Chapter 5.2.5).

Heavy rainfall lowers the temperature of turtle nests and may saturate the sands surrounding the eggs (Staines et al. 2019). Too low temperatures and the drowning of nests are lethal to embryonic development (Rivas et al. 2019). The storm surge associated with cyclones, overlapping with seas level rise may inundate turtle nests and drown the incubating eggs (Fuentes et al. 2010). Moreover, the storm surge associated with intense tropical cyclones strand turtles (and dugong) on nearby shores, particularly when nearby coasts are extensive salt flats only a metre or two above sea level (Limpus and Reed 1985, Marsh 1989). In the Northern Territory coast in the vicinity of the McArthur River estuary, Cyclone Kathy (1984) beached an estimated 1,000 turtles and 500 remained stranded and disorientated up to 9 km inland on the low supratidal mudflats, a week after the cyclone. They would have died without human assistance back to coastal waters. All of the stranded turtles were green turtles and >90% were large females, presumably feeding of the extensive seagrass beds in the littoral habitats along the coastline when Cyclone Kathy struck (Limpus and Reed 1985). Green turtles are vulnerable to both cyclonic-stranding and hunting by indigenous peoples as they make up mostly 100% of shallow-water seagrass-feeding turtles in both Torres Strait and the Gulf of Carpentaria (Limpus and Reed 1985, Harris et al. 1994). Green Turtles also make up 73% of coastal stranding that occurs daily along the Queensland coast (Meager and Limpus 2012). Therefore, the turtle species that is key to support a Torres Strait customary food source is the same species that is most vulnerable to stranding. Note however, that the area of mudflats available for stranding as a percentage of costal habitats is not as great in Torres Strait as it is in the Gulf of Carpentaria; probably lessening the chance of stranding in Torres Strait habitats.

Table 5. Observed and expected effects of climate change on turtles.

PHYSICAL DRIVER	CLIMATE CHANGE EFFECT	ECOLOGICAL EFFECT	INDIRECT EFFECTS	FISHERY EFFECT	NOTES	SOURCE(S)
Air Temperature	Increase in air temperature	Extreme temperatures affect sex ratio of hatchlings; reduced hatching success; feminisation of population; individual size and locomotion capacity	Seasonal reproductive shift	Changed population structure: seasonal behavioural changes	Sex ratio of population may change; optimal hatching success 25 to 35°C long generation time limits adaptability; tropical ecosystems already at upper thermal tolerance	Duarte (2002), Poloczanska et al. (2007) Collier et al. (2011) Expert opinion http\\www.climatechangeinaustralia.gov.au Monsinjon et al. (2019) Babcock et al. (2018)
Sea Temperature	Increase in sea tempertures	Mollusc/ crustacean population impacts due to niche decline; especially food	Coral bleaching; loss of dynamic reef ecosystem	Reduction in loggerhead turtle population and catch; starvation and turtle relocation	Expert opinion – ecosystem effects	Carruthers et al. (2002); . http\\www.climatechangeinaustralia.gov.au
Sea Temperature	Increase in SST	Extreme temperatures affect photosynthesis, nutrient uptake, flowering and germination in seagrasses	Spikes in air temperature impact seagrass habitat in shallow littoral waters	Reduction in turtle catch: increase in Turtle mortality due to starvation / Turtle relocation	Thermal optimum temperature – for seagrass range from 15 to 32-33°C	Duarte (2002), Poloczanska et al. (2007) http\\www.climatechangeinaustralia.gov.au Expert opinion Collier et al. (2011)
Salinity	Decrease in salinity due to large flood events	Decrease in salinity due to large flood events have	large scale turtle relocation and	Reduction in catch: turtle mortality due to starvation /	Based on habitat suitability models for Northern Australia	Carruthers et al. (2002) GoC cyclone Sandy.

PHYSICAL DRIVER	CLIMATE CHANGE EFFECT	ECOLOGICAL EFFECT	INDIRECT EFFECTS	FISHERY EFFECT	NOTES	SOURCE(S)
	(possibly from PNG)	been associated with a decline in seagrasses	mortality due to lack of food	turtle relocation		http\\www.climatechangeinaustralia.gov.au
Temperature	Increase in SST; Increase in the number / intensity of marine heat wave (MHW)	Sea temperature over migration routes Sea temperature above thermal tolerance	na	Seasonal behavioural changes Reduction in catch: Turtle mortality not likely as sea temperature within thermal tolerances MHW-mortality unknown.	Green Turtles don't nest in Torres Strait. They migrate there to forage; they nest in Great Barrier Reef waters	Duarte (2002), Poloczanska et al. (2007) Collier et al. (2011)
Extreme rainfall events	Increase in sedimentation and turbidity due to regional and local flood events causing erosion and sediment transport/deposition	possible increase in turtle mortality due to limited visual detection of large predators. Local scale turtle relocation	Decline in seagrasses abundance and extent due to turbidity – less fod for turtles	Reduction in local catch: Turtle relocation	Based on climate impact projections for Northern Australia	Carruthers et al. (2002) Expert opinion http\\www.climatechangeinaustralia.gov.au
Extreme temperature (heatwave) events	Increase in frequency of series of very hot days. (days over 35°C, Expected to increase threefold in Cairns).	Poor incubation success (terrestrial nests) due to heat stress	Thermal stress on just-emerged hatchlings before they reach seawater	Reduction in catch: Turtle hatchling mortality; poor locomotion by hatchlings, reduced access to the sea; lower individual weight	Extreme heat days estimated under RCP4.5 to ~2090 (website). ~34°C nest temperature lethal threshold for early stage embryos (Collier et al. 2011)	Duarte (2002), Poloczanska et al. (2007) Expert opinion http\\www.climatechangeinaustralia.gov.au
Sea level rise and frequency of intense cyclones	Combined inundation or erosion of nests due to sea level rise and cyclone-associated storm surge;	Poor incubation or mortality of embryos due to temperature drop associated with sea water inundation or anoxia due to semi-permanent inundation; erosion/ exposure of eggs in nests-100% mortality	Stranding of adult turtles due to storm surge and wave action during intense cyclones.	Reduction in catch: turtle hatchling mortality resulting in long-term population decline; adult mortality due to beaching	Based on climate models and habitat impact models for Northern Australia; stranding during cyclonic impact in the Gulf of Carpentaria.	Carruthers et al. (2002) http\\www.climatechangeinaustralia.gov.au

7.5.5 Opportunities

A caveat of the possibility of stochastic weather events impacting turtle populations is that turtles have survived for > 100 million years; over which temperature increases and ice-ages have come and gone. During times of ecosystem stress on Earth, turtles must have adapted to change in the locations of environmental conditions that support nests, either by locating nesting activity to more facilitative latitudes, or by changing the timing of nesting activities seasonally to benefit from favourable temperatures (Poloczanska et al. 2007). However, in the 2000s, spatial and temporal caveats exist on their ability to adapt. From now until the 2100s and ongoing, the rate of temperature change will be much greater than over past biome-wide fluxes; and today, urbanisation and coastal infrastructure, coastal modification and human use has rendered much of their historically-used natural habitat unavailable for undisturbed nesting activity.

7.6 Dugongs

7.6.1 Description

Torres Strait contains the largest Dugong population in the world. Dugongs have been hunted by Islanders since at least 4,000 years ago (Crouch 2015). They are considered the most significant and highest ranked marine food in the traditional subsistence economy (Carter et al. 2014). Dugongs are known as 'cultivation grazers' (Preen 1995). An adult dugong eats about 7 per cent of their body weight in seagrass per day (Department of Environment and Heritage Protection 2016). They feed in a way that promotes growth of *Halophila ovalis*; their preferred seagrass species. Pulling out the seagrass aerates the sea floor and increases the amount of organic matter in the area, thereby encouraging regrowth of the seagrass (Department of Environment and Heritage Protection 2016). Dugongs in Torres Strait were found to feed exclusively on seagrasses (mainly *Thalassia hemprichii*, *Cymodocea* spp. and *Syringodium isoetifolium*), suggesting slight differences in diet to other areas, based on abundance and palatability of seagrass species (Andre et al. 2005).

7.6.2 Trends and current status

Data on dugong population estimates from aerial surveys in Torres Strait are scarce and the absolute population size is unknown (Marsh et al. 2015), but estimates suggest the dugong population in 2013 was ca. 16,000 and stable with a seagrass area of 30,560km^2 (Sobtzick et al. 2014). Data on dugong harvest is sparse but the fishery is sustainable (although it was considered unsustainable in the past) (Marsh et al. 2015).

The area of dugong habitat that supports very high densities of dugongs in Torres Strait is large (5,268 km^2) and hunting is largely restricted to a very low percentage of that habitat (5%) due to the input control on the fishery and socio-economic reasons (Marsh et al. 2015).

7.6.3 Value

Dugong fisheries are customary subsistence fisheries whereby only indigenous inhabitants of Torres Strait are allowed access to harvest. Dugongs are considered the most significant and highest ranked marine food in TS traditional subsistence economy (Carter et al. 2014). The cultural services associated with hunting have been reported by Torres Strait traditional owners to be more important than provisioning services (Delisle et al. 2018).

7.6.4 Issues

Seagrasses provide critical habitats and are a critical food resource for dugongs (Carter et al. 2014) that feed almost exclusively on shallow water seagrasses, particularly on pioneer species from genera such as *Halophila* and *Halodule* (Wooldridge 2017; Preen, 1995). This means that dugongs are highly vulnerable to changes in seagrass abundance.

It is hard to predict the exact response of dugongs to changes in seagrass abundance because a combination of factors, such as age, sex, physical condition, matrilineally transmitted learned behavior can all contribute to apparently highly individualistic movement patterns (Marsh et al., 2011; Wooldridge 2017).

Effects of climate change on dugongs found in the literature were mostly indirect, showing changes in location, abundance and biomass of dugongs associated with changes in abundance and distribution of seagrasses (Table 6). Dugongs themselves are also sensitive to changes in water temperature and known to undertake meso-scale thermoregulatory movements in response to changes in temperature (Sheppard et al. 2006). Direct effects include stranding associated with extreme weather events (e.g., cyclones and flooding) (Marsh 1989, Fuentes et al. 2016). Boat strikes is a localised direct threat to dugongs (Marsh and Sobtzick 2019)

Table 6. Observed and expected effects of climate change on dugongs.

PHYSICAL DRIVER	CLIMATE CHANGE EFFECT	ECOLOGICAL EFFECT	FISHERY EFFECT	NOTES	REFERENCE(S)
Temperature	Increase in SST	Extreme temperatures affect photosynthesis, nutrient uptake, flowering and germination in seagrasses Dugongs are sensitive to changes in water temperature and known to undertake meso-scale thermoregulatory movements in response to changes in temperature	Reduction in catch: Dugong mortality due to starvation / Dugong relocation	Thermal optimum temperature –for seagrass range from 15 to 33ºC (Collier et al. 2011)	Duarte (2002), Poloczanska et al. (2007) Sheppard et al. (2006)
Salinity	Decrease in salinity due to large flood events	Decrease in salinity due to large flood events have been associated with a decline in seagrasses which led to large scale dugong relocation and mortality	Reduction in catch: Dugong mortality due to starvation / Dugong relocation	Based on habitat suitability models for Northern Australia	Carruthers et al. (2002)
Water clarity	Increase in extreme events	Reduced abundance of seagrass is associated with deteriorating water clarity due to: (a) floods and (b) longer-term impact of terrestrial fine sediment exports due to poor land practices.	Reduction in catch: Dugong mortality due to starvation / Dugong relocation	Burdekin region (GBR)	Wooldridge (2017)

Water clarity		Mean daily irradiance (I_d) above 5 and 8.4 mol m^{-2} d^{-1} was associated with gains in seagrass. Percent of days below 3 mol m^{-2} d^{-1}, correlated with change in seagrass cover with 16–18% of days below 3 mol m^{-2} d^{-1} being associated with more than 50% seagrass loss. Number of hours of light saturated irradiance (H_{sat}) correlated well with change in seagrass abundance; where H_{sat} of 4 associated with increases in seagrass abundance, and < 4 H_{sat} with more than 50% loss	Reduction in catch: Dugong mortality due to starvation / Dugong relocation	Experimental work in the GBR	Collier et al. (2011)
Extreme events (cyclone & flooding)	Stranding	Extreme weather events (e.g., cyclones and flooding) have been associated with mass stranding of dugongs	Reduction in catches		Fuentes et al. (2016)
Temperature	Increase in temperature	Conditions such as warm sea temperatures and low rainfall (promoting seagrass growth) may be facilitating explorative ranging south by dugongs.	Reduction in catches due to relocation of dugongs to cooler waters	New South Wales	Allen et al. (2004)

7.6.5 Opportunities

Understanding the indirect impacts of habitat degradation and food availability is important to manage dugong populations under climate change. Seagrasses are highly dynamic, subjected to seasonal changes in Torres Strait. Climate, localised impacts and harvest act synergistically, affecting seagrass communities and dugong populations in Torres Strait. Understanding these processes and behavioural responses thresholds (e.g. migration) will support the management of this important traditional fishery.

Seabed habitat has been monitored annually along transects by CSIRO divers undertaking TRL surveys since 1989, and although snapshots only, these data complement aerial survey data and provide valuable insights into abundance and trends in seagrass in Torres Strait. For example, Plaganyi et al. (2016) reported that seagrass declined to 2001 (from 1994) but increased post 2001. By species, the overall trend in seagrass cover for the repeated sites was not as evident, although the dominant species *Halophila spinulosa* showed a similar increasing trend post 2001. Seagrass composition also changed between years with *H. spinulosa* dominant in most years, but *S. isoetifolium* and *T. hemprichii* also dominant in three of the 19 years.

8 Conclusion of Part 2

This report identified a range of localised and climate change impacts potentially affecting the key fisheries selected for consideration. Anthropogenic impacts in Torres Strait are minimal, but exist in specific locations. Local impacts include sediment runoff and metal pollution from the Fly River (PNG), localised oil contamination, mangrove cutting, alteration of hydrology, nutrient and sediment runoff, chemical contamination, and over-harvest of marine living resources.

Climate change is already affecting Torres Strait fisheries and culture. Expected impacts from climate change include higher seas, warmer atmospheric and ocean temperatures, more acidic waters, changes in ocean circulation, and more intense rainfall events. Although minimal, simultaneous local impacts (e.g. untreated sewage, chemical, sediment and nutrients runoff, oil pollution, overfishing) act together with climate change impacts, such as sea-level rise, ocean warming, acidification, leading to interactive, complex and amplified impacts for species and ecosystems.

These pressures manifest directly in the form of changes in abundance, growth, reproductive capacity, distribution and phenology (changes in cyclic and seasonal phenomena such as reproduction and migrations)), and indirectly through changes in foodwebs and habitats. Invertebrates (TRL, prawns, BDM) are likely to be more impacted by climate change than vertebrates (Finfish, turtles and dugongs), although responses are species specific (Fulton et al. 2018). For example, TRL has wide ranging life history circulation pattern which gives it some flexibility to “move” whereas BDM are more sedentary with more localised recruitment.

Climate change will likely cause mostly negative direct effects on the fisheries investigated in this report, but some effects may also be positive. If climate-related environmental changes go beyond certain limits or ranges for species, they will simply move or have their abundance reduced (Pecl et al. 2014, Fulton et al. 2018). For example, changes in ocean currents and circulation in Torres Strait will likely affect larval transport and distribution of TRL, BDM, prawns and finfish. High water temperature can cause mortality, affect growth (relatively small warming may increase growth rates of sea cucumber and TRL), reproduction and its timing, and negatively affect supporting habitats (coral reefs, seagrasses) of finfish, invertebrates, dugongs and turtles. Elevated air temperatures can also reduce incubation success, shift timing of annual breeding cycle and increase ‘feminisation’ of Green turtle populations. Higher seas and extreme weather events can uproot mangrove trees and cause erosion and increase in turbidity, with consequent reduction in light penetration and salinity and an increase in sediment deposition, negatively affecting seagrasses and coral reefs. Some organisms, such as sea cucumbers may benefit from higher seas, but others like turtles and dugongs can be negatively effects via changes in abundance of preferred food (e.g. seagrass) and also via the inundation of nesting sites (turtles) and stranding (turtles and dugongs) associated with extreme weather events.

Although recent studies have shown that ocean acidification does not alter reef fish behaviour (Clark et al. 2020a, Clark et al. 2020b), there is strong evidence that it is already affecting carapaces of crustaceans in other parts of the world (Bednaršek et al. 2020). This can have potential ramifications for TRL and prawns, and, to a lesser extent, sea cucumbers.

Table 7. Main drivers causing changes in Torres Strait ecosystems and fisheries.

CLIMATE CHANGE IMPACT	DRIVER	ECOSYSTEMS	FISHERY
Change in ocean circulation	Currents	Seagrass, Mangroves, Coral Reefs	TRL, Prawns, Finfish (CT), BDM

CLIMATE CHANGE IMPACT	DRIVER	ECOSYSTEMS	FISHERY
Increase in intensity of extreme rainfall events	Turbidity	Seagrass, Coral Reefs	Indirect fishery effect via changes in seagrass and coral reefs (Dugongs, prawns, Turtles, TRL, BDM, Finfish)
Increase in air and sea temperature	Temperature	Seagrass, Coral Reefs	Prawns, Finfish (SM, CT), Turtles, BDM, TRL
Sea level rise	Tides / water level	Seagrass, Mangroves, Coral Reefs	TRL, BDM
Increase in intensity of extreme rainfall events	Light	Seagrass, Coral Reefs	Indirect fishery effect via changes in seagrass and coral reefs (Dugongs, prawns, Turtles, TRL, BDM, Finfish)
Increase in intensity of extreme rainfall events	Nutrients (N & P)	Seagrass, Coral Reefs, Mangroves	Finfish (SM, CT)
Increase in intensity of extreme rainfall events	Salinity	Seagrass, Mangroves, Coral Reefs	Indirect fishery effect via changes in seagrass and coral reefs (Dugongs, prawns, Turtles, TRL, BDM, Finfish)
Increase in intensity of extreme rainfall events	Sedimentation	Seagrass, Coral Reefs	Indirect fishery effect via changes in seagrass and coral reefs (Dugongs, prawns, Turtles, TRL, BDM, Finfish)
Ocean acidification	pH	Coral Reefs	TRL, Prawns, Finfish (SM, CT), BDM
Increase in sea temperature	Oxygen		TRL
Changes in ENSO / La Niña patterns	Exposure to the air	Seagrass, Coral Reefs	Turtles
-	(Over)grazing	Seagrass	
Increase in intensity of extreme rainfall events	Extreme events (e.g. rainfall, cyclones)	Seagrass, Coral Reefs, Mangroves	Finfish (CT), Turtles, Dugongs
Increase in intensity of extreme rainfall events	Waves / tidal surges	Seagrass, Mangrove	Dugongs and Turtles
-	Moon phase		TRL
Anthropogenic impact	Overfishing		BDM
Potentially associated with increase in temperatures	Diseases & parasites		Finfish, Prawns, BDM

Part 3: Scoping a future data framework project

Part 3 scopes a future project that would provide an over-arching data framework (e.g. from global atmospheric and oceanographic models, down-scaled to the broader TS region as appropriate) needed as a foundation for future work. Subsequent projects could ultimately use modelling approaches to quantitatively evaluate the effects of future climate change scenarios on the selected fisheries, and explore alternative adaptation options. More specifically, Part 3 presents the modelling requirements to simulate impacts of climate and non-climate drivers on the key fisheries to guide the development of a future data framework project. Based on the review provided in Part 2, Chapter 9 presents simulation requirements and identifies data gaps. Chapter 10 presents the proposed modelling and supporting data framework, followed by preliminary costs presented in Chapter 11. Finally, Chapter 12 provides the main conclusions and recommendations from the project.

9 Requirements for modelling and data framework

9.1 Modelling questions

The data framework will be specified in a way that meets the input data needs of various future fishery-specific and ecological modelling, addressing issues associated with changes in local and climate drivers and modelling needs presented in Part 2. In this Chapter, we first provide the key question that the future models need to address, the simulation requirements to address the research questions (Chapter 9.2), and an assessment of the minimum requirements versus available data (Chapter 9.3).

The data and modelling framework will primarily be designed to answer the following question: *What are the potential consequences associated with changes in local conditions, including climate variability and change, on the selected Torres Strait Fisheries, ecosystems and dependent communities?*

The objectives of the modelling exercise are to simulate future climate scenarios and assess the impacts of these on fisheries and associated habitats and species through quantitative evaluation. The modelling framework will support the exploration of responses and strategies to manage the selected Torres Strait fisheries, such as the evaluation of:

1. Interactions between different fisheries and broader ecosystem functioning;
2. Impacts of climate change scenarios on the abundance and distribution of selected species;
3. Impacts of current and future catchment conditions and management scenarios on fisheries;
4. Impacts of incidents (e.g. oil spills, ships run aground) on fisheries;

5. Combined scenarios of 1-4 to develop strategies that are robust across impacts and fisheries;
6. Evaluation of alternative adaptation options

9.2 Simulation requirements

Based on the summary of threats to Torres Strait provided in Part 2 and questions and objectives identified in Chapter 9.1, the modelling framework is expected to simulate the following processes:

1. *Catchment runoff:* The model should be able to represent catchment runoff (river flows, sediment and nutrients) to test scenarios associated with: a) changes in rainfall (annual average and changes in frequency/intensity of extreme rainfall events), and b) changes in land-use and practices. Ideally the model should incorporate runoff from main river systems entering the Gulf of Papua, especially turbidity and optionally mine tailings from the Fly River system. Sediments (and associated decline in light penetration), nutrients and pollutants from catchments can affect habitats (seagrasses, mangroves and coral reefs) directly with flow-on effects on targeted species, their prey and predators.
2. *Hydrodynamics and transport*: Understanding oceanographic processes such as currents, waves, sea level, tides and tidal surges, and how these affect turbidity, sediment plumes, suspension / resuspension and deposition of sediments, and larvae dispersal would be important to evaluate individual and synergistic impacts from localised impacts (e.g. changes in land-use and practices, oil spills) and climate change on habitats and fisheries. For a more holistic representation of catchment and coastal/oceanic connections, such models can use point-source outputs from the catchment model, such as flows, and loads of sediment, nutrients and other pollutants.
3. *Physio-chemical water quality constituents*: Variables, such as pH, dissolved oxygen, water and air temperature, total suspended solids, and salinity would be useful to include in the model to assist in the prediction of their direct and indirect impacts on key species and habitats.
4. *Biogeochemistry*: It may be advantageous if a model is capable of simulating the reactive transport and transformation of common parameters such as nitrogen, phosphorus, oxygen, carbon and inorganic suspended solids. Another desirable feature would be to simulate sediment-water column interactions for these parameters and assimilation of nutrients by primary producers. Simulating parameters such as bacteria, pathogens, algae and zooplankton is also desirable.
5. *Fisheries dynamics*: Simulation of fisheries processes (e.g. catch, effort, gear) and the interactions between ecosystems, species and fisheries is essential to understand direct and indirect effects of localised and climate change impacts.
6. *Ecological relations*: Simulation of higher order functions, such as interactions between targeted species and their predators and prey, and indirect impacts of changes in habitats on targeted species (e.g. coral bleaching and impacts on fishery or prey, impacts of climate change on nursery function of mangroves) are highly desirable. Simulation of mega-fauna trophodynamics, such as the dynamics between dugong, turtles and seagrass is important in

understanding impacts of localised and climate change impacts on habitats and flow-on effects in food chain and fisheries.

The various processes to be represented in the modelling framework are shown in Figure 6. This includes catchment processes, environmental effects (hydrodynamics, transport of sediments and nutrients, physical and biogeochemical processes), fisheries and interacting species and habitat dynamics, and trophodynamics.

We have outlined a suite of desirable model features that will facilitate in-depth understanding of the Torres Strait marine ecosystem. We note, however, that this is an ambitious list that may not be possible with all model frameworks, given limited available information and the level of detail that could be included depends on available funding for model construction. The model should also consider the specific high priority questions that need addressing, and hence whereas some of the features we overview may be essential, others are not or may simply be stretch objectives that could be built on at a later stage.

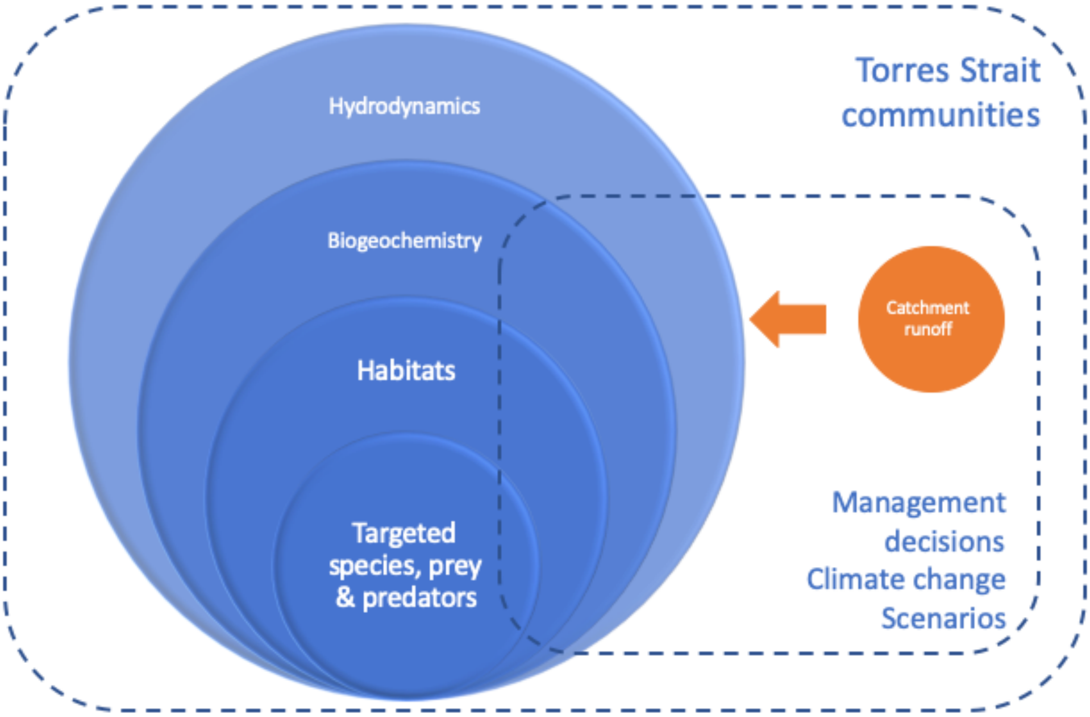


Figure 6. Torres Strait conceptual modelling framework.

