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# Torres Strait Tropical Rock Lobster Fishery

Working Draft

Harvest Strategy

December 2016

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GLOSSARY

**Types of reference points:**

|  |  |
| --- | --- |
| **Reference Point** | **Description** |
| Metarule | A rule that describes how the RBCs obtained from an assessment should be adjusted in calculating a recommended TAC |
| Target | Relates to a target reference point as per the HSP. Expressed in terms of biomass. |
| Limit | Relates to a limit reference point as per the HSP. Fishing stops if this reference point is exceeded a specified number of times. Expressed in terms of biomass. |
| Threshold | The reference point below which the TAC is adjusted to allow the stock to rebuild to the target reference point. |
| MEY | Maximum economic yield |
|  |  |
|  |  |

**Notation:**

|  |  |
| --- | --- |
| **Notation** | **Description** |
| B | Spawning biomass level |
| B0 | The unfished spawning biomass (determined from an appropriate reference point) |
| F | Fishing mortality rate |
|  |  |
|  |  |
|  |  |
|  |  |

**Other acronyms:**

|  |  |
| --- | --- |
| **Acronym** | **Description** |
| CPUE | Catch per unit effort |
| HSP | Commonwealth Harvest Strategy Policy and Guidelines 2007 |
| HS | Harvest Strategy |
| HSF | Harvest Strategy Framework |
| HCR | Harvest Control Rule |
| RBC | Recommended Biological Catch |
| TRLRAG | Tropical Rock Lobster Resource Assessment Group |
| TRLWG | Tropical Rock Lobster Working Group |
| TAC | Total Allowable Catch |
|  |  |
|  |  |

OVERVIEW

A summary of the document will be provided here.

* 1. BACKGROUND

This Torres Strait Tropical Rock Lobster Fishery (the Fishery) Harvest Strategy (HS) has been developed in accordance with the *Commonwealth Fisheries Harvest Strategy Policy and Guidelines 2007* (HSP) and consistent with objectives of the *Torres Strait Fisheries Act 1984* (the Act).

The Fishery HS takes into account key fishery specific attributes including:

1. there is potential for large, unpredictable inter‑annual variations in availability and abundance of tropical rock lobster (TRL);
2. TRL is a shared resource important for commercial, traditional and recreational sectors; and
3. advice from the TRL Resource Assessment Group (TRLRAG) industry members to maintain abundance at current levels (TRLRAG, 31 March 2016). (NOTE: TRLWG advice to be provided).
	1. COMMONWEALTH FISHERIES HARVEST STRATEGY POLICY

The objective of the HSP is the sustainable and profitable use of Australia’s Commonwealth fisheries in perpetuity through the implementation of harvest strategies that maintain key commercial stocks at ecologically sustainable levels, and within this context, maximise the economic returns to the Australian community.

To meet the HSP objective, harvest strategies are designed to pursue an exploitation rate that keeps fish stocks at a level required to produce maximum economic yield (MEY) and ensure stocks remain above a limit biomass level (BLIM) at least 90 per cent of the time. Alternative reference points may be adopted for some stocks to better pursue the objective of maximising economic returns across the fishery as a whole or other fishery specific objectives.

The HSP provides for the use of proxy settings for reference points to cater for different levels of information available and unique fishery circumstances. This balance between prescription and flexibility encourages the development of innovative and cost effective strategies to meet key policy objectives. Proxies must ensure stock conservation and economic performance as envisaged by the HSP. Such proxies, including those that exceed these minimum standards, must be clearly justified.

With a harvest strategy in place, fishery managers and stakeholders are able to operate with pre-defined rules, management decisions are more transparent, and there are likely fewer unanticipated outcomes necessitating hasty management responses. However, as stated above, the inherently variable abundance of TRL may necessitate significant changes in recommended catch on an annual basis.

* 1. DEVELOPMENT OF THE TRL HARVEST STRATEGY

The TRL HS has been developed in consultation with the TRLRAG and the TRL Working Group (TRLWG). It replaces an interim HS developed for the fishery in 2008 **(Appendix 1)**.

NOTE: TRLWG advice to be provided once TRLRAG advice finalised – this statement is to be updated as required.

* 1. TRL FISHERY HARVEST STRATEGY
		1. SCOPE

This HS applies to the whole fishery and it takes into account catch sharing arrangements between Australia and Papua New Guinea (PNG).

