Chapter 20
Torres Strait Bêche-de-mer and Trochus fisheries

M Flood and D George

FIGURE 20.1 Area of the Torres Strait Bêche-de-mer and Trochus fisheries

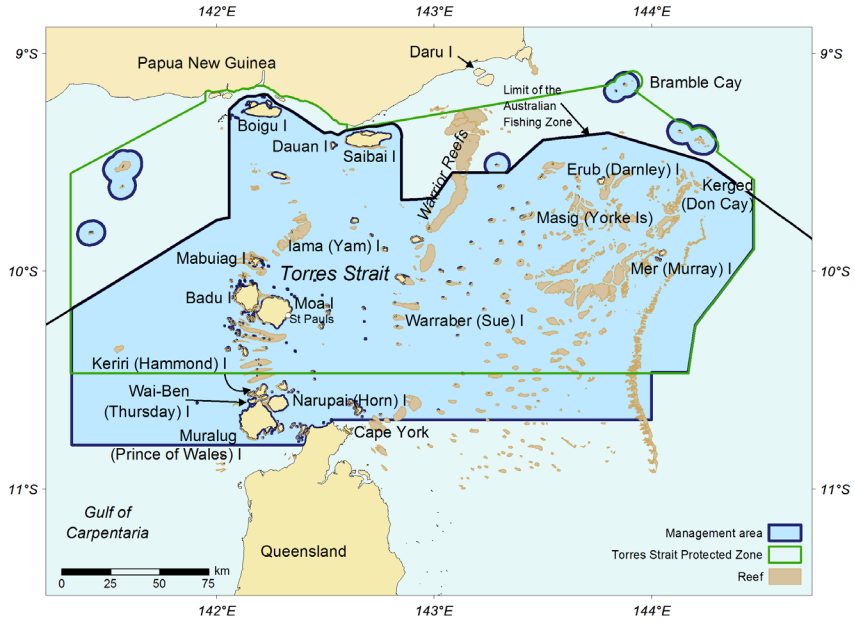


TABLE 20.1 Status of the Torres Strait Bêche-de-mer and Trochus fisheries

Status	2011		2012		Comments
Biological status	**Fishing mortality**	**Biomass**	**Fishing mortality**	**Biomass**	
Black teatfish (*Holothuria whitmaei*)					No recorded take in 2012. Recent survey indicates a recovered stock.
Prickly redfish (*Thelenota ananas*)					Catch is below TAC. Survey indicates relatively stable densities.
Sandfish (*Holothuria scabra*)					Two tonnes taken during experimental fishing in 2012. Most recent full survey indicated stock is still overfished.
White teatfish (*Holothuria fuscogilva*)					Catch slightly exceeded TAC. Survey indicates relatively stable densities.
Other sea cucumbers (up to 18 species)					Increased fishing effort and uncertainty regarding sustainability of current catch for some of the species caught. Uncertainty in historical catch for a number of species.
Trochus (*Trochus niloticus*)					No recorded take in 2012. Uncertain estimates of population size from most recent survey.
Economic status	The TAC for highly valued white teatfish was close to fully caught and indicates some level of positive NER. Some of this NER would have been captured by Traditional Inhabitant participants, meeting the fishery's management objective to develop stocks to benefit Traditional Inhabitants. There was no fishing in the TSTF.				

Notes: **NER** Net economic returns. **TAC** Total allowable catch. **TSBDMF** Torres Strait Bêche-de-mer Fishery. **TSTF** Torres Strait Trochus Fishery.

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

20.1 Description of the fishery

Participation in the Torres Strait Bêche-de-mer Fishery (TSBDMF) is limited to Traditional Inhabitants, with the exception of one long-term, non-traditional licence holder, who was active in the fishery before the introduction of limited entry in April 1999. Traditional Inhabitants who wish to fish commercially for bêche-de-mer (sea cucumber) are required to hold a Traditional Inhabitant Boat licence. Torres Strait Islanders are also entitled to take three sea cucumbers per person per day or six sea cucumbers per dinghy per day for personal use.

In total, 23 species of sea cucumber have been recorded in the Torres Strait. These vary in commercial value, and not all are targeted for commercial sale (Skewes et al. 2010). The fishery is highly selective, with fishers only permitted to collect animals by hand or using handheld non-mechanical implements. Fishing is usually conducted while free-diving from dinghies or reef-top walking. Following collection, sea cucumbers are processed for market, typically by gutting, cleaning, boiling, smoking and drying. Most of the catch is exported to China, and little (if any) is sold for domestic consumption (AFMA, pers. comm., 2013).