9.3 Assessment of data requirements

9.3.1 Data requirements

Biological / Fisheries data

Fishery-dependent data such as catch and effort (and preferably also fishery-independent survey data), are required to simulate populations of the target species, on which potential impacts of localised and climate change scenarios can be assessed. Having a good understanding of biomass of the fishery is important. In general, long-term data is sparse and restricted to certain species but there has been substantial improvements in recent times. Data collection of catches of all commercially fished species in Torres Strait communities has been mandated since 1 December 2017 using the Torres Strait Fish Receiver System and provides valuable information to communities and scientists. Additional voluntary information on changes in fishing behaviour and effort by community sectors would provide important data that can be incorporated in models to communicate information back to communities on status of fisheries, seafood consumption, catches / consumption trends over time. This would support local adaptation efforts and decisions, including the use of traditional knowledge to fishing practices, as well as the identification of socio-economic development needs, which will benefit traditional owners, non-traditional recreational sector and resource managers in Torres Strait (Bedford et al. 2020). The availability of fisheries and related biological data for each of the fisheries investigated in this report is presented in Table 8. The information provided in Table 8 refers only to presence/absence, not on the quantity or quality of data or its limitations. These are provided in Appendix A.

Table 8. Availability of essential data for each of the selected fisheries investigated in this report (TRL: Tropical Rock Lobster, FFISH: Finfish; BDM: Bêche-de-mer). Note that 'availability' may indicate fairly limited data. Details include period of data, references, spatial extent, with more specific information presented in Appendix A.

	TRL	PRAWNS	FFISH	BDM	TURTLES	DUGONGS
Catch location	Y	Y	Y	Y	N	N
Harvest numbers	Y	Y	Y	Y	N	N
Target species identification	Y	Y	Y	Y	N	N
Gear type	Y	Y	Y	Y	Y	Y
Age / Size frequency of catches	Y	N	Y	N	N	N
Species distribution	Y	Y?	Y	Y	N	N
Recruitment survey	Y	N	N	N	N	N
Population size	Y	N	N	Y	N	Y
Growth	Y	Y	Y	N	N*	N**
Reproduction	Y	Y	N	Y	N	Y
Maturity	Y	Y	Y	Y	N	Y

*Data exists for Green turtles in the Southern GBR (Chaloupka et al. 2008).

**Growth rates have been estimated from other sources in the literature (Hagihara et al. 2016).

Habitat data

Distribution and abundance data about habitats supporting the fisheries investigated can be used to assess direct impacts of climate-related events on habitats (e.g. marine heat waves; Duke et al. (2017), Babcock et al. (2019)) and potential flow-on effects (e.g. changes in abundance and distribution) on the fisheries (Plaganyi et al. 2019c). The availability of habitat data for Torres Strait is presented in Table 9. The information provided in Table 9 refers only to presence/absence, not on the quantity or quality of data or its limitations. These are provided in Appendix A.

Table 9. Availability of essential data for habitats supporting selected fisheries investigated in this report. Note that 'availability' may indicate fairly limited data. Details include period of data, references, spatial extent, with more specific information is presented in Appendix A.

	MANGROVES	SEAGRASSES	CORAL REEFS
Location	Y	Y	Y
Area	Y	Y	Y
Species	Y	Y	Y

Physio-chemical data

The following processes (identified in Chapter 8, Table 7) are desirable to incorporate in the modelling framework to evaluate potential impacts of climate change on system functioning and flow-on effects on habitats and species. The availability of physio-chemical data in Torres Strait is shown in Table 10. The information provided in Table 10 refers only to presence/absence, not the quantity or quality of data or its limitations. These are provided in Appendix A. In a general sense, there is limited data showing spatial differences in physical characteristics (e.g. depths and tides), which are important to understand Torres Strait dynamics.

Table 10. Availability of essential physio-chemical data to simulate localised and climate change impacts on fisheries of the Torres Strait region. Details including period of data, references, spatial scale and more specific information are presented in Appendix A.

	DATA AVAILABILITY IN TORRES STRAIT
Currents	Models, Observations
Turbidity	Models, Observations
Temperature	Models, Observations
Tides / water level	Models, Observations
Light	Models, Observations
Nutrients (N & P)	Models, Observations
Salinity	Models, Observations
Sedimentation	Models, Observations
pH	Models, Observations
Oxygen	Models, Observations
Exposure to the air	Related to water level
(Over)grazing	Observations
Extreme events (e.g. rainfall, cyclones)	Observations
Waves / tidal surges	Models, Observations
Moon phase	Modelled
Overfishing	Models, Observations
Diseases & parasites	Limited Observations?

The review of datasets available for Torres Strait revealed significant information covering Torres Strait fisheries, marine species, habitats, geology and physiochemical water quality parameters (Appendix A). However, datasets are sparse both in space and time and, with few exceptions (e.g.

Torres Strait Rock Lobster survey, recent Logbooks and catch disposal records) data have been collected opportunistically mostly due to financial and logistical limitations. A large-scale monitoring program for Torres Strait would support the identification of long-term trends and improve understanding about local and regional processes affecting habitats, species and fisheries (Pitcher et al. 2004), including the impacts of climate change on these. Modelling projects would also provide important insights into where to collect oceanographic data.

Most of the understanding about physical and biogeochemical cycles and processes (e.g. currents, tides, primary productivity, nutrients) in Torres Strait have been derived from remote sensing and hydrodynamic models developed in the 2000s (Hemer et al. 2004, Saint-Cast and Condie 2006, Saint-Cast 2008) and in the early 2010s (Wolanski et al. 2013), each with pros and cons relatively well-known (see Chapter 10.1.2). Limited physical long-term observational data are available and were mostly collected in the 1990s (Wolanski et al. 2013). These models would also benefit from a coherent monitoring program for data collection to reduce uncertainties, validate and improve such models (Pitcher et al. 2004, Margvelashvili et al. 2008, Wolanski et al. 2013).

Habitat, fisheries and ecological data are also sparse, but recent mapping of mangroves, seagrasses and coral reefs (Chapter 6) combined with survey data on substrate and species (Murphy et al. 2020, Plagányi et al. 2020b) offer valuable information about the location and health status of such habitats, which can support the development of models to explore impacts and adaptation options. It takes a long time to gather the financial means to run surveys, and collect adequate time series of data but we do have sufficient data to start modelling to investigate potential climate change impacts on fisheries. In what follows, we proposed a modelling and data framework to answer the research question presented in Chapter 9.1.

10 Proposed modelling and data framework

10.1 Modelling framework

The conceptual modelling framework presented in Figure 7 shows an example of how the different processes could be represented and their impacts on habitats and species, including on different life stages. We present below a summary of common modelling approaches that can be used in the framework based on simulation requirements presented in Chapter 9.2 and data availability for Torres Strait presented in Chapter 9.3. Important to note is that a number of modelling initiatives are already in place in Torres Strait and it would be worth considering capitalising on these efforts. We note also that a modular approach to modelling whereby different detailed components are coupled together rather than developing an entirely new model, may also be a productive method to address integrated modelling needs.

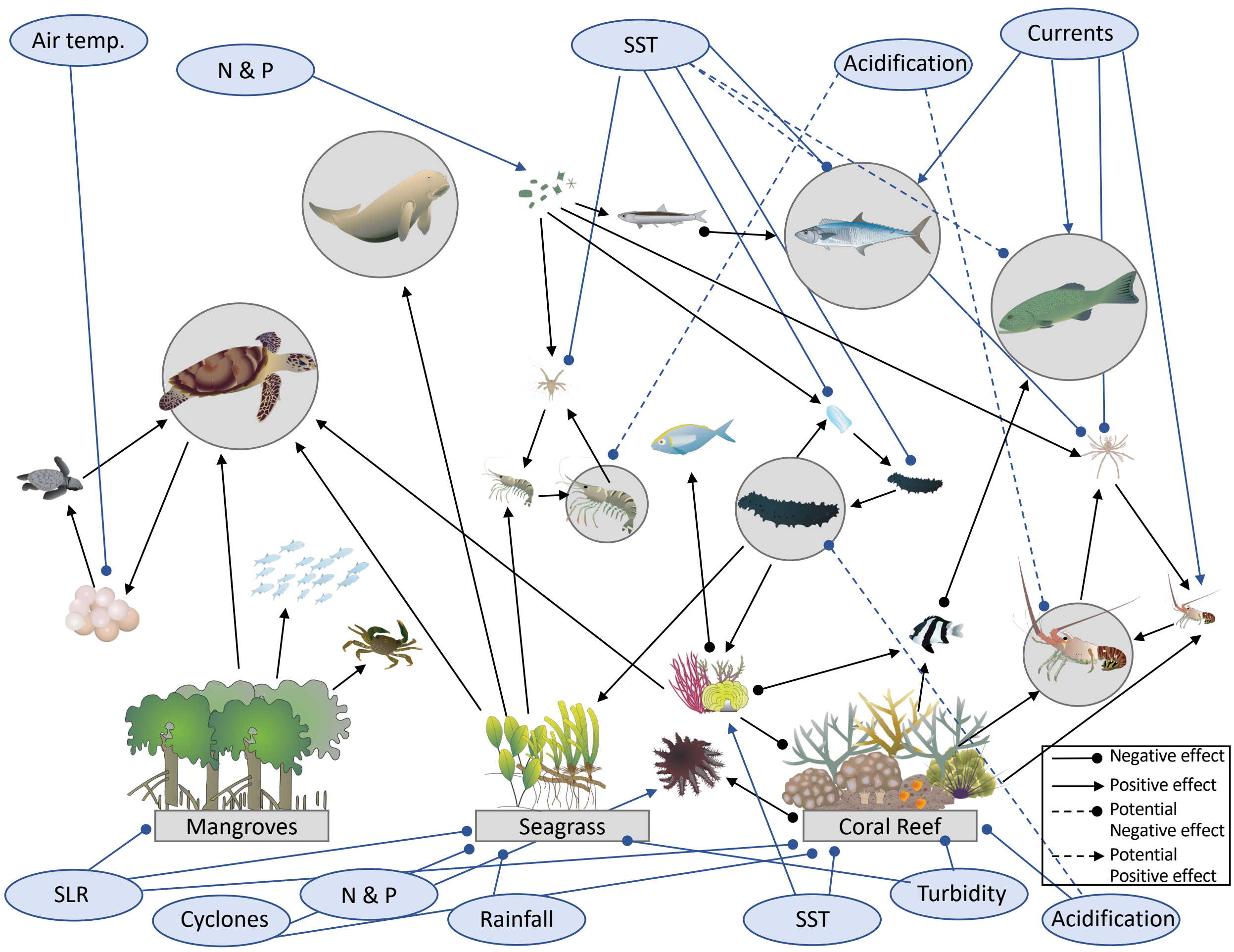


Figure 7. Torres Strait conceptual model framework. Symbols obtained from the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/). Blue lines: direct physio-chemical impacts; black lines: indirect biological / ecological impacts.

10.1.1 Catchment runoff

Catchment models generate outputs of freshwater flows and catchment runoff (nutrients, sediments and other pollutants) using data on soil characteristics, land-use and rainfall as inputs. In terms of impacts on some northern regions of Torres Strait, it is important to evaluate climate change and local impacts on Torres Strait fisheries in the simulation of catchment runoff from the rivers entering the Gulf of Papua (Fly, Purari and Kikori Rivers, and two smaller rivers: the Aramia and Era Rivers; especially mine tailings pollution from the Fly River) (Li et al. 2017), including the impacts of changes in rainfall due to climate change on catchment runoff. There are concerns that plumes from main rivers entering the Gulf of Papua may enter Torres Strait waters (Li et al. 2017), which can potentially impact fisheries resources and critical habitats in Torres Strait (Wolanski et al. 2013, NESP Earth Systems and Climate Change Hub 2018). A recent water quality study by Waterhouse et al. (2018) found trace metal enrichment originating from PNG rivers around the islands of Boigu and Saibai, but the trace metal analysis did not indicate that there was widespread deposition of mine-derived sediments in Torres Strait. Waterhouse et al. (2018) divided Torres Strait into six zones for which the potential risk of influence of Fly River waters varied form very likely to low risk (Appendix B).

10.1.2 Hydrodynamics and transport

A three-dimensional (3-D) fine-resolution hydrodynamic model coupled with a sediment transport model can potentially capture much of spatial and temporal variability of currents, waves, tides and sea level, as well as the sediment, light penetration and pollution characteristics on the shelf. Hydrodynamic models have previously been implemented in the Torres Strait region in the early 2000s and 2010s, using datasets from the 1990s. These models have a number of limitations and effort to address such limitations or re-run these models under different scenarios is likely to be similar to developing a new regional model (N. Margvelashvili pers. communication, June 2020). For example, Saint-Cast and Condie (2006), and Saint-Cast (2008) developed a regional circulation model for Torres Strait based on an 8-year hindcast period (i.e. 01/03/1997–31/12/2004) using realistic forcing fields, including winds, waves, tides, and large-scale regional circulation. Their model is an update from a model developed by Hemer et al. (2004). The model uses a curvilinear grid of approximately 4km resolution. This resolution may not reliably solve hydrodynamic processes in topographically complex areas such as Torres Strait (Wolanski et al. 2017) and would require nesting approaches to improve model resolution. Model outputs include 3-D distributions of velocity, temperature, salinity, and mixing coefficients, as well as two-dimensional fields such as sea level and bottom friction. Wolanski et al. (2013, 2017) developed a depth- averaged 2-D oceanographic hydrodynamic model on an unstructured mesh for Torres Strait. The unstructured mesh allows the spatial resolution to be made locally higher in shallow areas and near coastlines, where small-scale flow features are important, and lower in deeper areas, where the flow is more uniform. However, their modelling approach does not resolve vertical flow structure, which constrains its ability to simulate 3-D processes, thereby resulting in less realistic outputs.

More recently, CSIRO developed a modified Ocean Forecasting Australia Model version 3 (OFAM-v3), a near-global (does not include Arctic region) oceanographic model run under standard IPCC emissions scenarios to project future ocean states around Australia (Zhang et al. 2017, Fulton et al. 2018). These scenarios are taken from global ocean-atmosphere models (CMIP5 climate models), which set the context for the finer scale OFAM-v3 model, which focuses on the Australian region in more detail. The OFAM-v3 model was originally developed for upper-ocean short-range operational forecasting (e.g. ocean forecasts of the type found at the www.bom.gov.au website) and was adapted for climate change studies (Oke et al. 2013). The downscaling simulations run with OFAM-v3 provide monthly surface high-resolution (10km, 0.1^{o}) outputs that can resolve important oceanographic features (e.g. eddies) and how these may change under future climate change. Outputs for two scenarios are available for regions across Australia, including Torres Strait: a) a control scenario without emissions (control) and 2) a high emission scenario (RCP8.5) (Fulton et al. 2018). There were differences between observations in Torres Strait and outputs from downscaled models (Plaganyi et al. 2018b), which suggests the need to develop a regional hydrodynamic model to capture local dynamics (see Chapters 10.1.3, 10.1.4 and Figure 8).

Uncertainty in model predictions in previously deployed hydrodynamic models was high due to lack of adequate data in Torres Strait to specify initial and boundary conditions, as well as poor knowledge of the empirical parameters (Margvelashvili et al. 2008, Saint-Cast 2008, Wolanski et al. 2017). There is a strong need for a monitoring program with extensive spatial and temporal coverage to improve hydrodynamic modelling efforts in the region (Saint-Cast 2008).

Given recent improvements in hydrodynamic modelling capability, it is recommended that a dedicated regional model be constructed for Torres Strait. This will also help resolve differences in observations and predictions from ecosystem models developed for the region (Fulton et al. 2018, Plaganyi et al. 2018b). The effort to re-run previously developed models will likely be similar to deploying an up-to-date state-of-the-art modelling platform such as eReefs, a comprehensive interoperable information platform that has been developed for the Great Barrier Reef (GBR) region (Steven et al. 2019). eReefs is a CSIRO modelling platform that runs hydrodynamic models, sediments and biogeochemistry of the GBR shelf in near real time, routinely producing 3D hydrodynamic fields of the GBR environment on a 4km x 4km grid and building up an archive of such data. It is possible to extend boundaries of eReefs to cover the Torres Strait region and increase model resolution in eReefs by nesting high resolution models (10s to 100s of meters) inside eReefs, through the relocatable coastal ocean model (RECOM) (Steven et al. 2019) in a subset of the regional grid encompassing Torres Strait.

10.1.3 Physio-chemical water quality constituents

Modelling physio-chemical water constituents is important to investigate impacts of future climate (e.g. temperature, pH, salinity, light penetration) on critical habitats supporting the fisheries (Chapter 6), targeted species (Chapter 7) and their predators and prey in Torres Strait (see Chapters 10.1.5 and 10.1.6). Previously deployed hydrodynamic models implemented in Torres Strait have incorporated basic physio-chemical parameters. For example, Saint-Cast (2008) 3-D model simulates temperature and salinity and OFAM-v3 (see description in Chapter 10.1.2) model simulates temperature and salinity for base case and different climate change scenarios. Plaganyi et al. (2018b) analysed observations from Thursday Island, MODIS remotely sensed SST and full time series of CIMP5 outputs. They found that the modelled results exceeded the maximum temperature from observations and MODIS SST each year (Figure 8). Again, these differences between observations and model outputs highlight the paucity of data for the area and difficulties in downscaling oceanic models to a unique strait. This also underscores the need to prioritise data collection of physical variables through a monitoring program to improve modelling efforts in Torres Strait. A range of global and regional observations and model outputs for physio-chemical water quality and specific products are available through special licence arrangements or free of charge that can be used to build new or update existing physio-chemical models (Table 10 , Appendix A).

10.1.4 Biogeochemistry

Biogeochemical models coupled with hydrodynamics are important to understand the links between oceans, land and atmosphere. Such models are important to assess local and climate change impacts on biological and chemical cycles and flow-on impacts on food chains and fisheries in Torres Strait. A biogeochemical model that represents nutrient flows and plankton components of the ocean food web (primary producers such as phytoplankton, some bacteria and zooplankton consumers) was coupled with OFAM-v3 to produce patterns of primary productivity, nutrient cycling and carbon fluxes consistent with observations across Australia (outputs were extracted for Torres Strait). The OFAM-v3 outputs provide downscaled climate change projections for all common ocean state variables including currents, temperature (^{o}C), phytoplankton (mmol Nm^{-3})

and primary productivity (mmol C $m^{-2}day^{-1}$). These outputs were then used as input to ecosystem and fisheries models used to assess impacts of climate change on fisheries across Australia, including Torres Strait (Fulton et al. 2018).

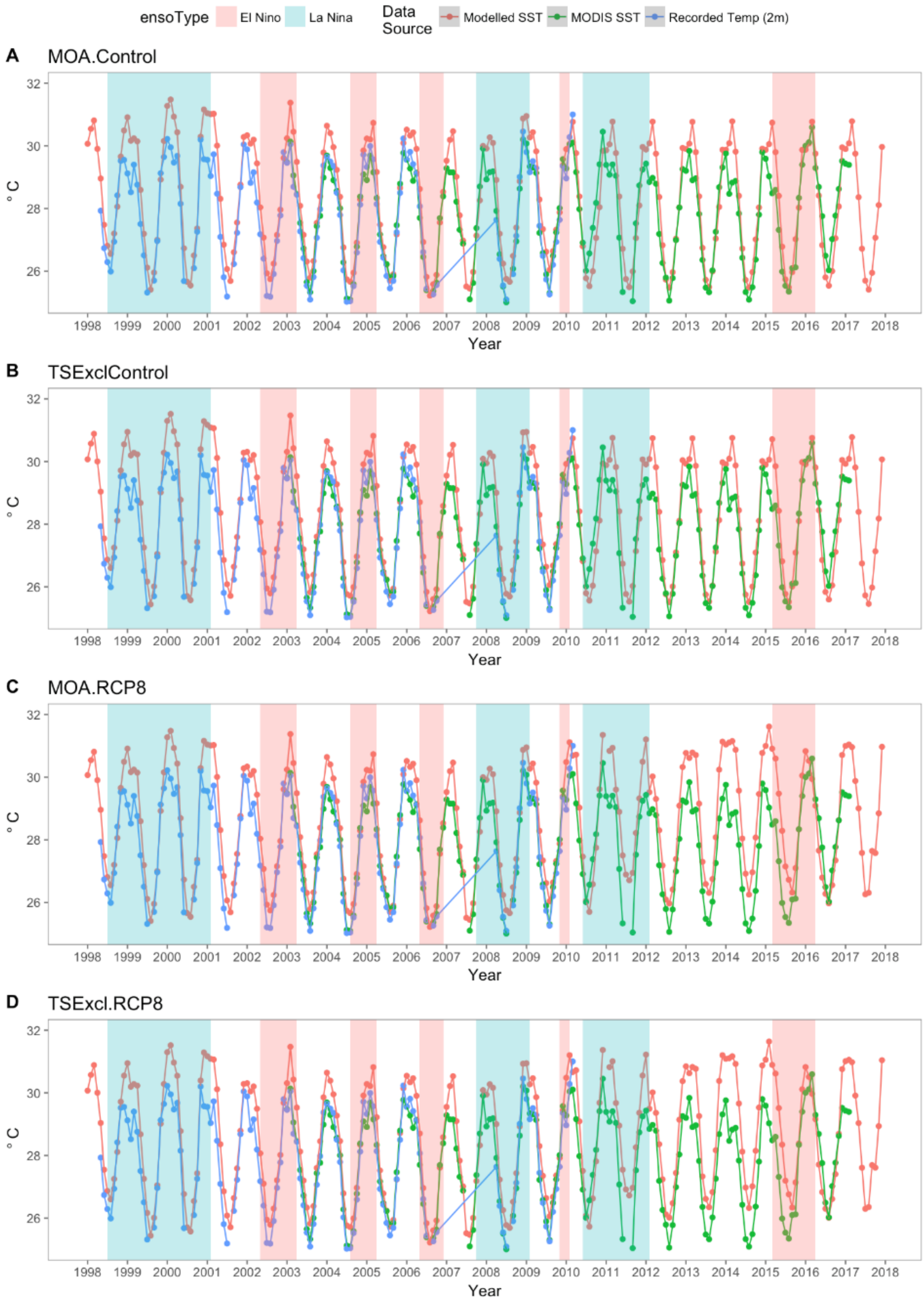


Figure 8. Plots of water temperature (modelled SST, remotely sensed (MODIS) SST and actual water temperature at 2 m depth at Thursday Island). The modelled SST is shown for the Torres Strait model output area (MOA) and the MOA minus the exclusion zone (TSExcl) under two future climate scenarios: no change (Control) and RCP8.5 (RCP8). Major ENSO events are overlaid (Figure from (Plaganyi et al. 2018b).

Sediment transport models have been developed to understand source and fate of sediments, processes maintaining naturally high turbidity in some parts of Torres Strait and the behaviour of sediment plumes from the Gulf of Papua into Torres Strait (Hemer et al. 2004, Margvelashvili et al. 2008, Saint-Cast 2008, Wolanski et al. 2013, Li et al. 2017, Wolanski et al. 2017).

10.1.5 Fisheries dynamics

The dynamics of fish stocks and how they are impacted by fishing can be simulated using models. For key fisheries across the world these are routinely performed as stock assessments. Three main groups of models are used in stock assessments – biomass dynamic models, age-structured models and size-based models (Hilborn 1992). These models, and their derivations, range in complexity and require key biological information on the species modelled, as well as indices of abundance such as catch and effort data generated from the fishery, and where possible, fishery independent survey data. In the Torres Strait region, stock assessment models have been developed for TRL (Plaganyi et al. 2013b, Plaganyi et al. 2018a, Plaganyi et al. 2019a); BDM (Plagányi et al. 2011b, Plaganyi et al. 2013a); Prawns (O'Neill and Turnbull 2006, Turnbull et al. 2009) and Fin Fish (Holden and Leigh 2019, O'Neill 2019).

It is usually difficult to correlate environmental variables with fish stock abundance, particularly for highly variable species such as prawns and TRL, and consequently many stock assessments do not explicitly incorporate environmental variables to help with the prediction of stock abundance. In Torres Strait, this has been the case for the TRL reference case stock assessment model, but there are model versions presented as sensitivities that explicitly incorporate an environmental driver (Plaganyi et al. 2013b)(see section 7.1.5). For the BDM fishery, Plaganyi et al. (2013a) used a set of operating models that incorporated environmental drivers in a Management Strategy Evaluation approach (Rademeyer et al. 2007, Punt et al. 2016) to evaluate the performance of alternative fisheries management strategies under varying climate scenarios.