The HS outlines rules used to develop advice on the Recommended Biological Catch (RBC) and setting the Total Allowable Catch (TAC) for the Fishery. The HS sets the criteria that pre-agreed decisions will be based in order to achieve the Fishery objectives.

Overtime the HS may be amended to use a tiered approach to cater for different amounts of data available and different types of assessments (for example mid-year surveys and annual assessments). Underpinning a tiered HS is increased levels of precaution with increasing levels of uncertainty about the stock status. Each tier has its own harvest control rule (HCR) and associated rules that are used to determine a RBC.

* + 1. OBJECTIVES

The operational objectives of the Harvest Strategy are to:

1. maintain the stock at (on average), or return to, a target biomass point BTARG equal to the stock size that aims to maximise net economic returns for the Fishery by maintaining abundance around recent levels while having regard for the fact that the resource is shared and important for the traditional way of life and livelihood of traditional inhabitants;
2. maintain stocks above the limit biomass level (BLIM), or an appropriate proxy, at least 90 per cent of the time;
3. reduce fishing levels if a stock is below BTHRESH but above BLIM; and
4. implement rebuilding strategies, if the stock moves below BLIM in repeated years.
	* 1. RECOMMENDING TACs FROM RBCs

The RBC is the recommended biological catch (the total catch of TRL, both retained and discards) from all sectors of the Fishery. Consistent with the HSP the TAC should take into account all sources of fishing mortality.

The HS does not account for catches taken by non-commercial fishing sectors, for example traditional, recreational or research catches. The TRLRAG recommended at Meeting No.18 that non‑commercial catches should not be accounted for, because the overall catches are likely to be relatively low and there would be limited impact on the stock assessment. The HS may be updated to account for changing circumstances in the Fishery, the review provisions are described in Section 2.13.

* + 1. MONITORING

Biological data for the Fishery are monitored by a range of methods listed below. Currently there is no ongoing monitoring strategy in place to collect economic information.

**Fishery independent surveys**

A key component of the monitoring program is the fishery‑independent survey which provides a time‑series of relative abundance indices for TRL. Fishery‑independent surveys have been conducted in the Fishery since 1989. Historically (1989-2014), mid‑season (July) surveys focused on providing an index of abundance of the spawning (2+) and recruiting (1+) lobsters, these surveys have been replaced with pre‑season (November) surveys (2005-2008; 2014 to current) which focus on providing an index of recruitment (1+ lobsters) as close as possible to the start of the fishing season to support the transition to quota management. Pre-seasons surveys also provide indices of recently-settled (0+) lobsters, which may become useful under quota management as they allow forecasting of stock one year in advance.

**Catch and effort information**

Fishers in the transferrable vessel holder (TVH) sector are required to record catch and effort information in the Torres Strait Tropical Rock Lobster Daily Fishing Log (TRL04). The following data is recorded for each TVH fishing operation: the port and date of departure and return, fishing area, fishing method, hours fished and the weight (whole or tails) of TRL retained. Fishers in the traditional inhabitant boat (TIB) sector voluntarily report catch and effort information in the Torres Strait Seafood Buyers and Processors Docket Book (TDB01). Some processors voluntarily report aggregate catch information directly to AFMA.

* + 1. INTEGRATED STOCK ASSESSMENT MODEL

The stock assessment model (termed the ‘Integrated Model’) (Plagányi *et al.* 2009) was developed in 2009 and is an Age-Structured Production Model, or Statistical Catch-at-Age Analysis (SCAA) (e.g. Fournier and Archibald 1982). It is a widely used approach for providing TAC advice with associated uncertainties. The model integrates all available information into a single framework to assess resource status and estimate a RBC. The model addresses all of the concerns highlighted in a review of the previous stock assessment approach (Bentley 2006, Ye et al. 2006, 2007). The model is fitted to the mid‑season and pre‑season survey data as well as CPUE data available from the TVH and TIB sector. The growth relationships used in the model were revised from the previous stock assessment model, and average mass compared with observations. The model is of a form that can be used as an Operating Model in a Management Strategy Evaluation (MSE) framework, given that the need for a MSE to support the management of the Fishery was identified by the TRL RAG.

The stock assessment model is non-spatial and assumes that the Torres Strait TRL stock is independent of the Queensland East Coast Tropical Rock Lobster Fishery stock. A spatial version of the model has been developed as part of an earlier MSE project, and can be used to investigate plausible linkages between these stocks (Plagányi *et al*. 2012, 2013).