Historically, sandfish was a primary target species, with most fishing for this species occurring on the Warrior Reef complex (Figure 20.1). Fishing pressure led to a considerable decline in abundance of sandfish and the subsequent introduction of a zero total allowable catch (TAC) in 1998. Fishing effort then shifted to targeting black teatfish, and what was originally thought to be surf redfish (*Actinopyga mauritiana*) but is now understood to be primarily deepwater redfish (*A. echinites*) and blackfish species (*Actinopyga* spp.). The TACs for black teatfish and surf redfish were set to zero in 2003. Findings from the most recent survey of sea cucumbers in the Torres Strait (Skewes et al. 2010) indicate that surf redfish are unlikely to have ever occurred at high densities in the fishery. Although the stock is still allocated a zero TAC, this is now intended to reflect the low sustainable yield of the species, rather than the previously suspected overfished status (AFMA, pers. comm., 2012). Stocks are included in the status determination process if they are considered to be, or have historically been, key commercial species. Since surf redfish density is no longer believed to have been reduced by historical fishing pressure and is no longer considered to be a key commercial species in the fishery, the stock was removed from the status determination process in 2011.

Fishing activity has been relatively light in recent years, but increased in 2011 and again in 2012 with the introduction of a limited number of developmental permits to trial 'hookah' (surface-supplied underwater breathing apparatus) gear. The Papua New Guinea sea cucumber fishery (all species) was closed for three years from 2009, and this closure has since been extended for a further three years (AFMA, pers. comm., 2013). In 2012, the CSIRO ran a small experimental fishing trial on the Warrior Reef sandfish stock, during which just over 2 t of catch was removed from this otherwise closed fishery (Murphy et al. 2012). The most recent full-scale stock survey of the Torres Strait sandfish stock was conducted in 2010 (Murphy et al. 2011). Anecdotal reports of recent illegal, unreported and unregulated activity in Papua New Guinea waters were noted in papers provided to the most recent Torres Strait Hand Collectables Working Group meeting (AFMA 2012). However, ABARES has been unable to confirm the extent of these activities.

Participation in the Torres Strait Trochus Fishery (TSTF) is restricted to Traditional Inhabitants. Although this is currently a relatively small commercial fishery, it has been an important source of income for some Islanders. The mother-of-pearl layer of the shell is used mainly for buttons, jewellery and fashion accessories. Ground shell may be used in floor tiles, metallic paints and shampoo. The trochus meat may be a valuable source of protein for some Islanders (Murphy et al. 2010). Subsistence fishing for this species has occurred in the Torres Strait for centuries. There was no reported catch of trochus in 2011 or 2012, probably because of the current low price received for mother-of-pearl.

The Commonwealth Fisheries Harvest Strategy Policy (HSP; DAFF 2007) is not prescribed for fisheries jointly managed by the Australian Government and other (domestic or international) management agencies, such as the fisheries in the Torres Strait. Although the Torres Strait Protected Zone Joint Authority (PZJA) has asked its management forums to provide advice on the application of the HSP to the Torres Strait fisheries, currently no formal harvest strategies are in effect in Bêche-de-mer and Trochus fisheries. Several communities have drafted community-based harvest strategies, and a number of others have expressed interest in developing harvest strategies.

Prickly redfish
Tim Skewes, CSIRO

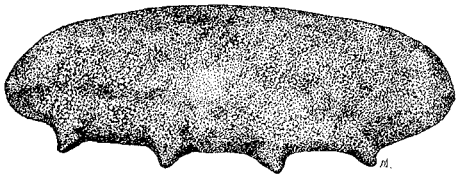
TABLE 20.2 Main features and statistics for the TSBDMF and TSTF

Fishery statistics a	2011			2012		
Stock	**TAC (t)**	**Catch (t)**	**Real value (2010–11)**	**TAC (t)**	**Catch (t)**	**Real value (2011–12)**
Black teatfish	0	0	0	0	0	na
Prickly redfish	20	9.9	na	20	1.0	na
Sandfish	0	0	0	0	2.1 **b**	na
White teatfish	15	14.6	na	15	15.7	na
Other sea cucumber species (18 species)	80	1	na	80	4.1 **c**	na
Trochus	150	0	0	150	0	na
Fishery-level statistics						
Effort (no. of sellers)	Bêche-de-mer: 2 Trochus: 0			Bêche-de-mer: 2 Trochus: 0		
Fishing permits (as at 30 June 2011)	Bêche-de-mer: 48 Trochus: 80			Bêche-de-mer: 59 Trochus: 68		
Active vessels	na			na		
Observer coverage	0			0		
Fishing methods	Hand collection—free-dive or reef walking, hookah under developmental permits					
Primary landing ports	Island processors and mobile product buyers					
Management methods Bêche-de-mer	Input controls: limited entry for non–Traditional Inhabitants, gear restrictions, vessel length restrictions Output controls: TACs, size limits					
Trochus	Input controls: limited entry, gear restrictions, vessel length restrictions Output controls: TACs, size limits					
Primary markets Bêche-de-mer	Domestic: minimal International: Asia—predominantly as a dried product; small amounts frozen or salted					
Trochus	Domestic: minimal International: historically, markets have included China, France, Germany, Italy, Japan, the Philippines, Spain, the United Kingdom, the United States and Thailand					
Management plan	No formal management plans					

a Fishery statistics are provided by fishing season, unless otherwise indicated. Fishing season is 1 January to 31 December. Real-value statistics are by financial year. Reported catch is understood to be gutted wet weight. **b** Catch taken during experimental fishing trial; the sandfish fishery remains closed. **c** Estimate does not include weight for 369 golden sandfish and 554 stonefish that were reported in numbers.
Notes: **na** Not available. **TAC** Total allowable catch.