When considering broader ecosystem impacts on fisheries, ecosystem models of varying complexity, depending on the questions being asked and data available, can be used to simulate changes in the environment, including from climate and flow-on effects to fisheries and vice-versa.

Fishery ecosystem models range from those that are simple in structure and complexity, representing only a simplified part of the system (e.g. one or two species), to those that have high complexity and capture many components of the system (e.g. whole of ecosystem models; see Chapter 10.1.6) (Collie et al. 2016). The former are usually fitted to fishery data (e.g. stock assessment models) and thus used for tactical (i.e. day-to-day) decision making, while the latter, which are not always fitted to data, often display large parameter uncertainty and are used more for strategic purposes (Collie et al. 2016). Models of intermediate complexity for ecosystem assessments (MICE; Plagányi et al. 2011a) fall somewhere in the middle. MICE aim to simulate key components of the system and thus only the most important species are represented e.g. the fished species and those that most closely interact with it. Where possible, these components are fitted to data, allowing these models to also be used for tactical decision-making purposes, with the benefit of considering other components such as habitats in the ecosystem.

Stock assessment models are a useful start for capturing the dynamics of key resources in the TS region, which can then be used to "ground-truth" larger whole of system models or can be added to by including other components of interest or for which there are data available, for example using a MICE model.

10.1.6 Ecological relations

Simple qualitative network-based representations of ecosystems, including ecological relations and system drivers, are a useful start to conceptualise the system and highlight key components and stressors (Plagányi et al. 2011a, Melbourne-Thomas et al. 2013, Metcalf et al. 2014, Dambacher et al. 2015, Fulton et al. 2019). Conceptual and qualitative models therefore provide better insight into ecosystem form and function before moving to more complex models. Information for these simple network models can be (and is) sourced from literature and engagement with stakeholders such as fishers, researchers and other sources of local ecological knowledge. These qualitative network models can then be developed into quantitative models, whose form and complexity will depend on their purpose and data available.

Ecosystem models commonly applied to marine systems include complex whole of system models such as Ecopath with Ecosim (EwE)(Christensen and Walters 2004) and Atlantis (Fulton et al. 2011a), and models of intermediate complexity such as MICE (Plagányi et al. 2011a). Socio-ecological models are increasingly being developed to account for the human dimension (Fulton et al. 2011b, Plagányi et al. 2014, van Putten et al. 2018, Hornborg et al. 2019).

EwE is a mass-balanced model, typically representing the entire ecosystem from detritus through to top-predators using built-in trophic relationships that track the flow of energy through the system. The model is forced by primary productivity and typically doesn't include links to environmental variables. Various sources of data are required for each species/trophic group and are usually gathered from research in the region of interest, or if not available, from similar systems elsewhere. EwE models have been created for many marine ecosystems around the world (e.g. Colleter et al. 2015). EwE models therefore have many advantages such as being relatively quick and easy to implement, but they also have a number of disadvantages such as those outlined in Plaganyi and Butterworth (2004).

Similar to EwE, Atlantis represents the whole system, but at a finer resolution including age and size components. Atlantis is a dynamic system model that attempts to represent both bottom-up (physical) and top-down (biological) forces interacting in an ecosystem (Fulton et al. 2011a). It is forced by environmental variables such as temperature, salinity and physical oceanographic variables. Anthropogenic activities can also be included in the system. Atlantis has a range of successful applications to support strategic decisions around the world and is highly regarded by modellers as one of the best approaches for addressing very broad ecosystem issues (Plagányi et al. 2011a). Atlantis models have the advantage of including a very large amount of complexity and components of the ecosystem. The disadvantage though is that there is considerable uncertainty associated with several components and hence these models are more suited for addressing strategic insights than tactical applications. These models are also relatively expensive with a long development time typically needed. An Atlantis model has been developed for the Coral Sea to look into fisheries management and climate change impacts (Hutton et al. 2017). A Torres Strait Atlantis model would need to be adapted/fine-tuned for just the Torres Strait region, which is quite distinct from the rest of the east Australian coast (Wolanski et al. 1988).

Unlike whole of system models, MICE only focus on representing key components in a system. Both trophic and non-trophic relationships can be modelled and are custom added as necessary (i.e. not already built-in as with EwE trophic relationships). MICE can include both temporal and spatial resolution, and if data are available, they can link environmental variables (e.g. temperature) to a species, e.g. through linking to recruitment or survival. MICE rely on stakeholder input to help capture key processes and links within the ecosystem and importantly they rely on fitting to data and thus can better account for uncertainty than many whole-of-system models, an important requirement in fisheries and ecosystem management. A limitation of this approach is that it does not consider all components in an ecosystem, but as a result these models are more question focussed, quicker to develop than Atlantis models, and they provide more rigorous predictions which can be used in ecosystem assessments (rather than broad strategic insights only).

MICE have been developed for a range of ecosystems, including coral reefs south of Torres Strait on the GBR to assess effectiveness of various measures in controlling Crown-of-Thorns Starfish (COTS) outbreaks (Morello et al. 2014). A spatial MICE is also currently being developed for the Gulf of Carpentaria to the west of Torres Strait, looking at impacts of reduced riverine water flow on prawns and other key species and associated fisheries (Plagányi et al. 2020a).

Morello et al. (2014) used a MICE to model trophic interactions between COTS and two types of coral on a reef in the GBR. By fitting to data, they were able to quantify COTS prey-switching between two types of coral prey. Parameters from this model were then used to help model trophic interactions in a larger metacommunity model, i.e. scaled to the whole GBR (Condie et al. 2018). This is an example of how models can be combined at different scales to address questions pertaining to local through to more regional scales. Some simple MICE (seagrass-dugongs and TRL) have been developed in Torres Strait, covering the areas to the west and east of Torres Strait (Fulton et al. 2018)

Modelling approaches can produce different outputs for similar fisheries (e.g. Atlantis model predicts that lobster populations will increase with climate change (Fulton et al. 2018), while MICE predicts a decline (Plaganyi et al. 2018b). Such discrepancies can be resolved by constructing a specific regional ecosystem model to assess climate change impacts on Torres Strait fisheries.

A more suitable strategy to develop ecosystem models for Torres Strait would be to develop some sort of hybrid MICE-Atlantis approach drawing on features from both approaches. There are existing examples of MICE that have successfully been coupled with general circulation models (Tulloch et al. 2019). Approaches such as these and other system-level hybrid models, which bring together the strengths of various modelling approaches, can represent each component of the system in a way that best captures that system and the data available (Fulton et al. 2019). The Torres Strait region will likely need a mix of modelling approaches that feed into one another. For example, it could start with conceptual / qualitative model of the ecosystem representing key fished species and other components of the ecosystem which are important for / linked to them, including drivers and stressors. Different model structures can be tested using qualitative network or other models to inform the development of a MICE or more complex ecosystem model(s).

A more pragmatic and cost-effective approach would be to develop a regional hydrodynamic model that simulates basic physical and biogeochemical processes coupled to fisheries, ecological or ecosystem models. Given there are already assessment models developed for some of the key species (e.g. TRL, BDM, prawns), a useful starting point would be to combine these in an integrated spatial MICE for the Torres Strait region. Modelling key species using MICE can include uncertainties and provide valuable information on their ecological status and integrating this information with stock assessments. Outputs/parameters from MICE can be fed into a more complex ecosystem model or help to ground-truth a larger more complex model. The modelling approach should be iterative with models developed and refined with improved understanding about the system.

Traditionally most marine ecosystem models have focused on physical and ecological components but it is increasingly recognised that the human dimension is important too (Fulton et al. 2011b). This is particularly the case in Torres Strait because of the close relationship with and custodianship of traditional owners towards their marine environment, as well as dependency on marine resources. Socio-ecological models are still in the early stages of development (Thebaud et al. 2017), but to the extent feasible, it would be advantageous to integrate social and cultural considerations into any ecosystem modelling approach. It may also be possible to draw on previous work as part of the Torres Strait lobster MSE project which integrated economics considerations, as well as coupling a Bayesian Belief Network (BBN) approach (van Putten et al. 2013b) with ecological and economic components (Pascoe et al. 2013), thereby integrating aspects of the social dimension to support operationalising a triple bottom line approach (Plaganyi et al. 2013b, Van Putten et al. 2013a).

10.2 Data framework

In order to support future modelling work to explore impacts of climate change in Torres Strait fisheries we propose the development of a data framework that identifies how the physio-chemical and ecological data should be managed and delivered to support the development of models. Consideration of confidentiality of some data (e.g. fisheries data) will be required. The assumption used to describe the future data framework project is that datasets will be managed on CSIRO IT infrastructure, utilising relational database systems and enterprise file servers. Datasets will be described using geonetwork (www.marlin.csiro.au) and these descriptions can be made public to allow third parties (non-CSIRO) to access data depending on level of permission granted (i.e. licence restrictions). Datasets can be shared using Open Geospatial Consortium (OGC) standards where appropriate, by using a standards-compliant webserver (geoserver) linked to the collated data. This framework is scalable, robust and compliant with open data/metadata standards, allowing a flexible data delivery method. The detailed specification of how the physical data should be managed and delivered is therefore the key output of the project, and is specified below and Figure 9.

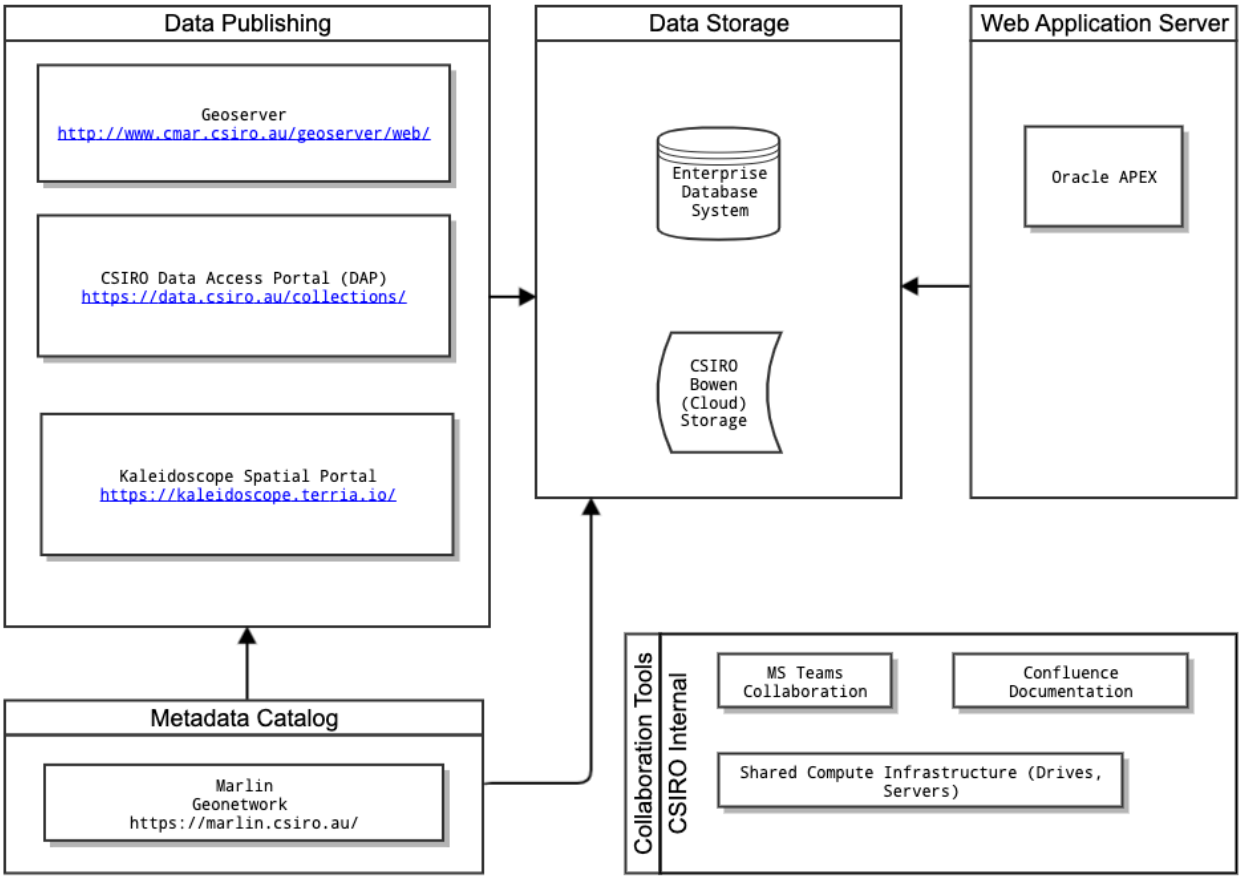


Figure 9. Data and modelling connections.

10.2.1 Data storage

Datasets are managed on CSIRO infrastructure where possible, making use of relational database systems, enterprise file systems and CSIRO's Bowen Cloud infrastructure (cloud-based storage systems). This ensures that data services are available to scientists, secure and provide a scalable platform to meet the expected data growth demands. The Bowen Research Cloud is an internal cloud resource that provides cloud storage for projects and virtual compute resources for data processing. The storage capability caters for datasets up to multiple terabytes. The Oracle database run by CSIRO Oceans & Atmosphere Business Unit is used to store structured information in a relational database system, and can provide an environment to manage information on the range of targeted datasets.

10.2.2 Data access / web services

To facilitate access to data across different analysis tools and platforms, data services will be configured to provide access to the various datasets. The open source Geoserver software will be used where the data is predominantly spatial in nature, and Geoserver supports the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Mapping (WMS) specifications. WFS and WMS provide a standard mechanism to exchange vector and image data respectively over http(s). Provision of fine-grained access to the data allows additional services - particularly spatial mapping or "spatial portals" - to be developed utilising standard data ingestion methods, leading to additional data visualisation tools.

10.2.3 Metadata (marlin)

The CSIRO marlin metadatabase is based on open standards, and provides a mechanism to store information on datasets in a standard way, and share this information with other web applications. It is based on Geonetwork (https://geonetwork-opensource.org/), an open source metadata system, and stores information using the Marine Community Profile, which is a profile of the latest ISO standard for encoding Geographic metadata information (ISO 19115-1:2014). This enables information to be exchanged readily with other services that are based on these open standards - in particular the Australian Ocean Data Network (AODN; https://portal.aodn.org.au/).

10.2.4 Visualisation (spatial portal / Kaleidoscope)

Datasets that are actively stored and managed within this project will be connected to allow visualisation and provide access to a broad range of users. CSIRO's Ocean & Atmosphere and Data61 business units are partnering to develop a spatial portal - Kaleidoscope - that is based on TerriaJS. This software is open source, and backs other portals such as Australia's National Maps data initiative (https://nationalmap.gov.au). This software uses open protocols and open data formats to access data, and provides a web-based platform for spatial data visualisation and analytics. This portal will provide capacity, as an ongoing service, to host, display and distribute spatial data from our centralised repositories, to support the ongoing requirements of data users.

A web-based database will be developed to track details on the datasets and model outputs that were identified in the initial stages of this project. Datasets will be managed on CSIRO infrastructure where possible, including relational database systems, enterprise file systems and CSIRO's Bowen Cloud infrastructure. This ensures that data services will be available to scientists, will be backed up, and will be secure.

10.2.5 Spatial scale

The boundaries for regional hydrodynamic model should include all important fishery areas in Torres Strait (https://www.pzja.gov.au/the-fisheries). We propose to use such regional scale coarser grid using boundaries defined in Plaganyi et al. (2018b)(Figure 10):

A. Top left coordinates: 9° 08' 24.83" S / 141° 01' 0.00" E

B. Bottom Right coordinates: 11° 10' 0.00" S / 144° 28' 0.00" E

The quadrants defined in the Tropical Rock lobster survey (Plagányi et al. 2020b/ Figure 11) are the primary spatial units (or areas) for ecological modelling and finer-scale (RECOM) hydrodynamics because of North/South differences in lobster growth rates, different fisheries in West and East, different oceanographic processes influencing the Eastern part of the Torres Strait (e.g. cooler upwelling intrusions into the area prevented bleaching), and northern region more influenced by runoff from PNG rivers and then also captures differences in underlying strata and habitat types. We would consider extending the eastern border of the Tropical Rock lobster survey quadrants or adding an additional spatial unit further to the east to include fisheries in the eastern Torres Strait, depending on how finely resolved the underlying oceanography is.

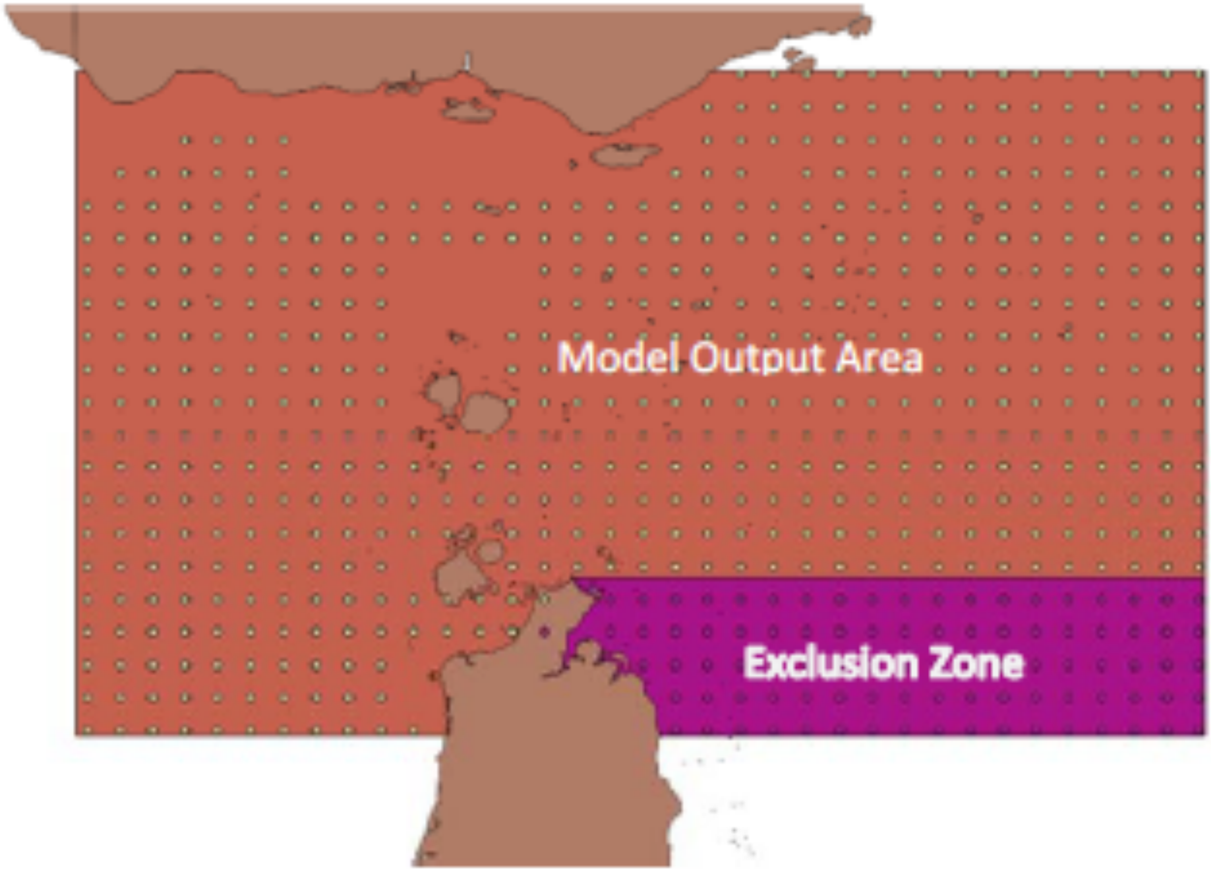


Figure 10. Proposed modelling region defined by: A) Top left coordinates: 9° 08' 24.83" S / 141° 01' 0.00" E, and B) Bottom Right coordinates: 11° 10' 0.00" S / 144° 28' 0.00" E.

For finer spatial scale within each quadrant if wanting to capture more localised oceanographic drivers and ecological processes, or if wanting to model the impacts on fisheries in the eastern side of Torres Strait, ecological modellers can opt to use the Management Strategy Evaluation sub-areas as previously implemented by Plagányi et al. (2020b) (Figure 12). These sub-divisions align broadly with fishery data and habitat characteristics although are not perfectly aligned with community spatial locations. Such subdivisions can facilitate the development of even finer-scale (e.g. RECOM) hydrodynamic models to support the evaluation of specific questions around particular ecosystems or fisheries.

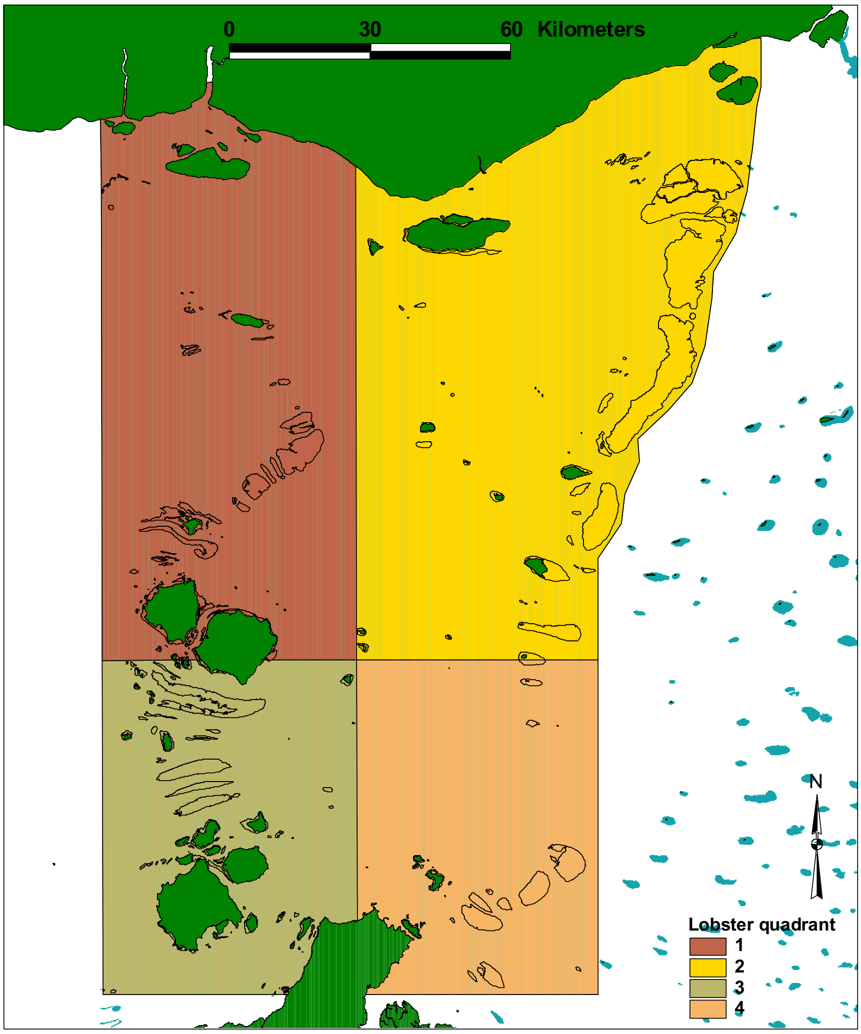


Figure 11. The area of the Torres Strait lobster survey split into four quadrants centered on 10.21 degrees S and 142.5 degrees E (from Plagányi et al. 2020b).

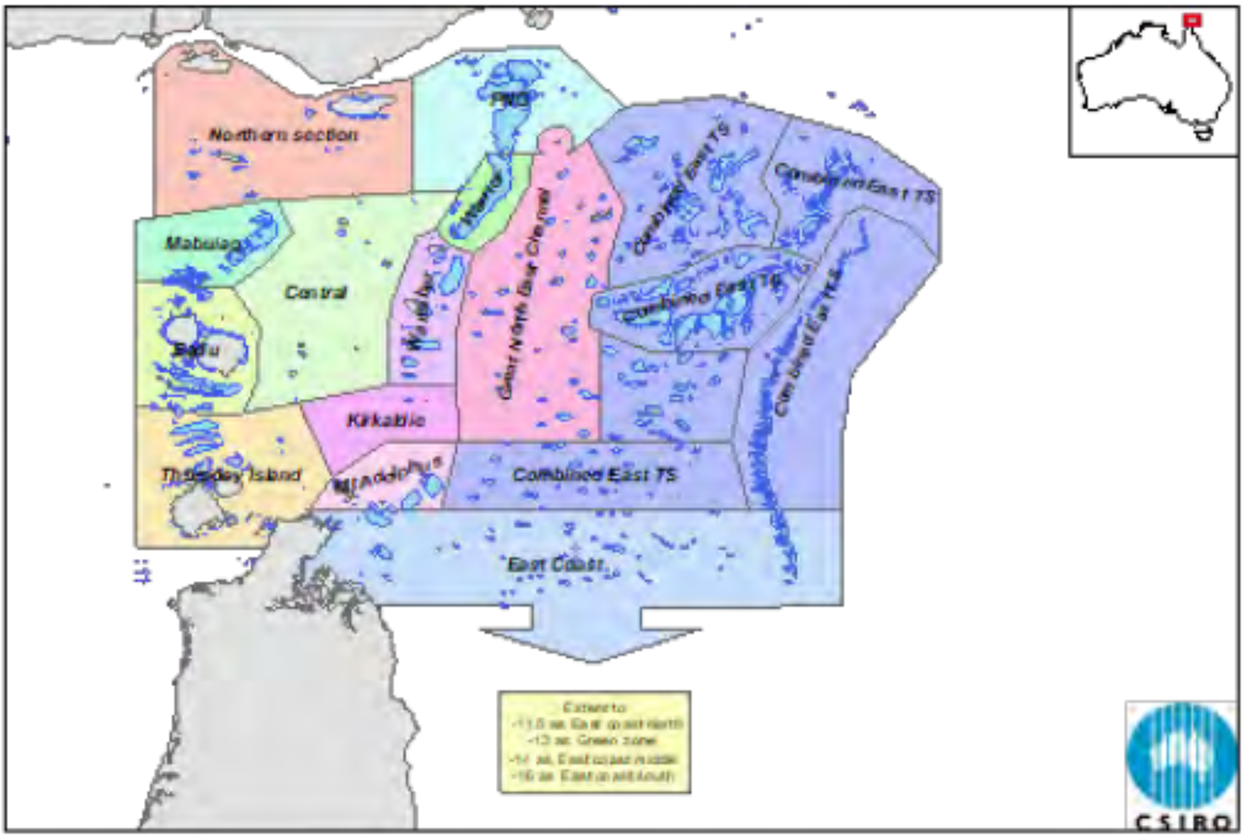


Figure 12. Proposed modelling sub-areas (source: Plaganyi et al. 2018b).

