5 Status determination for trochus and tropical rock lobster stocks in the Coral Sea Fishery Hand Collection Sector

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Summary

This brief study assesses the status of the tropical rock lobster and trochus stocks in the Coral Sea. The ABARES 2008 *Fishery status reports* classified the stocks as uncertain if overfished but not subject to overfishing.

This study considered the status of the tropical rock lobster under two alternative scenarios. The first scenario assumed that the Coral Sea population are part of a larger population with spawning grounds in the Torres Strait. The second scenario assumed that the Coral Sea population are a self-recruiting, self-sustaining population.

If the first scenario is true, historical catch in the Coral Sea was found to be negligible compared with catch in the Torres Strait Tropical Rock Lobster Fishery (TSTRLF). In this case, the current (2008) not overfished and not overfishing status of the TSTRLF implies that the combined Torres Strait–Coral Sea population is also not overfished and is not subject to overfishing.

If the Coral Sea tropical rock lobster population is assumed to be self-recruiting, historical effort has not been sufficient to cause substantial fishing mortality. Even under very precautionary criteria, a Coral Sea population of less than 16 000 individuals would be sufficient to sustain the highest recorded annual catch given productivity estimates for tropical rock lobster. Estimates of suitable Coral Sea habitat combined with observed catch rates would suggest that a self-recruiting population would be much larger than 16 000. Results show that under the self-recruiting scenario, the Coral Sea Rock Lobster Fishery is not overfished and not subject to overfishing.

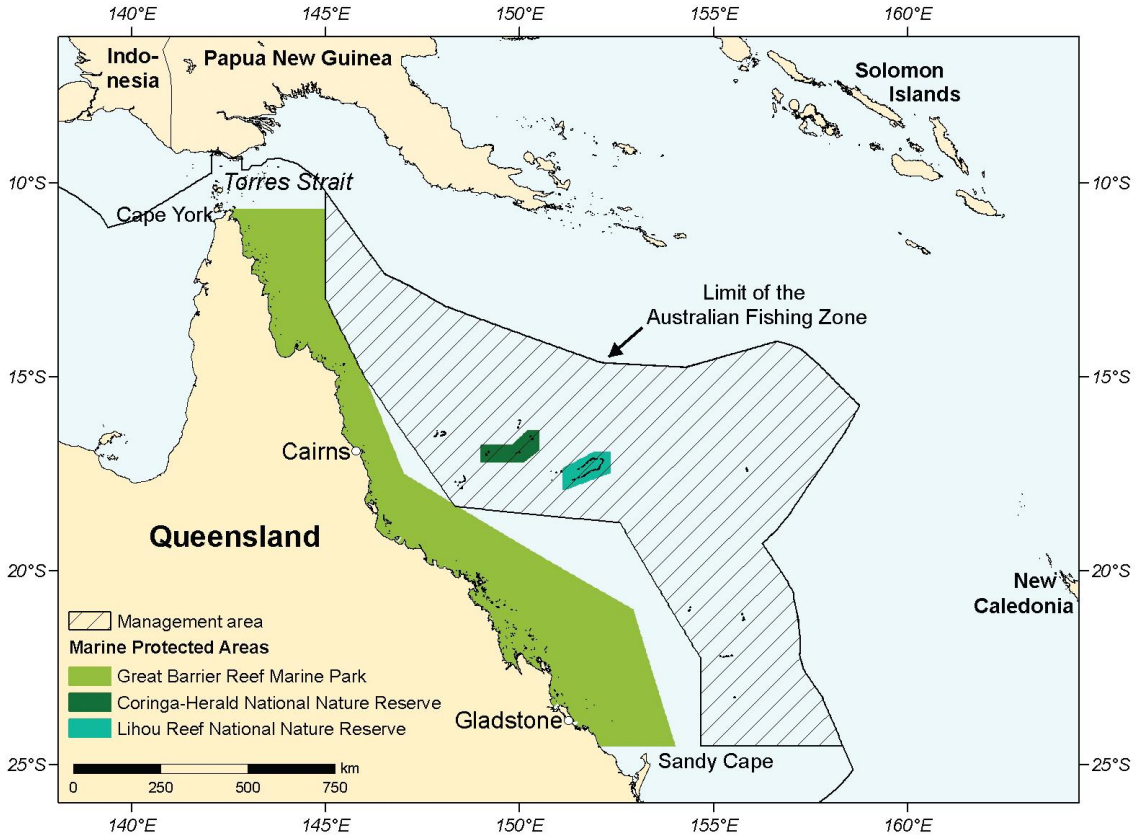
The history of commercial exploitation of trochus in the Coral Sea Hand Collection Fishery is limited to a single trip to a single reef in 2001. This study concludes that, because of negligible exploitation, trochus in the Coral Sea is not overfished and not subject to overfishing.