20.2 Biological status

20.2.1 Black teatfish



Line drawing: FAO

Stock assessment

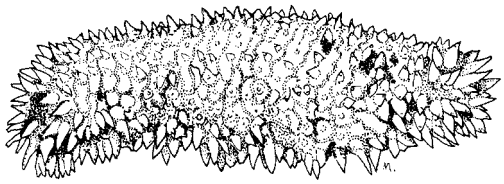
The Torres Strait black teatfish stock was last surveyed in 2009 (Skewes et al. 2010). This survey showed an increase in the mean density (from less than 1 individual per hectare to just over 10 individuals per hectare), mean length (an increase of almost 6 per cent) and mean weight (an increase of more than 11 per cent) of black teatfish, compared with the 2005 survey. However, there is considerable uncertainty around these mean estimates. In light of the increased densities and animal size, Skewes et al. (2010) recommended reopening the fishery for black teatfish with a TAC of 25 t. This would amount to an extraction rate of about 4 per cent of the lower 90th percentile of the standing stock estimate (estimated at 625 t). A separate study of black teatfish on the Great Barrier Reef had estimated that harvest rates of less than 5 per cent of the virgin biomass were likely to be sustainable (Uthicke et al. 2003).

The PZJA has not changed the zero TAC for this species. However, if a non-zero TAC were to be set, it would be likely to stimulate interest in the fishery. Mechanisms to effectively monitor catch and stop harvesting when the TAC has been reached will be important to ensuring the long-term sustainability of the fishery. Periodic surveys of the fishery should be continued to monitor the stock response to any increase in harvesting activity.

Stock status determination

There was a zero TAC for black teatfish in 2012 and no recorded catch. On this basis, the stock is classified as **not subject to overfishing**. Given the indications of recovery from the most recent survey, black teatfish is classified as **not overfished**.

20.2.2 Prickly redfish



Line drawing: FAO

Stock assessment

The Torres Strait prickly redfish stock was last surveyed in 2009 (Skewes et al. 2010). This survey indicated that densities had remained relatively stable across surveys in 1995, 2002, 2005 and 2009, ranging from 1.42 to 2.15 individuals per hectare. Between 2005 and 2009, the density increased from 1.44 to 1.99 individuals per hectare. The mean size of prickly redfish increased from 2147 g to 2812 g between 2005 and 2009. Although there is considerable uncertainty around these mean estimates, well-established and consistent methodologies have been used in the surveys.

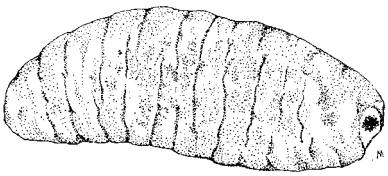
The current TAC for prickly redfish (20 t) is based on an estimate of maximum sustainable yield (MSY) using a biomass estimate from the 2002 survey (Skewes et al. 2004). MSY was estimated using a simplified surplus production scenario, assuming MSY = $0.2MB_0$, using the lower 90 per cent confidence interval of the 2002 estimate of standing stock (~343 t) as B_0 (M is natural mortality, B_0 is the unfished biomass, and 0.2 is the proportion of relative biomass at MSY). Following the 2002 survey of the eastern Torres Strait, Skewes et al. (2004) classified prickly redfish as 'exploited'. As a result of this classification, the MSY estimate was halved, generating the TAC of 20 t. The combination of using the lower 90 per cent confidence interval for biomass, the 0.2 scaling factor and the halving of the final MSY estimate, to allow for previous exploitation, resulted in a TAC that is considered to be conservative.

Stock status determination

Since the calculation of the TAC (in 2004), catches of prickly redfish have been recorded in 2004, 2007, 2010, 2011 and 2012. Reported catch[1] in all years was below the 20 t TAC, with the largest catch (9.9 t) being taken in 2011. Densities, lengths and weights of prickly redfish remained relatively stable between 1995 and 2009, and the stock was not considered to be overexploited at the time of the 2002 survey (Skewes et al. 2004). As a result, the stock is classified as **not overfished** and **not subject to overfishing**.