Modelling approaches were developed for TRL, BDM and dugongs in the past, considering environmental (including climate change drivers) and these can be improved as more data is now available since these models were developed. It takes a long time to organise surveys and collect adequate time series of data but as discussed in Chapter 9, sufficient data are available to start modelling. Efforts to improve data collection should be done in parallel so model refinements can be done when data from such monitoring program becomes available.

In summary, starting the modelling exercise sooner rather than later would provide a framework to utilise existing datasets and investigate potential climate change impacts on the fisheries and there are sufficient data available to start modelling. Our recommended approach would be to build the models in a stepwise fashion, adding new data and complexity as these become available or necessary. This also allows time to start obtaining feedback from stakeholders on preliminary model results, which allows time to communicate the usefulness of models as well as how to draw on local knowledge to further refine models.

The data framework described is needed to support the proposed modelling exercise to investigate impacts of climate change on the selected fisheries, but will also support other future research efforts in the region. Many ecosystem models involve coupling together different components and this is also how we envisage development of an ecosystem model proceeding – hence the starting point is to extend and link the current biological models of key species (e.g. TRL, BDM, dugongs), add current known environmental drivers (e.g. SST), gradually add other species (e.g. seagrass, finfish, turtles) and link with prelim hydrodynamic models or model outputs to start adding complexity associated with the oceanographic setting. A fully integrated couple hydrodynamic model usually takes a few years and is an expensive process so we recommend starting small and gradually expanding.

11 Preliminary costs of future project/s

1) The cost of a future project that will produce the over-arching data framework at the appropriate spatial scales, as required to address future climate variability and change scenarios for Torres Strait fisheries (i.e. deliver on Chapter 10.2) is approximately 0.4-0.5 FTE for 1 year or rough estimate of A$130k
2) We also strongly recommend a parallel project to initiate development of an integrated MICE-ATLANTIS modelling framework based on existing data to consolidate knowledge, fill gaps and support planning and adaptation in Torres Strait. Consideration should be given to drawing on existing assessment models available for some of the key species (e.g. TRL, BDM and dugongs). This would require approximately 0.5-0.7 FTE over each of 2 years, or rough estimate of $460k.
3) Developing a regional hydrodynamic modelling platform, such as eReefs, to provide link with ecological models would require approximately 0.3-0.5FTE over each of 2 years, or rough estimate of $350k

12 Conclusions and recommendations

12.1Conclusions

The first objective of this report was to detail findings from a literature review on the main climate change drivers in Torres Strait affecting tropical rock lobster, bêche-de-mer, finfish, prawns, turtles and dugongs, including a review on local and climate change threats to habitats and species (Parts 1 and 2).

- Anthropogenic impacts (other than climate change) in Torres Strait are relatively minor, but exist in specific locations. Torres Strait is, however, relatively highly vulnerable to shipping accidents, with this being recognised by TSRA (Carter et al. 2013) and oil spill risk may be important to consider in an ecosystem modelling framework.
- Local impacts include sediment runoff and metal pollution from the Fly River (PNG), localised oil contamination, mangrove cutting, alteration of hydrology, nutrient and sediment runoff, and chemical contamination.
- Fishing is an additional anthropogenic impact source. Most marine living resources have been managed sustainably but there are examples of past overharvesting (most notably Sandfish and Black teatfish) and this needs to be considered.
- Climate change is already affecting Torres Strait fisheries and culture. Impacts from climate change include higher sea levels and associated coastal erosion, warmer atmospheric and

ocean temperatures, more acidic waters, changes in ocean circulation, and more intense rainfall events.

- Although relatively minor, simultaneous local impacts (e.g. untreated sewage, chemical, sediment and nutrients runoff, oil pollution, overfishing) can act together with climate change impacts, such as sea-level rise, ocean warming and acidification, leading to interactive, complex and amplified impacts for species and ecosystems.
- These pressures manifest directly in the form of changes in abundance, growth, reproductive capacity, distribution and phenology (changes in cyclic and seasonal phenomena such as reproduction and migrations), and indirectly through changes in habitats.
- Invertebrates (Tropical Rock Lobster, prawns, bêche-de-mer) are likely to be more impacted by climate change than vertebrates (Finfish, turtles and dugongs). This is *inter alia* because although highly productive, their life spans are short, which makes it difficult for them to move out of a certain area severely impacted over many years before significant losses at the population level happen (Fulton et al. 2018).
- Climate change is likely to cause mostly negative direct effects on the fisheries investigated in this report, but some effects may also be positive, especially in the short to medium-term. If climate-related environmental changes exceed certain limits or ranges for species, they will either move if possible or have their abundance reduced (Pecl et al. 2014, Fulton et al. 2018).
- High water temperature can cause mortality, affect growth (relatively small warming may increase growth rates of sea cucumber and lobsters), reproduction and its timing, and negatively affect supporting habitats (coral reefs, seagrasses) of Finfish, invertebrates, dugongs and turtles. Elevated air temperatures can also reduce incubation success, shift timing of annual breeding cycle and increase 'feminisation' of Green turtle populations.
- Higher seas and extreme weather events can uproot mangrove trees and cause erosion and increase in turbidity, with consequent reduction in light penetration and salinity and an increase in sediment deposition, negatively affecting seagrasses and coral reefs. Some organisms, such as sea cucumbers may benefit from higher seas, but others like turtles and dugongs may be negatively affected via changes in abundance of preferred food (e.g. seagrass) and also via the inundation of nesting sites (turtles) and stranding (turtles and dugongs) associated with extreme weather events.

The second objective of the report was to use findings from the literature review to provide a detailed specification and costings for a future project that will produce an over-arching data framework at the appropriate spatial scales, as required to address future climate variability and change scenarios for Torres Strait fisheries, including detailed information about data availability, and specifications on data storage, management and data accessibility issues (Part 3).

- The data and modelling framework will primarily be designed to answer the following question: *What are the potential consequences associated with changes in local conditions, including climate variability and change, on the selected Torres Strait Fisheries and ecosystems?*
- The objectives of the modelling exercise are to simulate future climate scenarios and assess the impacts of these on fisheries and associated habitats and species through

quantitative evaluation. It will support the exploration of responses and strategies to manage the selected Torres Strait fisheries, such as the evaluation of:

1) Interactions between different fisheries and broader ecosystem functioning, including consideration of communities that rely on these resources;

2) Impacts of climate change scenarios on the abundance and distribution of selected species;

3) Impacts of current and future catchment conditions and management scenarios on fisheries;

4) Impacts of incidents (e.g. oil spills, ships run aground) on fisheries;

5) Combined scenarios of 1-4 to develop strategies that are robust across impacts and fisheries; and

6) Evaluation of alternative adaptation options.

- In order to address objectives, some of the desirable features of the modelling framework include: 1) Catchment runoff; 2) Hydrodynamics and transport; 3) Physio-chemical water quality constituents; 4) Biogeochemistry, 5) Fisheries dynamics; and 6) Ecological and socio-ecological relationships.
- Data requirements to simulate these desirable features include: a) biological and fisheries data (catches, catch locations, target species, gear, age and size frequency of catches, species distribution, growth rates, reproduction and maturity, mortality and population size); b) location, area and species of supporting habitats (mangroves, seagrasses and mangroves); and c) physical and biogeochemical data (currents, turbidity, temperature (air and sea), tides and water level, light penetration, nutrients, salinity, sedimentation, pH, oxygen, grazing, extreme events, waves, moon phase, diseases and parasites).
- There is significant information covering Torres Strait fisheries, key marine species, habitats, geology and physiochemical water quality parameters. However, datasets are sparse both in space and time. A large-scale monitoring program for Torres Strait would support the identification of long-term trends and improve understanding about local and regional processes affecting habitats, species and fisheries (Pitcher et al. 2004), including the impacts of climate change on these (NESP Earth Systems and Climate Change Hub 2018).
- Most of the understanding about physical and biogeochemical cycles and processes (e.g. currents, tides, primary productivity, nutrients) in Torres Strait have been derived from remote sensing and hydrodynamic models developed in the 2000s and in the early 2010s, each with pros and cons relatively well-known. Limited physical long-term observational data is available as was collected mostly in the 1990s (Wolanski et al. 2013).
- Habitat, fisheries and ecological data are also sparse, but recent mapping of mangroves, seagrasses and coral reefs (Chapter 6) combined with survey data on substrate and species collected in large-scale sea cucumber and Tropical Rock Lobster surveys (Murphy et al. 2020, Plagányi et al. 2020b) offer valuable information about the location and health status of such habitats, which can support the development of models to explore impacts and adaptation options.
- A number of modelling initiatives are already in place in Torres Strait and it would be worth considering capitalising on these efforts.

- It is recommended that a dedicated regional hydrodynamic model, including physics and biogeochemistry be constructed for Torres Strait as the effort to re-run previously developed models will likely be similar to deploying an up-to-date state-of-the-art modelling platform such as eReefs, which has been developed for the Great Barrier Reef (GBR) region (Steven et al. 2019).
- A suitable strategy to develop ecosystem models for Torres Strait would be to develop some sort of hybrid MICE-Atlantis approach drawing on features from both approaches and coupled with a regional hydrodynamic model.
- The Torres Strait region will likely need to integrate a mix of modelling approaches that feed into one another, built in a stepwise fashion, such as the development of conceptual / qualitative model of the ecosystem, representing key fished species and other components of the ecosystem which are important for/linked to them, including drivers and stressors. Different model structures can be tested using qualitative network or other models to inform the development of a MICE or more complex ecosystem models.
- A cost-effective approach would be to couple a regional hydrodynamic model that simulates basic physical and biogeochemical processes with an ecological or socio-ecological model. Given there are already assessment models developed for some of the key species (e.g. Tropical Rock Lobster, bêche-de-mer, prawns), a useful starting point would be to combine these in an integrated spatial MICE for the Torres Strait region. This can form the basis of a more complex ecosystem model or help to ground-truth a larger more complex model.
- The proposed data framework identifies how the physio-chemical and ecological data could be managed and delivered to support the development of models. Datasets will be managed on CSIRO IT infrastructure, utilising relational database systems and enterprise file servers. Datasets will be described using geonetwork (www.marlin.csiro.au) and these descriptions can be made public to allow third parties (non-CSIRO) access data depending on level of permission granted (i.e. licence restrictions). Datasets can be shared using Open Geospatial Consortium (OGC) standards where appropriate, by using a standards-compliant webserver (geoserver) linked to the collated data. This framework is scalable, robust and compliant with open data/metadata standards, allowing a flexible data delivery method.

12.2 Key Recommendations

1. Prioritise physical data collection and further strengthen and expand a large-scale monitoring program for Torres Strait that would support the identification of long-term trends and improve understanding about local and regional processes affecting habitats, species and fisheries, and to support the development of models.
2. Staged approach in the development of an integrated ecosystem modelling framework to investigate the impacts of climate and local changes on fisheries in Torres Strait, via coupling together:

a. Development and implementation of data framework to support future modelling efforts in Torres Strait

b. Development of integrated ecological or socio-ecological models capable of integration with a regional hydrodynamic model:

    i. For example, combining existing data and models (Tropical Rock Lobster, bêche-de-mer, and dugongs) into an integrated spatial MICE, which will form the basis for a hybrid MICE-ATLANTIS ecosystem model;

    ii. Dedicated regional hydrodynamic model, including physics and biogeochemistry for Torres Strait, for example similar to eReefs.

Acknowledgements

We are grateful to participants (see table below) of Technical workshop organised as part of this project, which was held virtually on the 14th of October 2020. The workshop involved fishery researchers, managers and stakeholders to identify data requirements, and spatial scale as required to address future climate variability and change scenarios for selected TS fisheries.

PZJA advisory committee	Position	Name
TRL RAG	Chairperson	Ian Knuckey
TRL RAG	Scientific member	Eva Plaganyi
FF RAG and FFWG	Chairperson and Sci Member	David Brewer
FF RAG and FF WG	Scientific member	Michael O'Neill
FF RAG	Scientific member	Rik Buckworth
FF RAG	Scientific member	Ashley Williams
FF WG	Permanent observer, scientific	Trevor Hutton
HCWG	Scientific member	Tim Skewes
HCWG	Scientific member	Steven Purcell
TSSAC	Chairperson	Ian Cartwright
TSSAC	Scientific member	Roland Pitcher
PrawnMAC	Scientific member	Clive Turnball
-	Climate and Coastal, TSRA	John Rainbird
-	AFMA	Selina Stoute
-	AFMA	Danait Ghebrezgabhier
-	AFMA	Georgia Langdon
-	AFMA	Kayla Yamashita
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Appendix A Available data

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
1	Fisheries	Prawn	AFMA	Logbooks and catch disposal records	Observational	1978	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005. Data is scattered until 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
2	Fisheries	Prawn - Tiger	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
3	Fisheries	Prawn - Endeavour	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
4	Fisheries	Prawn - King	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
5	Fisheries	Prawn - Vessels	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
6	Fisheries	By-Catch Flatback Turtle	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
7	Fisheries	By-Catch Green Turtle	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
8	Fisheries	By-Catch Hawksbill Turtle	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
9	Fisheries	By-Catch Loggerhead Turtle	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
10	Fisheries	By-Catch Pacific (Olive) Turtle	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
11	Fisheries	By-Catch Turtles	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
12	Fisheries	By-Catch Sawfish	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
13	Fisheries	By-Catch Seasnakes	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
14	Fisheries	By-Catch Seahorses and Pipefish	AFMA	Logbooks and catch disposal records	Observational	2015	2019	catch and effort information for the Torres Strait Prawn Fishery (TSPF) from the 2019 fishing season in comparison to previous years.The PZJA collect data for the TSPF through both operator completed daily fishing logbooks and an automatic Vessel Monitoring System (VMS) established in 2005.	on request to AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia.
15	Fisheries	Sea cucumbers	AFMA	Bêche-de-mer Fishery-dependent data (logbooks)	Observational	2017	2020		on request to AFMA	https://www.afma.gov.au/fisheries-services/logbooks-and-catch-disposal

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
16	Fisheries	*Coral trout (Plectropomus spp.)*	partly in the paper	Population biology of coral trout species in eastern Torres Strait: Implications for fishery management	Modelled and Observational	2004	2005	Information on the catch composition of coral trout species was obtained during observer surveys on board Islander and nonindigenous. Authors used modelled growth curves for coral trout. commercial vessels operating in the ETS		Williams, A. J., L. M. Currey, G. A. Begg, C. D. Murchie and A. C. Ballagh (2008). "Population biology of coral trout species in eastern Torres Strait: Implications for fishery management." Continental Shelf Research 28(16): 2129-2142.
17	Fisheries	*Dugong dugon*	CSIRO NERP	Quantification of risk from shipping to large marine fauna across Australia. Dugong	Modelled	2013	2015	Broadscale and finescale dugong vessel strike risk maps (2013-15). Also for other species: humpback whale, green turtle, seagrass locations and generic species	unknown	https://www.marlin.csiro.au/geonetwork/srv/eng/search#!40e7e293-e5e2-4d46-9611-c2db22182b24
18	Fisheries	*Dugong dugon*	Not clear. Needs search	The Torres Strait Dugong Fishery	Modelled	1991	1993	Population estimates and yield. 1994 Torres Strait Dugong fishery report	unknown	http://www.cmar.csiro.au/datacentre/torres/AFMA1980_2003/DVDVer101/Reports/r494.pdf
19	Fisheries	*Dugong dugon*	Not clear. Needs search	1991 The Status of the Dugong in Torres Strait	Observational	1987	1988	Observed count. Population estimate	unknown	researchgate.net/publication/237260190_The_Status_of_the_Dugong_in_Torres_Strait
20	Fisheries	*Dugong dugon*	https://dugongs.tropicaldatahub.org/	JCU Dugong aerial survey database	Observational	1984	2013	Online database of aerial surveys	Near CC. Details at https://dugongs.tropicaldatahub.org/	https://research.jcu.edu.au/researchdata/default/detail/70987a255de5bba750bd671901009ac3/
21	Fisheries	*Dugong dugon*	Not clear. Needs search	Stock Assessment Report on Dugong in the Torres Strait 1994	Modelled	1994	1994	Stock assessment report. Population estimates and yield	Copyrighted	http://dugong.id.au/publications/TechnicalReports/Marsh%201995.%20Torres%20Strait%20Dugong%20Stock%20Assessment%20Report.%20T~1.pdf
22	Fisheries	*Dugong dugon*	In the paper	Temporal variability in the life history and reproductive biology of female dugongs in Torres Strait: The likely role of sea grass dieback	Observational	1978	1982	Indigenous catch from 2 islands. 35+ specimens	unknown	https://www.sciencedirect.com/science/article/pii/S0278434308001349#fig1
23	Habitat	*Seagrass*	In the paper	Spatial patterns of sub-tidal seagrasses and their tissue nutrients in the Torres Strait, northern Australia:	Observational			Forraging sites	unknown	https://www.sciencedirect.com/science/article/pii/S0278434308001441#fig3

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
				Implications for management						
24	Fisheries	*Dugong dugon*	In the paper	Aerial surveys and the potential biological removal technique indicate that the Torres Strait dugong fishery is unsustainable	Observational	1987	2001	Population estimates from aerial surveys	unknown	https://zslpublications.onlinelibrary.wiley.com/doi/epdf/10.1017/S1367943004001635
25	Fisheries	*Dugong dugon*	In the paper	Diving behaviour of dugongs, Dugong dugon	Observational			Diving behaviour. One site is in the GOC	unknown	http://apps.webofknowledge.com/full_record.do?product=WOS&search_mode=GeneralSearch&qid=1&SID=F3cEpMRxEhS9IDR3OHk&page=4&doc=35&cacheurlFromRightClick=no
26	Fisheries	*Dugong dugon*	In the paper	Pathological findings in wild harvested dugongs Dugong dugon of central Torres Strait, Australia	Observational	2011	2011	Six dugongs hunted legally examined on Mabuiag Island in 2011	unknown	https://www.int-res.com/articles/dao2015/113/d113p089.pdf
27	Fisheries	*Dugong dugon*	Shapefile at: https://eatlas.org.au/pydio/public/0a6f55.php	Satellite Tracking of Sympatric Marine Megafauna Can Inform the Biological Basis for Species Co-Management	Observational	2009	2010	Tagging and tracking 6 dugongs at Mabuiag Isl.	unknown	https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0098944&type=printable
28	Fisheries	*Dugong dugon*	In the paper	Movements and distribution of dugongs (Dugong dugon) in a macro-tidal environment in northern Australia	Observational	2002	2002	Dugong sightings from aerial surveys in the TS 2002	unknown	https://www.publish.csiro.au/zo/pdf/ZO08033

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
29	Fisheries	*Dugong dugon*	On team share and in https://biocache.ala.org.au/occurrences/search?q=qid:1590003182716#tab_recordsView	ALA collection records search	Observational	1936	2007	Data search in ALA provides 26 records (in Excel file) from QM, AM, WAM, National Whale and Dolphin Sightings and Strandings Database, Australian Antarctic Data Centre, NT DENR, Fauna Atlas N.T.	CC-BY	On file
30	Fisheries	*Dugong dugon*	In the paper	Estimating Animal Abundance in Heterogeneous Environments: An Application to Aerial Surveys for Dugongs	Modelled		Uses previous surveys	Population estimates from aerial surveys	unknown	https://wildlife.onlinelibrary.wiley.com/doi/pdf/10.2193/0022-541X%282006%2970%5B255%3AEAAIHE%5D2.0.CO%3B2
31	Fisheries	*Dugong dugon*	In the paper	The Sustainability of the Indigenous Dugong Fishery in Torres Strait, Australia/Papua New Guinea		1987	1993	Sustainability of TS population. Based on previous studies	unknown	https://conbio.onlinelibrary.wiley.com/doi/epdf/10.1046/j.1523-1739.1997.95309.x
32	Fisheries	*Dugong dugon*	Needs search. Not easily found online. Data.gov does not provide it.	SPRAT Species Profile and Threats Database - Dugong	Australian distribution		From various sources		CC-BY	environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28
33	Fisheries	*Dugong dugon*	eAtlas	Dugong relative density 1987-2011 (JCU, NERP-TE1.2)	Modelled	1987	2011	Modelled distibution density	CC-BY	https://eatlas.org.au/data/uuid/70e21d20-cc5e-4d1d-9d2b-7b08f4b061a2
34	Fisheries	*Dugong dugon*	eAtlas	Dugong relative density 1987-2013 (JCU, NERP-TE2.1)	Modelled	1987	2013	Modelled distibution density	CC-BY	https://eatlas.org.au/data/uuid/8a49e81b-0f88-43b4-8599-fc371da4063a

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
35	Fisheries	*Dugong dugon*	Table 1 is a good overview of the aerial surveys conducted on Dungon in the TS	Informing Species Conservation at Multiple Scales Using Data Collected for Marine Mammal Stock Assessments	Observational			Species conservation	unknown	https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0017993#pone-0017993-g001
36	Fisheries	*Dugong dugon*	Fig. 8 in eAtlas, rest unknown	Aerial survey of Torres Strait to evaluate the efficacy of an enforced and possibly extended Dugong Sanctuary as one of the tools for managing the dugong fishery.	Modelled	2011	2011	Distribution modelling	unknown	https://data.marinemammals.gov.au/common/documents/grants/2010/Marsh_2.pdf
37	Fisheries	*Dugong dugon*	Figs. in the paper. Repository unknown	Condition, status and trends and projected futures of the dugong in the Northern Great Barrier Reef and Torres Strait; including identification and evaluation of the key threats and evaluation of available management options to improve its status	Observational			Temporal changes and desity. Some evidence that seagrass abundance affects reproductive rates in females.	copyrighted	http://rrrc.org.au/wp-content/uploads/2014/06/141-JCU-2007-Marsh-et-al-Dugong-status-and-trends.pdf
38	Fisheries	*Dugong dugon*		Analysis of Stomach Contents of Dugongs from Queensland	Observational	1968	1978	Stomach content, diet of 2 dugong from the TS	copyrighted	https://www.publish.csiro.au/wr/pdf/WR9820055