The model includes three age-classes only as it is assumed that lobsters migrate out of Torres Straits in October each year. Torres Strait rock lobsters emigrate in spring and breed during the subsequent summer (November-February) (MacFarlane and Moore 1986; Moore and Macfarlane 1984). A Beverton-Holt stock-recruitment relationship is used (Beverton and Holt 1957), allowing for annual fluctuation about the deterministic relationship. The model is fitted to the available abundance indices by maximising the likelihood function. Quasi-Newton minimization is used to minimize the total negative log-likelihood function (using the package AD Model BuilderTM (Fournier et al. 2012).

* + 1. EMPIRICAL HARVEST CONTROL RULE (to be updated)

The empirical harvest control rule (eHCR) recommended by the TRLRAG uses the pre‑season survey 1+ and 0+ indices, both CPUE indices (TVH and TIB), applies the natural logarithms of the slopes of the five most recent years’ data, an upper catch limit of 1,000 t. The relative weightings of the eHCR indices are 70 per cent pre-season survey 1+ index, 10 per cent pre-season survey 0+ index, 10 per cent TIB sector CPUE and 10 per cent TVH sector CPUE.. The basic formula is:

 

or if  > 1000t, = 1000.

where

 is the average achieved catch during the past 5 years, including the current year i.e. from year *y*-4 to year *y*,

 is the slope of the logarithms of the preseason survey 1+ abundance index, based on the 5 most recent values;

 is the slope of the logarithms of the preseason survey 0+ abundance index, based on the 5 most recent values;

 is the slope of the logarithms of the TVH and TIB CPUE abundance index, based on the 5 most recent values;

wt\_s1, wt\_s2, wt\_c1, wt\_c2 are tuning parameters that assign relative weight to the preseason 1+ (wt\_s1) and 0+ (wt\_s2) survey trends compared with the CPUE TVH (wt\_c1) and TIB (wt\_c2) trends;

* + 1. REFERENCE POINTS

The TRL Fishery HS reference points are:

1. The unfished biomass B0 is the model-estimate of spawning stock biomass in 1973 (start of the fishery). B0 = B1973.
2. The target biomass BTARG is the spawning biomass level which would result in a maximum economic yield (MEY), which is the point at which the sustainable catch for the fishery maximises profits. BTARG is the proxy for BMEY, BTARG = 0.65 B0.
	* The RAG noted a higher target biomass was considered important for the Fishery because: 1) the stock: is a shared resource that is particularly important for traditional fishing; 2) the stock has high variability; and, 3) all industry members recommended the HS maintain the stock around the relatively high current levels (TRLRAG meeting no. 17 and 18).
3. The threshold biomass BTHRES is the point below which more stringent rules for calculating the TAC apply. BTHRES = 0.48 B0.
4. The limit biomass BLIM is the spawning biomass level below which the risk to the stock is unacceptably high and the stock is defined as ‘overfished’. BLIM is agreed to be half of BTARG, BLIM = 0.32 B0.
5. If the limit reference point (BLIM) is triggered two years out of the most recent three year period, then the fishery is closed.
6. The target fishing mortality rate FTARG is the estimated level of fishing mortality rate that maintains the spawning biomass around BTARG. FTARG = 0.15.

***Rational for reference points:***

The HSP acknowledges that for highly variable stocks the default reference points may not apply as straightforward as is the case for less variable multiple cohort stocks. For example, the HSP states “For highly variable species that may naturally fluctuate (i.e. in the absence of fishing) below BLIM, the harvest strategy for these species must be consistent with the intent of the Policy.” Furthermore, ”Stocks that fall below BLIM due to natural variability will still be subject to the recovery measures stipulated in the HSP”, and that a number of adaptive management approaches may be used to deal with this, such as pre-season surveys to estimate stock abundance to which the eHCR is applied.

It is important to note that highly variable stocks will seldom be near a specified target biomass level but will fluctuate about this level, and hence the average level needs to be set high enough such that the natural variability about this level keep the stock well above lower limits where there is a risk of recruitment being compromised (and this is doubly important in the case of a single cohort fishery because there are no other age classes to compensate for a poor or failed recruitment year). Hence taking the past observed natural variability of TRL into account as well as considering that since 2001 essentially only a single age class is fished, the stock assessment model and MSE testing have suggested that the target reference biomass level for this fishery should be higher than the default value of 0.48B0, and instead in the region 0.65-0.8B0.