1 Reported catches of sea cucumbers are understood to be gutted wet weight.

20.2.3 Sandfish



Line drawing: FAO

Stock assessment

The Torres Strait sandfish stock was last surveyed in 2010 (Murphy et al. 2011). Results from this survey indicated that the mean density (± standard error [SE])—94 ± 50 sandfish per hectare—was similar to that in 2004 (94 ± 25 sandfish per hectare), suggesting that there had been no recovery up to the time of the 2010 survey. Survey densities were around 80 per cent lower than in 1995, at which time the stock was already considered to be depleted. The reason for the lack of observable recovery of sandfish between 1998 and 2010 is not clear, given that the fishery has been closed since 1998. Murphy et al. (2011) suggested several possible causes, including illegal fishing and poor recruitment. Illegal fishing by Papua New Guinea fishers is understood to have occurred in the Torres Strait until 2009 (Skewes et al. 2010). There have been anecdotal reports of recent illegal fishing on the Papua New Guinea side of Warrior Reef (AFMA 2012). Since sandfish on Warrior Reef is likely to be one stock, it is possible that catch of sandfish in Papua New Guinea waters could have an impact on recovery of the species. However, ABARES has been unable to confirm the extent of any catch in these waters. As a result, such reports do not inform status determination in 2012.

With respect to recruitment, it has been hypothesised that the relatively low density of sandfish remaining on Warrior Reef may have reduced fertilisation success, because individuals are widely dispersed (Murphy et al. 2011). Murphy et al. (2011) also noted that sandfish can burrow into the sand, making them difficult for survey observers to see. However, the authors consider that it is unlikely that the proportion of buried sandfish would have differed from one survey to the next, because the sampling methodology was specifically designed for sandfish. All surveys sampled the same sites during the same season, lunar phase, tide and time of day, providing confidence in comparisons of density between years. As a result, low density estimates in recent surveys are likely to indicate actual low density, rather than underestimates resulting from increased proportions of buried sandfish.

In 2012, CSIRO and the Australian Fisheries Management Authority (AFMA) conducted a small-scale experimental fishing trial of the Warrior Reef sandfish stock (Murphy et al. 2012). Methodology differed significantly from that used in previous surveys. Differences included sampling at different locations[2] from the previous surveys (only three previous sites were included), the walking of random search tracks rather than straight-line transects and choosing fishing areas of known high density (see Murphy et al. 2012). In previous survey reports, the authors emphasised the importance of sampling at the same sites (at the same lunar phase, tide and time of day) from one survey to the next to allow for repeated measures statistical analysis of data (e.g. Murphy et al. 2010). Given the methodological differences, caution should be used when comparing the 2012 work and previous surveys—although the findings of the study indicate that the density, biomass and size frequency of the stock have improved, it is unclear whether these data represent real improvements in the stock or artefacts of the different experimental design. The stock status determination provided here therefore continues to rely on the findings of the most recent full-scale sandfish survey described above (Murphy et al. 2010).

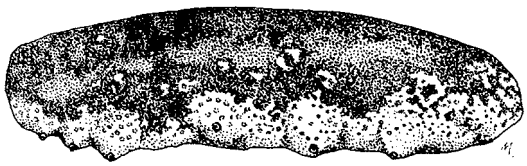
Management recommendations made by the authors of the fishing trial included a staged reopening of the sandfish Warrior Reef fishery through either (a) a series of annual experimental fishing exercises undertaken by Islander fishers, with increasing (but still conservative) TACs that are set on a catch and review basis, with scientific observations to slowly move to a sustainable catch; or (b) once stock has reached 50 per cent of virgin biomass (confirmed by a full-scale stock survey), a full reopening of the fishery. ABARES recommends that any decision to reopen this fishery should be based on a scientifically robust full-scale stock survey, maintaining previous experimental methodology to ensure that meaningful conclusions can be drawn about any potential stock recovery.

Stock status determination

Sandfish has been subject to a zero TAC since 1998. Although there was 2.1 t of reported catch of sandfish in the Torres Strait in 2012 (taken during the experimental fishing trial discussed above), this level of catch was considered to pose a low risk to the stock biomass estimated in the 2010 survey (Murphy et al. 2012). As a result, sandfish in the Torres Strait is classified as **not subject to overfishing**. Since no recovery in overall density has been observed between the full-scale surveys carried out in 2004 and 2010, the stock remains classified as **overfished**.

2 The term 'location' is used in the 2012 experimental fishing trial rather than 'site'. These locations were data logger tracks that indicated where experimental fishing occurred. They were labelled 'locations' rather than 'sites' because they were not generally separated by 500 m, a characteristic of the 'sites' used in previous full-scale stock surveys. Locations were chosen by individual fishers, rather than being specified by experimental design. A total of 37 locations were fished; 14 of these were adjacent to 3 sites surveyed for sandfish in previous years (N Murphy, CSIRO, pers. comm., 2013,).

20.2.4 White teatfish



Line drawing: FAO

Stock assessment

The Torres Strait white teatfish stock was last surveyed in 2009 (Skewes et al. 2010). The results of this survey indicate that white teatfish have maintained relatively stable or increasing densities across surveys in 1995, 2002 and 2005, with mean density (±SE) increasing from 0.47 (±0.20) to 0.85 (±0.43) individuals per hectare between 2005 and 2009 (Skewes et al. 2010). Between 2005 and 2009, mean weight increased from 2341 g to 2736 g, and mean length increased from 276 mm to 296 mm, although there is considerable uncertainty around these estimates.

