

Status report on bycatch within the Queensland Trawl Fishery

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Abstract

The Queensland Trawl Fishery is a complex multi-sector fishery extending 2,500 km along the Queensland east coast. About 800 otter-board trawlers record between 85,000 and 90,000 boat-nights (predominantly a night-time fishery) of fishing effort in offshore waters annually. In addition, about 210 beam trawlers record an average of 6,500 boat-days (predominantly a day-time fishery) annually in riverine and inshore areas. Trawling takes place over a diverse range of benthic communities and seabed habitats. Fishing effort is distributed non-uniformly, with a major proportion occurring in the Great Barrier Reef World Heritage Area.

Bycatch is a characteristic feature of the Queensland Trawl Fishery and, in this paper, is defined as that part of the catch that is discarded at sea. An assessment of the status of bycatch in the fishery is presented, based on a review of relevant literature. Major conclusions from the assessment are that, a) the species composition has been documented in some sectors of the fishery, but no reliable estimates of total bycatch have been published, and b) impacts of trawling on the populations of bycatch species and the ecosystem remain scant. Despite this uncertainty, there are strong social and political pressures in Queensland to reduce trawl bycatch. Current issues pertaining to bycatch in Queensland fall into the following categories: i) inter-sector conflict, ii) impact on benthic community and habitat structure, iii) wash-up of dead fish on beaches, iv) capture of unwanted species, and v) capture of threatened or protected species.

The Queensland Fisheries Management Authority is the primary agency responsible for the management of the fishery, but the Great Barrier Reef Marine Park Authority also has responsibility for parts of the fishery that occur within the Great Barrier Reef World Heritage Area. The agencies work in collaboration and both have policies to reduce trawl bycatch in order to maintain biodiversity, to ensure fisheries are ecologically sustainable and to minimise the 'waste' of fisheries resources.

The fishery

The Queensland Trawl Fishery encompasses all Queensland jurisdictional waters from the Queensland/New South Wales border at about 28°S, to the northern tip of Cape York Peninsula (10°30'S, 142°30'E). This includes areas of the continental shelf, several major embayments and the Great Barrier Reef World Heritage Area. World Heritage status places a duty upon the managing agencies to ensure the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage of areas listed under the World Heritage Convention (Valentine *et al.* 1997). It also increases the public's expectations and scrutiny of fisheries management (Tanzer *et al.* 1997).

The Queensland Trawl Fishery is a commercial fishery with restricted entry. It is the largest and most valuable commercial fishery in

Queensland, with annual landings valued between A\$120 and A\$130 million (Williams 1997). Logbook data indicate that between 85,000 and 90,000 boat-days of fishing effort each year are recorded each year, with about 10,000 t of landings. Targeted species include about 12 species of prawns (Penaeidae), two species of scallop (*Amusium* spp.) and one species of whiting (*Sillago robusta*). Several non-targeted species are also retained, including blue swimmer crabs (*Portunus pelagicus*), shovel-nosed lobsters (*Thenus* spp.) and squid (*Photololigo* spp., *Sepioteuthis* spp.). Two main categories of fishing apparatus are used: i) beam trawls in designated rivers and inshore areas targeting mainly banana and greasyback prawns, and ii) otter-board trawls targeting prawns, scallops and whiting.

The Queensland Trawl Fishery is one of the most complex in Australia in terms of its fleet size and diversity, the range of environments in which the fishery occurs, and the seasonal and spatial distribution of effort. In order to structure this report, we identified eight sectors within the fishery, based on the region, type of fishing gear and species targeted. The sectors are beam trawl, Moreton Bay, stout whiting, eastern king prawn, scallop, banana prawn, red spot king prawn, and tiger/endeavour prawn (Figure 1). Bycatch is common to all sectors, but its composition and the associated social and environmental issues vary between them. A summary of the status of bycatch within each sector is presented (Table 1). Where the data permit, preliminary estimates of the total bycatch of the sectors were made using either the ratio method or the catch per unit effort (CPUE) method (Andrew and Pepperell 1992). The ratio method is based on observed or sampled bycatch:prawn catch weight ratios. Total bycatch is then estimated as the product of the ratio and the total prawn catch. The CPUE method relies on bycatch per unit of fishing effort, with total bycatch estimated as

the product of bycatch CPUE and the total fishing effort. Andrew and Pepperell (1992) provide a review of the merits and drawbacks of each method.

Bycatch summaries by fishing sector

The beam trawl sector

About 210 vessels have beam trawl endorsements in Queensland (Anonymous 1998). Trawling occurs in rivers and inshore waters between Moreton Bay and Rockhampton, and to a limited extent near Bowen and Mackay (Figure 1). Logbook data indicate this sector expends about 6,500 boat-days of fishing effort annually, producing an average catch of about 400 t of prawns, valued at A\$2.4 million in 1996 (Reid and Campbell 1999). Target species consist mainly of greasyback prawns (*Metapenaeus bennettiae*), school prawns (*M. macleayi*) and banana prawns (*Penaeus merguensis*), marketed locally for consumption or recreational fishing bait. Trawling occurs mostly during the day, but may extend into the night, depending on the abundance of prawns. Beam trawling is not permitted on weekends.

Bycatch issues

The fishery is highly visible occurring in rivers and inshore areas, close to several population centres (Brisbane, Bundaberg, Rockhampton and Mackay). The main issues in this sector are: i) conflict with recreational fishers over the catch of juvenile angling species such as bream, whiting and flathead, ii) concerns about the disturbance to benthic communities and habitat structure by recreational fishers and conservation groups, and iii) conflict with the otter-trawl sector over the size of the prawns caught (i.e. debate over whether to harvest abundant small size-classes in rivers or fewer and larger size-classes offshore). Public perception of the composition, amount and ecological impact of the bycatch varies widely.

Table 1. Sectors of the Queensland Trawl Fishery: a summary of bycatch.