Introduction

The Lobster and Trochus Sector is part of the Coral Sea Fishery (CSF), which extends from Cape York to Sandy Cape in Queensland (Map 5.1). The Lobster and Trochus Sector of the CSF allows lobster and trochus to be collected by hand, with or without underwater breathing apparatus.

Historical catch records suggest that at least two species of tropical rock lobster have been taken. Ornate rock lobster (*Panulirus ornatus*) has accounted for most of the total catch and a smaller quantity of painted rock lobster (*P. versicolour*) has also been recorded. There is some doubt over which species of trochus is found in the Coral Sea. Two possibilities are *Trochus niloticus* and *Techtus pyramus* (Wilson et al. 2010).

Map 5.1 Map of the Coral Sea Fishery



Current management methods in the CSF involve catch triggers, spatial closures, move-on provisions and size limits.

Before this assessment, the ABARES 2008 *Fishery status reports* (Wilson et al 2009) classified the CSF lobster and trochus stock as uncertain if overfished but not subject to overfishing. The uncertain status determination was based on the lack of reliable mechanism for comparing the current biomass with an estimate of the biomass in an unfished state. The lobster stock was classified as not subject to overfishing as a result of no catch in 2007–08. Similarly, there has been no reported catch of trochus since 2001 (Wilson et al 2009).

Approach to status determination

The aim of this brief study is to assess the status of the tropical rock lobster and trochus stocks in the Coral Sea. Ideally an assessment of the lobster stock would be based on regular scientific surveys of lobster abundance. However, the gross value of Coral Sea tropical rock lobster production does not warrant the expense associated with scientific surveys so no such data are available. Additionally, no biological data are available specific to the Coral Sea stock of tropical rock lobster. In the absence of these data, a minimum population size that would be required to sustain the maximum annual catch of tropical rock lobster in the Coral Sea is estimated and compared with what might be expected to be a plausible minimum population for a self-sustaining tropical rock lobster population in the Coral Sea. Similarly, limited data are available for trochus. In the absence of these data, stock status are estimated based on known natural mortality and logbooks records from 2001.

The study is divided into two parts. In the first part, the status of the tropical rock lobster is considered under two alternative scenarios. The first scenario assumes the tropical lobster stock

in the CSF is part of a larger population with spawning grounds in the Torres Strait. The second scenario assumes the Coral Sea stock is a self-recruiting and self-sustaining population. The second part deals with the historical catch and recovery potential of trochus in the Coral Sea.