The 2009 survey estimated the standing stock biomass of white teatfish to be 110 t. However, it is likely that the survey underestimated the population size of the species as a result of the 20 m limit on diving depth for survey operations. White teatfish are known to occur at depths of more than 40 m, and previous research indicates that the majority inhabit waters deeper than 20 m (SPC 1994). Furthermore, the northern Don Cay region (Figure 20.1) was not included in the survey, potentially contributing to the underestimate of stock size. Past surveys may also have underestimated abundance and biomass. However, the deeper depth preference of white teatfish is likely to have offered the species some protection, given the historical restrictions on the use of breathing apparatus in this fishery.

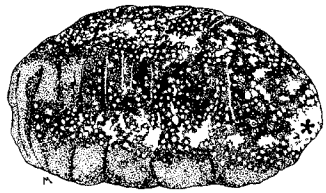
The TAC of 15 t for white teatfish is based on an estimate of MSY calculated using a biomass estimate of 156 t from the 2002 surveys (see Section 20.2.2 for methodology). Before 2011, the total reported catch was less than 400 kg. Catch in 2011 increased to 14 609 kg as a result of developmental permits issued to trial hookah gear, and increased again in the 2012 fishing season to 15 667 kg.

Stock status determination

The reported catch of white teatfish in 2012 was 667 kg over the 15 t TAC. This additional catch is unlikely to have lasting negative effects on the stock given the historical undercatch and the likelihood that previous estimates of biomass have been underestimates due to depth preferences of the species. This stock is therefore classified as **not subject to overfishing**. However, the overcatch emphasises the need to implement mechanisms to effectively monitor catch in real time and to stop harvesting when the TAC has been reached. This will be important to ensure the long-term sustainability of the fishery. It may also be worth considering provisions for carryover of undercatch/overcatch, such as applied in other TAC-managed fisheries, to ensure that overall catches better reflect TACs over time.

The relatively stable densities, mean weight and length from the surveys indicate that the portion of stock that could have been accessed by the fishery (both fishing and surveys did not cover the full depth range of the species) was likely to be stable. On this basis, this stock is classified as **not overfished**.

20.2.5 Other sea cucumber (18 species)



Line drawing: FAO

Stock assessment

The 'other sea cucumber' multispecies stock in the Torres Strait comprises about 18 species. No quantitative stock assessments have been conducted for any of these species. However, many of the species within this basket group have been included in previous surveys of sea cucumbers in the Torres Strait (1995, 2002, 2005 and 2009). The results of the 2002 survey were used to estimate MSYs, and subsequently TACs, for 15 species from this basket group (Skewes et al. 2004).[3] For species considered to be 'unexploited', the recommended TAC was equal to the estimate of MSY; for species considered 'exploited', the recommended TAC was half of MSY; and for species considered 'overexploited' or with MSY estimates less than 10 t, zero TACs were recommended. These analyses were updated in Skewes et al. (2006). Because of the multispecies nature of this stock, the PZJA established an 80 t TAC for all of these species combined, although this TAC is not biologically meaningful at the species level.

Reported catch for species in this basket in 2012 was 4.1 t, comprising 1.7 t of blackfish species (*Actinopyga* spp.) and 2.4 t of deepwater redfish (*Actinopyga echinites*). Reported catch also included 554 individual stonefish (*Actinopyga lecanora*) and 369 individual golden sandfish (*Holothuria lessoni*), for which weights were not recorded.

The Torres Strait deepwater redfish stock was last surveyed in 2009 (Skewes et al. 2010). Although there is considerable uncertainty around the mean estimates, the results of the survey indicated that the average density of deepwater redfish was several times greater in 2009 (mean ± SE: 1.55 ± 0.89) than in 2002 (0.42 ± 0.25) and 2005 (0.59 ± 0.59), following a large decline after 1995 (3.13 ± 1.29). The authors linked the initial decline with high fishing pressure between 1996 and 2001. Before the 2009 survey, Skewes et al. (2006) estimated the TAC of deepwater redfish to be 0 t, based on the survey results from 2002, having classified the stock at the time as 'exploited' and with a 5.9 t lower 90th percentile estimate of biomass. Skewes et al. (2010) updated the recommended TAC to 25 t, representing approximately 10 per cent of the updated biomass estimate of 245 t. The lower 90th percentile for deepwater redfish resulting from the most recent survey (2009) was 76.2 t. The 2012 catch was well under the amended 25 t TAC of deepwater redfish and only about 3.2 per cent of the lower 90th percentile estimate for biomass.

