A preliminary report on the adequacy of protection provided to species and benthic habitats in the east coast otter trawl fishery by the current system of closures.

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Summary

There is a complex system of spatial closures in the Great Barrier Reef World Heritage Area (GBRWHA) and since the Great Barrier Reef Marine Park Representative Areas Program of 2004 there have been considerable reductions in available fishing area.

The Queensland East Coast Otter Trawl Fishery (ECOTF) effort in the GBRWHA is highly clumped and trends in distribution of trawl effort shown by the Vessel Monitoring System (VMS) data suggest the location of the main fishing grounds where most fishing effort is expended have not changed markedly between 2002 and 2005.

Information now available (on seabed biodiversity, seagrass distribution, distribution of turtle and dugong populations and interactions with populations of other marine species of conservation concern), suggest the recent changes to the area available for trawling, reduction in effort, implementation of gear restrictions, and other fishing regulations have reduced the impact of trawling on marine habitats and marine ecosystems. While fishing effort remains in its present locations and at current levels, there does not seem to be a strong case for additional spatial closures in the GBRWHA.

The ECOTF to the south of the GBRWHA also operates on only a small fraction (less than 10% of 6 minute grid cells trawled greater than 5 hours per year) of the permitted area. Similar to the GBRWHA there are complex spatial and temporal closures in place and closures to protect life stages of target and non-target species susceptible to impacts from trawling. There are also specific closure arrangements in Moreton Bay and the Great Sandy Strait Marine Park to protect juvenile prawns and to protect nesting sea turtles. It would be difficult to support a case for additional closures south of the GBRWHA based on the present information.

There are problems of scale and precision in overlaying the existing VMS and CFISH (logbook) data sets on fishing location, and catch and effort with the spatial seabed and benthic biota research data that makes these data sets difficult to compare.

At the scale of the data available it is not possible to separate out locations where “hot spots” of regulated byproduct species may occur on trawl grounds and to implement spatial closures at a fine scale. These species are widely distributed across the fishing ground

Targeted, independent observations of trawl catch and bycatch composition and actual catch location by QDPI&F onboard observers is likely to be the most feasible method of obtaining fine scale spatial data to improve our understanding of any risk to sustainability of non-target species in the fishery if that is required.

Introduction

The Queensland East Coast Otter Trawl Fishery (ECOTF) operates in coastal (tidal waters excluding estuaries) waters of Queensland east of 142^{o}31.89'E between Cape York in the north and the New South Wales Border in the south. The fishery targets mainly penaeid prawns and scallops with incidental catches of byproduct species including bugs, pinkies, barking crayfish (champagne lobsters) and mantis shrimp (Annual Status Report – East Coast Trawl Fishery 2006).

Vessels carry a variety of fishing gear using as many as four nets depending on the location and the species being targeted. The total amount of net is regulated by the Fisheries (East Coast Trawl) Management Plan 1999 (Trawl Plan). Regardless of the configuration, all nets use an otter board to spread the nets and these are set so the spread of the net and the amount of contact it has with the bottom suit the fishing conditions.

While fishers avoid areas of "rough" ground (where there is complex bottom topography) to minimise damage to nets and set nets to skim across the bottom rather than "bogging" in bottom sediments, inevitably there is some interaction between nets and benthic marine structures. There has been extensive research on the effect of trawling on reef bottom types in tropical north Queensland (Pitcher et al. 2000) and the likelihood of otter trawlers interacting with seagrass meadows within the Great Barrier Reef World Heritage Area (GBRWHA) has been reported as part of the Cooperative Research Centre (CRC) and Marine and Tropical Sciences Research Facility programs (Coles et al. 2007).

The effects of otter trawling on benthic communities can be influenced or reduced by modifications to gear type and deployment, reductions in overall effort in the fishery, restrictions on areas open to trawling, reductions in the amount of time any one location is fished, and/or a combination of these factors. The distribution of effort and spatial and temporal restrictions is highly correlated and if poorly implemented can increase fishing effort in some locations at the expense of others as fishers respond to changing circumstances. Nevertheless limiting the location of fishing effort is a powerful tool when there is sufficient information on the type and complexity (biodiversity) of benthic communities warranting enhanced protection by spatial arrangements.

Two programs of the CRC Reef Research Centre, the deep water seagrass mapping project and the seabed biodiversity project have modelled, based on transect and point source data and GBRWHA wide biophysical data sets, probability gradients of benthic communities and more abundant individual taxa / species. This enables an estimation of the exposure of benthic communities and species (at least in the GBRWHA) to potential impacts from otter trawl nets. A research program to characterise seabed biodiversity is being planned for the area of the fishery south of the GBRWHA (J Kirkwood, DPI&F pers comm.).

Recognising this advance in knowledge of the benthic communities of Queensland's east coast the Commonwealth Government as part of its assessment of the ecological sustainability of management arrangements for the ECOTF (under Parts 13 and 13a of the *Environment Protection and Biodiversity Conservation Act* 1999) made a recommendation to the DPI&F in 2004 as part of a Wildlife Trade Operation approval : *Initiate a review and provide a preliminary report on the adequacy of protection provided to species and benthic habitats in the east coast otter trawl fishery by the current system of closures within and outside the Great Barrier Reef Marine Park and whether additional closures are required outside the marine park.*

This report addresses that requirement.

Data sets available for a review and preliminary report

The data sets can be grouped into five categories:

1. **Spatial information on closures to trawling, changes in closures to trawling due to rezoning and temporal spatial closures to trawling:** The data is current to 2007 in a vector shapefile format and includes:
    - State and Commonwealth marine park locations, (Map 1). Trawling is only permitted in "General Use" (light blue) zones.
    - Spatial closures to trawling in the GBRWHA before and after the 2004 Representative Areas program (RAP) rezoning, (Maps 2 and 3). These maps demonstrate the significant increase in permanent spatial closures throughout the GBRWHA.
    - Areas permanently closed to trawling south of the GBRWHA (Map 4)
    - The Great Sandy Strait Marine Park zoning plan, Map 17.
    - Seasonal closures implemented to achieve specific management outcomes eg effort reduction for part of the year, replenishment of scallop grounds and to reduce any potential social conflicts with other users (e.g. closure to daylight and weekend trawling), (Map 5).

2. **Modelled trawl effort data in grid cells approximately 1km^2 in area from Vessel monitoring system (VMS) position polling data (data is only available for 2002 – 2005)):** These corrected and interpolated data with known non-fishing locations and times removed are presented as individual effort distributions (hours per cell per year) for each year in the 2002 to 2005 time series, (Maps 6-9)..

3. **Data on effort and retained catch from the fishing log books and held in the QDPI&F CFISH data base (locations of maximum nightly catch estimated by fishers):** These data are distributions of total annual trawl effort (days per cell per year) (Maps 10-14). Data for the 2002 to 2006 effort years are recorded by six minute grid cell or by 30 minute grid cell. These cells are equivalent to areas of approximately 11km x11km and 55km x 55km (121 km^{2}and 2,916 km^2) respectively.

4. **Habitat information from the seabed in deep water (mostly deeper than 15 metres) from two projects:** Data from seagrass surveys in 1993 to 1999 (Coles et al. 2007; De'ath et al. 2007) is modelled from point source information; and data from the 2002 to 2004 seabed biodiversity project also modelled but collected using different methods (trawl, dredge and video) from the 1993 to 1999 data. Seagrass species distribution and biomass data is also available from various other QDPI&F surveys as polygons (Coles et al. 2007) from 1985 to the present time. Modelled information from the 1993 to 1999 surveys is presented in grid cells of approximately 5.5 x 5.5 km. (Map 19).

5. **Information on the impact of trawling on seagrass meadows (a major seabed habitat type within the ECOTF area), protected species and several byproduct species**: Data includes deepwater seagrass distribution, RAP closures protecting seagrass and estimated effort distribution in relation to seagrass distribution pre- and post- RAP, (Maps 19, 20 and 21); dugong information in grid cells of 2km x 2km (Map 22) and turtle information in 11km x11km grid cells (Map 23); and byproduct species distributions (Maps 24 to 28). The distributions of catch weight per six minute grid cell per year of byproduct species are presented with modelled VMS and CFISH effort distributions. Balmain bugs, barking crayfish (champagne lobsters) pinkies, mantis shrimps and pipefish were considered to

have a higher risk to their sustainability than other trawl byproduct species in the 2004 General Effort Review of the fishery (Kerrigan et al. 2004). The fishery was assessed to pose a lower risk to the sustainability of other trawl byproduct species and as such these species have not been considered in this assessment.

Management of the Fishery

The ECOTF has been limited entry since 1981 and effort has been restricted by the number of boats that can operate. The Trawl Plan was introduced in 1999 to manage the fishery. This included a cap on effort at the 1996 level less 5%, tradable effort units and surrender provisions (as a condition of effort unit trading and boat replacement) to reduce effort over time. The number of vessels in the fishery and fishing effort has significantly declined due to these provisions (Annual Status Report DPI&F October 2006). In 2006, there were approximately 500 boats operating in the fishery for approximately 42,500 nights.