Sector and target species	Catch & value (tonnes, A\$ millions)	Effort (avg. days fished)	Bycatch issues	Bycatch extent & characterisation	Preliminary bycatch estimates
River & inshore beam trawl <i>Metapenaeus macleayi</i> <i>M. bennettiae</i> <i>Penaeus merguensis</i>	400 t A\$2.4 m	6,500	Catch of juvenile prawns; impact on benthic habitat; catch of angling species	2 bycatch studies, 2 bioeconomic bycatch studies; several species are recreationally or commercially important fish, average bycatch:catch ratio 3.5:1	1,415 t bycatch
Otter trawl					
Moreton Bay <i>M. bennettiae</i> <i>P. esculentus</i> <i>P. plebejus</i>	640 t A\$4.5 m	11,500	Catch of angling species, blue swimmer crabs, and sea turtles; impact on benthic habitats; public perception	52% crustaceans; bycatch:catch ratio 3.2:1 to 6:1; bycatch rate about 35 kg/hr	4,000 t bycatch (1,700 t – 6,300 t) 3,000 sea turtles caught annually
Eastern king prawn <i>P. plebejus</i>	1,800 t A\$25 m	18,500	Mostly relate to effort in inshore areas (i.e. <20 m); include sea turtle catch, and fish washups on beaches; occurs partially within the GBRWHA	66%–86% fish; bycatch greatest inshore; bycatch:catch ratio for inshore 11.2:1 (but highly variable)	Unknown total bycatch weight. 250 sea turtles caught annually
Scallop <i>Amusium balloti</i> <i>A. pleuronectes</i>	1,200 t A\$30 m	12,700	Catch of sea turtles and sea snakes; impact on benthic habitat; occurs within the GBRWHA	No comprehensive studies; bycatch unquantified	Unknown total bycatch weight 200 sea turtles caught annually
Banana prawn <i>P. merguensis</i> <i>P. indicus</i>	600 t A\$6 m	5,000	Fish washups on public beaches; a highly visible inshore day-time fishery; catch of angling species and sea turtles; occurs mostly within the GBRWHA	8 species accounted for 50% of all individuals in samples of commercial bycatch; highly skewed bycatch:catch ratio; average bycatch:catch ratio of 5:1	Unknown total bycatch weight, study underway 350 sea turtles caught annually
Red spot king prawn <i>P. longistylus</i> <i>P. latissulcatus</i>	800 t A\$9 m	13,000	Impact on benthic habitat; damage to benthos; catch of sea turtles and sea snakes; occurs within the GBRWHA	High species diversity; bycatch dominated by fish; variable depending on location; bycatch catch rates of 55 kg/hr	8,000 t bycatch 65 sea turtles caught annually
Tiger & endeavour prawn <i>Penaeus esculentus</i> <i>P. semisulcatus</i> <i>P. monodon</i> <i>Metapenaeus ensis</i> <i>M. endeavouri</i>	3,200 t A\$45 m	27,000	Fish bycatch washups on beaches; catch of angling species, sea turtles and sea snakes; impact on benthic habitat; occurs within the GBRWHA	Dominated by fish (75%); variable depending on location; high bycatch:catch ratios; bycatch catch rates of 38 kg/hr	10,260 t – 19,200 t bycatch 1,600 sea turtles caught annually
Stout whiting <i>Sillago robusta</i>	2,400 t A\$4 m	12,500 hrs	Some conflict with prawners; occasional catch of sea turtles	Mostly fish; highly variable; avg 3.3:1; likely to be reduced due to marketing of bycatch species	unknown