3 See section 20.2.2 for methodology for calculating MSY and TAC.

Three species of blackfish make up the blackfish catch from the Torres Strait: hairy blackfish (*Actinopyga miliaris*), deepwater blackfish (*A. spinea*) and burrowing blackfish (*A. palauensis*). In 2012, species-specific catch was not recorded. However, the most recent survey (Skewes et al. 2010) indicates that most of the blackfish catch taken from this fishery is likely to be hairy blackfish. The density trend information for this species is very uncertain (Skewes et al. 2010). Skewes et al. (2006) estimated the MSY for hairy blackfish at 1.5 t, classifying the stock as 'exploited' and recommending a 0 t TAC for the species, based on survey results from 2002. The lower 90th percentile for hairy blackfish at that time (2004) was estimated to be 9.6 t.

Biomass estimates are not available for deepwater blackfish or burrowing blackfish. Skewes et al. (2010) estimated the lower 90th percentile for hairy blackfish in 2009 to be 0 t and recommended a 5 t TAC for all three species of blackfish combined. Although this TAC does not appear to be biologically appropriate, it was recommended by the authors as a way to facilitate the collection of spatial catch data, and provide information on the range and species mix of the blackfish species group (Skewes et al. 2010). Since catch information for these species in 2012 is provided with no breakdown by species, the aims of determining range and species mix are not currently being achieved.

Skewes et al. (2004, 2006) estimated the MSY for stonefish at 0 t, classifying the stock as 'unknown' and recommending a 0 t TAC. During the 2002 survey (Skewes et al. 2004), the stonefish density was estimated at 0.05 ± 0.04 (mean ± SE) individuals per hectare. No stonefish were observed in the 2004 survey (Skewes et al. 2006) or the 2009 survey (Skewes et al. 2010). The lack of stonefish observed during surveys was attributed to the species being mostly found in the central Torres Strait, outside the study area (Skewes et al. 2010). The weights of the 554 individual stonefish reported in 2012 were not recorded. Data describing typical weights of stonefish from the Torres Strait are scarce. The only stonefish that was observed in the 2002 survey weighed 575 g whole wet weight (Skewes et al. 2004). More data are available for the Queensland East Coast Fishery, where the average weight of individuals was estimated at 254 g, and the maximum weight at 651 g (gutted wet weights; T Skewes, CSIRO, pers. comm., 2013). Using these data, the 554 individuals recorded for 2012 could have a maximum of 361 kg gutted wet weight.

Similar information to that provided for the three species above is not available for golden sandfish. None of the recent Torres Strait sea cucumber surveys have reported on this species. As with stonefish, the weights of the 369 individual golden sandfish caught in 2012 were not recorded. No data are available on the typical weights of individuals of this species in the Torres Strait, but data are available from the Queensland East Coast Fishery, where the average weight of individuals was estimated at 753 g and the maximum weight at 1950 g (gutted wet weights; T Skewes, pers. comm., 2013). Using these data, the 369 individuals recorded for 2012 could have a maximum gutted wet weight of around 720 kg.

Stock status determination

The reported catch of deepwater redfish in 2012 was below the most recent TAC recommended for this species and only a small proportion of the biomass estimate from the most recent survey (Skewes et al. 2010). As a result, this species is considered not subject to overfishing in 2012.

The combined TAC for the three species of blackfish in the Torres Strait was set at 5 t. It is uncertain whether this TAC is biologically appropriate for all species in this multispecies fishery, given the previous recommendation that the TAC for hairy blackfish should be set at zero and acknowledgement by the authors of the 2009 survey that the population density trend information for blackfish is very uncertain (Skewes et al. 2010). Although the reported catch in 2012 was only 1.7 t, these combined species should be considered uncertain if subject to overfishing in 2012 because of the concerns regarding any catch of hairy blackfish and the escalating fishing effort in 2011 and 2012.

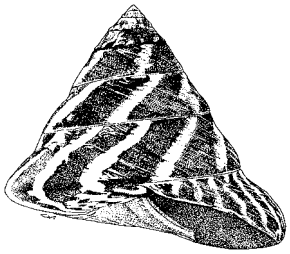
Catch disposal records indicate that the total wet gutted landed weight of stonefish was unlikely to exceed 361 kg. The 2002 survey recommended a zero TAC for stonefish. Despite the 2012 catch being above the recommended TAC, the uncertainty around estimates of the size of this stock in the Torres Strait would result in the stonefish stock being classified as uncertain if subject to overfishing.

To ABARES's knowledge, the 2012 fishing season was only the second season in the past decade with reported catch for golden sandfish. The first season with catch in this period was 2011. The catch reported in 2012 (unlikely to exceed 361 kg) is higher than that recorded in 2011 (37 kg). This stock was not discussed in the 2002, 2004 or 2009 survey reports, and therefore it is not possible to reliably estimate the current biomass or to recommend a biologically meaningful TAC for the species. Given the lack of research recommendations on the management of this species, the effect of the 2012 catch on the available biomass is unclear. As a result, golden sandfish would be classified as uncertain if subject to overfishing.