The fishery is also managed by a series of restrictions on boat length, net length and mesh size and a requirement for installation of turtle excluder devices and at least one other bycatch reduction device in all nets.

Separate trawl fisheries are managed in the Torres Strait and in Moreton Bay. Some vessels in those fisheries also may operate in the ECOTF provided they meet the 14 m maximum length restriction and are endorsed with the appropriate T1 or T2 fishing symbols under Queensland fisheries legislation (Annual Status Report DPI&F October 2006).

Also used to manage the distribution of fishing effort is a mosaic of spatial closures to trawling including complex permanent closures in the GBRWHA and closures in the Great Sandy Strait and other Queensland Marine Parks. Supporting the permanent spatial closures are seasonal closures aimed at managing issues related to target species biology. Other closures, including those such as port limits, may also restrict trawling in some coastal locations.

Present Closure Types and Description

There are a large number of spatial closures in the ECOTF. Some involve large areas and influence the location and time of fishing effort but most are small in time and/or space and specifically targeted and likely to have only a minor impact on fishing effort. Closed areas are summarised in the Fisheries (East Coast Trawl) Management Plan 1999 (Reprint 5 03/11/2006 Office of the Queensland Parliamentary Counsel). Many of these areas are difficult to depict spatially at the scale of the whole Queensland east coast due to their complexity and small size. The types of closures recognised as being associated with the fishery are summarised below.

Spatial Closures

- The Great Barrier Reef Marine Park through which protection of the GBRWHA is implemented has seven levels of zoning. The least protective is General Use – the only zone in which trawling is allowed. General Use is depicted in light blue in Map 1 and is ~33% of the park area (117,000 km^2) (Maps 1 - 3). Other zones: Habitat Protection, Conservation, Park Buffer, Scientific Research, Marine National Park, and Preservation do not allow trawling (Map 1).

- Port Limits are declared around major port infrastructure and precludes trawling in most instances (Map 1). Generally these are shallow inshore areas; Townsville Harbour for

example has an extensive exclusion zone that follows the main shipping channel. In total the area of these zones in Queensland is approximately 1600 km^2 and has only a small impact on how trawl effort is distributed.

- State Marine Parks complement the GBRWHA zonings but are mostly inshore where they have little impact on the ECOTF with the possible exception of the new Great Sandy Strait Marine Park. There are additional zones (additional to those in the Great Barrier Reef Marine Park) in the Queensland marine parks – Conservation and Mineral Resource Zones and Estuarine Conservation Zones. Apart from the extra zones State Marine Parks match Commonwealth zones and protect shallow coastal waters and the internal (estuarine) marine waters of Queensland (Map 1 and 17).

- There are approximately 70 Fish Habitat Areas (FHAs) declared in Queensland under the Queensland *Fisheries Act* 1994. This includes approximately 6500 km^2 along the east coast of Queensland (Map 1). All FHAs are inshore and are declared based on the perceived high value of the coastal habitat they encompass. Fish Habitat Areas do not preclude otter trawling and most are estuarine. Similarly there are Dugong Protected Areas which limit some forms of net fishing and are designed to protect the marine mammal *Dugong dugon* from accidental entrapment in nets but at this time do not preclude otter trawling. There are 14 of these zones encompassing 4650 km^2. All are inshore areas with seagrass meadows and little if any trawling would actually occur in these areas.

Major Temporal Closures

Seasonal closures are employed widely in the ECOTF to synchronise the fishery with times when the target species are of an optimal size to capture highest market value. The fishery is closed entirely north of 22 degrees south from the 15th December to the 1st March and closed south of that from the 1st January to the 31st March (Map 5).

There are seasonal, rotating spatial closures in areas within Hervey Bay, at Bustard Head and near Yeppoon for scallop replenishment.

Other Spatial and Temporal closures

There are small seasonal and permanent strip closures in other areas deemed to be critical e.g. Wide Bay bar off Fraser Island, and off North Stradbroke Island to the Queensland/ New South Wales border. These may be implemented for biological reasons e.g. closures to protect Grey Nurse sharks or to protect juvenile prawns from premature capture or to separate commercial and recreational fishing for example daylight or weekend closures. There are approximately 150 of these closures although many overlap port limits, marine parks and other closures. These closures are legislated through the Trawl Plan and Commonwealth and State Marine Park legislation.

Effort Trends in the Fishery

Effort in the fishery has been declining more or less constantly since a peak in numbers of just over 1400 vessels in the early 1980's. There are presently approximately 318 vessels recorded fishing in the GBRWHA and approximately 202 vessels operating in the area south of the GBRWHA (Figure 1). Catch has remained relatively constant with a slight downward trend since 1996 (Figure 2). Effort reduction results from three separate sources: a reduction in the area allowed for fishing particularly since 2004; a reduction in the number of vessel and

fishing nights allowed; and a reduction in the actual number of boat nights fishing (possibly because of poor economic conditions in recent years). Boat nights in the GBRWHA have declined from 58,687 nights in 1990 to 26,865 in 2006 and from 22,080 nights in 1990 to 15,441 nights south of the GBRWHA in 2006 (Figure 3).

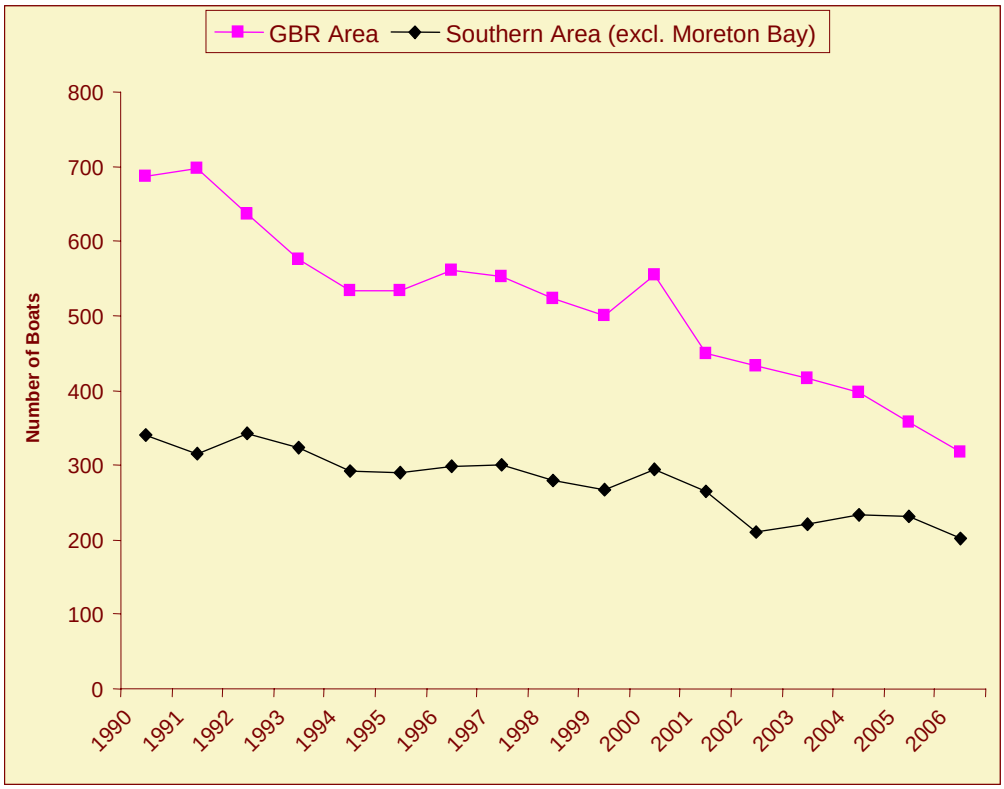

Figure 1. Number of trawlers licensed in each year (QDPI&F CFISH data).