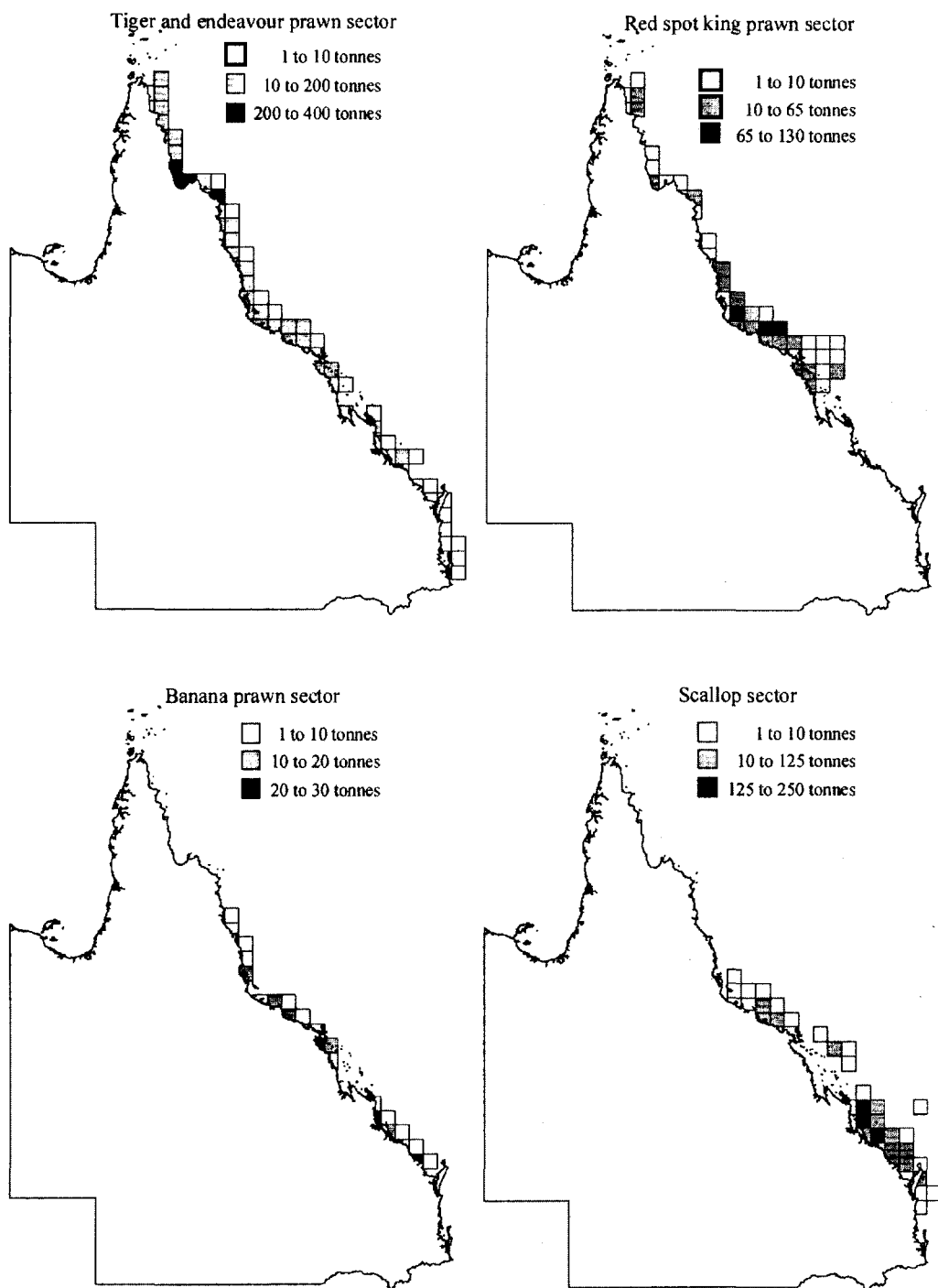


Figure 1. Spatial distribution of the average annual catch within eight sectors of the Queensland Trawl Fishery. Landings are derived from the commercial logbook database held by the Queensland Fisheries Management Authority and are pooled across 30 nautical mile grids, except for Moreton Bay and the beam trawl sector (pooled by management area).⁴Estimates for the beam trawl sector are derived from Reid and Campbell (1999).

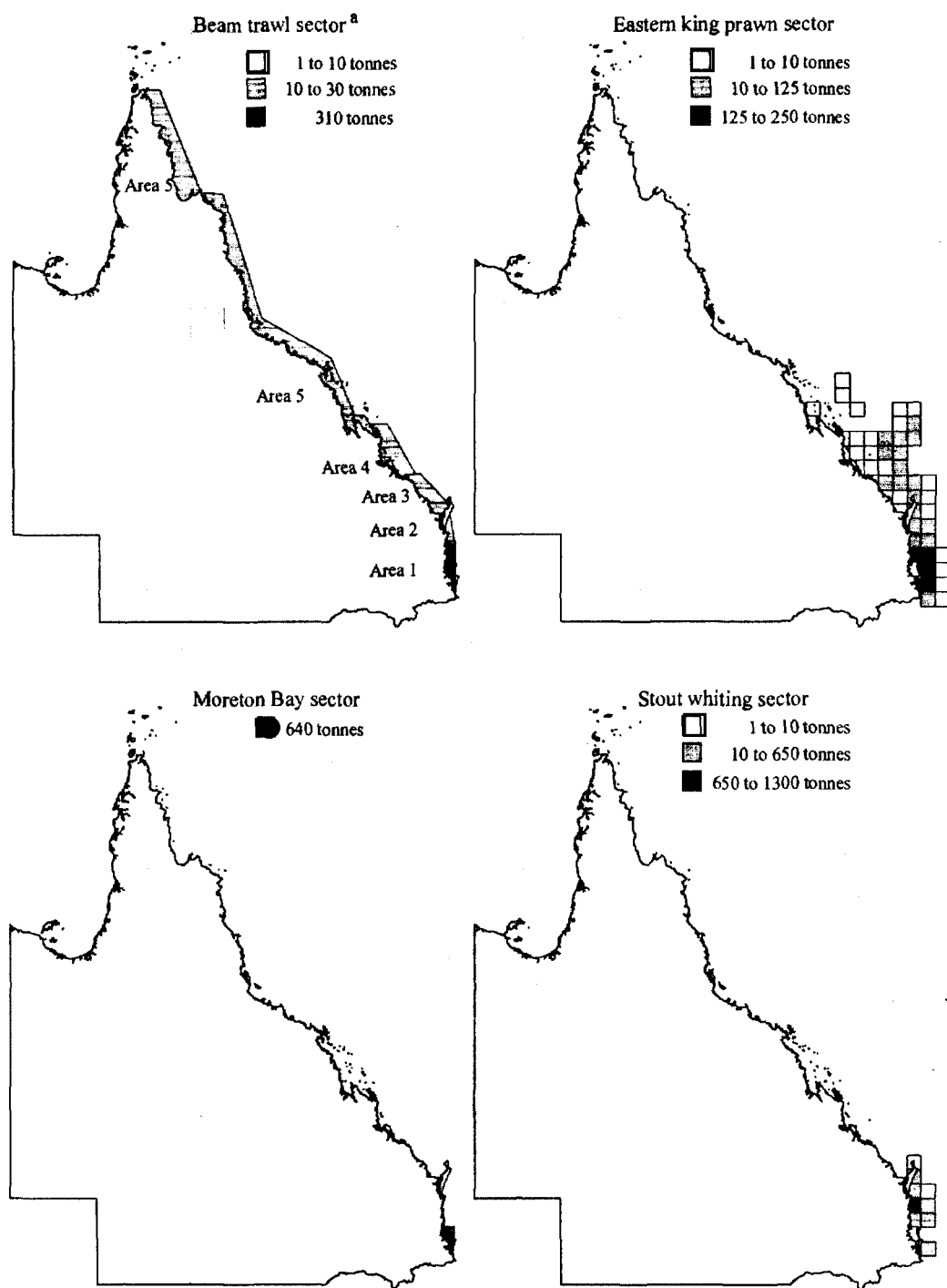


Figure 1. cont.