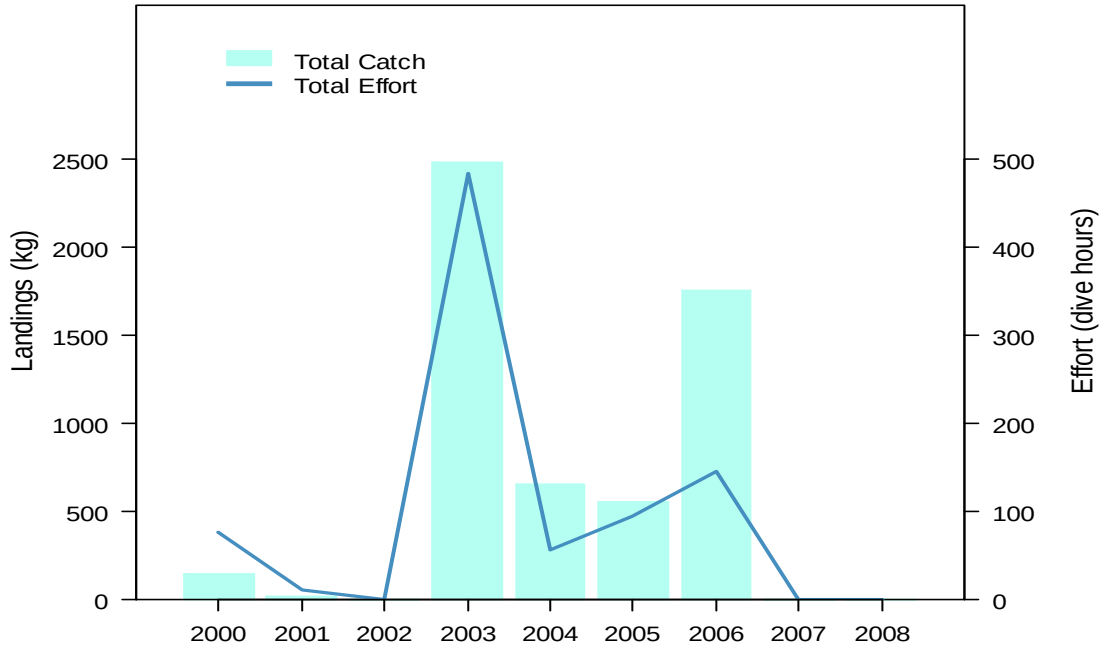
Tropical rock lobster

Catch and effort records from the Hand Collection Sector in the Coral Sea suggest that at least two species have been taken. Ornate rock lobster (*Panulirus ornatus*) has accounted for most of the total catch, with a smaller quantity of painted rock lobster (*P. versicolour*) recorded.

A number of authors (for example, Dennis et al. 2001; MacFarlane & Moore 1986) have suggested that most ornate rock lobster in the Coral Sea arrive from larval dispersal rather than migration. This has led to a commonly held view that ornate rock lobster in the Coral Sea can be regarded as a sink population within a larger stock that includes the Torres Strait. Whether ornate rock lobster in the Coral Sea are a sink population within the larger stock is a key question for management to consider, although it does not affect current status.

Total catch over the history of the fishery has been less than 10 tonnes and the highest annual catch was recorded in 2003 (2.5 tonnes; Figure 5.1).

Figure 5.1 Total annual catch and effort for tropical lobster in the Coral Sea Hand Collection Fishery