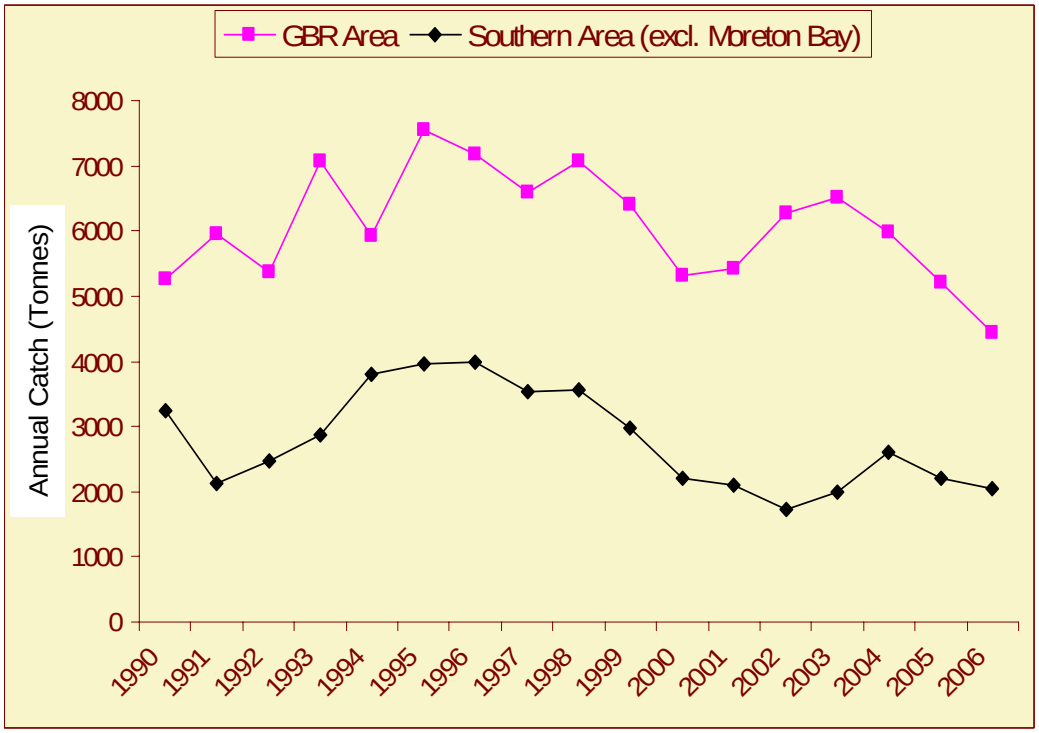

Figure 2. Annual prawn trawl catch (QDPI&F CFISH data).

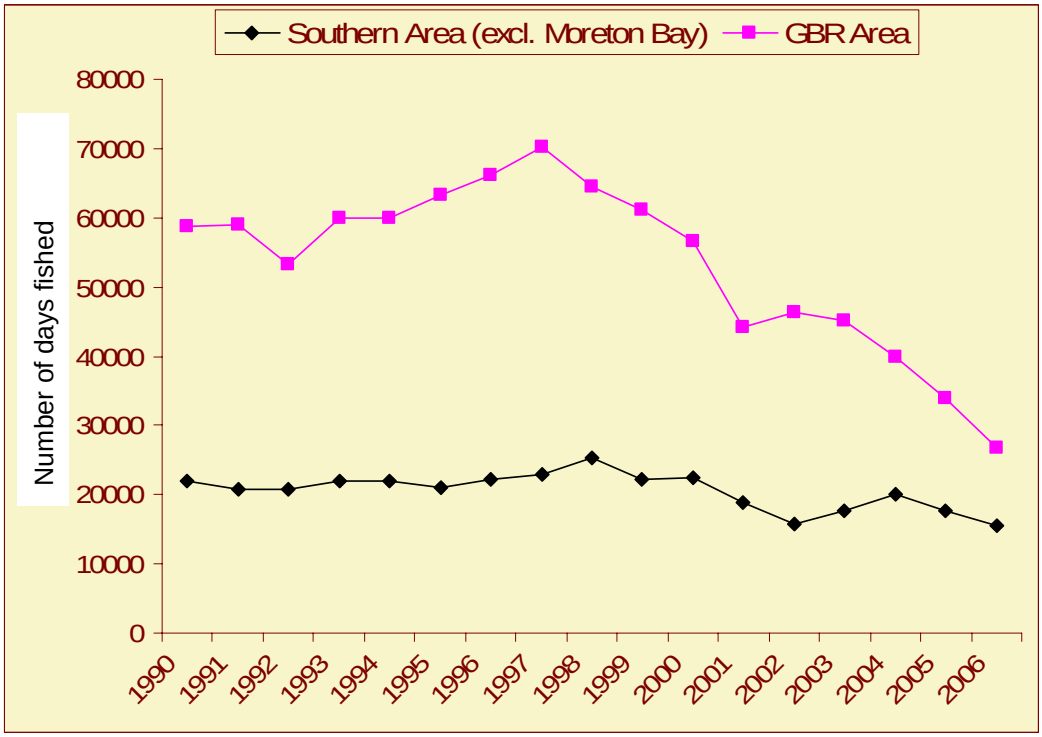

Figure 3. Number of days fished (QDPI&F CFISH data).

Location and Spatial Extent of Trawl Effort

An overall large scale spatial constraint on the ECOTF is the long thin shape of the coastline and fishing area, ~ 2,500 km north to south but only 400 km from the coast to the outer trawl

grounds at the widest point and much narrower in most locations. The effect of this is that the trawl fishing grounds also stretch in a long north south strip and effort is clumped in the east - west direction. On the outer reef slopes and east of Moreton Island this is accentuated by topography and the depth range favoured by the target prawn species. Trawling along a constant depth contour favours a north south trawling pattern. On the inner reef lagoon trawling follows the coast and inner edge of the coral reef string and with the exception of large bays also follows a north south pattern.

The clumped nature of the trawl fishing effort is evident from the GBRWHA VMS data that shows of the modelled VMS (1km x 1km) grid cells that are being trawled, only between 30% and 40% are fished for more than five hours in a year (Figure 4). Less than 0.5 % of VMS grid cells were fished for more that 100 hours in 2005 (the last year that corrected VMS data is available).

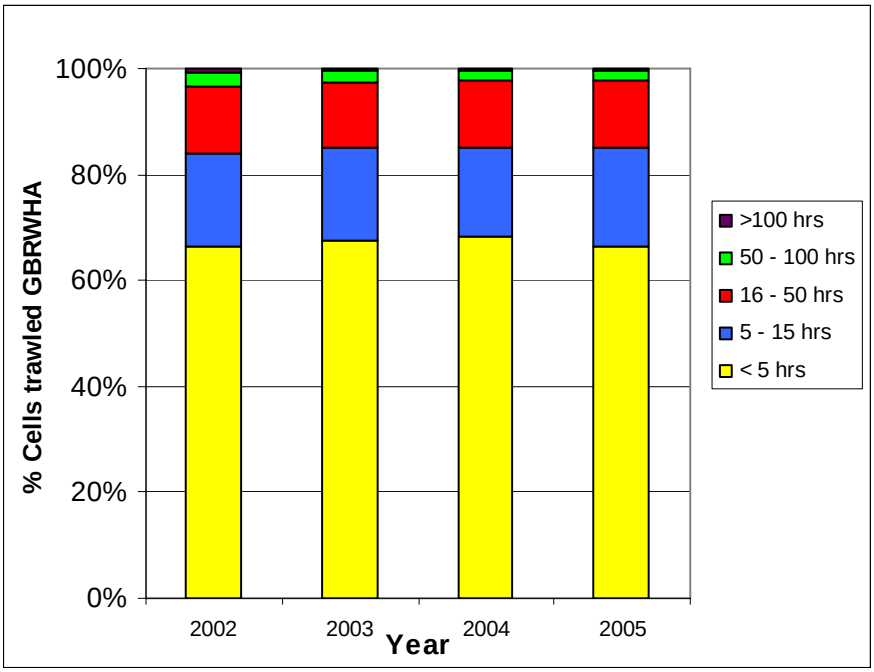

Figure 4. Percentage of the GBRWHA trawled within five effort density groups between 2002 and 2005 (grid cells are ~ 1km$^{2)}$.

Comparing spatial distributions of effort from 2002 to 2006 from six minute grid cells recorded in the logbook data and modelled trawl effort derived from VMS grid cell data there is a reduction in fishing area at the margins of the fishery reflecting a gradual decrease in the number of boat days (Map 6 – 14).

Trawling north of Townsville is restricted almost entirely to a narrow coastal strip interrupted by the GBRMP zoning restrictions. South of Townsville effort continues in a coastal strip and a mid shelf strip south to Mackay. Between Rockhampton and Fraser Island there is a large mid shelf fishery and a king prawn fishery that follows the outer edge of the Swains reefs. South of Fraser Island the fishery mostly follows depth contours in a strip outside the large sand masses of Fraser and Moreton Islands (Maps 6 – 14). A spatial representation of the changes in the area available for trawling within the GBRWHA resulting from the GBRMP RAP is presented in Map 15. Effort re-distribution within the GBRWHA since the RAP closures were implemented is presented in Map 16. Effort re-distribution south of the GBRWHA in the 2002 to 2005 period is presented in Map 18.

Changes to the ECOTF are noticeable in the GBRWHA where there was a downward trend in the area trawled from 2002 – 2005. There was a small decline in the 2004 year which resulted from an increase in the spatial trawl closures designated in the rezoning of the Great

Barrier Reef Marine Park (Great Barrier Reef Marine Park Zoning Plan 2003). However, many of the areas removed from the total area allowed for trawling by the rezoning were not trawled or not trawled regularly. This has resulted in the reduction in the potential area available for trawling not having a comparative impact on the area of the GBRWHA being trawled (Figure 5). The actual percentage trawled has been in slow decline as the number of boats has reduced and economic circumstances have focussed trawling in areas historically producing higher catch rates.