Extent and characterisation of the catch

There have been two main studies of bycatch in Queensland beam trawl fisheries (Dredge 1983; Hyland 1988). Dredge (1983) examined the bycatch of beam trawlers operating in the Burnett River, near Bundaberg. He recorded 108 fish species, nine of which were important commercially or recreationally. These were dusky flathead (*Platycephalus fuscus*), bar-tailed flathead (*Platycephalus indicus*), gold-lined whiting (*Sillago analis*), winter whiting (*Sillago maculata*), grunter (*Pomadourys* spp.), yellowfin bream (*Acanthopagrus australis*), jew (*Argyrosomus hololepidotus*), king salmon (*Polydactylus sheridani*) and sea mullet (*Mugil cephalus*). Three species comprised over 67% of the total number of fish caught. These species were dollar fish (*Leiognathus* sp.), catfish (*Neonarius australis*) and perchlet (*Ambassis marianus*). Dredge (1983) commented that it was difficult to interpret the implications of the beam trawl bycatch without some knowledge of the stocks of the fish that are caught. The incidental catch of some species was variable through time, making extrapolations difficult. One of the possible environmental effects of this fishery was the removal of fallen mangrove timber that may act as habitat for some species.

Hyland (1988) reported 93 species from 51 families in bycatch from the beam trawl fishery in the Moreton region (southeast Queensland). The composition of beam trawl catches by major taxonomic group were also reported (Table 2). Sixty-nine fish species occurred in samples from the Logan, Brisbane, Pine and Caboolture Rivers. Hyland (1988) reported a high diversity of fish species in river beam trawls, although most species captured were numerically scarce. The 12 most common fish species were southern herring (*Harengula castelnaui*), river perch (*Johnius vogleri*), silver biddy (*Gerres oyeana*), winter whiting (*Sillago maculata*), yellowfin bream (*Acanthopagrus australis*), perchlet (*Ambassis marianus*), estuary

catfish (*Arius australis*), puttynose perch (*Polydactylus multiradiatus*), trumpeter (*Pelates quadrilineatus*), siphonfish (*Siphamia roseigaster*), weeping toadfish (*Spheroides pleurostictus*) and estuary anchovy (*Thrissina aestuari*). About 10 had importance as recreational or commercial species. These included river perch (*Johnius vogleri*), winter whiting (*Sillago maculata*), sea mullet (*Mugil cephalus*), yellowfin bream (*Acanthopagrus australis*), tailor (*Pomatomus saltatrix*), golden trevally (*Gnathanodon speciosus*), gold-lined whiting (*Sillago analis*), tarwhine (*Rhabdosargus sarba*), summer whiting (*Sillago ciliata*) and dusky flathead (*Platycephalus fuscus*). Hyland (1988) reported that the survival of fish bycatch from beam trawls was variable. Yellowfin bream (*Acanthopagrus australis*) was suggested to be resilient to beam trawling, while river perch (*Johnius vogleri*) suffered high trawl-induced mortality.

Estimate of total bycatch

Hyland (1988) noted that while crude estimates of the total beam trawl bycatch could be obtained by extrapolation, it would not be possible to quantify mortality rates from beam trawling without some knowledge of the natural mortality rates of the populations in question. Using an annual total catch of 400 t of prawns (Reid and Campbell 1999) and Hyland's (1988) breakdown of the catch composition from the Logan River (Table 2), the total tonnage of bycatch from Queensland's beam trawl fishery is estimated to be in the order of 1,415 t per year.

Reid and Campbell (1999) undertook a bioeconomic analysis of the impact of beam trawling on both recreational and offshore trawl fishing sectors in Queensland. They partitioned the beam trawl fishery into four areas and estimated the impact for each area. Species of recreational importance, determined from recreational fisher surveys, included yellowfin bream, flathead, river perch, trevally, tailor,

Table 2. Composition of beam trawl catches from the Logan River (Hyland 1988).

Taxonomic Group	Catch (by weight) (%)
Penaeidae	22.04
Sergestidae	0.08
Caridae	1.92
Squillidae	0.02
Teuthoidae	0.08
Brachyura	5.76
Elasmobranchii	6.68
Teleostomi	63.42
– catfish	39.14
– ‘trash’	7.8
– potential bait fish	0.66
– food fish	15.82

mullovey and grunter. The analysis concluded that returns from beam trawling in the main fishery area (Double Island Point to the NSW border) were more than sufficient to justify the long-term continuation of the current level of investment in the fishery. In two other areas they found that returns were sufficient, but not quite sufficient in the fourth area to justify current levels of investment.

Beam trawl operators have often used ‘blubber chutes’ (grid-like structures in the trawl codend) to reduce catches of jellyfish. Recently, researchers involved in the FRDC-funded project to extend the use of bycatch reduction devices (Project No. 96/254 *Commercialisation of bycatch reduction strategies and devices into northern Australian prawn trawl fisheries*), have noted an increase in the development and use of grids by beam trawl operators to further reduce catches of fish and other bycatch species (J. Robins, pers. comm.). Although the impact of the devices is unquantified at present, anecdotal evidence suggests that they are likely to reduce the weight of the bycatch by about 20%.

The stout whiting sector

This relatively new fishery has developed since 1991 and consists of five vessels with endorsements to target stout whiting (*Sillago robusta*) using modified prawn trawls. The entire catch is exported and valued at about A\$4 million annually. Standard prawn trawl nets are modified for targeting stout whiting by adding sweeps of about 120 m length, between the net and the otter-boards. Operators target schools of stout whiting, mainly between the 40 and 100 m depth contours from Sandy Cape (24°42’S, 153°15’E) to Caloundra (26°48’S, 153°8’E). Although officially closed between 1st January and 31st March, fishers continue fishing for stout whiting during this period using standard, non-modified, prawn trawl nets. Fishing effort was estimated to be about 12,500 hrs per year, with a catch of about 2,400 t (Williams 1997).

Bycatch issues

There is some conflict between the stout whiting trawl sector and the established prawn

Table 3. Composition of total catch in samples from the stout whiting fishery (A. Butcher, unpublished data).