The quantity B0 is estimated within the stock assessment model, and hence estimates of B0 as well as BTARG/B0 have varied over time in response to annual data updates and model parameter settings and estimates (particularly parameter *h*, which determines the steepness of the stock-recruit relationship, and the input parameter that controls the level of stock-recruit variability). Thus independent of some variability in B0, the target fishing mortality rate FTARG =0.15 is applied to maintain the spawning biomass around BTARG, which is the average level over the past two decades. This is assumed to be a proxy for BMEY because stakeholders agreed that this target level corresponded to an optimal level in terms of economic, biological and social considerations. The choice of BLIM as higher than the default 0.2 level is supported further by recommendations of similar target levels for other highly variable species such as forage fish.

Given that BLIM is typically taken to be half of BTARG, BLIM preliminary estimates have varied from 0.32 to 0.4 given changes in the estimates of BTARG/B0 as explained above. However recent MSE testing suggested that 0.4 may be too conservative and hence the TRLRAG agreed to set BLIM = 0.32 B0, but added the condition that the stock needs to fall below BLIM  two out of three years to trigger a closure of the Fishery. Note however that the final HCR is tuned so that it is consistent with the HSP criterion to ‘ensure that the stock stays above the limit biomass level at least 90 per cent of the time’ (i.e. a 1 in 10 year risk that stocks will fall below BLIM). The HSP suggests that for highly variable species, this might be done by specifying a limit to the increase in frequency of breaching the limit reference point or by altering BLIM.

* + 1. ASSESSMENT METHOD

The integrated stock assessment occurs on a three year cycle, unless the fishery is at or below the biomass limit reference point (BLIM) in two out of three years for an assessment cycle. If this occurs, the stock assessment must be repeated the following year in order to monitor the condition of the stock. In the intervening years the eHCR will be applied.

* + 1. DATA SUMMARY

The annual data summary reviews the catch per unit effort (CPUE) from the TIB and TVH sectors, as well as total catch from all sectors, and size information provided from a sub-sample of commercial lobsters. The data summary is used as an indicator to identify if catches correspond to the TAC, and to monitor CPUE.

Information to be included in the annual data summary to be inserted by CSIRO.

* + 1. DECISION RULES

The RAG recommended:

* the eHCR include a maximum catch limit of 1000 t and the cap will be reviewed in three years using the integrated stock assessment model;
* a pre season +1 survey trigger point of 1.25 average lobsters per survey transect, if in any year the index is lower than 1.25 it triggers a stock assessment.

The RAG recommended the following decision rules to be applied if the limit reference point (BLIM = 0.32) is triggered (**Figure 1**):

* If after the first year the stock is assessed below the biomass limit reference point it is optional to conduct a mid season survey, the pre season survey must continue annually.
* If the biomass limit reference point is triggered in two consecutive years, the fishery closes. It is optional to conduct a mid-season survey, the pre-season survey must continue annually.
* The fishery should remain closed until the stock assessment model shows the stock has recovered to be above the limit reference point.



**Figure 1.** RAG recommended decision rules to apply if the limit reference point is triggered.

* + 1. METARULE

Do be discussed by the RAG.

* + 1. GOVERNANCE

The status of the TRL Fishery and how it is tracking against the Harvest Strategy Framework (HSF) is reported to the TRLRAG, TRLWG and the PZJA as part of the yearly TAC setting process.

* + 1. REVIEW

Under certain circumstances, it may be necessary to amend the harvest strategy. For example if:

1. there is new information that substantially changes the status of a fishery, leading to improved estimates of indicators relative to reference points; or
2. drivers external to management of the fishery increase the risk to fish stock/s; or
3. it is clear the strategy is not working effectively and the intent of the HSP is not being met; or
4. alternative techniques are developed (or a more expensive but potentially more cost-effective harvest strategy that includes mid-year surveys and annual assessments is agreed) for assessing the fishery, the HS may be amended to incorporate decision rules appropriate for those assessments.
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**Appendix 1**

**Background: *Interim Torres Strait Tropical Rock Lobster Fishery Harvest Strategy, 2008.***

In response to a planned change to quota management of the Fishery, in 2008 a HCR was established and set out the management actions necessary to achieve defined biological and economic objectives of the Fishery. In accordance with the HSP, the TRLRAG agreed that the HCR is defined by Btarg=SMSY, Blim=0.2S0, Ftarg=0.35 year-1, and Flim=FMSY.