Up to 6 species from this 'other sea cucumber' stock of 18 species were caught in 2012. The biomass status of a number of species in the basket is uncertain. Redfish and blackfish species may not have been correctly identified in historical catch records and surveys. It is thought that what has previously been recorded as surf redfish is likely to be mostly deepwater redfish, with some blackfish (Skewes et al. 2010). Because catches reported as surf redfish were relatively high, the impact on the redfish and blackfish species that are likely to have contributed to the catch is difficult to quantify. Skewes et al. (2010) indicate that it is difficult to recommend a catch level for hairy blackfish because of the uncertainty in estimates of density and population size from recent surveys; however, a TAC of 5 t was recommended for the blackfish group. A 5 t catch trigger was recommended for all other species not subject to species-specific TACs.

Therefore, while some species that make up this stock were considered to be at, or near, pre-fished biomass levels in 2009 (Skewes et al. 2010), the uncertain density and population sizes for a number of species (relative to pre-fished levels) leads to an **uncertain** biomass classification for the multispecies stock as a whole. As outlined above, blackfish, stonefish or golden sandfish would be considered uncertain if subject to overfishing in 2012, while deepwater redfish would be considered not subject to overfishing. Given the uncertainty in classification for three species from this basket stock, the entire stock is classified as **uncertain** if subject to overfishing.

20.2.6 Trochus



Line drawing: FAO

Stock assessment

Trochus was surveyed in the Torres Strait in 1995, 2002, 2005 and 2009, mostly in combination with surveys of broadscale marine resources or sea cucumbers. The 2009 survey sampled 113 sites (11 specifically for trochus) over 10 days. Only 73 trochus were found at 12 sites. The survey transects sampled to a depth of 20 m, but trochus were only found to a depth of 3 m. Murphy et al. (2010) suggest that the low numbers and often complete absence of trochus may be indicative of the cryptic and patchy distribution of this species. The average density was estimated at 25 trochus per hectare (lower 90th percentile: 5 individuals per hectare), and the standing stock estimate was 634 t in 2009 (lower 90th percentile: 138 t). The density of trochus in 2009 was similar to that observed in 1995, and the authors suggest that it was comparable with unfished stocks in other South Pacific locations.

Despite the well-established and repeated methodology used in the surveys, the reliability of the estimates of density and standing stock are uncertain because of the low number of sites at which trochus was found (only 12 of 113 sites), the low total number of trochus observed (73) and high variability around mean estimates of abundance. Murphy et al. (2010) concluded that the density estimates had very low precision, and that there was low probability of detecting even large changes in trochus density.

The current TAC for trochus in the Torres Strait is 150 t, but there is no robust basis for this TAC (Murphy et al. 2010). Murphy et al. (2010) recommended setting a trigger catch level of 75 t (live shell weight), based on historical information, anecdotal harvest patterns and a 20 per cent exploitation rate of the estimated standing stock biomass. It was recommended that the TAC should be reassessed and a stock assessment undertaken if catches exceeded this level. The 75 t trigger level is more conservative than the 150 t TAC. However, given the uncertainties in the estimates of density, further caution is probably justified.

Stock status determination

There was no reported catch of trochus in 2012. As a result, the stock is classified as **not subject to overfishing**. Given the long history of fishing for trochus in the Torres Strait (pre-European settlement; DPIE 1994), the pre-fished biomass is unknown. Furthermore, the 2009 survey results are uncertain. As a result, this stock is classified as **uncertain** with regard to the level of biomass.

20.3 Economic status

20.3.1 Key economic trends

Following three years of minimal catch in the TSBDMF, total catch increased substantially in 2011, driven by relatively large catches of white teatfish and prickly redfish. Catch decreased slightly in 2012, with a reduction in catch of prickly redfish. The TAC for white teatfish was close to fully caught in 2011 and slightly overcaught in 2012, suggesting that a profitable fishery may be developing around this species. With no catch reported in the TSTF in 2012 or 2011, net economic returns (NER) in 2011–12 and 2010–11 would have been close to zero. Estimates of gross value of production are not available for either fishery.

20.3.2 Management arrangements

Both the TSBDMF and the TSTF are currently managed under TACs, together with a range of input controls. For the TSBDMF, only the TAC for white teatfish appears to be constraining catch. For the TSTF, no catch has been recorded in the fishery in the past two seasons, suggesting that it is not a profitable fishery in the current environment.

The trial of hookah gear in the TSBDMF has contributed to the recent increase in catch. This is likely to have been associated with increased NER. The use of hookah gear would be expected to enable collectors to access species that cannot be reached through free-diving and may be a more efficient harvesting method. If this is the case, allowing this method may generate higher NER in the Torres Strait.

20.3.3 Performance against economic objective

The HSP is not prescribed for Torres Strait fisheries, and there are no explicit economic targets for the TSBDMF or the TSTF. For the TSBDMF, the PZJA aims to provide for the sustainable use of the resource, develop stocks for the benefit of Australian Traditional Inhabitants and develop a long-term strategy for sandfish (PZJA 2012). The trial of hookah gear appears to have generated increased activity in the TSBDMF, which is likely to have flow-on benefits for Traditional Inhabitants. Rebuilding the sandfish stock should increase the potential benefits to local communities from the fishery.