Grouping	Average weight of total catch (%)
Target species	22.7
Commercial non-target fish	1.2
Recreational fish	4.6
Fish of no commercial or recreational value	62.8
Crustaceans	2.2
Mollusca	5.7
Others	0.9

trawl sector that operates concurrently in the same areas. In March 1998, a number of dead loggerhead turtles (*Caretta caretta*) washed ashore in the Southport area. The deaths were attributed by some to the stout whiting sector and by others to the prawning sector. Another bycatch issue within this sector is the extent of unwanted fish bycatch. Nets used in the trawl whiting fishery are modified to herd and catch fish, and therefore the fish bycatch is likely to differ from that of prawn trawlers operating in the same area. Anecdotal evidence suggests that because the bottom type in the fishery is predominantly bare sand, the impact of trawling on benthic habitats is likely to be relatively low (Gibbs *et al.* 1980).

Extent and characterisation of catch

The stout whiting sector has been required to use observers and to allow catch samples to be taken by researchers because it is a developmental fishery. Bycatch was recorded as part of the monitoring process and includes two species of shark, three species of ray, 68 species of fish, 17 species of crustaceans and isopods, five families of echinoderms, several species of mollusc as well as bristle worms, whips and sea salps (A. Butcher pers. comm. 1998). Stout whiting ranged from 1.5% to 60.0% of the total

catch, but averaged 22.7% (Table 3). Teleost fish dominated the bycatch. Species of other commercial or recreational value averaged 5.8% of the total catch (range 1% to 10%) and included tailor (*Pomatomus saltatrix*), flathead (*Platycephalus* sp.), mackerel (*Scomberomorus* spp.) and spangled emperor (*Lethrinus nebulosus*). Operators in this sector have since developed markets for some of the bycatch fish species, such as *Nemipterus* sp.. The effect of utilising some of the bycatch would be to lower the bycatch:catch ratio that was recorded during the sampling program.

Two of the five operators have voluntarily adopted turtle excluder devices (TEDs). The TEDs not only reduce the incidence of turtle captures, but the fishers involved have also reported lower incidental captures of large stingrays.

The Moreton Bay sector

The Moreton Bay sector differs from others in the Queensland Trawl Fishery, in that it is primarily defined by location rather than by catch composition (Figure 1). It also has separate management measures relating to maximum vessel length, trawl-net head-rope length and mesh size (Anonymous 1998).

Table 4. Estimates of total annual bycatch from the Moreton Bay trawl fishery. Assuming a) 640 tonnes of prawns caught in Moreton Bay per year, b) 10 hours of trawling per night, c) 11,500 nights trawled per year. Ranges determined using upper and lower 95% confidence intervals of mean bycatch catch rates.

Source	Bycatch ratios and catch rates	Method	Estimate of bycatch (tonnes)	Bycatch range (95% CL) (tonnes)
Wassenberg & Hill (1989, 1990)	6:1 discards:catch	Ratio	3840	—
	36±8.9 kg/hr trawled	CPUE	4140	2093–6187
QDPI (unpublished data)	3.2:1 (discards:catch)	Ratio	2048	—
	34.6±10.3 kg/hr trawled	CPUE	3910	1657–6300

Logbook data indicate that an average of about 640 t of prawns was trawled from Moreton Bay annually for the period 1991 to 1996. The fishery recorded an average of 11,500 boat-days of effort over the same period; accounting for about 14% of the total effort in the Queensland Trawl Fishery. Effort peaks in January and declines to a minimum in July. The main species are greasyback prawns (*Metapenaeus bennettiae*), eastern king prawns (*Penaeus plebejus*) and brown tiger prawns (*P. esculentus*). Fishers commonly retain and market several smaller or less abundant species, including endeavour prawns (*Metapenaeus endeavouri*, *M. ensis*), hardback prawns (*Trachypenaeus fulvus*) and New Guinea prawns (*Metapenaeopsis novaeguineae*). Squid and blue swimmer crabs are also retained for marketing and make a significant contribution to fishers' incomes.

Bycatch issues

Bycatch and the effects of trawling in Moreton Bay have received considerable attention mainly because of the close proximity to the city of Brisbane. Incidental catch of fish is a source of ongoing conflict between recreational fishers and trawler operators. Species of particular concern are bream, snapper, whiting and flathead. There is also conflict between trawler operators in Moreton Bay and those operating farther offshore over the size at which eastern

king prawns are harvested. Eastern king prawns move rapidly through the bay as they undertake a northern, seaward migration. Moreton Bay also supports significant populations of loggerhead turtles and green turtles (*Chelonia mydas*). Sea turtles are a relatively frequent catch of Moreton Bay trawlers (i.e. >1 per week per vessel, (Robins 1995) and there is concern over the impact of this capture on population numbers (Limpus and Reimer 1994).

Extent and characterisation of catch

Several studies have been undertaken on the sub-littoral, benthic fauna of Moreton Bay. While some of these studies have addressed broad ecological objectives (Jones 1973; Burgess 1980; Stephenson *et al.* 1982a; Stephenson *et al.* 1982b), others have focused on the problem of trawl bycatch (Wassenberg and Hill 1989; Robins 1995; Robins-Troege *et al.* 1995).

Stephenson *et al.* (1982a, b) examined factors affecting the catch rates and distribution of species trawled from three sites in Moreton Bay, sampled monthly for 13 months. They recorded 117 species and based their analyses on 60 to 70 species that were represented frequently in the catches. The most numerically dominant species, apart from prawns, included small fish (*Leiognathus* spp., Apogonidae, *Paramonacanthus* spp.) and crabs (*Charybdis callianassa*). Trawl site

was generally the most important factor affecting catch rates, followed by time of day and then port/starboard net and tidal direction. A high proportion of species showed strong annual cycling, with prevailing warm and dry conditions affecting abundance of many species between years.