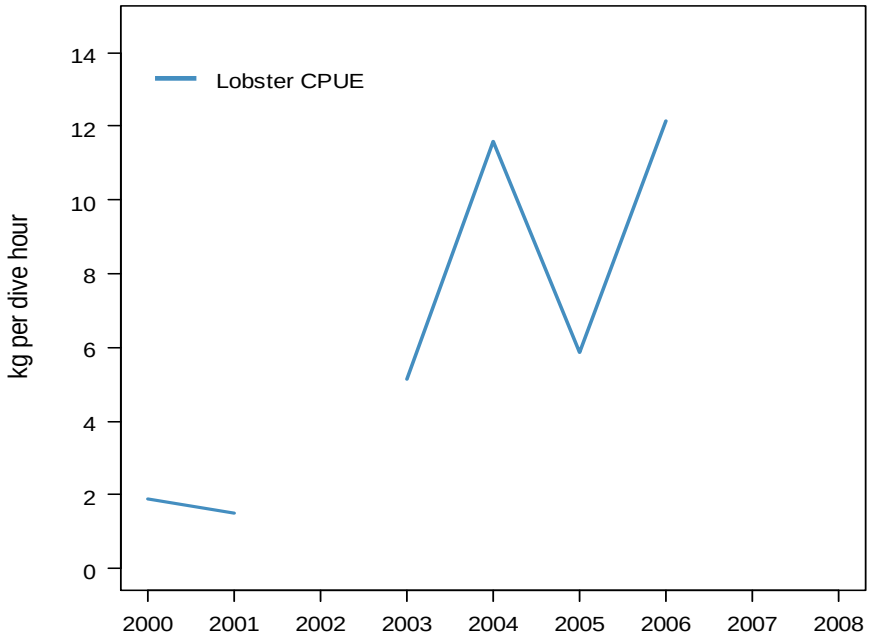
Source: Data from AFMA

Using geomorphological data provided by the Millennium Coral Reef Mapping Project (Andréfouët et al. 2005) shallow reef area in the Coral Sea is estimated to be greater than 1 million hectares (this estimate excludes Mellish Reef and Cato Island, which are not covered by the Millennium Reef Project).

Observed catch rates have varied from around 2 to 12 kilograms per dive hour (Figure 5.2). These catch rates are consistent with values for the Torres Strait reported in Chittleborough (1974), suggesting that densities in areas that have been fished in the Coral Sea are comparable with the areas surveyed in the Torres Strait. Ye and Dennis (2009) derived a standardised Tropical Rock Lobster Fishery CPUE timeseries for the Torres Strait Fishery taking fishing

power into account. They found this standardised CPUE timeseries to be roughly proportional to survey estimated densities.

Figure 5.2 Time series of unstandardised catch per unit effort for tropical rock lobster in the Coral Sea



Source: Data from AFMA

Calculation of population size to sustain maximum catch

Numerical values need to be assumed for some characteristics of the lobster population. ABARES assume values for natural mortality and target fishing mortality from the nearby Torres Strait rock lobster fishery, which harvests the same species. Plagányi et al. (2010) recommended a target fishing mortality (F_{MSY}) of 0.15 year^{-1}. Natural mortality was estimated to be 0.68 year^{-1}, and between 0.53 year^{-1} and 0.82 year^{-1} with 90 per cent confidence (Plagányi et al. 2010).

Given this information, a basic population model can be used to estimate the population size at the time of recruitment that would support the maximum observed catch for the target fishing mortality.

For a lobster population of size P_0 just after an assumed annual recruitment pulse, the population size at time t throughout the year (t measured in years), where M is natural mortality and F is fishing mortality, is given by:

$$P(t) = P_0 \, e^{-(M+F)t}$$

The average population size across the year is then:

$$\overline{P} = \int_{t=0}^{1} P_0 \, e^{-(M+F)t} dt = \frac{-P_0}{M+F}\left[e^{-(M+F)} - 1\right]$$

The total catch is equal to the average population size throughout the year multiplied by the fishing mortality.

$$F\overline{P} = \frac{-FP_0}{M+F}\left[e^{-(M+F)} - 1\right]$$

If we assume that the reduction in population size because of fishing mortality is equal to the number of individuals taken (reasonable for a hand collection fishery), we can write:

$$Catch = \frac{-FP_0}{M+F}\left[e^{-(M+F)} - 1\right] = \frac{FP_0}{M+F}\left[1 - e^{-(M+F)}\right]$$

The minimum initial population can be expressed in terms of annual catch, fishing mortality and natural mortality:

$$P_0^* = \frac{C(M+F)}{F\left(1-e^{-(M+F)}\right)}$$

According to logbook records from the Coral Sea Fishery Hand Collection Sector the maximum number of lobsters taken in a calendar year was 1 285 in 2003. If we estimate fishing mortality at F_{MSY} = 0.15 year^{-1}we can calculate a lobster population that would support the historic maximum catch, P^*_{MSY}