Besides the technical issues in setting a TAC, it was recognised at that time that operational issues under a TAC management system should also be taken into account. Although the reliability of the TAC estimation improves with the pre-season survey data, this TAC can only be released to the industry after the start of the fishing season, usually in March following a TRLRAG meeting. This was foreseen as creating problems for the industry and management (Ye et al. 2008). The industry preferred a TAC released before the season starts as they need to make logistical plans. Due to the dual endorsement of licences between Torres Strait and the Queensland east coast, the TVH sector prefer information on the TAC one year in advance so that they can make a longer term investment plan. The RAG had a comprehensive discussion at its March 2008 meeting in Cairns about how the process of TAC setting should facilitate the operation of the industry and reached a decision on a three stage process.

The final selection of the decision rule for the preliminary TAC was discussed at the October 2008 RAG meeting in Cairns. It was noted that the preliminary TAC is not really a TAC, but a preliminary figure used to control the Fishery at the beginning of the fishing season before the final TAC has been decided on. So, the purpose of setting a preliminary TAC is mainly for operational reasons. Similarly, the forecast TAC is just employed to give the industry some rough indication about the coming fishing season to meet their planning requirements.

In 2009, a new integrated model was adopted by the RAG as the preferred method for setting TACs under the future quota management system. It deviated from the previous three stage approach to setting the TAC, because it integrates all available information in a single consistent framework. This facilitates an understanding of the way in which data inputs ultimately translate into an assessment of resource status and productivity, sustainable catch levels and the RBC. In addition, there were pre-season surveys conducted during 2009-2013 considered a transition period in moving towards quota management, and from 2010, there was a change to holding a single RAG meeting only, around Aug-Oct. This necessitated changes to the TAC setting process.

The TAC recommendations are obtained after applying the interim HCR to the model output of the RBC. The HCR needed to be updated to be consistent with the revised integrated model, and interim parameters were defined as Btarg=0.65B0, Blim=0.4B0, Ftarg=0.15 year-1, and Flim=Ftarg.

Target reference points specify preferred targets for management to aim at. However it was noted that these are estimated quantities only and hence have associated errors and uncertainties. Moreover, they correspond to deterministic assumptions regarding the stock-recruit relationship, yet for variable recruit-driven fisheries such as this, yield is determined predominantly by the strength of recruitment, and hence annual sustainable yields can be expected to fluctuate widely about the deterministically predicted estimates.

Hence the RAG agreed that a sensible target reference point to specify where management should aim was to keep the stock on average at the target biomass level, as a proxy for BMEY, which was set as the average biomass level over the past two decades and corresponded to Ftarg=0.15 year-1 as the average fishing mortality over the past two decades was 0.15 year-1. The RBC for years 2009-2015 was computed using this target fishing mortality rate. However, there have been a number of changes to the assessment over time due to changes in data, as well as estimation of key parameters such as stock-recruitment steepness *h*, as well as the setting for parameter (sigma) that determines the extent of variability about the stock-recruit relationship.

As a result, estimation of B0, which is assumed to be the model-estimated start biomass in 1973, has varied from lower to higher values without substantially affecting model predictions of productivity or replacement yield (RY) – the latter is generally considered more robustly determined than B0 in isolation. As a result, the estimated target spawning biomass level as a proportion of B0 has varied from 0.65B0 to 0.8B0 as it is dependent on model-estimation. For this reason, when Btarg=0.8B0, Blim was set at half this level, i.e. Blim=0.4B0. It has been queried whether these target levels are too high, but it is important to bear in mind that this is a single cohort recruit fishery (rather than a long-lived multiple cohort fishery) that displays very large inter-annual fluctuations in recruitment (e.g. recruitment of the fished age class can double or halve from one year to the next) and hence the stock fluctuates about the target level, which needs to be high enough so that during poor recruitment years the stock abundance does not drop unacceptably low. A lower biomass limit and threshold level (defined as the biomass level below which more stringent rules for calculating a TAC are applied) were selected based on comparison with past stock fluctuations and preliminary simulation testing.