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
39	Fisheries	*Dugong dugon*	Access is via registration and registration is not provided. Requires emailing JCU.	Dugong Tropical Data Hub. Dugong Aerial Survey Database. DOI: 10.4225/28/557F7B61ED8E1	Observational	1984	2013	Observations from aerial surveys	contact researchdata@jcu.edu	https://dugongs.tropicaldatahub.org/
40	Fisheries	*Dugong dugon*	Some in eAtlas, rest unknown	An assessment of the distribution and abundance of dugongs in the Northern Great Barrier Reef and Torres Strait	Observational	1985	2013	Distribution and abundance		http://www.nerptropical.edu.au/sites/default/files/publications/files/An%20assessment%20of%20the%20distribution%E2%80%A6%20Sobtzick%20et%20al%202014.pdf
41	Fisheries	*Dugong dugon*	Partly in the paper	Improving the estimates of abundance of dugongs and large immature and adult-sized green turtles in Western and Central Torres Strait	Observational	2006	2013	Distribution and abundance		http://www.tsra.gov.au/__data/assets/pdf_file/0007/13975/JCU-TSRA-2016-Improving-the-Estimates-of-Abundance-of-Dugongs-Green-Turtles-in-Western-and-Central-Torres-Strait.pdf
42	Fisheries	*Tropical Rock Lobster*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	CSIRO has been engaged, for the past 30 years, by AFMA to undertake annual diving surveys to determine the relative abundance of Tropical Rock Lobsters (TRL) (Panulirus ornatus). Divers complete a census of lobster along transects at pre-determined sampling sites, with a subset of lobster collected for additional measurements. Data collected: The number and age-class of lobsters observed, but not collected; The number of lobsters collected per age-class; The size (tail width in mm), sex and moult stage of the collected lobsters	Contact CSIRO	Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
43	Habitat	*Algae*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	Torres Strait		Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
44	Habitat	*Coral reefs*		Marine resources, biophysical processes, and environmental management of a tropical shelf seaway: Torres Strait, Australia-Introduction to the special issue				Torres Strait		Harris, P. T., A. J. Butler and R. G. Coles (2008). "Marine resources, biophysical processes, and environmental management of a tropical shelf seaway: Torres Strait, Australia-Introduction to the special issue." Continental Shelf Research 28(16): 2113-2116.
45	Habitat	*Coral reefs*	eAtlas: https://eatlas.org.au/ts/maps/torres-strat-islands-reefs-poster	Mapping the Torres Strait Reef and Island Features: Extending the GBR Features (GBRMPA) dataset. Report to the National Environmental Science Programme.	Observational		2015	historical landsat images		Lawrey, E. P. and M. Stewart (2016). Mapping the Torres Strait Reef and Island Features: Extending the GBR Features (GBRMPA) dataset. Report to the National Environmental Science Programme. Cairns, Reef and Rainforest Research Centre Limited.
46	Habitat	*Coral reefs*	CSIRO	Mapping and characterisation of the inter-reefal benthic assemblages of the Torres Strait	Observational	2004	2004	Torres Strait	unknown	Haywood, M. D. E., C. R. Pitcher, N. Ellis, T. J. Wassenberg, G. Smith, K. Forcey, I. McLeod, A. Carter, C. Strickland and R. Coles (2008). "Mapping and characterisation of the inter-reefal benthic assemblages of the Torres Strait." Continental Shelf Research 28(16): 2304-2316.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
47	Physiochemical	*Water depth*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Data from various surveys since 1989	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
48	Physiochemical	*Slope of the seabed*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
49	Physiochemical	*Nitrate*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
50	Physiochemical	*Oxygen*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
51	Physiochemical	*Phosphate*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
52	Physiochemical	*Silicate*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
53	Physiochemical	*Salinity*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
54	Physiochemical	*Water temperature*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
55	Physiochemical	*Currents*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
56	Physiochemical	*Tides*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
57	Physiochemical	*Carbonate concentration*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
58	Physiochemical	*Bottm Sediments*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
59	Physiochemical	*Chlorophyl a*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
60	Physiochemical	*Suspended sediments*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
61	Ecological	*Benthic irradiance*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	2004	2004	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
62	Fisheries	*Prawn Trawling effort*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	1987	2002	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
63	Habitat	*Epibenthos*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	1987	2002	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
64	Habitat	*Seagrass*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	1987	2002	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
65	Habitat	*Algae*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	1987	2002	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/
66	Ecological	*Seabed fishes*	CSIRO	Torres Strait seabed and water-column data collation, biophysical modeling and characterization	Models and Observations	1985	1986	Torres Strait	unknown	Pitcher, C. R., S. Condie, N. Ellis, I. McLeod, M. Haywood, S. R. Gordon, T. D. Skewes, J. Dunn, D. Dennis, E. Cotterell, M. Austin, W. Venables and T. Taranto (2004). Torres Strait seabed and water-column data collation, biophysical modeling and characterization. Final Report to the National Oceans Office. Cleveland: 117. https://parksaustralia.gov.au/marine/management/resources/scientific-publications/torres-strait-seabed-and-water-column-data-collation-bio-physical-modeling-and/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
67	Habitat	*Coral reefs*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2020	Torres Strait		Pitcher, C. R., T. D. Skewes, D. M. Dennis and J. H. Prescott (1992). "Distribution of Seagrasses, Substratum Types and Epibenthic Macrobiota in Torres Strait, with Notes on Pearl Oyster Abundance." Australian Journal of Marine and Freshwater Research 43(2): 409-419.
68	Fisheries	Rock Lbster (*Panulirus ornatus*)	CSIRO	Tropical Rock Lobster recent catches	Observational	1973	2019			Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
69	Fisheries	*Prawns*	AFMA	Trawl effort data - AFMA fisheries logbook	Observational				on request to AFMA	https://www.afma.gov.au/resources/catch-data
70	Fisheries	*Prawns: Brown tiger*	on paper	Migration and growth of two tropical penaeid shrimps within Torres Strait, northern Australia	Observational	1986	1988			Watson, R. A. and C. T. Turnbull (1993). "Migration and growth of two tropical penaeid shrimps within Torres Strait, northern Australia." Fisheries Research 17(3): 353-368.
71	Fisheries	*Prawns: Blue-tailed endeavour*	Queensland Department of Primary Industries	Settlement of juvenile Penaeus esculentus	Observational	1986	1988	Information on settlement, maturity, growth and reproduction for Torres Strait.		Turnbull, C. T. and J. E. Mellors (1990). Settlement of juvenile Penaeus esculentus (Haswell, 1879) on nursery grounds in Torres Strait. Torres Strait Prawn Project: A review of research 1986-88. J. E. Mellors. Brisbane, Fisheries Branch, Queensland Departmnet of Primary Industries, Information series Q190018.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
72	Fisheries	*Prawns: Red-spot king prawn*	Queensland Department of Primary Industries	Experimental beam trawls for sampling juvenile prawns	Observational	1986	1988			Turnbull, C. T. and R. A. Watson (1990). Experimental beam trawls for sampling juvenile prawns. Torres Strait Prawn Project: A review of research 1986-88, Information series Q190018. J. E. Mellors. Brisbane, Fisheries Branch, Queensland Departmnet of Primary Industries.
73	Fisheries	*Prawns*	AFMA	Torres Strait Prawn Fishery Data Summary 2015	Observational	2015	2015		Contact AFMA	Cocking, L. and C. Turnbull (2016). Torres Strait Prawn Fishery Data Summary 2015. Canberra, Australia.
74	Fisheries	*Prawns*	AFMA	Torres Strait Prawn Fishery Data Summary 2016	Observational	2016	2016		Contact AFMA	Cocking, L. and C. Turnbull (2017). Torres Strait Prawn Fishery Data Summary 2016. Canberra, Australia: 22.
75	Fisheries	*Prawns*	AFMA	Torres Strait Prawn Fishery Data Summary 2017	Observational	2017	2017		Contact AFMA	Turnbull, C. and L. Cocking (2018). Torres Strait Prawn Fishery Data Summary 2017. Canberra, Australia.
76	Fisheries	*Prawns*	AFMA	Torres Strait Prawn Fishery Data Summary 2018	Observational	2018	2018		Contact AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2018. Canberra, Australia.
77	Fisheries	*Prawns*	AFMA	Torres Strait Prawn Fishery Data Summary 2019	Observational	2019	2019		Contact AFMA	Turnbull, C. and L. Cocking (2019). Torres Strait Prawn Fishery Data Summary 2019. Canberra, Australia: 33p.
78	Fisheries	Sea cucumbers	PZJA website	Beche-de-mer catch watch reports	Observational	2019	2020		available through website	https://www.pzja.gov.au/fishery-catch-watch-reports
79	Fisheries	Sea cucumbers	CSIRO	Stock survey of sea cucumbers in East Torres Strait	Observational	2019	2020	Fishery independent survey across Torres Strait		Murphy, N., T. Skewes, E. Plaganyi, S. Edgar, K. Salee and C. Wildermuth (2020). Stock survey of sea cucumbers in East Torres Strait. Progress report. May 2020. . Brisbane, Australia.
80	Fisheries	Sea cucumbers	CSIRO	Stock survey of sea cucumbers in East Torres Strait	Observational	2009	2009	Fishery independent survey across Torres Strait		Skewes, T. D., N. E. Murphy, I. McLeod, E. Dovers, C. Burridge and W. Rochester (2010). Torres Strait Hand Collectables, 2009 survey: Sea cucumber - Final Report. Cleveland: 70p.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
81	Fisheries	Sea cucumbers	CSIRO	Survey and stock size estimates of the shallow reef (0-15 m deep) and shoal area (15–50 m deep) marine resources and habitat mapping within the Timor Sea MOU74 Box	Observational	1995	1996	Fishery independent survey		Skewes, T. D., D. M. Dennis, D. R. Jacobs, S. R. Gordon, T. J. Taranto, M. Haywood, C. R. Pitcher, G. P. Smith, D. Milton and I. R. Poiner (1999). Survey and stock size estimates of the shallow reef (0-15 m deep) and shoal area (15–50 m deep) marine resources and habitat mapping within the Timor Sea MOU74 Box. Cleveland, Australia: 71p.
82	Fisheries	Sea cucumbers	CSIRO	Stock survey and Sustainable Harvest Strategies for the Torres Strait Beche-de-Mer	Observational	2002	2002	Fishery independent survey across Torres Strait		Skewes, T., D. Dennis, A. Koutsoukos, M. Haywood, T. Wassenberg and M. Austin (2004). Stock survey and Sustainable Harvest Strategies for the Torres Strait Beche-de-Mer. Report prepared for the Australian Fisheries Management Authority and Queensland Fishery Service. Thursday Island, Queensland, CSIRO Marine and Atmospheric Research.
83	Fisheries	Sea cucumbers	CSIRO	Torres Strait Hand Collectables, 2009 survey: Sea cucumber	Observational	2005	2009	Fishery independent survey across Torres Strait. Only for years 2005 and 2009		Skewes, T. D., N. E. Murphy, I. McLeod, E. Dovers, C. Burridge and W. Rochester (2010). Torres Strait Hand Collectables, 2009 survey: Sea cucumber - Final Report. Cleveland: 70p.
86	Physiochemical	Sea Surface Temperature	UK Met Office		Modelled	1850	2020	Global dataset for land and sea surface temperature (HADCRUT4)	Free download	https://crudata.uea.ac.uk/cru/data/temperature/#datdow
87	Physiochemical	Sea Surface Temperature	UK Met Office		Modelled	1851	2020	Global dataset for sea surface temperature anomaly (HADST3)	Free download	https://www.metoffice.gov.uk/hadobs/hadsst3/data/download.html
88	Physiochemical	Sea Surface Temperature	Bureau of Meteorology		Modelled	1900	2020	Sea surface temp (SST) time series data is available for boxed region round Australia and six regions within this box. Relevant to Torres Strait are the Northern Tropics and Coral Sea regions.	Mean SST values for Northern Tropics and Coral Sea can be requested to BoM	http://www.bom.gov.au/climate/change/about/sst_timeseries.shtml

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
89	Physiochemical	Sea Surface Temperature	QLD DSITIA	QLD storm tides monitoring sites	Observational	2011	2020	Obervations every minute for Sea surface temp (SST) is available for the following stations: 1) Boigu Island monitoring site, 2) Ugar Island monitoring site, 3) Iama Island monitoring site, 4) Moa Island (St Pauls) monitoring site, 5) Moa Island (Kubin) monitoring site, and 6) Thursday Island monitoring site.	Data can be obtained by contacting Daryl Metters from the Queensland Department of Science Information Technology Innovation and the Arts (DSITIA)	1- Boigu Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/boigu): Installation 23 November 2013 2- Ugar Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/ugar): Installation 22 November 2013 3- Iama Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/iama): Installation 22 November 2013 4- Moa Island (St Pauls) monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/stpauls): Installation 23 November 2013, not currently recording 5- Moa Island (Kubin) monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/kubin): Installation 22 November 2013 6- Thursday Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/thursday-island): Installation 13 May 2011

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
90	Physiochemical	Sea Surface Temperature	Geosciences Australia		Modelled	1997	2004	outputs include three-dimensional distributions of velocity, temperature, salinity, and mixing coefficients, as well as two-dimensional fields such as sea level and bottom friction	Not known	Saint-Cast, F. (2008). "Multiple time-scale modelling of the circulation in Torres Strait-Australia." Continental Shelf Research 28(16): 2214-2240.
91	Physiochemical	Sea Surface Temperature	IMOS		Modelled		check	SST maps obtained from satellite data based on AVHRR instruments on a 2D grid with a cell size of 0.02deg. X 0.02deg., with each cell representing SST averaged over 14 days.	Free access	https://portal.aodn.org.au/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
92	Physiochemical	Sea Surface Temperature	CSIRO		Modelled	1992	2099	The modified Ocean Forecasting Australia Model version 3 (OFAM-v3) run under standard IPCC emissions scenarios to project future ocean states around Australia. These scenarios are taken from global ocean-atmosphere models (CMIP5 climate models, which set the context for the finer scale OFAMv3 model, which focuses on the Australian region in more detail. The OFAM-v3 model was originally developed for upper-ocean short-range operational forecasting (e.g. ocean forecasts of the type found at the bom.gov.au website) and was adapted for climate change studies. The downscaling simulations run with OFAM-v3 provide high-resolution (10km, 0.1º) outputs that can resolve important oceanographic features (e.g. eddies) and how these may change under future climate change. A biogeochemical model that represents nutrient flows and plankton components of the ocean food web (primary producers such as phytoplankton, some bacteria and zooplankton consumers) was coupled with OFAM-v3 to produce patterns of primary productivity, nutrient cycling and carbon fluxes that are consistent with observations. The OFAM3 outputs provide downscaled climate change projections for all common ocean state variables including currents, temperature (ºC), phytoplankton (mmol Nm-3) and primary productivity (mmol C m-2day-1). These outputs were then used as input to the ecosystem models.Data were modelled for the Torres Strait as defined by: A. Top left coordinates: 9o 08’ 24.83” S / 141o 01’ 0.00” E B. Bottom Right coordinates: 11o 10’ 0.00” S / 144o 28’ 0.00” E	on request to Richard Matear and Xuebin Zhang (CSIRO)	Fulton, E. A., A. J. Hobday, H. Pethybridge, J. Blanchard, C. Bulman, I. Butler, W. Cheung, L. X. C. Dutra, R. Gorton, T. Hutton, H. Lozano-Montes, R. Matear, G. Pecl, E. E. Plagányi, C. Villanueva and X. Zhang (2018). Decadal scale projection of changes in Australian fisheries stocks under climate change. Canberra. Plaganyi, E., M. Haywood, B. Gorton and S. Condie (2018). Environmental drivers of variability and climate projections for Torres Strait tropical lobster Panulirus ornatus. Brisbane: 156.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
93	Physiochemical	Nutrient	CSIRO		Modelled	1992	2099	The modified Ocean Forecasting Australia Model version 3 (OFAM-v3) run under standard IPCC emissions scenarios to project future ocean states around Australia. These scenarios are taken from global ocean-atmosphere models (CMIP5 climate models, which set the context for the finer scale OFAMv3 model, which focuses on the Australian region in more detail. The OFAM-v3 model was originally developed for upper-ocean short-range operational forecasting (e.g. ocean forecasts of the type found at the bom.gov.au website) and was adapted for climate change studies. The downscaling simulations run with OFAM-v3 provide high-resolution (10km, 0.1º) outputs that can resolve important oceanographic features (e.g. eddies) and how these may change under future climate change. A biogeochemical model that represents nutrient flows and plankton components of the ocean food web (primary producers such as phytoplankton, some bacteria and zooplankton consumers) was coupled with OFAM-v3 to produce patterns of primary productivity, nutrient cycling and carbon fluxes that are consistent with observations. The OFAM3 outputs provide downscaled climate change projections for all common ocean state variables including currents, temperature (ºC), phytoplankton (mmol Nm-3) and primary productivity (mmol C m-2day-1). These outputs were then used as input to the ecosystem models.Data were modelled for the Torres Strait as defined by: A. Top left coordinates: 9o 08’ 24.83” S / 141o 01’ 0.00” E B. Bottom Right coordinates: 11o 10’ 0.00” S / 144o 28’ 0.00” E	on request to Richard Matear and Xuebin Zhang (CSIRO)	Fulton, E. A., A. J. Hobday, H. Pethybridge, J. Blanchard, C. Bulman, I. Butler, W. Cheung, L. X. C. Dutra, R. Gorton, T. Hutton, H. Lozano-Montes, R. Matear, G. Pecl, E. E. Plagányi, C. Villanueva and X. Zhang (2018). Decadal scale projection of changes in Australian fisheries stocks under climate change. Canberra. Plaganyi, E., M. Haywood, B. Gorton and S. Condie (2018). Environmental drivers of variability and climate projections for Torres Strait tropical lobster Panulirus ornatus. Brisbane: 156.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
94	Physiochemical	Primary Productivity	CSIRO		Modelled	1992	2099	The modified Ocean Forecasting Australia Model version 3 (OFAM-v3) run under standard IPCC emissions scenarios to project future ocean states around Australia. These scenarios are taken from global ocean-atmosphere models (CMIP5 climate models, which set the context for the finer scale OFAMv3 model, which focuses on the Australian region in more detail. The OFAM-v3 model was originally developed for upper-ocean short-range operational forecasting (e.g. ocean forecasts of the type found at the bom.gov.au website) and was adapted for climate change studies. The downscaling simulations run with OFAM-v3 provide high-resolution (10km, 0.1º) outputs that can resolve important oceanographic features (e.g. eddies) and how these may change under future climate change. A biogeochemical model that represents nutrient flows and plankton components of the ocean food web (primary producers such as phytoplankton, some bacteria and zooplankton consumers) was coupled with OFAM-v3 to produce patterns of primary productivity, nutrient cycling and carbon fluxes that are consistent with observations. The OFAM3 outputs provide downscaled climate change projections for all common ocean state variables including currents, temperature (ºC), phytoplankton (mmol Nm-3) and primary productivity (mmol C m-2day-1). These outputs were then used as input to the ecosystem models.Data were modelled for the Torres Strait as defined by: A. Top left coordinates: 9o 08’ 24.83” S / 141o 01’ 0.00” E B. Bottom Right coordinates: 11o 10’ 0.00” S / 144o 28’ 0.00” E	on request to Richard Matear and Xuebin Zhang (CSIRO)	Fulton, E. A., A. J. Hobday, H. Pethybridge, J. Blanchard, C. Bulman, I. Butler, W. Cheung, L. X. C. Dutra, R. Gorton, T. Hutton, H. Lozano-Montes, R. Matear, G. Pecl, E. E. Plagányi, C. Villanueva and X. Zhang (2018). Decadal scale projection of changes in Australian fisheries stocks under climate change. Canberra. Plaganyi, E., M. Haywood, B. Gorton and S. Condie (2018). Environmental drivers of variability and climate projections for Torres Strait tropical lobster Panulirus ornatus. Brisbane: 156.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
95	Physiochemical	Phytoplankton	CSIRO		Modelled	1992	2099	The modified Ocean Forecasting Australia Model version 3 (OFAM-v3) run under standard IPCC emissions scenarios to project future ocean states around Australia. These scenarios are taken from global ocean-atmosphere models (CMIP5 climate models, which set the context for the finer scale OFAMv3 model, which focuses on the Australian region in more detail. The OFAM-v3 model was originally developed for upper-ocean short-range operational forecasting (e.g. ocean forecasts of the type found at the bom.gov.au website) and was adapted for climate change studies. The downscaling simulations run with OFAM-v3 provide high-resolution (10km, 0.1º) outputs that can resolve important oceanographic features (e.g. eddies) and how these may change under future climate change. A biogeochemical model that represents nutrient flows and plankton components of the ocean food web (primary producers such as phytoplankton, some bacteria and zooplankton consumers) was coupled with OFAM-v3 to produce patterns of primary productivity, nutrient cycling and carbon fluxes that are consistent with observations. The OFAM3 outputs provide downscaled climate change projections for all common ocean state variables including currents, temperature (ºC), phytoplankton (mmol Nm-3) and primary productivity (mmol C m-2day-1). These outputs were then used as input to the ecosystem models.Data were modelled for the Torres Strait as defined by: A. Top left coordinates: 9o 08' 24.83" S / 141o 01' 0.00" E B. Bottom Right coordinates: 11o 10' 0.00" S / 144o 28' 0.00" E	on request to Richard Matear and Xuebin Zhang (CSIRO)	Fulton, E. A., A. J. Hobday, H. Pethybridge, J. Blanchard, C. Bulman, I. Butler, W. Cheung, L. X. C. Dutra, R. Gorton, T. Hutton, H. Lozano-Montes, R. Matear, G. Pecl, E. E. Plagányi, C. Villanueva and X. Zhang (2018). Decadal scale projection of changes in Australian fisheries stocks under climate change. Canberra. Plaganyi, E., M. Haywood, B. Gorton and S. Condie (2018). Environmental drivers of variability and climate projections for Torres Strait tropical lobster Panulirus ornatus. Brisbane: 156.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
96	Physiochemical	Currents	CSIRO		Modelled	1992	2099	The modified Ocean Forecasting Australia Model version 3 (OFAM-v3) run under standard IPCC emissions scenarios to project future ocean states around Australia. These scenarios are taken from global ocean-atmosphere models (CMIP5 climate models, which set the context for the finer scale OFAMv3 model, which focuses on the Australian region in more detail. The OFAM-v3 model was originally developed for upper-ocean short-range operational forecasting (e.g. ocean forecasts of the type found at the bom.gov.au website) and was adapted for climate change studies. The downscaling simulations run with OFAM-v3 provide high-resolution (10km, 0.1º) outputs that can resolve important oceanographic features (e.g. eddies) and how these may change under future climate change. A biogeochemical model that represents nutrient flows and plankton components of the ocean food web (primary producers such as phytoplankton, some bacteria and zooplankton consumers) was coupled with OFAM-v3 to produce patterns of primary productivity, nutrient cycling and carbon fluxes that are consistent with observations. The OFAM3 outputs provide downscaled climate change projections for all common ocean state variables including currents, temperature (ºC), phytoplankton (mmol Nm-3) and primary productivity (mmol C m-2day-1). These outputs were then used as input to the ecosystem models.Data were modelled for the Torres Strait as defined by: A. Top left coordinates: 9o 08’ 24.83” S / 141o 01’ 0.00” E B. Bottom Right coordinates: 11o 10’ 0.00” S / 144o 28’ 0.00” E	on request to Richard Matear and Xuebin Zhang (CSIRO)	Fulton, E. A., A. J. Hobday, H. Pethybridge, J. Blanchard, C. Bulman, I. Butler, W. Cheung, L. X. C. Dutra, R. Gorton, T. Hutton, H. Lozano-Montes, R. Matear, G. Pecl, E. E. Plagányi, C. Villanueva and X. Zhang (2018). Decadal scale projection of changes in Australian fisheries stocks under climate change. Canberra. Plaganyi, E., M. Haywood, B. Gorton and S. Condie (2018). Environmental drivers of variability and climate projections for Torres Strait tropical lobster Panulirus ornatus. Brisbane: 156.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
97	Physiochemical	Currents	Geosciences Australia		Modelled	1997	2004	outputs include three-dimensional distributions of velocity, temperature, salinity, and mixing coefficients, as well as two-dimensional fields such as sea level and bottom friction	Not known	Saint-Cast, F. (2008). "Multiple time-scale modelling of the circulation in Torres Strait-Australia." Continental Shelf Research 28(16): 2214-2240.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
98	Physiochemical	Tides	QLD DSITIA	QLD storm tides monitoring sites	Observational	2011	2020	Obervations every minute of Tide actual, predicted and residuals plotted against predicted Lowest Astronomical Tide datum (LAT), and also plotted on the Australian Height Datum (AHD) is available for the following stations: 1) Boigu Island monitoring site, 2) Ugar Island monitoring site, 3) Iama Island monitoring site, 4) Moa Island (St Pauls) monitoring site, 5) Moa Island (Kubin) monitoring site, and 6) Thursday Island monitoring site. 1- Boigu Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/boigu): Installation 23 November 2013 2- Ugar Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/ugar): Installation 22 November 2013 3- Iama Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/iama): Installation 22 November 2013 4- Moa Island (St Pauls) monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/stpauls): Installation 23 November 2013, not currently recording 5- Moa Island (Kubin) monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/kubin): Installation 22 November 2013 6- Thursday Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/thursday-island): Installation 13 May 2011	Data can be obtained by contacting Daryl Metters from the Queensland Department of Science Information Technology Innovation and the Arts (DSITIA)	https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
99	Physiochemical	Tides	Geosciences Australia	Development of a bathymetric grid for the Gulf of Papua and adjacent areas	Modelled			bathymetric grid for the Gulf of Papua and northern Australia was produced for the area 140°–150°E, 6°–14°S, with a 3.6″ (~110 m) cell size.	Not known	Daniell, J. J. (2008). "Development of a bathymetric grid for the Gulf of Papua and adjacent areas: A note describing its development." Journal of Geophysical Research: Earth Surface 113(F1).
100	Physiochemical	Tides	Geosciences Australia / Partly in the report	Circulation modelling in Torres Strait	Modelled and Observational	1997	2002	The circulation model incorporated realistic atmospheric and oceanographic forcing, including winds, waves, tides, and large-scale regional circulation taken from global model outputs. Simulations covered a hindcast period of eight years, allowing the tidal, seasonal, and interannual flow characteristics to be investigated		Saint-Cast, F. and S. Condie (2006). Circulation modelling in Torres Strait: 82.
101	Physiochemical	Currents	Geosciences Australia / Partly in the report	Circulation modelling in Torres Strait	Modelled and Observational	1997	2002	The circulation model incorporated realistic atmospheric and oceanographic forcing, including winds, waves, tides, and large-scale regional circulation taken from global model outputs. Simulations covered a hindcast period of eight years, allowing the tidal, seasonal, and interannual flow characteristics to be investigated		Saint-Cast, F. and S. Condie (2006). Circulation modelling in Torres Strait: 82.
102	Physiochemical	Sea level	Geosciences Australia / Partly in the report	Circulation modelling in Torres Strait	Modelled and Observational	1997	2002	The circulation model incorporated realistic atmospheric and oceanographic forcing, including winds, waves, tides, and large-scale regional circulation taken from global model outputs. Simulations covered a hindcast period of eight years, allowing the tidal, seasonal, and interannual flow characteristics to be investigated		Saint-Cast, F. and S. Condie (2006). Circulation modelling in Torres Strait: 82.
103		Temperature	Geosciences Australia / Partly in the report	Circulation modelling in Torres Strait	Modelled and Observational	1997	2002	The circulation model incorporated realistic atmospheric and oceanographic forcing, including winds, waves, tides, and large-scale regional circulation taken from global model outputs. Simulations covered a hindcast period of eight years, allowing the tidal, seasonal, and interannual flow characteristics to be investigated		Saint-Cast, F. and S. Condie (2006). Circulation modelling in Torres Strait: 82.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
104		Salinity	Geosciences Australia / Partly in the report	Circulation modelling in Torres Strait	Modelled and Observation al	1997	2002	The circulation model incorporated realistic atmospheric and oceanographic forcing, including winds, waves, tides, and large-scale regional circulation taken from global model outputs. Simulations covered a hindcast period of eight years, allowing the tidal, seasonal, and interannual flow characteristics to be investigated		Saint-Cast, F. and S. Condie (2006). Circulation modelling in Torres Strait: 82.
105	Physiochemica l	Tides	Geosciences Australia		Modelled	1997	2004	outputs include three-dimensional distributions of velocity, temperature, salinity, and mixing coefficients, as well as two-dimensional fields such as sea level and bottom friction	Not known	Saint-Cast, F. (2008). "Multiple time-scale modelling of the circulation in Torres Strait-Australia." Continental Shelf Research 28(16): 2214-2240.
106	Physiochemica l	Mean Sea Level	Aviso	Altimeter Mean Sea Level Data	Modelled	2015	2016	Altimetry-derived surface currents in the NCS were obtained from NOAA OSCAR. The spatial and temporal resolution of the data was 1/3 and 5 days respectively, from mid-November 2015 to mid-April 2016.	unknown	Wolanski, E., F. Andutta, E. Deleersnijder, Y. Li and C. J. Thomas (2017). "The Gulf of Carpentaria heated Torres Strait and the Northern Great Barrier Reef during the 2016 mass coral bleaching event." Estuarine Coastal and Shelf Science 194: 172-181. (http://www. aviso.altimetry.fr/
108	Physiochemica l	Light penetration	CSIRO; Partly in the paper		Modelled	1997	2000	The 3-D sediment transport model was driven by a 3-D nonlinear, non-stationary hydrodynamic model, which solved Reynolds' equations with a free surface boundary condition, using the Boussinesq approximation and the hydrostatic assumption.	None mentioned	Margvelashvili, N., F. Saint-Cast and S. Condie (2008). "Numerical modelling of the suspended sediment transport in Torres Strait." Continental Shelf Research 28(16): 2241-2256.
109	Physiochemica l	Salinity	Geosciences Australia		Modelled	1997	2004	outputs include three-dimensional distributions of velocity, temperature, salinity, and mixing coefficients, as well as two-dimensional fields such as sea level and bottom friction	Not known	Saint-Cast, F. (2008). "Multiple time-scale modelling of the circulation in Torres Strait-Australia." Continental Shelf Research 28(16): 2214-2240.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
110	Geological	Sediment	CSIRO; partly in the paper	Sediment mobility due to currents and waves in the Torres Strait Gulf of Papua region	Modelled and Observational	1990	1994			Hemer, M. A., P. T. Harris, D. Coleman and J. Hunter (2004). "Sediment mobility due to currents and waves in the Torres Strait Gulf of Papua region." Continental Shelf Research 24(19): 2297-2316.
111	Physiochemical	Currents	CSIRO; partly in the paper	Sediment mobility due to currents and waves in the Torres Strait Gulf of Papua region	Modelled and Observational	1990	1994			Hemer, M. A., P. T. Harris, D. Coleman and J. Hunter (2004). "Sediment mobility due to currents and waves in the Torres Strait Gulf of Papua region." Continental Shelf Research 24(19): 2297-2316.
112	Physiochemical	Tides	CSIRO; partly in the paper	Sediment mobility due to currents and waves in the Torres Strait Gulf of Papua region	Modelled and Observational	1990	1994			Hemer, M. A., P. T. Harris, D. Coleman and J. Hunter (2004). "Sediment mobility due to currents and waves in the Torres Strait Gulf of Papua region." Continental Shelf Research 24(19): 2297-2316.
113	Geological	Sediment	CSIRO; Partly in the paper	Numerical modelling of the suspended sediment transport in Torres Strait	Modelled	1997	2000	Torres trait region. The 3-D sediment transport model was driven by a 3-D nonlinear, non-stationary hydrodynamic model, which solved Reynolds' equations with a free surface boundary condition, using the Boussinesq approximation and the hydrostatic assumption.		Margvelashvili, N., F. Saint-Cast and S. Condie (2008). "Numerical modelling of the suspended sediment transport in Torres Strait." Continental Shelf Research 28(16): 2241-2256.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
114	Physiochemical	Barometric pressure	QLD storm tides monitoring sites		Observational	2011	2020	Obervations every minute for Sea barometric pressure is available for the following stations: 1) Boigu Island monitoring site, 2) Ugar Island monitoring site, 3) Iama Island monitoring site, 4) Moa Island (St Pauls) monitoring site, 5) Moa Island (Kubin) monitoring site, and 6) Thursday Island monitoring site. 1- Boigu Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/boigu): Installation 23 November 2013 2- Ugar Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/ugar): Installation 22 November 2013 3- Iama Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/iama): Installation 22 November 2013 4- Moa Island (St Pauls) monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/stpauls): Installation 23 November 2013, not currently recording 5- Moa Island (Kubin) monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/kubin): Installation 22 November 2013 6- Thursday Island monitoring site (https://www.qld.gov.au/environment/coasts-waterways/beach/storm-sites/thursday-island): Installation 13 May 2011	Data can be obtained by contacting Daryl Metters from the Queensland Department of Science Information Technology Innovation and the Arts (DSITIA)	https://www.qld.gov.au/environment/coasts-waterways/beach/storm/storm-sites/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
115	Habitat	Mangroves	ESRI grid: https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/spatial-data/forest-cover	Forests of Australia 2018 dataset	Observational (Landsat Foliage cover 30x30m)	2018	2018		CC BY4.0	https://www.agriculture.gov.au/sites/default/files/abares/forestsaustralia/documents/datasets/sofr2018/Forests_of_Australia_2018_Metadata.pdf
116	Habitat	Mangroves	527 MB data download on CM's PC: Queensland Spatial Catalogue Data Request (JobID: 20200525_132500028000-67480, Date: 25/05/2020)	REDD Regional Ecosystem Database (Excel, Access)	Observational (Ecosystem (vegetation) distribution observed, multiple sources)	2019	2019		CC	https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/descriptions/download