$$P^*_{MSY} = \frac{1285\ (0.68+0.15)}{0.15\left(1-e^{-(0.68+0.15)}\right)}$$

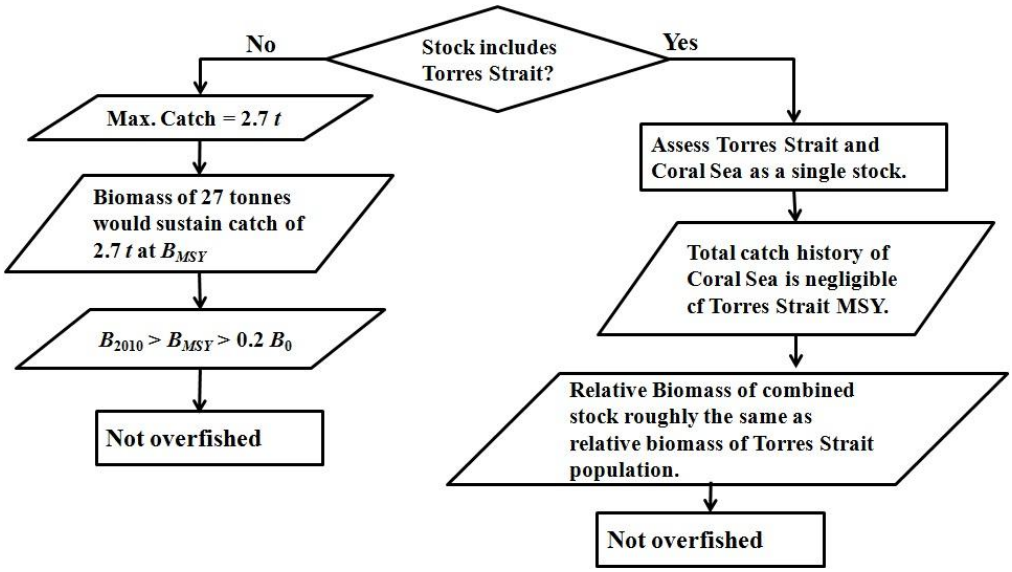
A few points should be mentioned about the calculated minimum population size. The calculation relies upon parameter estimates of M and F_{MSY} from a population in Torres Strait that is assumed to be distinct from the Coral Sea population. The assumed fishing mortality is applicable at the biomass associated with maximum sustainable yield rather than the unfished biomass. The low level of tropical lobster catch in the Coral Sea before 2003 (Figure 5.2) suggests that the Coral Sea population was likely to have been in an approximately unfished state in 2003. Plagányi et al. (2010) estimate that maximum sustainable yield for the Torres Strait tropical rock lobster stock occurs at a spawning stock biomass of roughly 80 per cent of unfished levels. Our simple calculation makes no distinction between the exploitable stock biomass (in terms of size) and total biomass and applies fishing mortality to the entire population for the entire year, so the figure is probably best considered as the population vulnerable to the fishery.

Based on the simple calculation, the virgin biomass required to support the historic maximum catch is around 12 700 individuals or 27 tonnes, which is the number of individuals multiplied by the mean weight of captured lobsters (2.15 kilograms) in the Coral Sea. If it was assumed that the figure of 12 700 individuals refers to the population size at maximum sustainable yield, the required unfished population vulnerable to the fishery would be 15 900 individuals or approximately 34 tonnes. Alternatively, given that the average catch in the Coral Sea has been considerably less than 1 285 individuals (2.7 tonnes) in most years, a one-off catch of this size might be treated as contributing to a fish down toward B_{MSY}.