Wassenberg and Hill (1989) reported a bycatch composition by weight of 52% crustaceans, 15% elasmobranchs, 8% bony fish, 18% echinoderms, 3% cephalopods and 4% debris. They reported that 85% of crustaceans survived trawling (8 hours after capture) while only about 20% of teleost fish survived. The average weight of discards collected per trawl was 36 kg (s.d. = 8.9, n = 12).

Research trials of TEDs in northern and western Moreton Bay found that non-commercial bycatch accounted for 85% to 95% (by weight) of the total catch in standard commercial nets (Robins-Troeger *et al.* 1995). Seventy-nine species of teleost fish, three species of ray and 15 species of invertebrates were recorded in bycatch samples. Dominant fish species (by weight) were cardinal fish (*Apogon poecilopterus*, *A. fasciatus*), grinders (*Saurida undosquamis*), ponyfish (*Leiognathus moretoniensis*), red bigeye (*Priacanthus macracanthus*), long-tailed catfish (*Euristhmus lepturus*), puttynose perch (*Polydactylus multiradiatus*) and siphonfish (*Siphamia roseigaster*). Several species of recreational importance were also caught, including tailor (*Pomatomus saltatrix*), gold-lined whiting (*Sillago analis*), mackerel (*Scomberomorus* sp.) and snapper (*Pagrus auratus*) (QDPI unpublished data). Commercial trials of TEDs in eastern and southern Moreton Bay recorded an average bycatch:prawn catch ratio of 3.2:1 ($\cong$ 76% bycatch by weight) in standard nets during November 1995 (QDPI unpublished data). This ratio decreased to 1.8:1 ($\cong$ 64% bycatch by

weight) if marketable bycatch (blue swimmer crabs and squid) was included. Average weight of bycatch per hour of trawling was 34.6 kg (s.d. = 10.3, n = 37), similar to that reported by Wassenberg and Hill (1989).

Estimates of total bycatch

Estimates of the total annual bycatch from the Moreton Bay trawl fishery are provided in Table 4. Two estimates are made using the ratio method (i.e. total prawn catch x bycatch:prawn catch ratio) and two using the CPUE method (i.e. bycatch per unit effort x total effort). Estimates range from 1,657 t to 6,187 t per year.

The impact of trawling on sea turtles has received considerable public attention and was the subject of a research project aimed at estimating the total catch and mortality of sea turtles within the Queensland Trawl Fishery. Robins and Mayer (1998) estimated 3,199 ($\pm$ 325 s.e.) turtles are caught annually by Moreton Bay trawlers. Most were loggerhead turtles, (*Caretta caretta*) (76%), with virtually all of the remainder (21%) being green turtles, (*Chelonia mydas*). The low reported mortality rate of less than 1% appears to reflect the relatively short tow durations (i.e. <90 mins., avg. 76 mins) characteristic of the Moreton Bay fishery (Robins and Mayer 1998).

The eastern king prawn sector

This fishery is based on a single species (*Penaeus plebejus*), comprised of a single straddling stock shared between New South Wales and Queensland. In Queensland, the fishery occurs in waters south of 21°S to the Queensland/New South Wales border (28°S). It produces about 1,800 t of eastern king prawns annually and accounts for about 20% of total effort in the Queensland Trawl Fishery. The main difference between the eastern king prawn fishery and the other trawl sectors is that fishing occurs farther offshore (up to 250 km) in

deeper, more oceanic waters to depths of about 300 m (Figure 1). Tagging studies have shown *P. plebejus* undertakes a significant migration, generally in a northerly direction (Ruello 1975; Glaister *et al.* 1987; Montgomery 1990). Individuals remain in shallow estuaries and embayments for very short periods (Lucas 1974; Coles and Greenwood 1983) before migrating. The fishery tracks the movement of the prawns, beginning early in the season as an inshore fishery, then moving to offshore waters later in the season.

Bycatch issues

Despite the high level of fishing effort in this sector of the trawl fishery (about 18,500 boat-days per year), bycatch from the eastern king prawn fishery has generated comparatively little social or political concern in Queensland. This is because fishing occurs predominantly at night and well offshore. Occasionally, fish bycatch washes onto adjacent beaches causing public concern. In addition, the Queensland Environmental Protection Agency expressed concern over recent catches of sea turtles by vessels near the Southport bar by trawlers targeting school prawns and eastern king prawns.

Extent and characterisation of catch

There is scant information on the composition or quantity of bycatch in the eastern king prawn sector of the Queensland Trawl Fishery. Preliminary information on bycatch rates and species composition was collected during commercial trials of the AusTED in shallow waters adjacent to Fraser Island (Robins *et al.* 1997). Bycatch:prawn catch ratio averaged 11.2:1 in standard commercial nets, but was highly variable (s.d. = 10.27, $n = 32$). This is similar to a bycatch:prawn catch ratio of 8.8:1 reported at inshore sites of the NSW eastern king prawn fishery during commercial testing of square-mesh panels by NSW Fisheries (Broadhurst and Kennelly 1997). There is some

evidence to suggest that the bycatch:prawn catch ratios decline as depth and distance offshore increase (Broadhurst and Kennelly 1997).

Samples of bycatch collected from standard trawl nets during the commercial trials of the AusTED adjacent to Fraser Island contained 68 species of fish, 18 species of crustaceans and a limited number of molluscs and cephalopods (Robins *et al.* 1997). Fish comprised between 66% and 85% of the bycatch. The 10 most abundant fish species were stout whiting (*Sillago robusta*), leatherjacket (*Paramonacanthus filicauda*), tongue sole (*Paraplagusia* sp.), toadfish (*Torquigener hicksii*), flathead (*Platycephalus longispinus*, *P. arenarius*, *Sugggrundus harrisi*), grinnners (*Saurida* sp.), spiny headed flounder (*Engyprosopon grandisquama*) and red spot gurnard (*Lepidotrigla argus*). Other species particularly abundant in the samples were blue swimmer crab (*Portunus pelagicus*), three spot crab (*Portunus sanguinolentus*) and saucer scallop (*Amusium balloti*).