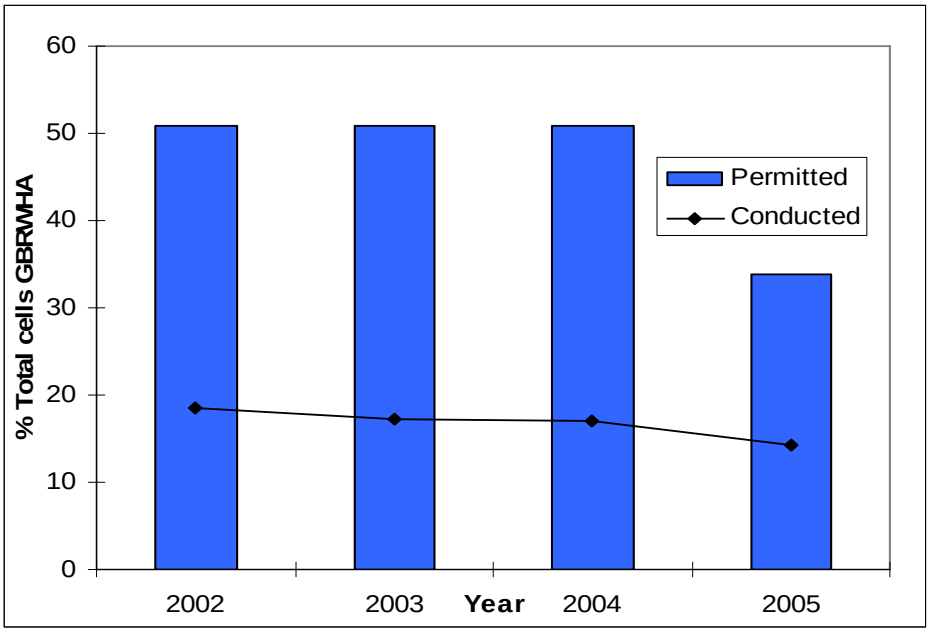

Figure 5. A comparison of the percentage of the area of the GBRWHA where trawling is allowed and the actual percent trawled between 2002 and 2005.

If it is assumed that VMS grid cells trawled for 5 hours or more in a year are VMS grid cells that have been fished more than once in a year, (a single trawl shot rarely exceeds 2.5 hours, Neil Gribble pers com) between 2002 and 2005 less that 10% of available grid cells ($1km^2$ VMS grid cells) were visited by a trawl fishing boat more than once (Figure 6).

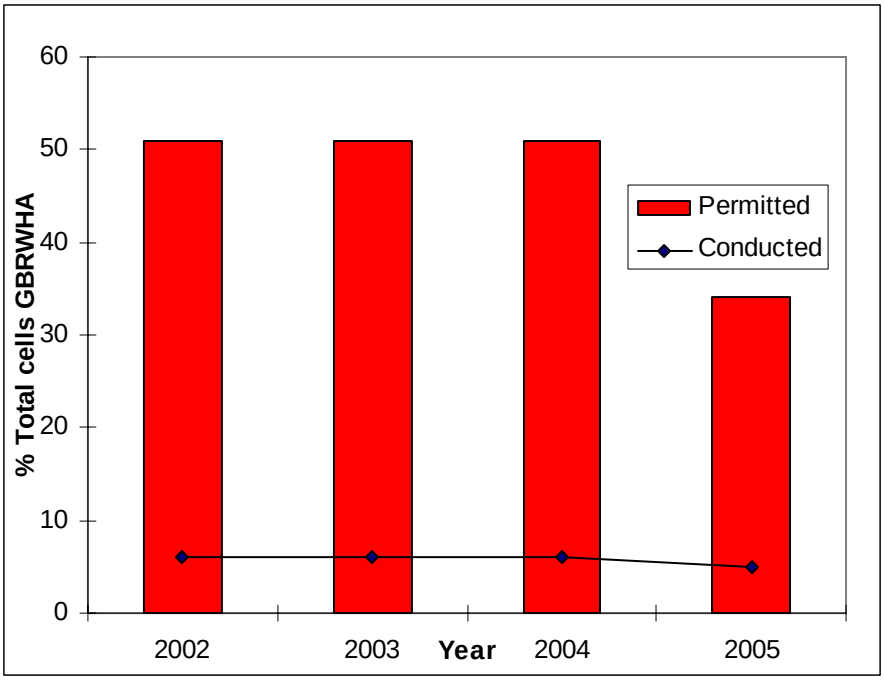

Figure 6. A comparison of the percentage of area of the GBRWHA where trawling is allowed , and the actual percent trawled more than once a year between 2002 and 2005.

The distribution of fishing south of the GBRWHA is similar to that inside it, with trawling occurring on slightly less than 25% of the available area and trawling for more that five hours in a VMS grid cell occurring in approximately 10% of those grid cells. There is a very slight increase in fishing effort south of the GBRWHA from 2002 to 2005. (Figures 7 and 8). The Great Sandy Strait Marine Park has increased the spatial trawl closures around Hervey Bay; we were not able to assess the impact of this recently declared Marine Park as the relevant digital boundary datasets were not finalized at the time this document was prepared.

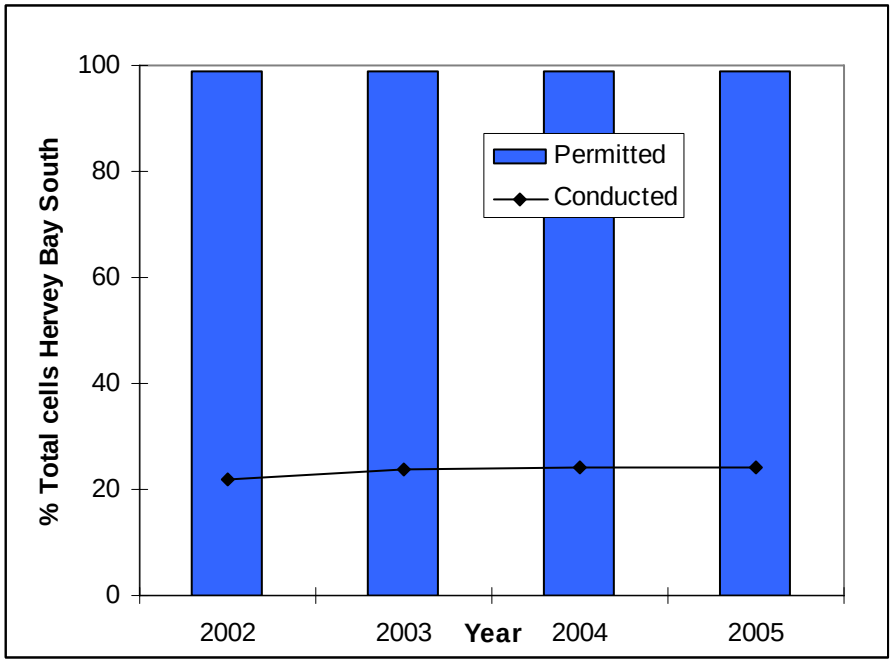

Figure 7. A comparison of the percentage of the area from Hervey Bay south where trawling is allowed, and the actual percent trawled between 2002 and 2005.

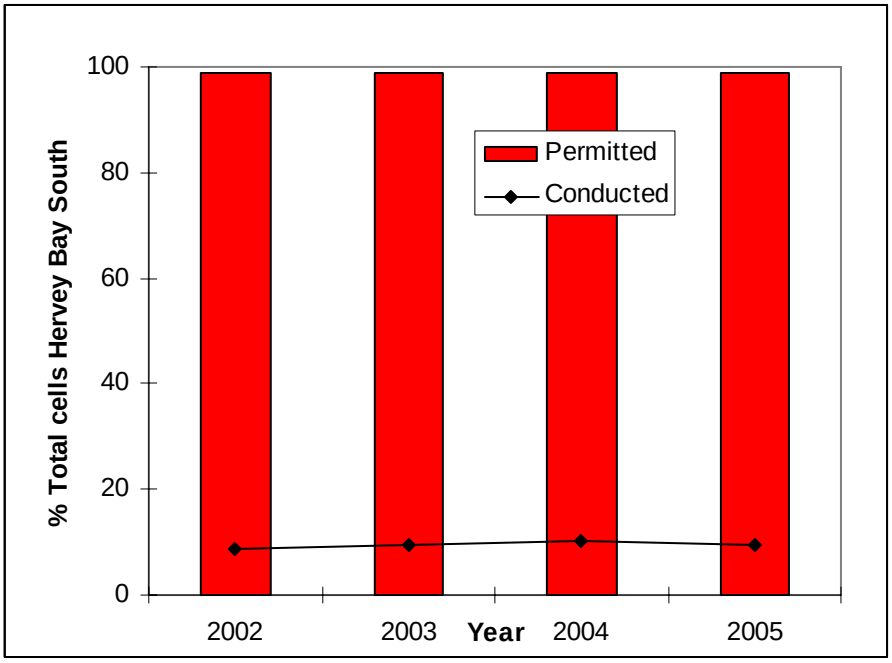

Figure 8. A comparison of the percentage of the area from Hervey Bay south where trawling is allowed, and the actual percent trawled more than once a year between 2002 and 2005.