Two scenarios were considered to assess the status of tropical lobster in the Coral Sea. The first scenario assumed that the Coral Sea population are part of a larger population with spawning grounds in the Torres Strait. The second scenario assumed that the Coral Sea population are a self-recruiting, self-sustaining population. A flowchart diagram of the Coral Sea lobster status

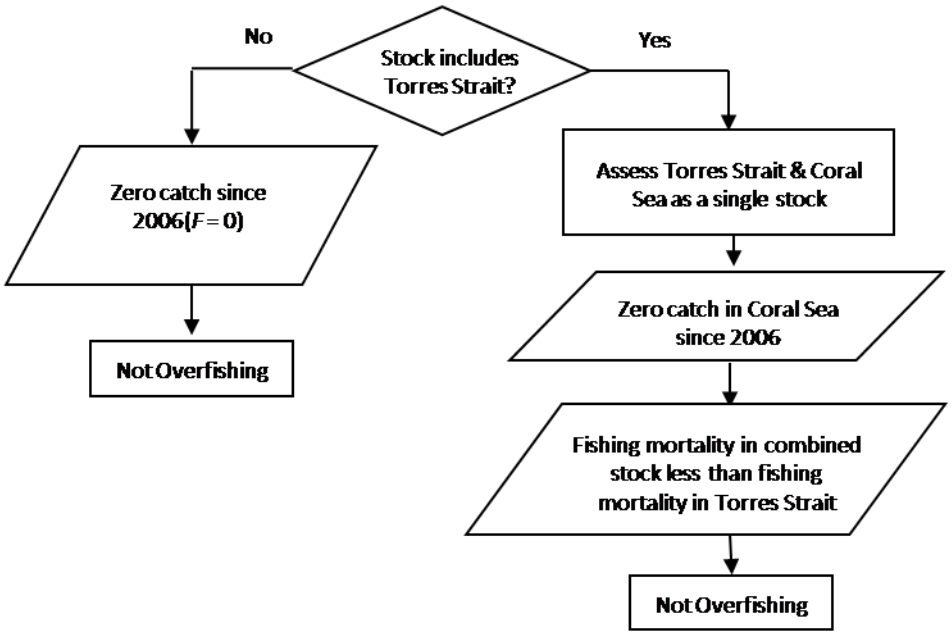
determination logic is given in Figure 5.3 for overfished status and Figure 5.4 for overfishing status.

Figure 5.3 Flowchart for tropical lobster overfished (biomass) status determination.



Source: ABARES

Figure 5.4 Flowchart for tropical lobster overfishing (fishing mortality) status determination



Source: ABARES

Under the assumption that the Coral Sea population is part of a larger population with spawning grounds in the Torres Strait, historical catch in the Coral Sea was found to be negligible compared with catch in the Torres Strait Rock Lobster Fishery. In this case, the current (2008) not overfished and not overfishing status of the Torres Strait Rock Lobster Fishery would also apply to the Coral Sea sub-population.

If the Coral Sea tropical rock lobster population is assumed to be self-recruiting, historical fishing has not been sufficient to cause substantial fishing mortality. Even under very precautionary criteria, a Coral Sea population of less than 16 000 individuals would be sufficient to sustain the highest recorded annual catch given productivity estimates for tropical rock lobster. Estimates of suitable Coral Sea habitat combined with observed catch rates would suggest that a self-recruiting population would be much larger than 16 000 individuals. The conclusion under the self-recruiting scenario is that the Coral Sea Rock Lobster Fishery is not overfished and not subject to overfishing.

Trochus

Logbooks record that trochus catch has been limited to 160 kilograms from a single reef in 2001. For a stock to be considered overfished their biomass should fall below 20 per cent (B_{20}) of the unfished abundance (biomass). For trochus to have been overfished in 2001, a Coral Sea trochus unfished biomass of less than 200 kilograms would be required. Trochus are a somewhat cryptic species (T Skewes, pers. comm., 2010). It is not plausible that a single trip in 2001 to one reef would have yielded more than 80 per cent of the trochus biomass in the Coral Sea.

For trochus to be classified as overfished in 2009, more than 80 per cent of unfished Coral Sea trochus biomass would have had to be taken in the single trip in 2001 and the standing stock biomass would need to be yet to recover to 40 kilograms (the equivalent of B_{20} if B_0 was 200 tonnes). This is also not plausible. As such, the trochus stock in the Coral Sea is not overfished. There has been no recorded trochus catch from the Coral Sea since 2001, so trochus is not subject to overfishing.

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