Estimates of total bycatch

The total tonnage of bycatch produced by the eastern king prawn sector is unknown and the preliminary data collected during commercial TED trials are insufficient for use in estimating the bycatch. Sea turtle bycatch was estimated to be 246 (± 36 s.e.) turtles per year (Robins and Mayer 1998). Species composition was predominantly loggerhead turtles (47%) and green turtles (36%), caught incidentally during trawling in shallow, coastal waters (i.e. <40 m). In general, the incidence of trawl-induced turtle mortality in this sector was rare (Robins and Mayer 1998), partly because relatively few turtles were caught.

The scallop sector

Scallops are taken throughout the Queensland Trawl Fishery but are caught mainly between Hervey Bay (25°S) and Hydrographers Passage

(20°42'S). Annual catch is about 1,200 t (meat weight) valued at about A\$30 million (Williams 1997). The catch consists of two species. *Amusium balloti*, often referred to as the reef scallop, is caught predominantly in southern offshore waters, while *Amusium pleuronectes*, also known as the mud scallop, is caught predominantly in northern inshore waters. The trawl nets used for scalloping have a larger mesh size and thicker ply (60 ply) than those used by prawn trawlers. *Amusium* spp. has a comparatively good swimming ability and readily swims up off the bottom when disturbed by the trawl gear. Underwater video footage of scallop trawls contacting the sea floor suggests the gear has a similar mode of operation and impact to that of prawn trawls (QDPI unpublished video footage).

Bycatch issues

This sector has a relatively low profile with respect to bycatch because it occurs predominantly in waters that are several kilometres from the coast. Sponges commonly occur in the bycatch and there is concern over incidental catches of sea turtles and sea snakes. The ecological sustainability of scallop trawling is a bycatch issue in this sector, particularly because much of the sector occurs within the Great Barrier Reef World Heritage Area.

Extent and characterisation of catch

Bycatch from the scallop sector has not been comprehensively documented. In some areas, the composition of the bycatch is likely to be similar to that of the tiger prawn or red spot king prawn sectors as the trawl nets used by these sectors are similar. The main difference is mesh size; the mesh size used during scallop trawling is larger (75 mm) than that used during prawn trawling (38 to 60 mm). Anecdotal reports from commercial fishers suggest that sea snakes occur in the bycatch, but their frequency of occurrence is unknown. The composition of

the bycatch is currently being examined using samples collected from an annual stock assessment survey of the scallop fishery (M. Dredge, pers. comm. 1998).

Estimates of total bycatch

At present no reliable estimates of total bycatch can be made due to a lack of data. Sea turtle bycatch was estimated to be 203 ($\pm$ 74 s.e.) turtles per year (Robins and Mayer 1998), comprised mainly of loggerhead turtles (39%), green turtles (27%) and flatback turtles (*Natator depressus*) (27%).

The banana prawn sector

Compulsory logbook data indicate an average of 600 t of banana prawns (*Penaeus merguensis*), worth about A\$6 million, are caught in Queensland coastal waters annually (Williams 1997). Catches are strongly influenced by rainfall and show greater yearly variation compared with other prawn species. Most of the catch is taken between 17°S and 25°S in selected areas off Cairns, Townsville, Mackay, Gladstone and Bundaberg (Figure 1). The fishery is seasonal with most of the catch landed between February and May. This sector is relatively small, representing 5–10% of total effort in the Queensland Trawl Fishery (Table 1).

Bycatch issues

Despite the fishery's relatively small scale, bycatch from the banana prawn trawl sector has attracted a great deal of social and political concern. This disproportionately high level of concern is due largely to trawling operations and trawling discards being highly visible to the residents of coastal towns. Fishing takes place during daylight in shallow (<15 m) coastal or estuarine waters. As a consequence, bycatch sometimes washes up onto beaches where it is encountered by recreational fishers, tourist operators or local residents. Conservationists have expressed concern over

Table 5. Numerically dominant bycatch taxa in the Queensland banana prawn trawl fishery, collectively accounting for about 50% of all individuals found in the bycatch. Data are preliminary and based on a current FRDC-funded study (A. Courtney, unpublished data).

Species	Number in samples	Composition of total bycatch (%)
<i>Leiognathus splendens</i>	15,026	9.1
<i>Johnius vogleri</i>	12,532	7.6
<i>Charybdis callianassa</i>	11,769	7.1
<i>Leiognathus bindus</i>	11,557	7.0
<i>Pomadasys maculatum</i>	8,263	5.0
<i>Metapenaeus</i> sp.	8,091	4.9
<i>Caranx para</i>	7,907	4.8
<i>Terapon theraps</i>	7,192	4.4

the incidence of threatened sea turtles that are caught, while recreational fishers are particularly concerned over the impact on angling species.

Extent and characterisation of catch

A research project funded by FRDC (Project No. 96/257 *Ecological sustainability of bycatch and biodiversity in prawn trawl fisheries*) is in progress and includes a component to describe bycatch from the Queensland banana prawn trawl sector. Preliminary results from this study, based on sub-samples from 184 standard net trawls, indicate that the bycatch is comprised of about 316 species, and characterised by small demersal fish, pelagic fish, portunid crabs and penaeid prawns. Eight species comprise about 50% of all individuals in the bycatch (Table 5). Pony fishes (Leiognathidae) numerically dominate, accounting for about 24% of all individuals sampled, followed by penaeid prawns (other than banana prawns). Other numerically important species include the sharp-toothed croaker (*Johnius vogleri*), a small portunid crab (*Charybdis callianassa*) and blotched javelin-fish (*Pomadasys maculatum*). Composition of the

bycatch varies with latitude and distinct groups can be discerned along the coast. The bycatch:prawn catch weight ratios are highly variable and display a skewed distribution with a mode at about 5:1. Two green turtles and sea snakes were part of the bycatch. The most common sea snake was *Lepemis hardwickii* (141 individuals), followed by *Hydrophis elegans* (43), then by *Disteira major* (6) and *Disteira kingii* (4). Sea snake catch rates averaged about 1.0 individual per trawl per net.