Spatial interaction between trawl effort, habitat and species of concern

Seagrass

Seagrass distribution on the ECOTF grounds in waters deeper than 15 metres has been modelled as part of the CRC Reef Research Centre (Coles et al. 2000). Almost all seagrass at this depth are from the Genus *Halophila*. Seagrasses occur down to approximately 60 metres below mean sea level. Detailed maps and conceptual models of the distribution of seagrass for this region are available (Coles et al. 2007). The distribution of seagrasses is related to depth, light and sediment type and there is little evidence of seagrass distribution being affected by trawling (Coles et al. 2007, Pitcher et al. 2007) and trawlers generally avoid areas of seagrass to limit net clogging.

Prior to new zoning in the GBRWHA, trawling was permitted on ~ 82% of the identified deepwater seagrass beds. This number reduced to 57 % after July 2004. If the trawl effort estimated from VMS data is overlaid on the areas where seagrass meadows were estimated to have a greater than 50% probability of being present in 2002; 46.6% of seagrass meadows were in VMS grid cells that were trawled reducing to 36.3% in 2005 (Table 1). Over 60% of seabed with a high probability of supporting seagrass is not trawled.

The distribution of seagrass and trawling is presented in Maps 19, 20 and 21. The risk of trawling having an impact on deepwater seagrass habitats decreases as the number of times a meadow is trawled decreases. Around 60 % of trawl events on deepwater seagrass occurred less than once . Only ~ 14% of all deepwater seagrass habitats were trawled more than once in 2005. Most seagrass area has a very low probability of being trawled at all and this pattern is consistent between 2002 and 2003 (Figure 9).

Table 1. % Deepwater seagrass habitats (total) trawled using effort modelled from VMS data.

Year	% Seagrass trawled
2002	46.6
2003	43.2
2004	42.0
2005	36.3

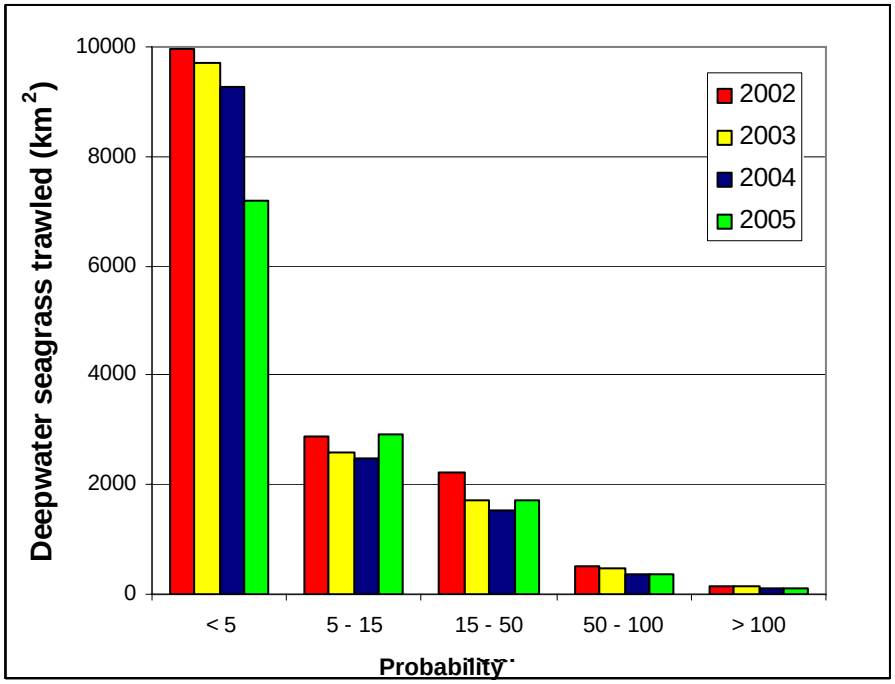

Figure 9. Area of deep water seagrass habitat trawled within five trawl probability groups between 2002 and 2005

Extensive seagrass meadows extend south of the GBRWHA into Hervey Bay where they are excluded from trawling areas close to shore by the former Wongarra and Hervey Bay marine parks and current Great Sandy Strait Marine Park. Seagrasses in Hervey Bay have been previously mapped and are monitored as part of the Seagrass-Watch project (www.SeagrassWatch.org). The distribution of seagrass on the eastern coast of Fraser Island and the ocean coast of the ECOTF to the NSW border has not been investigated to our knowledge but exposure to ocean swells and depth would make it unlikely that extensive meadows open to trawling exist in this region.

Dugong

Areas of high conservation value for dugong are mapped over VMS data in Map 22 for years 2002 and 2005. Dugong data is modelled data from dugong aerial surveys conducted between 1985 and 2005 (Grech and Marsh, 2007). In the GBRWHA south of Cairns most dugong populations are in shallow water and do not significantly overlap with high density trawl areas. North of Cairns and particularly in the Princess Charlotte Bay region dugong may feed offshore and are at least swimming across the trawl fishing grounds. Reports of dugong caught in trawl nets are extremely rare but some disturbance to feeding from the presence of vessels could occur.

The RAP rezoning has reduced the proportion of dugong habitat in the GBRWHA where trawling is permitted (Table 2). The area actually trawled within the dugongs range has also decreased and presently only 15 percent of high conservation dugong areas are exposed to trawling (Table 3).

Table 2. Proportion (%) of high, medium and low conservation value dugong habitats in the GBRWHA with trawling allowed

Conservation Value[a]	Total Area (km^2)	Pre new zoning %	Post new zoning %
High	2399	27	25
Medium	2175	42	31
Low	27490	56	40

[a] - as defined by Grech and Marsh 2007

Table 3. Proportion (%) of high, medium and low conservation value dugong habitats in the GBRWHA trawled (VMS) 2002 – 2005

Conservation Value	Total Area (km^2)	2002	2003	2004	2005
High	2399	20	19	18	15
Medium	2175	25	24	23	21
Low	27490	31	30	28	24

[a] - as defined by Grech and Marsh 2007

Sea Turtles

Turtles are captured incidentally in trawl nets along most inshore waters of the Queensland coast with areas around the Whitsunday Islands and north of Princess Charlotte Bay having areas of highest catch (Robbins 2002) (Map 23). Fishing sites offshore are less likely to record turtle catches. The extent of trawling in areas identified by Robbins 2002 as having sea turtle catches has steadily declined for all levels of catch with the introduction of turtle excluder devices (TEDs) (Tables 4 and 5). In 2006 only 14 turtles were recorded as being caught in the ECOTF and all were released alive.

Table 4. Proportion (%) of fisheries VMS grid cells within six levels of turtle by-catch (catch-per-unit-effort) for all species (Robins, 2002) with trawling allowed before and after the implementation of TEDs through the Trawl Plan and before and after RAP rezoning.

		Level of turtle catch-per-unit-effort					
		1[a]	2[b]	3[c]	4[d]	5[e]	6[f]
All turtles	Total Area (km^2)	6064	46789	32164	5747	11368	245570
	Pre ECTMP	65	75	86	61	94	84
	Pre new zoning	61	67	86	56	94	41
	Post new zoning	46	51	65	36	71	24

[a] > 0.14286 sea turtles caught per <7 days fished
[b] 0.03333 – 0.14286 sea turtles caught per 30 – 7 days fished
[c] 0.01111 – 0.03333 sea turtles caught per 90 – 30 days fished
[d] 0.00549 – 0.01111 sea turtles caught per 180 – 90 days fished
[e] 0.000001 – 0.00549 sea turtles caught per >180 days fished
[f] No sea turtles caught

Table 5. Proportion (%) of fisheries grid cells within six levels of turtle by-catch (catch-per-unit-effort) for all species (Robins, 2002) with trawling conducted (VMS) between 2002 – 2005 in the GBRWHA.

	Level of turtle catch-per-unit-effort					
Year	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]
2002	2063	15802	16527	1950	6346	21711
2003	1683	15300	14849	1659	6186	20153
2004	1635	14297	14547	1498	6332	20895
2005	1368	11894	11250	1241	5714	17907

[a] > 0.14286 sea turtles caught per <7 days fished
[b]0.03333 – 0.14286 sea turtles caught per 30 – 7 days fished
[c]0.01111 – 0.03333 sea turtles caught per 90 – 30 days fished
[d]0.00549 – 0.01111 sea turtles caught per 180 – 90 days fished
[e]0.000001 – 0.00549 sea turtles caught per >180 days fished
[f]No sea turtles caught

Balmain Bug (Ibacus spp) catches

Balmain Bugs (*Ibacus*) are regulated byproduct species in the ECOTF subject to a ban on harvesting females and a minimum carapace width of 10 cm. Balmain Bug catches have steadily increased (2007 catches are not complete) since 2002 (Figure 10). Catches are distributed widely throughout the fishing ground and cannot easily be spatially separated from areas of trawling (Map 24).