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
117	Habitat	Mangroves	1.6 GB data download on CM's PC: Queensland Spatial Catalogue Data Request (JobID: 20200525_130636315000-30676, Date: 25/05/2020)	Remnant 2017 broad vegetation groups - Queensland	Observational (Ecosystem (vegetation) distribution observed, multiple sources)	2020	2020		CC	http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={43A2CB31-9D83-4BB9-ACE7-05E7BD271FE3}
118	Habitat	Mangroves	http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={F5CF90D6-5881-4D8F-9581-D8F55D25F9CE}	Remnant vegetation cover - 2017 - Queensland	Observational	2017	2017	Ecosystem mapping	CC BY 4.0	http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={F5CF90D6-5881-4D8F-9581-D8F55D25F9CE}
119	Habitat	Mangroves	http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=Queensland+wetland+data+series	Wetland data - version 5 - Queensland series	Observational	2019	2019	Mapping of water bodies and wetland regional ecosystems at 1:100,000 scale across Queensland	CC BY 4.0	http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=Queensland+wetland+data+series

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
120	Habitat	Mangroves	https://wetlandinfo.des.qld.gov.au/ is another portal with wetland v5 maps. Check source and if it has more than qldspatial	Wetland data - version 5 - Queensland series	Observational	2019	2019	Mapping of water bodies and wetland regional ecosystems at 1:100,000 scale across Queensland	CC BY 4.0	https://wetlandinfo.des.qld.gov.au/
121	Habitat	Mangroves	553 MB data download on CM's PC: Queensland Spatial Catalogue Data Request (JobID: 20200525_144339773000-67480, Date: 25/05/2020)	Map of Queensland wetland environmental values		2020	2020		cc	qldspatial.information.qld.gov.au/catalogue/custom/search.page?q="Map+of+Queensland+wetland+environmental+values"

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
122	Habitat	Mangroves	Can be downloaded as xls file. Search in approximate TS area returned 137 record from approx. 15 institutions which are on CM's PC	Atlas of Living Australia	Observational	2020	2020		CC	https://www.ala.org.au/
123	Habitat	Mangroves	eAtlas. Downloaded to GIS on CM's PC	Map of research work undertaken by NERP project 2.2.	Locations and tracks of mangrove surveys	2015	2015		CC	https://eatlas.org.au/nerp-te/ts-jcu-mangrove-freshwater-status-torres-strait-islands-2-2
124	Habitat	Mangroves	Excel spreadsheet. Downloaded on CM's PC: https://eatlas.org.au/pydio/public/ts_nerp-te-2-2_jcu_mangrove-species-surveys_1981-2013-zip.php	Mangrove species in Torres Strait (list of species per island) (NERP TE 2.2, JCU)	Observational				Not clear	https://eatlas.org.au/node/1525

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
125	Habitat	Mangroves	In paper	Mangrove and Freshwater Wetland Habitat Status of the Torres Strait Islands Biodiversity, Biomass, Changing Condition of Wetlands	Observations (percentage coverage by island)	2012	2014		Not clear	https://www.researchgate.net/publication/309721863_Mangrove_and_Freshwater_Wetland_Habitat_Status_of_the_Torres_Strait_Islands_Biodiversity_Biomass_Changing_Condition_of_Wetlands
126	Habitat	Mangroves	Data source given as 'in publication'. Location of spatial layers not clear. Requires search	Distribution of Mangroves in Torres Strait	Observations (Mapping based on Landsat TM satellite imagery)	1997	1997		Not clear	http://www.marlin.csiro.au/geonetwork/srv/eng/search#!e2d96ace-98da-76c3-e043-08114f8c0f19
127	Habitat	Mangroves	data.gov	Queensland - National Intertidal-Subtidal Benthic NISB Habitat Map (PLUS)		2007	2007		CC	http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B3C2A5C8D-8AC6-43EC-B603-8150F2B2BBD1%7D
128	Fisheries	Turtles	eAtlas	Marine turtles and dugongs of the Torres Strait - Spatial models of dugong and turtle distribution and relative density of aerial surveys from 1987 - 2013 (NERP TE 2.1, JCU)	Modelled and Observational	1987	2013	raster spatial model of the distribution and relative density of dugongs (Dugong dugong) in the Torres Strait region based on an aggregate of 27 years (1987 - 2013) of systematic aerial surveys; and (2) a raster spatial model of the distribution and relative density of marine turtles (green turtles, Chelonia mydas) in the Torres Strait based on an aerial survey conducted in 2013. https://eatlas.org.au/geonetwork/srv/eng/metadata.show?uuid=939cb936-68b9-4d9f-925e-f5ce12a3bf34&currTab=complete	CC	https://eatlas.org.au/data/uuid/939cb936-68b9-4d9f-925e-f5ce12a3bf34

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
129	Habitat	Seagrass	JCU	Torres Strait Mapping: Seagrass Consolidation, 2002 – 2014	Modelled and Observational	2002	2014		The large seagrass spatial composite is not available publically but may be obtained through special request to Dr Alex Carter, Centre for Tropical Water & Aquatic Ecosystem Research (TropWATER)	Carter, A. B., H. A. Taylor and M. A. Rasheed (2014). Torres Strait Mapping: Seagrass Consolidation, 2002 – 2014. Carins, Centre for Tropical Water & Aquatic Ecosystem Research: 47pp. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+55+Torres+strait+mapping+seagrass+consolidation+(2).pdf&subfolder_nav_tracking=1
130	Habitat	Seagrass	JCU	Torres Strait Seagrass 2019 Report Card	Modelled and Observational	2018	2019	Data used in this report card was collected from mid-2018 to mid-2019 for the Torres Strait Seagrass Monitoring Program (TSSMP). The TSSMP incorporates the Torres Strait Seagrass Observers Program, Ranger Subtidal Monitoring Program, Queensland Ports Seagrass Monitoring Program, and Reef-top Monitoring Program. Twenty-seven sites/meadows were classified for the 2019 report card across four Torres Strait Island Clusters.		Carter, A. B., J. M. Mellors, C. Reason and M. A. Rasheed (2019). Torres Strait Seagrass 2019 Report Card. Cairns: 62p.. https://www.dropbox.com/s/uydzgt5jk40rirj/19%2016%20Torres%20Strait%20seagrass%202019%20report%20card.pdf?dl=0
131	Habitat	Seagrass	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Modelled and Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=1

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
132	Physiochemical	Light penetration	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=2
133	Physiochemical	Solar exposure	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=3
134	Physiochemical	Daytime tidal air exposure	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=4

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
135	Physiochemical	Water temperature	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=5
136	Physiochemical	Rainfall	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=6
137	Physiochemical	Wind speed	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=7

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
138	Physiochemical	Salinity	JCU	The effects of climate on seagrass in the Torres Strait – 2011-2014 Report	Observational	2011	2014	An intertidal seagrass monitoring site was established at Mabuiag Island where information on seagrass biomass and species composition, and environmental data including irradiance (light), global solar exposure, daytime tidal air exposure, mean and maximum daily water temperature, rainfall, wind speed and salinity, were collected		Carter, A. B., H. A. Taylor, S. A. McKenna, P. Y. York and M. A. Rasheed (2014). The effects of climate on seagrass in the Torres Strait – 2011-2014 Report. Cairns: 36p. https://www.dropbox.com/sh/mo8dcq1322qv5c3/AACBP7wEpNeQfiI2f8RqT8MOa/2014?dl=0&preview=14+48+The+effect+of+climate+on+seagass+in+the+Torres+Strait.pdf&subfolder_nav_tracking=8
139	Habitat	Seagrass	JCU	Seagrass Habitat in the Port of Thursday Island: Annual Monitoring Report 2019	Observational	2019	2019	Aerial and boat surveys of seagrass meadows were conducted between 26th – 30th March 2019. The surveys included a whole of port survey as well as a survey of the annual monitoring meadows		Wells, J. N., M. A. Rasheed and R. G. Coles (2019). Seagrass Habitat in the Port of Thursday Island: Annual Monitoring Report 2019. Cairns: 43p. https://www.dropbox.com/s/4jcufvc75gfs7bw/19%2027%20Seagrass%20habitat%20in%20the%20port%20of%20Thursday%20Island.pdf?dl=0
142	Physiochemical	Water temperature	AIMS	AIMS weather stations	Observational	2017	2020		Freely available on website	https://weather.aims.gov.au/#/overview
143	Physiochemical	Wind	AIMS	AIMS weather stations	Observational	2017	2020		Freely available on website	https://weather.aims.gov.au/#/overview
144	Physiochemical	Air temperature	AIMS	AIMS weather stations	Observational	2017	2020		Freely available on website	https://weather.aims.gov.au/#/overview
145	Physiochemical	Rainfall	AIMS	AIMS weather stations	Observational	2017	2020		Freely available on website	https://weather.aims.gov.au/#/overview
146	Physiochemical	Atmospheric pressure	AIMS	AIMS weather stations	Observational	2017	2020		Freely available on website	https://weather.aims.gov.au/#/overview
147	Physiochemical	Humidity	AIMS	AIMS weather stations	Observational	2017	2020		Freely available on website	https://weather.aims.gov.au/#/overview

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
148	Physiochemical	Light	AIMS	AIMS weather stations	Observational	2017	2020		Freely available on website	https://weather.aims.gov.au/#/overview
149	Physiochemical	Sea level	BoM	About ACCESS model	Modelled		3 hours to 240 hours	3-day predictions; from 12km to 24km grid resolution. ACCESS output is available in map form or as gridded data products	on request to BoM	http://www.bom.gov.au/australia/charts/about/about_access.shtml
150	Physiochemical	Wind	BoM	About ACCESS model	Modelled		3 hours to 240 hours	3-day predictions; from 12km to 24km grid resolution. ACCESS output is available in map form or as gridded data products	on request to BoM	http://www.bom.gov.au/australia/charts/about/about_access.shtml
151	Physiochemical	Rainfall	BoM	About ACCESS model	Modelled		3 hours to 240 hours	3-day predictions; from 12km to 24km grid resolution. ACCESS output is available in map form or as gridded data products	on request to BoM	http://www.bom.gov.au/australia/charts/about/about_access.shtml
152	Physiochemical	Air temperature	BoM	About ACCESS model	Modelled		3 hours to 240 hours	3-day predictions; from 12km to 24km grid resolution. ACCESS output is available in map form or as gridded data products	on request to BoM	http://www.bom.gov.au/australia/charts/about/about_access.shtml
153	Physiochemical	Humidity	BoM	About ACCESS model	Modelled		3 hours to 240 hours	3-day predictions; from 12km to 24km grid resolution. ACCESS output is available in map form or as gridded data products	on request to BoM	http://www.bom.gov.au/australia/charts/about/about_access.shtml
154	Physiochemical	Sea Surface Temperature	BoM	About the sea surface temperature timeseries graphs	Modelled and Observational	1900	2020			http://www.bom.gov.au/climate/change/about/sst_timeseries.shtml
155	Physiochemical	Sea Surface Temperature	NOAA	NOAA Extended Reconstructed Sea Surface Temperature (SST) V5	Modelled	1854	2020	A global monthly SST analysis from 1854 to the present derived from ICOADS data with missing data filled in by statistical methods	Access through website	https://psl.noaa.gov/data/gridded/data.noaa.ersst.v5.html
156	Physiochemical	Air temperature	BoM	Horn Island Station ID 027058	Observational	1995	2020		Access through website	http://www.bom.gov.au/climate/averages/tables/cw_027058.shtml
157	Physiochemical	Rainfall	BoM	Horn Island Station ID 027058	Observational	1995	2020		Access through website	http://www.bom.gov.au/climate/averages/tables/cw_027058.shtml

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
158	Physiochemical	Wind speed	BoM	Horn Island Station ID 027058	Observational	1995	2020		Access through website	http://www.bom.gov.au/climate/averages/tables/cw_027058.shtml
159	Physiochemical	Atmospheric pressure	BoM	Horn Island Station ID 027058	Observational	1995	2020		Access through website	http://www.bom.gov.au/climate/averages/tables/cw_027058.shtml
160	Physiochemical	Air temperature	BoM	Thursday Island Station ID 200892	Observational		?			http://www.bom.gov.au/products/IDQ60801/IDQ60801.94181.shtml
161	Physiochemical	Wind speed	BoM	Thursday Island Station ID 200892	Observational		?			http://www.bom.gov.au/products/IDQ60801/IDQ60801.94181.shtml
162	Physiochemical	Atmospheric pressure	BoM	Thursday Island Station ID 200892	Observational		?			http://www.bom.gov.au/products/IDQ60801/IDQ60801.94181.shtml
163	Physiochemical	Air temperature	BoM	Coconut Island Station ID 027054	Observational	1995	2020			http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=027054
164	Physiochemical	Atmospheric pressure	BoM	Coconut Island Station ID 027055	Observational	1995	2020			http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=027054
165	Physiochemical	Rainfall	BoM	Coconut Island Station ID 027056	Observational	1995	2020			http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=027054
166	Physiochemical	Sea Surface Temperature	BoM	OceanMaps	Modelled		7-day forecasts	OceanMAPS produces 7-day forecasts of the ocean circulation around Australia (900-180E, south of 20N) every day.	Site registration	http://www.bom.gov.au/oceanography/forecasts/index.shtml
167	Physiochemical	Currents	BoM	OceanMaps	Modelled		7-day forecasts	OceanMAPS produces 7-day forecasts of the ocean circulation around Australia (900-180E, south of 20N) every day.	Site registration	http://www.bom.gov.au/oceanography/forecasts/index.shtml
168	Physiochemical	Sea level	BoM	OceanMaps	Modelled		7-day forecasts	OceanMAPS produces 7-day forecasts of the ocean circulation around Australia (900-180E, south of 20N) every day.	Site registration	http://www.bom.gov.au/oceanography/forecasts/index.shtml

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
169	Physiochemical	Salinity	BoM	OceanMaps	Modelled		7-day forecasts	OceanMAPS produces 7-day forecasts of the ocean circulation around Australia (900-180E, south of 20N) every day.	Site registration	http://www.bom.gov.au/oceanography/forecasts/index.shtml
170	Physiochemical	Sea level	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
171	Physiochemical	Sea Surface Temperature	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
172	Physiochemical	Aragonite Saturation	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
173	Physiochemical	Rainfall	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
174	Physiochemical	Air temperature	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
175	Physiochemical	Ocean pH	CSIRO / BoM	Climate Change in Australia	Modelled	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
176	Physiochemical	Wind Speed	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
177	Physiochemical	Humidity	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
178	Physiochemical	Solar radiation	CSIRO / BoM	Climate Change in Australia	Modelled and Observational	1900	2020	Climate change projections show how Australia's climate may change in the future. Using up to 40 global climate models, the projections found here represent the most comprehensive analysis of Australia's future climate ever undertaken	Mostly freely accessible with areas that require registration	https://www.climatechangeinaustralia.gov.au/
179	Physiochemical	Air temperature	WorldClim	WorldClim	Modelled	1970	2000	This is WorldClim version 2.1 climate data for 1970-2000. This version was released in January 2020. There are monthly climate data for minimum, mean, and maximum temperature, precipitation, solar radiation, wind speed, water vapor pressure, and for total precipitation. There are also 19 "bioclimatic" variables. The data is available at the four spatial resolutions, between 30 seconds (~1 km2) to 10 minutes (~340 km2). Each download is a "zip" file containing 12 GeoTiff (.tif) files, one for each month of the year (January is 1; December is 12).	Free download	https://worldclim.org/data/worldclim21.html

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
180	Physiochemical	Rainfall	WorldClim	WorldClim	Modelled	1970	2000	This is WorldClim version 2.1 climate data for 1970-2000. This version was released in January 2020. There are monthly climate data for minimum, mean, and maximum temperature, precipitation, solar radiation, wind speed, water vapor pressure, and for total precipitation. There are also 19 "bioclimatic" variables. The data is available at the four spatial resolutions, between 30 seconds (~1 km2) to 10 minutes (~340 km2). Each download is a "zip" file containing 12 GeoTiff (.tif) files, one for each month of the year (January is 1; December is 12).	Free download	https://worldclim.org/data/worldclim21.html
181	Physiochemical	Solar radiation	WorldClim	WorldClim	Modelled	1970	2000	This is WorldClim version 2.1 climate data for 1970-2000. This version was released in January 2020. There are monthly climate data for minimum, mean, and maximum temperature, precipitation, solar radiation, wind speed, water vapor pressure, and for total precipitation. There are also 19 "bioclimatic" variables. The data is available at the four spatial resolutions, between 30 seconds (~1 km2) to 10 minutes (~340 km2). Each download is a "zip" file containing 12 GeoTiff (.tif) files, one for each month of the year (January is 1; December is 12).	Free download	https://worldclim.org/data/worldclim21.html

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
182	Physiochemical	Wind speed	WorldClim	WorldClim	Modelled	1970	2000	This is WorldClim version 2.1 climate data for 1970-2000. This version was released in January 2020. There are monthly climate data for minimum, mean, and maximum temperature, precipitation, solar radiation, wind speed, water vapor pressure, and for total precipitation. There are also 19 “bioclimatic” variables. The data is available at the four spatial resolutions, between 30 seconds (~1 km2) to 10 minutes (~340 km2). Each download is a “zip” file containing 12 GeoTiff (.tif) files, one for each month of the year (January is 1; December is 12).	Free download	https://worldclim.org/data/worldclim21.html
183	Physiochemical	Air temperature	WorldClim	WorldClim	Modelled		2021-2100	The data available here are CMIP6 downscaled future climate projections. The downscaling and calibration (bias correction) was done with WorldClim v2.1 as baseline climate. Monthly values of minimum temperature, maximum temperature, and precipitation were processed for nine global climate models (GCMs): BCC-CSM2-MR, CNRM-CM6-1, CNRM-ESM2-1, CanESM5, GFDL-ESM4, IPSL-CM6A-LR, MIROC-ES2L, MIROC6, MRI-ESM2-0, and for four Shared Socio-economic Pathways (SSPs): 126, 245, 370 and 585. The monthly values were averages over 20 year periods (2021-2040, 241-2060, 2061-2080, 2081-2100). The following spatial resolutions are available (expressed as minutes of a degree of longitude and latitude): 10 minutes, 5 minutes, 2.5 minutes. Data at 30-seconds spatial resolution is expected to be available by the end of March, 2020. CMIP6 terms of use and citation information.	Free download	https://worldclim.org/data/cmip6/cmip6climate.html