For the TSTF, the PZJA aims to make best use of the resource, maximise opportunities for the Traditional Inhabitants and encourage participation in the fishery (PZJA 2012). Expectations of low economic returns are likely to have contributed to low participation in the fishery.

20.4 Environmental status

The TSBDMF was assessed against Parts 13 and 13A of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 16 June 2011. Recommendations that accompanied the approval include that the PZJA implement strategies to improve estimates of community harvest, progress with developing harvest strategies and performance measures and responses, continue to pursue opportunities for further research, and develop complementary management arrangements for stocks across fisheries and across jurisdictions.

The TSTF was assessed against Part 13 and 13A of the EPBC Act on 5 October 2012. Recommendations that accompanied the approval include that the PZJA implement strategies to improve estimates of all fishery-related removals from the TSTF, review the fishery-dependent data collection processes on a regular basis, review and consider implementing management measures proposed in the CSIRO report by Murphy et al. (2010), investigate methods to improve stock estimates and review stock assessments on a regular basis.

No ecological risk assessments have been conducted for the TSBDMF or the TSTF. The most recent assessments of the TSBDMF (DSEWPaC 2011) and the TSTF (DSEWPaC 2012) assume that impacts on the ecosystem of each fishery would be restricted to exploitation of target species; translocation of species via anchor and hull fouling; and impacts on reef ecosystems related to anchoring, mooring and other anthropogenic activities, such as reef-top walking.

AFMA publishes quarterly reports of logbook interactions with threatened, endangered and protected species on its website. There were no reported interactions in the TSBDMF or the TSTF in 2012.

Sandfish
Tim Skewes, CSIRO

20.5 Literature cited

AFMA (Australian Fisheries Management Authority) 2012, Agenda item 5.1—Foreign compliance update, Torres Strait Hand Collectable Working Group meeting no. 6, AFMA, Thursday Island.

DAFF (Australian Government Department of Agriculture, Fisheries and Forestry) 2007, *Commonwealth Fisheries Harvest Strategy: policy and guidelines*, DAFF, Canberra.

DPIE (Australian Government Department of Primary Industries and Energy) 1994, *Fisheries and marine research in Torres Strait*, Bureau of Resource Sciences, DPIE, Canberra.

DSEWPaC (Australian Government Department of Sustainability, Environment, Water, Population and Communities) 2011, *Assessment of the Torres Strait Bêche-de-mer Fishery*, DSEWPaC, Canberra.

——2012, *Assessment of the Torres Strait Trochus Fishery*, DSEWPaC, Canberra.

Murphy, NE, McLeod, I, Skewes, TD, Dovers, E, Burridge, C & Rochester, W 2010, *Torres Strait hand collectables, 2009 survey: trochus*, CSIRO Marine and Atmospheric Research, Cleveland, Queensland.

——, Skewes, T, Filewood, F, David, C, Seden, P & Jones, A 2011, *The recovery of the* Holothuria scabra *(sandfish) population on Warrior Reef, Torres Strait*, final report to AFMA, CSIRO Marine and Atmospheric Research, Cleveland, Queensland.

——, Skewes, TD, Dovers, E & Leatherbarrow, A 2012, *Assessing stock recovery using experimental fishing for sandfish on Warrior Reef, Torres Strait*, final report, CSIRO, Dutton Park, Queensland.

PZJA (Protected Zone Joint Authority) 2012, *Torres Strait Trochus Fishery*, <http://pzja.gov.au/the-fisheries/torres-strait-trochus-fishery>.

Skewes, T, Dennis, DM, Koutsoukos, A, Haywood, M, Wassenberg, T & Austin, M 2004, *Stock survey and sustainable harvest strategies for Torres Strait bêche-de-mer,* AFMA project R01/1345, CSIRO Marine and Atmospheric Research, Cleveland, Queensland.

——, Taylor, S, Dennis, D, Haywood, M & Donovan, A 2006, *Sustainability assessment of the Torres Strait sea cucumber fishery*, CRC TS project task T1.4, final report, CSIRO Marine and Atmospheric Research, Cleveland, Queensland.

——, Murphy, NE, McLeod, I, Dovers, E, Burridge, C & Rochester, W 2010, *Torres Strait hand collectables, 2009 survey: sea cucumber*, CSIRO Marine and Atmospheric Research, Cleveland, Queensland.

SPC (Secretariat of the Pacific Community) 1994, *Sea cucumbers and bêche-de-mer of the tropical Pacific: a handbook for fishers*, handbook 18, SPC, Noumea.

Uthicke, S, Welch, D & Benzie, JAH 2003, 'Slow growth and lack of recovery in overfished holothurians on the Great Barrier Reef: evidence from DNA fingerprints and repeated large-scale surveys', *Conservation Biology*, vol. 18, pp. 1395–404.