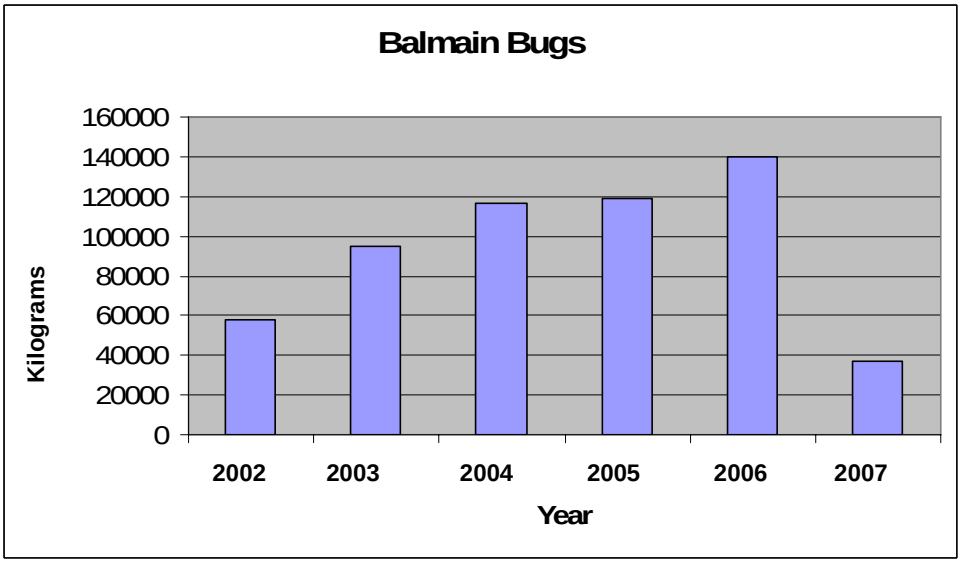

Figure 10. The catch of Balmain Bugs (QDPI&F CFISH data).

Mantis Shrimp (Squilloidea spp) Catches

Mantis Shrimp catches recorded from the ECOTF are low – less than three tonnes per year and catches have steadily declined since 2002 (2007 data is incomplete) (Figure 11). Catches are too small to represent spatially in a meaningful way (Map 26) other than to note that most catches recorded are from trawling north of Cairns and south of Cape Grenville. In possession limits ensure mantis shrimps are not targeted in the fishery and that retained catches remain small.

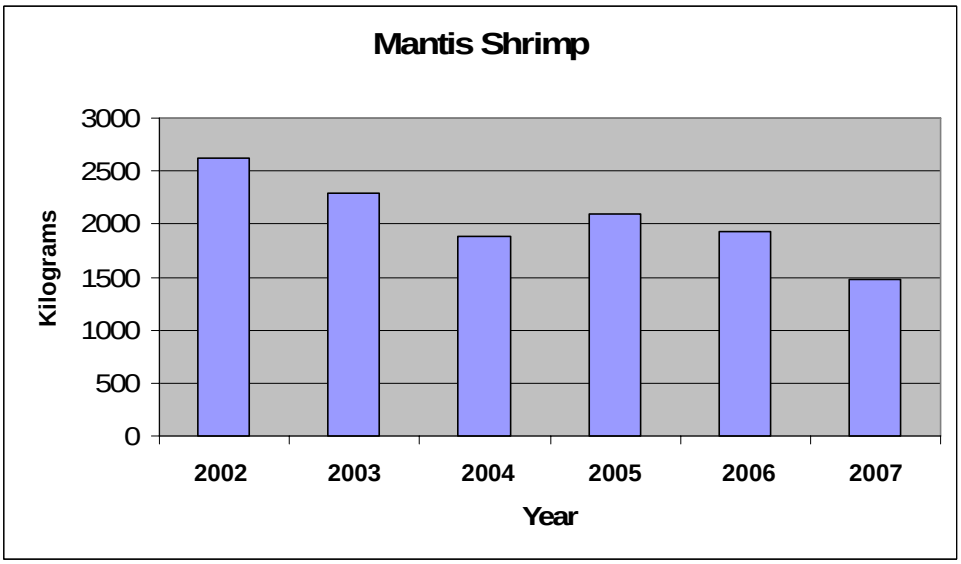

Figure 11. Mantis Shrimp catches (QDPI&F CFISH data).

Pinkies (Threadfin Bream - Nemipterus) Catches

Very few catches of pinkies are recorded from the ECOTF with a peak catch of around 250 kilograms in 2004 (Figure 12). There are now "in possession" limits which restrict potential catches and reduce the capacity for targeting. As for mantis shrimp, the total catch of pinkies reported is too small to easily display spatially (Map 27). Reported catches are from trawling north of Townsville to just north of Princess Charlotte Bay.

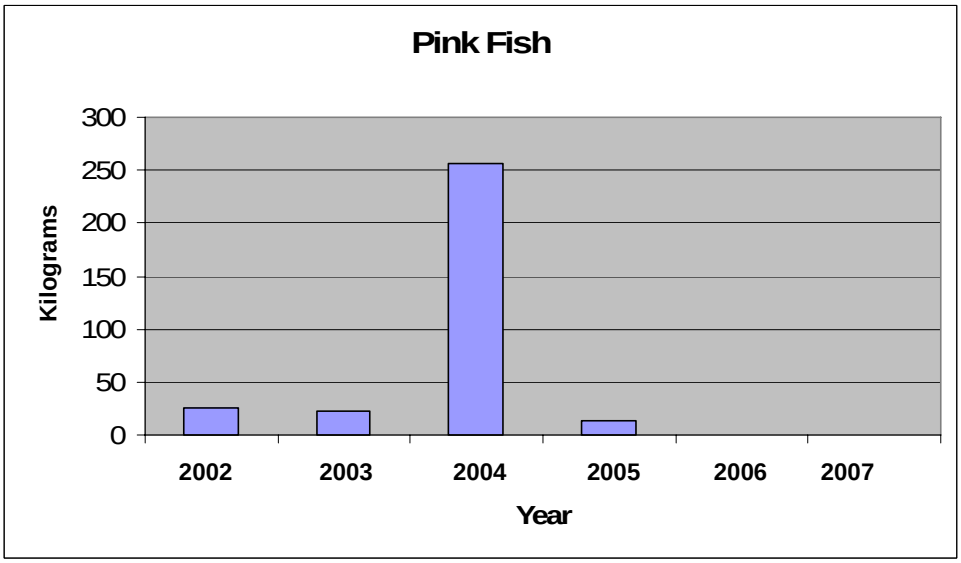

Figure 12 Distribution of pink fish catches (QDPI&F CFISH data).

Pipefish Catches

Pipefish are reported in log records as unclassified, Dunkers pipefish (*Solegnathus dunckeri*) and Pallid pipefish (*S. hardwickii*) and recorded as numbers retained rather than weight (Figures 13,14, 15). Numbers in all three groups are few and declining (2007 data is incomplete) and are combined in the distribution map (Map 28). Pipefish are widely distributed on the fishing grounds between Cairns and Mackay and off Fraser Island. There are very few records north of Cairns.

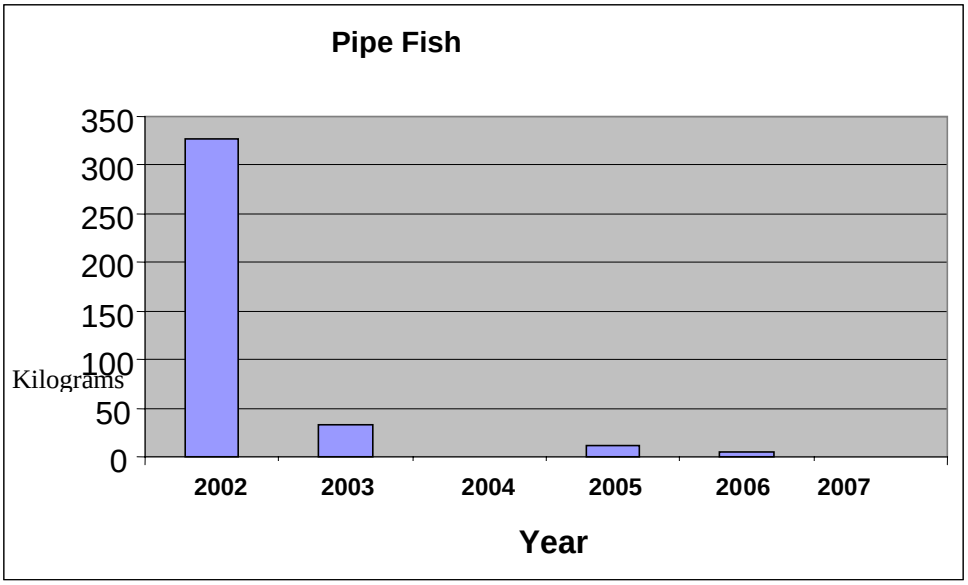

Figure 13. Pipefish catches (unclassified) (QDPI&F CFISH data).