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
184	Physiochemical	Rainfall	WorldClim	WorldClim	Modelled	2021	2100	The data available here are CMIP6 downscaled future climate projections. The downscaling and calibration (bias correction) was done with WorldClim v2.1 as baseline climate. Monthly values of minimum temperature, maximum temperature, and precipitation were processed for nine global climate models (GCMs): BCC-CSM2-MR, CNRM-CM6-1, CNRM-ESM2-1, CanESM5, GFDL-ESM4, IPSL-CM6A-LR, MIROC-ES2L, MIROC6, MRI-ESM2-0, and for four Shared Socio-economic Pathways (SSPs): 126, 245, 370 and 585. The monthly values were averages over 20 year periods (2021-2040, 241-2060, 2061-2080, 2081-2100). The following spatial resolutions are available (expressed as minutes of a degree of longitude and latitude): 10 minutes, 5 minutes, 2.5 minutes. Data at 30-seconds spatial resolution is expected to be available by the end of March, 2020. CMIP6 terms of use and citation information.	Free download	https://worldclim.org/data/cmip6/cmip6climate.html
185	Ecological	fish	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.
186	Ecological	Seagrass	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
187	Ecological	Live coral cover	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.
188	Ecological	Algae	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.
189	Geological	Sand	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.
190	Geological	Rubble	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.
191	Geological	Boulders	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.
192	Geological	Consolidated rubble	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.
193	Geological	Pavement	CSIRO	Influence of coastal processes on large scale patterns in reef fish communities of	Observational	1995	1996	Underwater visual transects at 276 sites on 41 reefs. Data stored in excel /shared drive	Contact CSIRO	Milton, D. A. and B. G. Long (1997). Influence of coastal processes on large scale patterns in reef fish communities of Torres Strait, Australia. Cleveland.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
				Torres Strait, Australia						
194	Fisheries	Finfish - Spanish Mackerel	AFMA	Spanish Mackerel Catch data	Observational	1989	2019	Data on Torres Strait Spanish mackerel harvests were from two sources: 1) AFMA compulsory logbook (Log) database and 2)AFMA docket (Doc) book records. The docket (Doc) book records are important information for harvest reporting through community processor/freezer establishments. At the time of this report, the Doc data recorded mostly harvests from Islander commercial fishers. Historically, docket book reporting was noncompulsory and database maintenance was not frequent	Contact AFMA	O'Neill, M. F. (2019). Appendix B - Torres Strait Spanish mackerel stock assessment. In: Harvest Strategies for the Torres Strait Finfish fishery, T. Hutton, M. O'Neill, G. Leigh et al. Brisbane, AFMA
195	Fisheries	Finfish - Spanish Mackerel	AFMA	Spanish Mackerel CPUE data	Observational	2013	2019	Data on Torres Strait Spanish mackerel harvests were from two sources: 1) AFMA compulsory logbook (Log) database and 2)AFMA docket (Doc) book records. The docket (Doc) book records are important information for harvest reporting through community processor/freezer establishments. At the time of this report, the Doc data recorded mostly harvests from Islander commercial fishers. Historically, docket book reporting was noncompulsory and database maintenance was not frequent	Contact AFMA	O'Neill, M. F. (2019). Appendix B - Torres Strait Spanish mackerel stock assessment. In: Harvest Strategies for the Torres Strait Finfish fishery, T. Hutton, M. O'Neill, G. Leigh et al. Brisbane, AFMA

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
196	Fisheries	Finfish - Spanish Mackerel	AFMA	Spanish Mackerel Length data	Observational	2000	2002	Data on Torres Strait Spanish mackerel harvests were from two sources: 1) AFMA compulsory logbook (Log) database and 2)AFMA docket (Doc) book records. The docket (Doc) book records are important information for harvest reporting through community processor / freezer establishments. At the time of this report, the Doc data recorded mostly harvests from Islander commercial fishers. Historically, docket book reporting was noncompulsory and database maintenance was not frequent	Contact AFMA	O'Neill, M. F. (2019). Appendix B - Torres Strait Spanish mackerel stock assessment. In: Harvest Strategies for the Torres Strait Finfish fishery, T. Hutton, M. O'Neill, G. Leigh et al. Brisbane, AFMA
197	Fisheries	Finfish - Coral Trout	AFMA	Coral Trout Catch Data	Observational	1992	2019		Contact AFMA	Holden, M. H. and G. M. Leigh (2019). Appendix E - Preliminary Stock Assessment for Coral Trout in Torres Strait - Project No. 2016/0824. In: Harvest Strategies for the Torres Strait Finfish fishery, T. Hutton, M. O'Neill, G. Leigh et al. Brisbane, AFMA.
198	Fisheries	Finfish - Coral Trout	AFMA	Coral Trout CPUE Data	Observational	1992	2019		Contact AFMA	Holden, M. H. and G. M. Leigh (2019). Appendix E - Preliminary Stock Assessment for Coral Trout in Torres Strait - Project No. 2016/0824. In: Harvest Strategies for the Torres Strait Finfish fishery, T. Hutton, M. O'Neill, G. Leigh et al. Brisbane, AFMA.
199	Physiochemical	Sea level	AIMS	Water circulation in the Gulf of Papua	Observational	1990	1992	Aanderaa water level recorders were bottom mounted at Tirere at the mouth of the Fly River estuary, as well as at the mouth of the two other channels of the estuary. Temperature and salinity profiles were obtained using a Seabird profiler.	unknown	Wolanski, E., A. Norro and B. King (1995). "Water circulation in the Gulf of Papua." Continental Shelf Research 15(2): 185-212.
200	Physiochemical	Currents	AIMS	Water circulation in the Gulf of Papua	Observational	1990	1992	two current meters were deployed, at least some of the time, to measure the current velocity both in and below the river plume. At site F, three meters were deployed, two above and one below the thermocline.	unknown	Wolanski, E., A. Norro and B. King (1995). "Water circulation in the Gulf of Papua." Continental Shelf Research 15(2): 185-212.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
201	Physiochemical	Water temperature	AIMS	Water circulation in the Gulf of Papua	Observational	1990	1992	Temperature profiles were obtained using a Seabird profiler.	unknown	Wolanski, E., A. Norro and B. King (1995). "Water circulation in the Gulf of Papua." Continental Shelf Research 15(2): 185-212.
202	Physiochemical	Salinity	AIMS	Water circulation in the Gulf of Papua	Observational	1990	1992	Salinity profiles were obtained using a Seabird profiler.	unknown	Wolanski, E., A. Norro and B. King (1995). "Water circulation in the Gulf of Papua." Continental Shelf Research 15(2): 185-212.
203	Physiochemical	Currents	AIMS	Water Circulation and Shelf Waves in the Northern Great Barrier Reef Lagoon	Observational	1979	1979	Currents and sea levels were measured at a number of locations in the Great Barrier Reef (GBR) lagoon from about 10 to 13°S., during the period October-December 1979.	unknown	Wolanski, E. and B. Ruddick (1981). "Water Circulation and Shelf Waves in the Northern Great Barrier Reef Lagoon." Marine and Freshwater Research 32(5): 721-740.
204	Physiochemical	Sea level	AIMS	Water Circulation and Shelf Waves in the Northern Great Barrier Reef Lagoon	Observational	1979	1979	Currents and sea levels were measured at a number of locations in the Great Barrier Reef (GBR) lagoon from about 10 to 13°S., during the period October-December 1979.	unknown	Wolanski, E. and B. Ruddick (1981). "Water Circulation and Shelf Waves in the Northern Great Barrier Reef Lagoon." Marine and Freshwater Research 32(5): 721-740.
205	Physiochemical	Currents	AIMS	Tidal Period Upwelling within Raine Island Entrance Great Barrier-Reef	Observational	1981	1982	Temperature and current measurements collected from November 1981 to May 1982 at the head of Raine Island Entrance	unknown	Thomson, R. E. and E. J. Wolanski (1984). "Tidal Period Upwelling within Raine Island Entrance Great Barrier-Reef." Journal of Marine Research 42(4): 787-808.
206	Physiochemical	Water temperature	AIMS	Tidal Period Upwelling within Raine Island Entrance Great Barrier-Reef	Observational	1981	1982	Temperature and current measurements collected from November 1981 to May 1982 at the head of Raine Island Entrance	unknown	Thomson, R. E. and E. J. Wolanski (1984). "Tidal Period Upwelling within Raine Island Entrance Great Barrier-Reef." Journal of Marine Research 42(4): 787-808.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
207	Physiochemical	Salinity	AIMS	River plumes, Coral Reefs and mixing in the Gulf of Papua and the northern Great Barrier Reef	Observational	1979	1982	Oceanographic cruises were completed in the area in November 1981, April-May 1982 and October 1982. Salinity, temperature and silicate concentration were measured from water samples (Mitchell et al., 1982) and, for salinity and temperature, also with a profiler and a thermosalinograph.	unknown	Wolanski, E., G. L. Pickard and D. L. B. Jupp (1984). "River plumes, Coral Reefs and mixing in the Gulf of Papua and the northern Great Barrier Reef." Estuarine, Coastal and Shelf Science 18(3): 291-314.
208	Physiochemical	Water temperature	AIMS	River plumes, Coral Reefs and mixing in the Gulf of Papua and the northern Great Barrier Reef	Observational	1979	1982	Oceanographic cruises were completed in the area in November 1981, April-May 1982 and October 1982. Salinity, temperature and silicate concentration were measured from water samples (Mitchell et al., 1982) and, for salinity and temperature, also with a profiler and a thermosalinograph.	unknown	Wolanski, E., G. L. Pickard and D. L. B. Jupp (1984). "River plumes, Coral Reefs and mixing in the Gulf of Papua and the northern Great Barrier Reef." Estuarine, Coastal and Shelf Science 18(3): 291-314.
209	Physiochemical	Silicate	AIMS	River plumes, Coral Reefs and mixing in the Gulf of Papua and the northern Great Barrier Reef	Observational	1979	1982	Oceanographic cruises were completed in the area in November 1981, April-May 1982 and October 1982. Salinity, temperature and silicate concentration were measured from water samples (Mitchell et al., 1982) and, for salinity and temperature, also with a profiler and a thermosalinograph.	unknown	Wolanski, E., G. L. Pickard and D. L. B. Jupp (1984). "River plumes, Coral Reefs and mixing in the Gulf of Papua and the northern Great Barrier Reef." Estuarine, Coastal and Shelf Science 18(3): 291-314.
210	Physiochemical	Currents	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1992	1992	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised one or two vector-averaging current meters.	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.
211	Physiochemical	Salinity	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1992	1992	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised a Dataflow self-logging salinometer	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
212	Physiochemical	Turbidity	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1992	1992	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised three nephelometers spread from 0.2 to 2.2 m above the bottom.	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.
213	Physiochemical	Currents	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1995	1995	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised three nephelometers spread from 0.2 to 2.2 m above the bottom.	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.
214	Physiochemical	Salinity	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1995	1995	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised three nephelometers spread from 0.2 to 2.2 m above the bottom.	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.
215	Physiochemical	Turbidity	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1995	1995	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised three nephelometers spread from 0.2 to 2.2 m above the bottom.	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.
216	Physiochemical	Water depth	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1995	1995	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised three nephelometers spread from 0.2 to 2.2 m above the bottom.	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.
217	Physiochemical	Water depth	AIMS	Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea	Observational	1992	1992	Oceanographic moorings were maintained over 8 weeks in 1992 in the southeast trade wind season a number of stations in the Fly River mouth. Each mooring comprised three nephelometers spread from 0.2 to 2.2 m above the bottom.	unknown	Wolanski, E., R. J. Gibbs, S. Spagnol, B. King and G. Burnskill (1998). "Inorganic sediment budget in the mangrove-fringed Fly River Delta, Papua New Guinea." Mangroves and Salt Marshes 2(2): 85-98.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
218	Physiochemical	Salinity	AIMS	Patchiness in the Fly River plume in Torres Strait	Observational	1994	1995	Four oceanographic cruises were completed, each about 12 days long, in August 1994, September 1994, January–February 1995 and February-March 1995. On each mooring a vector-averaging current meter, three optical-fibre backscattering nephelometers and one Dataflow salinometer were deployed.	unknown	Wolanski, E., S. Spagnol, B. King and T. Ayukai (1999). "Patchiness in the Fly River plume in Torres Strait." Journal of Marine Systems 18(4): 369-381.
219	Physiochemical	Currents	AIMS	Patchiness in the Fly River plume in Torres Strait	Observational	1994	1995	Four oceanographic cruises were completed, each about 12 days long, in August 1994, September 1994, January–February 1995 and February-March 1995. On each mooring a vector-averaging current meter, three optical-fibre backscattering nephelometers and one Dataflow salinometer were deployed.	unknown	Wolanski, E., S. Spagnol, B. King and T. Ayukai (1999). "Patchiness in the Fly River plume in Torres Strait." Journal of Marine Systems 18(4): 369-381.
220	Physiochemical	Turbidity	AIMS	Patchiness in the Fly River plume in Torres Strait	Observational	1994	1995	Four oceanographic cruises were completed, each about 12 days long, in August 1994, September 1994, January–February 1995 and February-March 1995. On each mooring a vector-averaging current meter, three optical-fibre backscattering nephelometers and one Dataflow salinometer were deployed.	unknown	Wolanski, E., S. Spagnol, B. King and T. Ayukai (1999). "Patchiness in the Fly River plume in Torres Strait." Journal of Marine Systems 18(4): 369-381.
221	Physiochemical	Sea level	AIMS	Patchiness in the Fly River plume in Torres Strait	Observational	1994	1995	Four oceanographic cruises were completed, each about 12 days long, in August 1994, September 1994, January–February 1995 and February-March 1995. On each mooring a vector-averaging current meter, three optical-fibre backscattering nephelometers and one Dataflow salinometer were deployed.	unknown	Wolanski, E., S. Spagnol, B. King and T. Ayukai (1999). "Patchiness in the Fly River plume in Torres Strait." Journal of Marine Systems 18(4): 369-381.
222	Physiochemical	Water temperature	AIMS	Patchiness in the Fly River plume in Torres Strait	Observational	1994	1995	Four oceanographic cruises were completed, each about 12 days long, in August 1994, September 1994, January–February 1995 and February-March 1995. On each mooring a vector-averaging current meter, three optical-fibre backscattering nephelometers and one Dataflow salinometer were deployed.	unknown	Wolanski, E., S. Spagnol, B. King and T. Ayukai (1999). "Patchiness in the Fly River plume in Torres Strait." Journal of Marine Systems 18(4): 369-381.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
223	Habitat	*Coral reefs*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	Torres Strait		Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
224	Habitat	*Seagrass*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2020			Pitcher, C. R., T. D. Skewes, D. M. Dennis and J. H. Prescott (1992). "Distribution of Seagrasses, Substratum Types and Epibenthic Macrobiota in Torres Strait, with Notes on Pearl Oyster Abundance." Australian Journal of Marine and Freshwater Research 43(2): 409-419.
225	Physiochemical	Alkalinity	IMOS	IMOS ARGOS Profile	Modelled	1990	2020		Free download	https://portal.aodn.org.au/search
226	Physiochemical	Nutrient	IMOS	IMOS ARGOS Profile	Modelled	1990	2020		Free download	https://portal.aodn.org.au/search
227	Physiochemical	Oxygen	IMOS	IMOS ARGOS Profile	Modelled	1990	2020		Free download	https://portal.aodn.org.au/search
228	Physiochemical	Salinity	IMOS	IMOS ARGOS Profile	Modelled	1990	2020		Free download	https://portal.aodn.org.au/search
229	Physiochemical	Temperature	IMOS	IMOS ARGOS Profile	Modelled	1990	2020		Free download	https://portal.aodn.org.au/search
230	Physiochemical	Water Pressure	IMOS	IMOS ARGOS Profile	Modelled	1990	2020		Free download	https://portal.aodn.org.au/search
231	Physiochemical	Acoustics	IMOS	IMOS - Australian National Mooring Network (ANMN) Facility - Current velocity time-series	Modelled	2007	2020		Free download	https://portal.aodn.org.au/search
232	Physiochemical	Currents	IMOS	IMOS - Australian National Mooring Network (ANMN) Facility - Current velocity time-series	Modelled	2007	2020		Free download	https://portal.aodn.org.au/search
233	Physiochemical	Water Pressure	IMOS	IMOS - Australian National Mooring Network (ANMN)	Modelled	2007	2020		Free download	https://portal.aodn.org.au/search

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
				Facility - Current velocity time-series						
234	Ecological	Phytoplankton	IMOS	IMOS - AusCPR: Phytoplankton Abundance	Observational	2008	2020	Vessel	Free download	https://portal.aodn.org.au/search
235	Physiochemical	Sea Surface Temperature	IMOS	IMOS - SRS - SST - L3S - Single Sensor - 6 day - day and night time - Australia	Modelled	2002	2020		Free download	https://portal.aodn.org.au/search
236	Physiochemical	Chlorophyl a	IMOS	IMOS - SRS - MODIS - 01 day - Chlorophyll-a concentration (OC3 model)	Modelled	2002	2020		Free download	https://portal.aodn.org.au/search
237	Physiochemical	Alkalinity	IMOS	Ocean acidification historical reconstruction	Modelled	1870	2013		Free download	https://portal.aodn.org.au/search
238	Physiochemical	Salinity	IMOS	Ocean acidification historical reconstruction	Modelled	1870	2013		Free download	https://portal.aodn.org.au/search
239	Physiochemical	Carbon	IMOS	Ocean acidification historical reconstruction	Modelled	1870	2013		Free download	https://portal.aodn.org.au/search
240	Physiochemical	Sea Surface Temperature	IMOS	Ocean acidification historical reconstruction	Modelled	1870	2013		Free download	https://portal.aodn.org.au/search
241	Physiochemical	Currents	IMOS	IMOS - OceanCurrent - Gridded sea level anomaly - Near real time	Modelled	2011	2020		Free download	https://portal.aodn.org.au/search
242	Physiochemical	Sea Surface Height	IMOS	IMOS - OceanCurrent - Gridded sea level anomaly - Near real time	Modelled	2011	2020		Free download	https://portal.aodn.org.au/search
243	Physiochemical	Sea Surface Temperature	IMOS	SST Atlas of Australian Regional Seas (SSTAARS) - Daily climatology fit	Modelled	1992	2016		Free download	https://portal.aodn.org.au/search
244	Physiochemical	Sea Surface Temperature	IMOS	IMOS - SRS - SST - L3S - Single Sensor - 1 day - night time - Australia	Modelled	1992	2020		Free download	https://portal.aodn.org.au/search

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
245	Ecological	Phytoplankton	IMOS	The Australian Phytoplankton Database (1844 - ongoing) - abundance and biovolume	Modelled	1844	2020		Free download	https://portal.aodn.org.au/search
246	Physiochemical	Chlorophyl a	IMOS	IMOS - SRS - MODIS - 01 day - Net Primary Productivity (OC3 model and Eppley-VGPM algorithm)	Modelled	2002	2020		Free download	https://portal.aodn.org.au/search
247	Physiochemical	Density	IMOS	CARS 2009 - CSIRO Atlas of Regional Seas - Australian weekly	Modelled	1985	2009		Free download	https://portal.aodn.org.au/search
248	Physiochemical	Nutrient	IMOS	CARS 2009 - CSIRO Atlas of Regional Seas - Australian weekly	Modelled	1985	2009		Free download	https://portal.aodn.org.au/search
249	Physiochemical	Oxygen	IMOS	CARS 2009 - CSIRO Atlas of Regional Seas - Australian weekly	Modelled	1985	2009		Free download	https://portal.aodn.org.au/search
250	Physiochemical	Salinity	IMOS	CARS 2009 - CSIRO Atlas of Regional Seas - Australian weekly	Modelled	1985	2009		Free download	https://portal.aodn.org.au/search
251	Physiochemical	Sea Surface Temperature	IMOS	CARS 2009 - CSIRO Atlas of Regional Seas - Australian weekly	Modelled	1985	2009		Free download	https://portal.aodn.org.au/search
252	Physiochemical	Air Pressure	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - delayed mode data	Observational	2008	2020	Vessels	Free download	https://portal.aodn.org.au/search
253	Physiochemical	Carbon	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - delayed mode data	Observational	2008	2020	Vessels	Free download	https://portal.aodn.org.au/search
254	Physiochemical	Salinity	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - delayed mode data	Observational	2008	2020	Vessels	Free download	https://portal.aodn.org.au/search

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
255	Physiochemical	Sea Surface Temperature	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - delayed mode data	Observational	2008	2020	Vessels	Free download	https://portal.aodn.org.au/search
256	Physiochemical	Wind	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - delayed mode data	Observational	2008	2020	Vessels	Free download	https://portal.aodn.org.au/search
257	Physiochemical	Sea Surface Temperature	IMOS	IMOS - SRS - SST - L3S - Single Sensor - 1 month - day and night time - Australia	Modelled	1992	2020	Satellite	Free download	https://portal.aodn.org.au/search
258	Physiochemical	Chlorophyl a	IMOS	IMOS - SRS - MODIS - 01 day - Chlorophyll-a concentration (GSM model)	Modelled	2002	2020		Free download	https://portal.aodn.org.au/search
259	Physiochemical	Wind	IMOS	IMOS - SRS Surface Waves Sub-Facility - scatterometer wind	Modelled	1992	2020		Free download	https://portal.aodn.org.au/search
260	Physiochemical	Sea Surface Temperature	IMOS	AIMS Sea Water Temperature Observing System (AIMS Temperature Logger Program)	Modelled	1991	2020		Free download	https://portal.aodn.org.au/search
261	Physiochemical	Sea Surface Temperature	IMOS	MARVL3 - Australian shelf temperature data atlas	Modelled	1994	2015		Free download	https://portal.aodn.org.au/search
262	Physiochemical	Air Pressure	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - Near real-time raw data	Observational	2017	2020	Vessel	Free download	https://portal.aodn.org.au/search
263	Physiochemical	Carbon	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - Near real-time raw data	Observational	2017	2020	Vessel	Free download	https://portal.aodn.org.au/search
264	Physiochemical	Salinity	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group -	Observational	2017	2020	Vessel	Free download	https://portal.aodn.org.au/search

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
				Near real-time raw data						
265	Physiochemical	Sea Surface Temperature	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - Near real-time raw data	Observational	2017	2020	Vessel	Free download	https://portal.aodn.org.au/search
266	Physiochemical	Wind	IMOS	IMOS - SOOP Underway CO2 Measurements Research Group - Near real-time raw data	Observational	2017	2020	Vessel	Free download	https://portal.aodn.org.au/search
267	Physiochemical	Air Pressure	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search
268	Physiochemical	Air temperature	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search
269	Physiochemical	Humidity	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search
270	Physiochemical	Optical Properties	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search
271	Physiochemical	Precipitation	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search
272	Physiochemical	Evaporation	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
273	Physiochemical	Sea Surface Temperature	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search
274	Physiochemical	Wind	IMOS	Northern Australia Automated Marine Weather and Oceanographic Stations	Observational	1980	2020	Automated weather and oceanographic stations	Free download	https://portal.aodn.org.au/search
275	Physiochemical	Salinity	IMOS	Royal Australian Navy (RAN) - CTD profiles	Observational	2004	2016	Vessel	Free download	https://portal.aodn.org.au/search
276	Physiochemical	Water temperature	IMOS	Royal Australian Navy (RAN) - CTD profiles	Observational	2004	2016	Vessel	Free download	https://portal.aodn.org.au/search
277	Physiochemical	Water Pressure	IMOS	Royal Australian Navy (RAN) - CTD profiles	Observational	2004	2016	Vessel	Free download	https://portal.aodn.org.au/search
278	Physiochemical	Wave	IMOS	IMOS - SRS Surface Waves Sub-Facility - SAR wave - Near real-time data	Modelled	2019	2020	Satellite	Free download	https://portal.aodn.org.au/search
279	Physiochemical	Pigment	IMOS	The Australian Chlorophyll a Database (1965 - 2017)	Modelled	1965	2017		Free download	https://portal.aodn.org.au/search
280	Physiochemical	Salinity	IMOS	MARVL3 - Australian shelf salinity data atlas	Modelled	1994	2015		Free download	https://portal.aodn.org.au/search
281	Physiochemical	Chlorophyl a	IMOS	Marine Plastic Pollution in Waters around Australia	Modelled	2013	2013		Free download	https://portal.aodn.org.au/search
282	Physiochemical	Salinity	IMOS	Marine Plastic Pollution in Waters around Australia	Modelled	2013	2013		Free download	https://portal.aodn.org.au/search
283	Physiochemical	Sea Surface Temperature	IMOS	Marine Plastic Pollution in Waters around Australia	Modelled	2013	2013		Free download	https://portal.aodn.org.au/search
284	Physiochemical	Turbidity	IMOS	Marine Plastic Pollution in Waters around Australia	Modelled	2013	2013		Free download	https://portal.aodn.org.au/search
285	Ecological	Ocean Biota	IMOS	Redmap - Sightings of range shifting marine species	Observational	2010	2020		Free download	https://portal.aodn.org.au/search