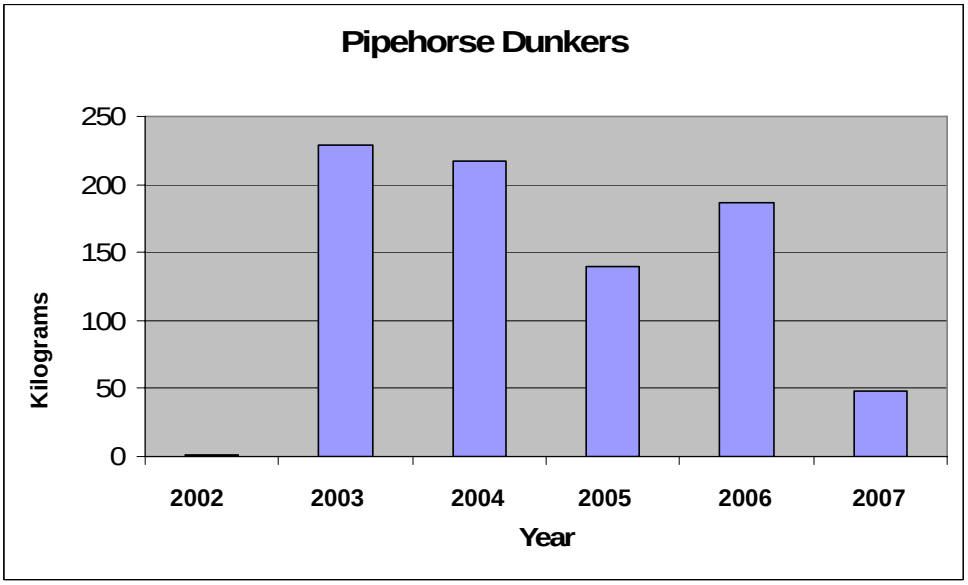

Figure 14. Dunkers pipefish catches (QDPI&F CFISH data).

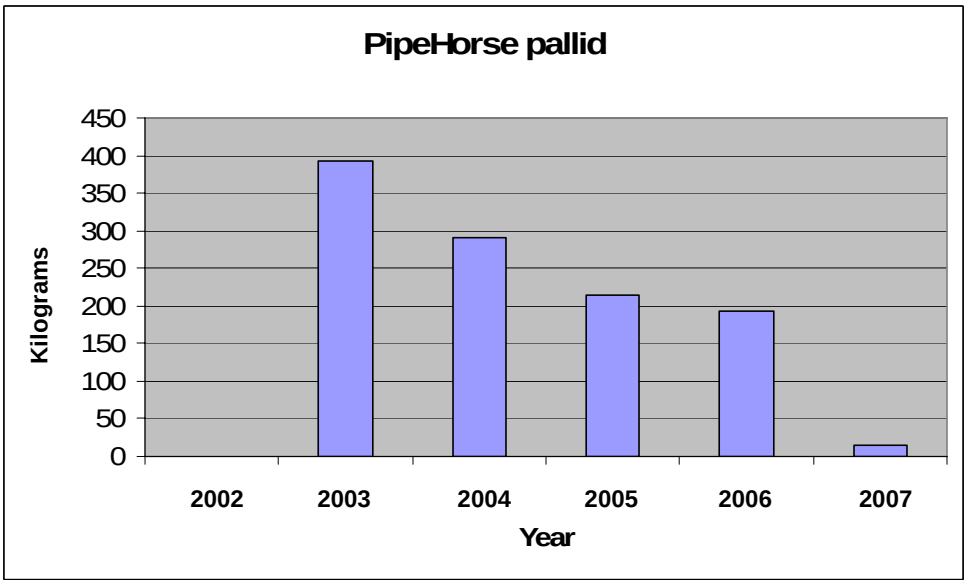

Figure 15. Pallid pipefish catches (QDPI&F CFISH data).

Champagne lobster catches

Champagne Lobster or Barking Crayfish (*Linuparus trigonus*) catches have declined to less than 10 tonnes a year since 2005 (2007 data is incomplete) (Figure 16). There is now an in possession limit. Catches are concentrated in offshore fishing grounds around the Swains Reefs and on offshore fishing grounds south of Cairns (Map 25).

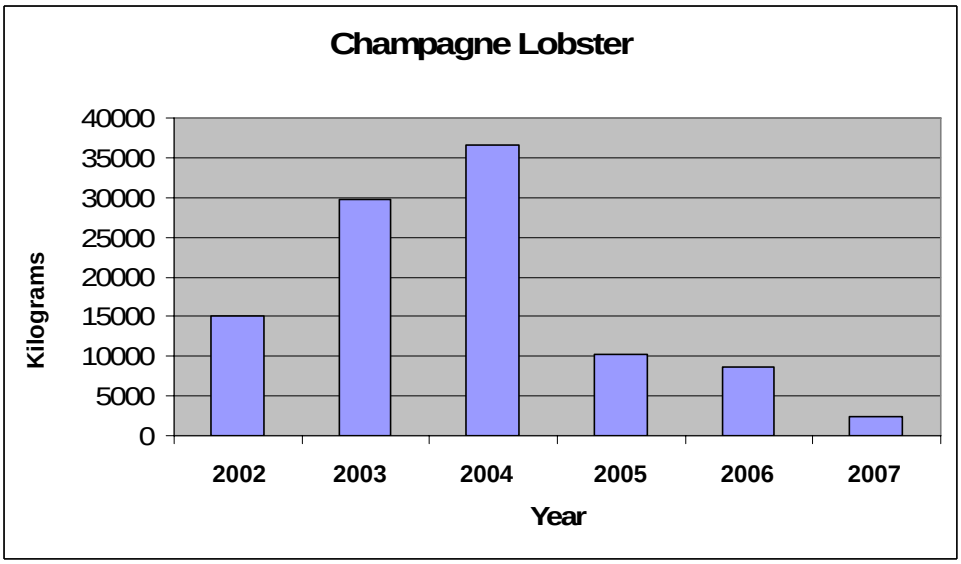

Figure 16 Champagne lobster catches (QDPI&F CFISH data).

Seabed Biodiversity Report

The Seabed Biodiversity Project Report was completed in July 2007 (Pitcher et al. 2007) (FRDC project 2003/021). Using data from comprehensive benthic faunal and floral mapping, it focused specifically on the development of sustainability indicators and risk assessment of the effects of trawling on the sustainability of trawl bycatch, benthic species, assemblages, and seabed habitats within the GBRWHA.

The report developed Ecological Risk Indicators on the basis of exposure to trawling in areas that are open to trawling, areas where trawl effort is present, and areas where the intensity of trawling is taken into account and those three approaches are replicated for biomass. The study uses a 0.01 degree grid cells (approximately $1km^2$) and assumes trawling is conducted uniformly. Risk rating incorporates both vulnerability and the ability of species / habitats / communities to recover. It is not possible to include a full assessment of the implications of the report in relation to adequacy of trawl closures in this initial assessment but the key implications can be summarised:-

- The report provides survey, transect and point data and interpolated distributions (referred to as maps in the report) for 850 seabed taxa / species.
- Estimates of the likely extent of the effects of past trawling activity shows trawling has had a negative effect on the biomass of only 4.5% of these species and a positive effect on 2.0%.
- More than 800 taxa / species had a very low proportion of their estimated overall biomass in the sampling area caught annually by trawling – 15 species had a higher relative risk when recovery capacity in addition to trawl exposure was included. There are 48 species listed in the project report which, because of the high levels of uncertainty in estimates and the limited knowledge of their life history biology, should be investigated further.
- Recent management interventions - the 2001 buyback and the 2004 rezoning have arrested or reversed the bottom habitat deletion trends that had possibly been occurring .
- Of the species listed in the present report only nemipterids (*N. hexodon*, and *N. peronii*) have a biomass that is greater than 50% in areas that could be trawled with 21% and 37% respectively in grid cells (approximately $1km^2$) that have trawl effort. When effort levels are included *Nemipterus furcosus* is found in 25% of trawled grids with an effort percentage of 32%.
- Two nemipterid species, *N. peronii* and *N. furcosus* were at the higher end of catchability uncertainty limits for catch/mortality estimates.
- The species modelling process selected Trawl Effort Index as significant for only 6.5% of species – little more than would be expected by chance. This supports previous CRC Reef Research Centre results by Coles et al. (2007) and Coles et al. 2008 (unpublished manuscript in review) that found trawl effort was not a significant factor determining modelled predictions of seagrass distribution.
- Habitat components from video data were examined individually, particularly marine plants. Pinnate and ovoid seagrass had an exposure ranging from 24% to 15% respectively, Crustose coralline algae was most exposed at 44%

primarily off Gladstone. Filamentous blue-green algae was the most extensive and had an exposure of 25%. All other marine plants had an exposure 17% or less. Available evidence is that catchability of marine plants in trawls is low in the GBRWHA and that the exposure to trawling risk for marine plants is similarly low.

As the models used assume that a trawler trawls novel ground on each trawl pass on any night these results represent the greatest likely impact. As trawlers do at times go up and back on the same ground the amount of area and percentage of biomass of a species or assemblage that is exposed would be expected to be less than estimated here although impacts on the area actually trawled could be higher.

Discussion

The spatial closures in place in the ECOTF are extremely complex with a mixture of Commonwealth and Queensland legislation, covering areas within and outside marine parks and World Heritage Areas. There are large spatial closures implemented to protect proportions of bioregions, and a myriad of overlapping small spatial closures, some permanent, some temporary and some seasonal. Overlying this is a large area temporal closure in the north and south of the fishery closing the entire fishery for three months each year. Many pages of the *Fisheries (East Coast Trawl) Management Plan 1999* are devoted to explaining this complex closure system. The rationale generally is for conservation of fish habitat in the GBRWHA, to limit targeting of juveniles of target species, protecting fisheries resources as in the scallop closures or to protect a species needing protection such as the Grey Nurse Shark closures. Alternatively the rationale may be simply operational to protect infrastructure or shipping channels.

This complexity extends south of the GBRWHA into Hervey Bay becoming less so in the offshore king prawn fishery between Hervey Bay and the Queensland - New South Wales border.

It is not possible to present this state wide complex system in an understandable way at a fishery scale in the form of a map and can only be viewed effectively in a GIS layer format.

Because of the complexity it is difficult to make general comments about spatial arrangements without specifying an area but some statements can be made:

1. The state wide three month seasonal closures implemented to prevent capture of juvenile prawns and to allow for seasonal refits (Map 5) provides an opportunity for recovery of bottom communities and for a reduction in any damage to the bottom that has occurred.
2. Fishing effort is highly clumped in space. Many areas are not fished or fished very little. At the scale of the entire ECOTF grounds, the reduction in the area permitted to be fished that occurred in the RAP rezoning had little discernable impact on the actual amount or pattern of fishing because of this factor (Maps 6 – 9). If the fishing effort was evenly spread, then reducing the area allowed to be fished would provide for a reduced probability of impact on benthic habitats. However with a highly clumped fishery such as the ECOTF, removing areas from the fishery may either have little effect on reducing

impact on the bottom if the area chosen was not regularly trawled or severely effects the efficiency of the fishery by removing heavily fished areas possibly without providing any greater protection for seabed habitats and benthic species identified as important to protect.

3. Trawling intensity is extremely low with few areas trawled more than a couple of times a year. VMS grid cells roughly equate to a kilometre square. Seventy percent of VMS grid cells have less than five hours trawling annually (Maps 6 – 9).
4. The number of grid cells (5.5km^2) identified by the CRC Reef deepwater seagrass mapping research project (Coles *et al.* 2000) with greater than a probability of 50% likelihood of having seagrass that are trawled has reduced from 47% to 36% as a result of the RAP zoning changes (Table 1). This 36% is almost certainly an overestimate due to spatial scale issues as trawlers are likely to be operating near seagrass meadows not on them. This could only be confirmed by ground truthing actual VMS polled trawl locations or by surveys at a finer spatial scale.
5. While there are fewer closed areas in the king prawn fishery south of the northern tip of Fraser Island the fishery self organises into north -south inshore and offshore strings that probably reflects depth contours, prawn aggregations and the location during the season of an area with suitable prawns and suitable bottom type. This pattern is likely to be relatively stable as comparisons between years from 2002 to 2005 show little change at a fishery wide scale (Maps 6 – 9).
6. The continued decline in effort in the fishery as a result of structural adjustment, increasing variable costs and business decisions of fishers is likely to continue a trend to fish only in the most productive areas providing effective protection to most areas of the fishing grounds without any formal legislative or management intervention.
7. The known impacts on turtles and dugong from trawling have been minimised with gear modifications, such as the introduction of turtle excluder devices or due to the limited spatial coincidence over most of the fishery as in the case of trawl effort location and dugong presence.
8. Of the regulated byproduct species only Balmain Bugs are caught and retained in large numbers. For all the species in this report where numbers are sufficient to map, catches are distributed widely across fishing grounds such that a change in placement of closures would not be able to successfully separate target species catching areas from those where regulated byproduct species are distributed.

The spatial data that is available for analysis is difficult to compare. It is collected for different purposes (catch verification and catch location data, supporting stock assessment models, or resolution of biophysical patterning processes) and in different spatial units. For a fine scale spatial assessment, the pre 2001 CFISH 30 minute catch data is of limited value. The six minute grid data is also likely to overestimate the actual area from which the catch is taken (Maps 10 – 14). The VMS data is resolved to approximately 1km^2 degree grid cells but the actual position recording from hourly polls or polls taken four times a day is much coarser than this. Seabed biodiversity and seagrass data are resolved to grid cells of just over

one kilometre square. Dugong spatial data is in 2km^2 grid cells. A standardised cell/grid/site system for all spatial fisheries and seabed habitat data would make spatial analysis more precise.

The Innovative stock assessment/VMS effort mapping project (Good et al. 2007) experienced recurring difficulties due to data deficiencies related to the assignment of activities and catch to vessel tracks. Novel technological solutions, such as direct recording of data that accurately characterises vessel activity, may diminish the need for estimation procedures that define vessel activity through the. Technological solutions could also be used to collect high resolution catch and effort data that may empirically validate the precision provided by the low resolution commercial data that are currently available.

All the data sets available have location or estimation errors. The catch data in fishing log books is for catch collected at a location within a relatively large grid 30 minute or six minute grids of latitude or longitude. The seagrass distribution data from the CRC Reef Research Centre project and the Seabed Biodiversity project data are not true maps but probability distributions interpolated from multiple empirical point source data and other modelled data. The trawl VMS location data is relatively unsophisticated – the transponder providing only a position with no speed, activity or direction of travel information. Speed, activity and direction are inferred by comparing sequential poll locations. VMS data has been filtered and modelled (Good et al. 2007) but it is likely that errors remain. At a fishery scale these errors are not likely to affect decision making but if the biological processes that need protecting occur at small scales - less than a kilometre – then the spatial resolution of the data presently available is inappropriate.

These location and estimation errors are the most likely explanation for catch being recorded in sites where VMS effort is not. This is most obvious in maps such as for Champagne Lobster (Map 25 a,b,c) where some of the higher catches off the central Queensland coast are recorded from locations (a) at some distance from recorded effort (b and c).

Improved spatial resolution of catch information would result from shortened trawl shot durations, coupled with shot by shot catch and location recording. However, such a change would interfere with normal fishing operations and cannot be practically implemented for a commercial fishing fleet. A more practical solution may be to collect high resolution catch and effort data and possibly sea bed habitat data specifically to empirically validate the precision provided by low resolution data collection and modelling. Both the Seabed Biodiversity Project (Pitcher et al. 2007) and the VMS Project (Good et al. 2007) recommend some ongoing monitoring or validation and this task could be undertaken by the assessment and monitoring LTM and observer groups.

While the deficiencies in the data may complicate scientific interpretation they are not as important at the spatial scale of fisheries management. Improving the data available is unlikely to further assist management decisions at a scale that it is practical to manage. The ECOTF is highly regulated and limited in where it can or does fish. Of the species of concern exposed to trawling identified in the Seabed Biodiversity report

only two species of pinkies are listed and there are limits on harvesting and targeting of these species. Exposure of other species has already been reduced by the reductions in effort fishing location already implemented and by limits on harvesting and targeting.

QDPI&F implemented a Fishery Observer program in 2004 which over time will build a higher resolution picture of the distribution of retained and non retained catch in the ECOTF. This program records a GPS location for the start and finish of each trawl shot and records species composition and relative abundance for retained species and bycatch species from subsamples of the bycatch. Within the limits of commercial fishing operations, high and low effort trawl sites are sampled. The observer program is also essential for validating self reported log book records of Species of Conservation Interest (protected species). It would also be of ecological and fisheries assessment value to subsample the seabed biome from these actual trawl shot locations to validate the actual exposure of bottom types to trawling as predicted from the GBR seabed biodiversity project.

Future work plans

This is a preliminary report summarising the current status of the adequacy of trawl closures. If require future plans could include:

- a more comprehensive discussion and incorporation of the GBR Seabed Biodiversity project results and their implications for trawl fishery management;
- Supporting the development of a Seabed Biodiversity assessment in Queensland waters south of the GBRWHA; and
- Analysis of the higher spatial resolution observer program species distribution and relative abundance data as that data set is populated over the next few years.

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Conclusions

- There is an extensive and complex system of spatial closures in the GBRWHA. Through the Great Barrier Reef Marine Park RAP process in 2004, significant reductions in available fishing area have recently occurred.

- Existing information on seabed biodiversity, seagrass distribution and exposure to trawling of turtle and dugong populations suggests the recent spatial closures, reduction in effort and fishing regulations have reduced the impact of trawling and there is no evidence supporting the need for expanded or new spatial closures in the GBRWHA.

- Similar to the GBRWHA, the fishery to the south operates on only a small fraction (less than 10%) of the permitted area. Complex spatial and temporal closures are in place and it would be difficult to support a case for additional closures
- At the scale of the data available it is not possible to clearly define locations where “hot spots” of regulated species and species of concern occur within

trawl grounds and to implement spatial closures on a finer scale. Most of these species appear to be widely spread across the fishing ground.

- The data sets available have been collected at different scales and have different precisions and accuracies making them hard to reconcile at all but the coarsest scale. This is evident when comparing recorded catch and recorded effort locations.
- Observers and seabed assessment could provide a better understanding of impacts at a finer spatial scale particularly south of the GBR in the future.

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