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
286	Ecological	Ocean Biota	IMOS	Seamap Australia - a national seafloor habitat classification scheme	Observational	1966	2017		Free download	https://portal.aodn.org.au/search
287	Habitat	Seagrass	IMOS	Seagrass Presence Absence Australia (ACEAS)	Modelled	1983	2012	Presence / Absence	Free download	https://portal.aodn.org.au/search
288	Habitat	Seagrass	IMOS	Torres Strait Seagrass Mapping Consolidation	Modelled	1983	2012		Free download	https://portal.aodn.org.au/search
289	Fisheries	Tropical Rock Lobster	AFMA	Torres Strait Tropical Rock Lobster Fishery Daily Fishing Log (transferrable vessel holder; TVH)	Observational	1994	2019	catch and effort data to be recorded for individual fishing operations related to each vessel tender	on request to AFMA	Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
290	Fisheries	Tropical Rock Lobster	AFMA	TIB Docket-Book Data	Observational	2004	2017	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.	on request to AFMA	Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
291	Fisheries	Tropical Rock Lobster	AFMA	Torres Strait Catch Disposal Record	Observational	2017	2019	require only aggregate catch and effort data to be recorded at the end of each trip.	on request to AFMA	Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
292	Habitat	*Seagrass*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	Torres Strait		Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
293	Physiochemical	*Salinity*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	Torres Strait		Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
294	Physiochemical	*Visibility*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	CSIRO has been engaged, for the past 30 years, by AFMA to undertake annual diving surveys to determine the relative abundance of Tropical Rock Lobsters (TRL) (Panulirus ornatus). Divers complete a census of lobster along transects at pre-determined sampling sites, with a subset of lobster collected for additional measurements. Data collected: The number and age-class of lobsters observed, but not collected; The number of lobsters collected per age-class; The size (tail width in mm), sex and moult stage of the collected lobsters	Contact CSIRO	Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
295	Physiochemical	*Water depth*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	CSIRO has been engaged, for the past 30 years, by AFMA to undertake annual diving surveys to determine the relative abundance of Tropical Rock Lobsters (TRL) (Panulirus ornatus). Divers complete a census of lobster along transects at pre-determined sampling sites, with a subset of lobster collected for additional measurements. Data collected: The number and age-class of lobsters observed, but not collected; The number of lobsters collected per age-class; The size (tail width in mm), sex and moult stage of the collected lobsters	Contact CSIRO	Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
296	Physiochemical	*Water temperature*	CSIRO	Torres Strait Tropical Rock Lobster Mid- and Pre-season surveys and commercial catch samples	Observational	1989	2019	Torres Strait		Plagányi, É., M. Tonks, N. Murphy, R. Campbell, R. Deng, S. Edgar, K. Salee and J. Upston (2020). Torres Strait Tropical Rock Lobster (TRL) Milestone Report 2020 on fishery surveys, CPUE, stock assessment and harvest strategy: AFMA Project R2019/0825 - Draft Final Report 2020. Cleveland: 183.
297	Health	*Diseases*	Centre for Tropical Environmental and Sustainability Studies	Detecting Emerging Infectious Diseases in the Torres Strait: a review of mosquito-borne disease studies	Modelled and Observational	1995	2011	Review on mosquitoe borne diseases with insights into risks of dispersal from PNG into Australia from other organisms	Not known	Laurance, S. G. W., D. Meyer-Steiger and S. Ritchie (2014). Detecting Emerging Infectious Diseases in the Torres Strait: a review of mosquito-borne disease studies. Report to the National Environmental Research Program. Cairns: 17.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
298	Physiochemical	rainfall	Queensland Government	Queensland Future Climate	Modelled	2030	2050	downscaled models from CMIP5 from RCP8.5 and 4.5 for a range of different metrics: queensland futureclimatedashboard. Website: Resolution is 10km x 10km grid regionalised at council scale. But also time series base on information on grid-based scale for TERN. Products have been developed to provide information for the land (not water), but they have capability to link with ocean information. Differs from climate change in Australia because the areas of interest are based on council areas so better regionalised outputs. SLR and SST are expected to be developed in the future and Ralph and Jacqui are keen to collaborate on this. Problem is time commitment and availability to do this. By late November another person from the group will be back from leave and can provide better information on this. Working with this group will have the advantage of using already made products with a better resolution than Climate in Australia website. Need to consider the need of a dedicated data person to extract downscaled model outputs if not available in the portal.	none: data can be accessed via login on website	https://www.longpaddock.qld.gov.au/qld-future-climate/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
299	Physiochemical	evaporation	Queensland Government	Queensland Future Climate	Modelled	2030	2050	downscaled models from CMIP5 from RCP8.5 and 4.5 for a range of different metrics: queensland futureclimatedashboard. Website: Resolution is 10km x 10km grid regionalised at council scale. But also time series base on information on grid-based scale for TERN. Products have been developed to provide information for the land (not water), but they have capability to link with ocean information. Differs from climate change in Australia because the areas of interest are based on council areas so better regionalised outputs. SLR and SST are expected to be developed in the future and Ralph and Jacqui are keen to collaborate on this. Problem is time commitment and availability to do this. By late November another person from the group will be back from leave and can provide better information on this. Working with this group will have the advantage of using already made products with a better resolution than Climate in Australia website. Need to consider the need of a dedicated data person to extract downscaled model outputs if not available in the portal.	none: data can be accessed via login on website	https://www.longpaddock.qld.gov.au/qld-future-climate/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
300	Physiochemical	temperature	Queensland Government	Queensland Future Climate	Modelled	2030	2050	downscaled models from CMIP5 from RCP8.5 and 4.5 for a range of different metrics: queensland futureclimatedashboard. Website: Resolution is 10km x 10km grid regionalised at council scale. But also time series base on information on grid-based scale for TERN. Products have been developed to provide information for the land (not water), but they have capability to link with ocean information. Differs from climate change in Australia because the areas of interest are based on council areas so better regionalised outputs. SLR and SST are expected to be developed in the future and Ralph and Jacqui are keen to collaborate on this. Problem is time commitment and availability to do this. By late November another person from the group will be back from leave and can provide better information on this. Working with this group will have the advantage of using already made products with a better resolution than Climate in Australia website. Need to consider the need of a dedicated data person to extract downscaled model outputs if not available in the portal.	none: data can be accessed via login on website	https://www.longpaddock.qld.gov.au/qld-future-climate/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
301	Physiochemical	solar radiation	Queensland Government	Queensland Future Climate	Modelled	2030	2050	downscaled models from CMIP5 from RCP8.5 and 4.5 for a range of different metrics: queensland futureclimatedashboard. Website: Resolution is 10km x 10km grid regionalised at council scale. But also time series base on information on grid-based scale for TERN. Products have been developed to provide information for the land (not water), but they have capability to link with ocean information. Differs from climate change in Australia because the areas of interest are based on council areas so better regionalised outputs. SLR and SST are expected to be developed in the future and Ralph and Jacqui are keen to collaborate on this. Problem is time commitment and availability to do this. By late November another person from the group will be back from leave and can provide better information on this. Working with this group will have the advantage of using already made products with a better resolution than Climate in Australia website. Need to consider the need of a dedicated data person to extract downscaled model outputs if not available in the portal.	none: data can be accessed via login on website	https://www.longpaddock.qld.gov.au/qld-future-climate/

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
302	Physiochemical	vapour pressure deficit	Queensland Government	Queensland Future Climate	Modelled	2030	2050	downscaled models from CMIP5 from RCP8.5 and 4.5 for a range of different metrics: queensland futureclimatedashboard. Website: Resolution is 10km x 10km grid regionalised at council scale. But also time series base on information on grid-based scale for TERN. Products have been developed to provide information for the land (not water), but they have capability to link with ocean information. Differs from climate change in Australia because the areas of interest are based on council areas so better regionalised outputs. SLR and SST are expected to be developed in the future and Ralph and Jacqui are keen to collaborate on this. Problem is time commitment and availability to do this. By late November another person from the group will be back from leave and can provide better information on this. Working with this group will have the advantage of using already made products with a better resolution than Climate in Australia website. Need to consider the need of a dedicated data person to extract downscaled model outputs if not available in the portal.	none: data can be accessed via login on website	https://www.longpaddock.qld.gov.au/qld-future-climate/

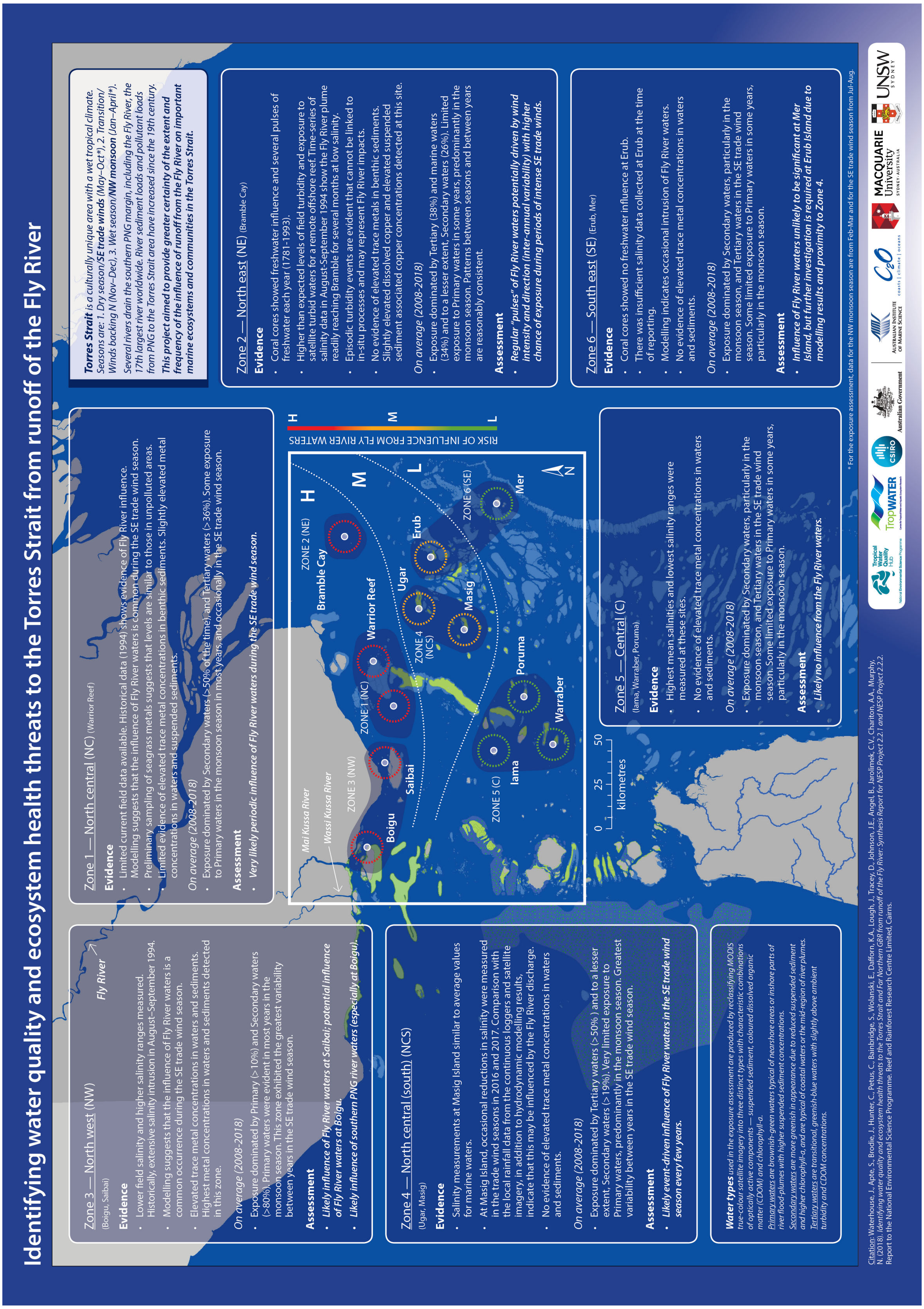
#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
303	Physiochemical	Trace metals	NESP	Identifying water quality and ecosystem health threats to the Torres Strait from runoff arising from mine-derived pollution of the Fly River	Observational	2018	2018	habitats located in the northeast corner of the Torres Strait Protection Zone, north of Masig Island and northwest as far as Boigu Island, are located in a higher potential risk area of exposure to brackish and turbid waters from or derived from the Fly River, as well as from/or derived from local PNG river discharges. While this movement of water from the Fly River is a historic pattern, the estimated 40% increase in sediment discharge associated with the operation of Ok Tedi mine is likely to have changed the characteristics of sediment and contaminant concentrations in this region. Despite the increased load, water and sediment quality is generally excellent across the region. Increased metal concentrations in waters and sediments were only observed around Boigu and Saibai islands.	contact authors	Waterhouse, J., et al. (2018). Identifying water quality and ecosystem health threats to the Torres Strait from runoff arising from mine-derived pollution of the Fly River: Synthesis Report for NESP Project 2.2.1 and NESP Project 2.2.2. Report to the National Environmental Science Programme. Cairns: 25p.
304	Physiochemical	Turbidity	NESP	Identifying water quality and ecosystem health threats to the Torres Strait from runoff arising from mine-derived pollution of the Fly River	Observational	2018	2018	habitats located in the northeast corner of the Torres Strait Protection Zone, north of Masig Island and northwest as far as Boigu Island, are located in a higher potential risk area of exposure to brackish and turbid waters from or derived from the Fly River, as well as from/or derived from local PNG river discharges. While this movement of water from the Fly River is a historic pattern, the estimated 40% increase in sediment discharge associated with the operation of Ok Tedi mine is likely to have changed the characteristics of sediment and contaminant concentrations in this region. Despite the increased load, water and sediment quality is generally excellent across the region. Increased metal concentrations in waters and sediments were only observed around Boigu and Saibai islands.	contact authors	Waterhouse, J., et al. (2018). Identifying water quality and ecosystem health threats to the Torres Strait from runoff arising from mine-derived pollution of the Fly River: Synthesis Report for NESP Project 2.2.1 and NESP Project 2.2.2. Report to the National Environmental Science Programme. Cairns: 25p.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
305	Physiochemical	Mean Surface Temperature	CSIRO	Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2090	Modelled	2055	2090	Three global models (GFDL-CM2.1, UKMO-HadCM3 and ECHAM5 60 km CCAM global simulations) were selected for further downscaling to 8 km resolution. Of the six host models, these show a low, middle and high amount of global warming into the future, respectively. Due to the very high demand for computer resources when downscaling at 8 km resolution, the temporal and spatial extent of the simulations was limited. Only the 1980-1999, 2046-2065 and 2080-2099 time periods were simulated for seven 1000 km x 1000 km regions, including Papua New Guinea, East Timor, Fiji, Solomon Islands, Vanuatu, Samoa and the Federated States of Micronesia. The results from the PNG simulation were used in this study because they also cover the Torres Strait region.	Contact Authors	Katzfey, J. and W. Rochester (2012). Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2090. Thursday Island.
306	Physiochemical	Rainfall	CSIRO	Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2091	Modelled	2055	2090	Three global models (GFDL-CM2.1, UKMO-HadCM3 and ECHAM5 60 km CCAM global simulations) were selected for further downscaling to 8 km resolution. Of the six host models, these show a low, middle and high amount of global warming into the future, respectively. Due to the very high demand for computer resources when downscaling at 8 km resolution, the temporal and spatial extent of the simulations was limited. Only the 1980-1999, 2046-2065 and 2080-2099 time periods were simulated for seven 1000 km x 1000 km regions, including Papua New Guinea, East Timor, Fiji, Solomon Islands, Vanuatu, Samoa and the Federated States of Micronesia. The results from the PNG simulation were used in this study because they also cover the Torres Strait region.	Contact Authors	Katzfey, J. and W. Rochester (2012). Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2090. Thursday Island.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
307	Physiochemical	Relative humidity	CSIRO	Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2092	Modelled	2055	2090	Three global models (GFDL-CM2.1, UKMO-HadCM3 and ECHAM5 60 km CCAM global simulations) were selected for further downscaling to 8 km resolution. Of the six host models, these show a low, middle and high amount of global warming into the future, respectively. Due to the very high demand for computer resources when downscaling at 8 km resolution, the temporal and spatial extent of the simulations was limited. Only the 1980-1999, 2046-2065 and 2080-2099 time periods were simulated for seven 1000 km x 1000 km regions, including Papua New Guinea, East Timor, Fiji, Solomon Islands, Vanuatu, Samoa and the Federated States of Micronesia. The results from the PNG simulation were used in this study because they also cover the Torres Strait region.	Contact Authors	Katzfey, J. and W. Rochester (2012). Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2090. Thursday Island.
308	Physiochemical	Wind Speed	CSIRO	Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2093	Modelled	2055	2090	Three global models (GFDL-CM2.1, UKMO-HadCM3 and ECHAM5 60 km CCAM global simulations) were selected for further downscaling to 8 km resolution. Of the six host models, these show a low, middle and high amount of global warming into the future, respectively. Due to the very high demand for computer resources when downscaling at 8 km resolution, the temporal and spatial extent of the simulations was limited. Only the 1980-1999, 2046-2065 and 2080-2099 time periods were simulated for seven 1000 km x 1000 km regions, including Papua New Guinea, East Timor, Fiji, Solomon Islands, Vanuatu, Samoa and the Federated States of Micronesia. The results from the PNG simulation were used in this study because they also cover the Torres Strait region.	Contact Authors	Katzfey, J. and W. Rochester (2012). Downscaled Climate Projections for the Torres Strait Region: 8 km results for 2055 and 2090. Thursday Island.

#	Domain	Parameter / species / habitat	Where is the data	Title	Obervation / Model	Date start	Date end	Metadata (e.g. Scale / Location)	Licence use	Source/ reference
309	Ecological	Growth: Panulirus ornatus	CSIRO	Long-Term Variation of Tropical Rock Lobster Panulirus Ornatus (Decapoda, Palinuridae) Growth in Torres Strait, Australia	Modelled and Observational	1989	2009	In the past two decades, growth rates have fluctuated inter-annually without displaying any distinctive trend. Associated uncertainties are large, suggesting that sampling will need to be intensified in order to detect an effect of climate change	Contact authors	Kienzle, M., et al. (2012). "Long-Term Variation of Tropical Rock Lobster Panulirus Ornatus (Decapoda, Palinuridae) Growth in Torres Strait, Australia." Crustaceana 85(2): 189-204.
310	Ecological	*Growth: Brown tiger prawn*	on paper	Migration and growth of two tropical penaeid shrimps within Torres Strait, northern Australia	Observational	1986	1988		Contact authors	Watson, R. A. and C. T. Turnbull (1993). "Migration and growth of two tropical penaeid shrimps within Torres Strait, northern Australia." Fisheries Research 17(3): 353-368.
311	Ecological	*Growth: Spanish mackerel*	on paper	Stock assessment of the Torres Strait Spanish mackerel fishery	Modelled and Observational	1988	2003	Stock assessment report that used published growth rates specific for Torres Strait in models.	Contact authors	Begg, G. A., et al. (2006). Stock assessment of the Torres Strait Spanish mackerel fishery. CRC Reef Research Centre Technical Report No. 66. Townsville.
312	Ecological	Reproduction: sea cucumbers	On Book	Torres Strait Beche-de-mer (Sea cucumber) species ID guide	Observational			Data on age at maturity, spawning season for species found in Torres Strait	Contact authors	Murphy, N., et al. (2019). Torres Strait Beche-de-mer (Sea cucumber) species ID guide. Brisbane, Commonwealth Scientific and Industrial Research Organisation
313	Ecological	Reproduction: Panulirus ornatus	on paper	Reproductive cues in Panulirus ornatus	Observational	2002	2003	Experimental work which reviews Panulirus ornatus reproductive behaviour for application in aquaculture	Contact authors	Sachlikidis, N. G., et al. (2005). "Reproductive cues in Panulirus ornatus." New Zealand Journal of Marine and Freshwater Research 39(2): 305-310.
314	Ecological	Finfish - Spanish Mackerel	on paper	Stock assessment of the Torres Strait Spanish mackerel fishery	Modelled and Observational	2000	2004	Summary of data for growth, sex ratios, maturity, reproduction, and age structure	Contact authors	Begg, G. A., et al. (2006). Stock assessment of the Torres Strait Spanish mackerel fishery. CRC Reef Research Centre Technical Report No. 66. Townsville.

Appendix B Water quality and ecosystem health threats to the Torres Strait from runoff of the Fly River (Waterhouse et al. 2018)



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TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
OTHER BUSINESS	Agenda Item 7 For DISCUSSION

RECOMMENDATIONS

1. That the Working Group **NOMINATE** any further business for discussion.

TORRES STRAIT HAND COLLECTABLES WORKING GROUP	Meeting No. 18 28-29 October 2021
FUTURE PRIORITIES AND DATE FOR THE NEXT MEETING	Agenda Item 8 FOR DISCUSSION & ADVICE

RECOMMENDATIONS

1. That the WG **DISCUSS** and **PROVIDE ADVICE** on priorities for the WG together with a work plan for addressing recommended priorities; and

2. That the WG **NOMINATE** a date and a venue for the next meeting.

KEY ISSUES

1. Having agreed priorities (WG issues to focus on) and a corresponding work plan aims to achieve a more efficient WG process.

2. Where possible, the WG should aim to prioritise and set a timeline for any identified items, having regard for resourcing. As far as practical AFMA proposes that a work plan be developed in-session.

3. Subject to WG advice, AFMA proposes the next meeting be held around July/August 2022 (**Table 1**).

4. In considering its priorities, the WG may wish to note the summary of management priorities previously identified by the HCWG as outlined in **Table 2.** Progress against each priority is provided.

Table 1. Key dates for the BDM Fishery in 2022.

Key dates 2022	Activity
1 January	Start of BDM fishing season
Late January	PZJA to consider future PZJA meetings
April/May (possible)	Black teatfish opening (PZJA decision having regard for RAG and WG advice)
June/July (tentative)	HCRAG. Potentially consider outcomes of black teatfish outcomes, applying harvest strategy to remaining species, research priorities.
July/August (tentative)	HCWG. Potentially consider outcomes of black teatfish outcomes, applying harvest strategy to remaining species, research priorities.

Table 2. Comments relating to any progress against each management priority previously identified by the HCWG. Management priorities are listed chronologically and not in order of importance.

Management Priority			**Progress to date and comments**
1	HCWG9 June 2016	Development of a harvest strategy and recovery plans for overfished species	**Complete.** CSIRO, together with AFMA, the HCWG and broader industry stakeholders have developed a Beche-de-mer Harvest Strategy. The BDM Harvest Strategy was endorsed by the PZJA in November 2019 and implemented on 1 January 2020.
2	HCWG9 June 2016	Future management arrangements for Black Teatfish and White Teatfish	**Ongoing.** The TSRA supported PZJA Traditional Inhabitant members to undertake cluster consultations in late 2019 which sought feedback from communities on the use of hookah to fish for white teatfish. Given the strongly divided community views on this matter, the HCWG recommended that it be further discussed at a Malu Lamar led broader industry workshop which was scheduled for April 2020 but did not proceed due to COVID-19 related restrictions. See also management priority #9 **Completed** Fishing for black teatfish occurred on a trial basis during 30 April – 3 May 2021 in accordance with the BDM Harvest Strategy.
3	HCWG9 June 2016	Review the size limits set for the Torres Strait Beche-de-mer Fishery taking into consideration the size limits in place for the Queensland and the Commonwealth Coral Sea Fishery	**Complete.** This work was progressed under the Harvest Strategy project. Proposed changes to minimum size limits of beche-de-mer will be considered by the PZJA as part of the Harvest Strategy.
4	HCWG9 June 2016	Review weight conversion ratios for gutted and dried beche-de-mer species	**Ongoing.** This work was progressed under the Harvest Strategy project. Updates to weight conversion ratios are captured within the new Beche-de-mer Species Identification Guide. CSIRO is continuing to work with industry on understanding weight conversion ratios for curryfish species. A full proposal was developed and allocated funding in 2019/20 but did not proceed due to COVID-19.
5	HCWG9 June 2016	Develop communication materials to assist industry members with the	**Complete.**

Management Priority			Progress to date and comments
		requirements of the new Fish Receiver System being implemented on 1 December 2017 and on current management arrangements and proposed future management priorities for the fishery.	As part of the 2019 Fish Receiver System community visits, AFMA developed some educational material such as fact sheets and and frequently asked questions (FAQs) sheets on the FRS and harvest strategies for industry, as well as consulting on the draft BDM Harvest Strategy. A number of PZJA Traditional Inhabitant (TI) members also accompanied AFMA during the community visits and assisted in communicating the importance and benefits of the FRS. During the TSRA cluster visits in late 2019 and January 2020, PZJA TI members presented on each fishery, including management priorities and the FRS. AFMA and PZJA TI members undertook further community visits in late 2020 – early 2021 leading up to the black teatfish trial opening during which the FRS was also discussed and communication material provided.
6	HCWG13 July 2018	Developing a Beche-de-mer management plan.	**Not progressed.** The development and implementation of the BDM Harvest Strategy and mandatory fish receiver system was progressed as the highest immediate priority. Further consideration by the HCWG on the intended purpose of developing a statutory management plan for the BDM Fishery. A key purpose for implementing such a plan is to implement quota (or effort unit) management.
7	HCWG13 July 2018	Continuing education and awareness training with the Fish Receiver System	**Ongoing.** AFMA undertook a round of community visits in April and May 2019 to discuss the Fish Receiver System with industry and communities and AFMA continues to liaise with industry on how to improve reporting through the FRS.
8	HCWG13 July 2018	Improving communication and engagement with industry on current management arrangements and proposed future management priorities for the fishery.	**Ongoing.** In addition to the comments provided at #5 above, AFMA Thursday Island is continuing to work with the AFMA communications team to improve communications on a range of fisheries topics, including segments on Radio 4MW, the PZJA website and a fisheries notice board outside the AFMA Torres Strait office.

Management Priority			Progress to date and comments
9	HCWG14 October 2018	Some industry members expressed support for Malu Lamar to develop their own proposal on the use of hookah to fish for white teatfish and fast track the issue to the PZJA for consideration, separate to the work that the TSRA is undertaking in this regard.	**Ongoing.** AFMA stands ready to consider Malu Lamar's proposal and will work with Malu Lamar to undertake further industry consultation, and/or workshops similar to that undertaken in the lead up to the trial opening of black teatfish in 2021. See also management priority #2
10	HCWG15 August 2019	AFMA to arrange a half/full day future management priorities workshop in conjunction with the next Hand Collectables Working Group meeting. Participants to the meeting should include HCWG members, other industry stakeholders including factory processors and/or buyers and should also include discussions on pearl shell and trochus fisheries.	**Ongoing.** The highest priority for 2020-21 was the trial opening of black teatfish which occurred on 30 April – 3 May 2021. AFMA will continue to work with the HCWG and industry to progress discussions on future management priorities for Hand Collectables Fisheries. AFMA considers this a high priority.