During commercial trialing of bycatch reduction devices (BRDs), the bycatch:prawn catch ratios of standard nets was highly variable, ranging from 1.4:1 to 19.4:1, but averaged at 2.7:1 (J. Robins, unpublished data). The prawn catch represented 27% of the total catch, but ranged from 4.91% to 41.35% ($n = 35$ tows sampled).

Estimates of total bycatch

Estimates of total bycatch in the banana prawn sector will be an output of the above FRDC project. Sea turtle bycatch was estimated to be 342 (± 79 s.e.) turtles per year (Robins and

Table 6. Abundance and biomass of taxonomic groups, from Jones and Derbyshire (1988).

Group	Abundance of taxa		Abundance of individuals (%)	Biomass (%*)
	Number	%		
Pisces	272	57	38.3	75
Crustacea	91	19	41.8	20
- 30% portunid crabs				
- 61% coral prawns				
- 8% commercial prawns				
Echinodermata	50	11	15.8	2
Mollusca	49	10	3.7	1
Other animals	15	3	0.4	2

*estimated

Mayer 1998). Species composition was 41% green turtles, 38% loggerhead turtles and 16% flatback turtles.

The red spot king prawn sector

A trawl fishery for red spot king prawns (*Penaeus longistylus*) and blue-leg king prawns (*Penaeus latisulcatus*) occurs in offshore waters within the Great Barrier Reef lagoon, mainly north of 21°S (Figure 1). Red spot king prawns are caught generally in the vicinity of reefs and account for about 70% of the catch. Fishers generally do not differentiate between the two species when recording their catch. Logbook data indicate a total of about 800 t are landed annually.

Bycatch issues

Bycatch issues in this sector include: i) the impact of trawling on benthic communities, habitat structure and the adjacent reef ecosystem, ii) the catch of threatened and protected species, such as sea turtles, sea snakes and pipefish, and iii) the effect of trawling on the World Heritage values of the area.

Extent and characterisation of catch

Several studies have documented the trawlable fauna of parts of this sector (Jones and Derbyshire 1988; Dredge 1988, 1989; Watson and Goeden 1989; Watson *et al.* 1990). Jones and Derbyshire (1988) reported 477 taxa from their trawl survey, of which 3.8% had commercial importance. Fish comprised an estimated 75% of the weight of the bycatch (Table 6). Flatfish (Bothidae and Paralichthyidae), goatfish (Mullidae), leatherjackets (Monacanthidae), grinders (Synodontidae) and threadfin bream (Nemipteridae) dominated the catch by numbers. Few species were considered to be typical of coral reef associated fishes.

Watson and Goeden (1989) reported that about 4% of bycatch had some commercial value. In total, 38% of the bycatch were fish and 42% crustaceans (by number). Dredge (1988) reported bycatch weights of 18 kg to 30 kg (30 minute tows, 6 fathom nets) during research sampling of inter-reef sites. He suggested there was a seasonal change in the biomass of the bycatch which decreased from May until December.

Table 7. Discards by taxonomic group from 43 inter-reef trawls in the Green Zone, reproduced from Poiner *et al.* (1999).

	Number (%)	Weight (%)
All fish	64	60
All sponges	na	7
Hard corals	0	3
All crustaceans	25	13
Crabs (brachyurans) only	23	10
All molluscs	7	4
Bivalves only	6	1
Cephalopods only	1	1
All echinoderms	2	7
Total number or weight analysed	13,768	564 kg

Watson *et al.* (1990) reported that there was little clear pattern in the abundance of species between the wet and dry seasons in north Queensland. They used similarity measures and multi-dimensional scaling to group bycatch assemblages from several sites sampled by demersal trawls each month for two years. Faunal composition was more affected by the location of the sites than by time. Inter-reef sites in the study had high abundances of *Metapenaeopsis* spp., *Penaeus longistylus* and *Portunus tenuipes*. The bycatch was characterised by large numbers of threadfin bream (*Nemipterus celebicus*), grubfish (*Parapercis nebulosa*), oblong leatherjacket (*Paramonacanthus japonicus*) and a crab (*Portunus argentatus*).

A recent study in the northern Great Barrier Reef assessed the impact of trawling on areas open and closed to commercial trawling (Poiner *et al.* 1999). The study also collected information on the trawlable fauna of the cross-shelf closure (about 12°S) and adjacent areas. The mean catch rate of fish bycatch was 13.1 kg/hr, in research trawls in offshore/inter-reef (= inter-shoal) sites. The mean catch rate of invertebrate bycatch was 41.9 kg/hr. Fish were the dominant taxonomic group (Table 7).

While anecdotal reports suggest that sea snakes are likely to contribute to bycatch, there is scant information on their catch rates or composition for this sector.

Estimate of total bycatch

Two preliminary estimates of the total annual weight of bycatch in the red spot king prawn sector were made. The first, using the ratio method, estimated total bycatch to be in the order of 8,000 t, based on an average offshore bycatch:prawn catch ratio of 10:1 (Hill *et al.* 1999) and a total red spot king prawn catch of 800 t (Table 8). The second estimate used the CPUE method and was based on the product of a nightly bycatch (fish + invertebrates) of 550 kg per vessel (Hill *et al.* 1999) and an average total fishing effort of 13,000 boat-nights (Robins and Mayer 1998), resulting in an estimate of 7,150 t (Table 8). Although these estimates are similar, their reliability is largely dependent upon the assumptions and representativeness of the sampled bycatch rates. Sea turtle bycatch was estimated to be 65 ($\pm$ 45 s.e.) turtles per year and comprised of 46% flatback turtles, 20% green turtles, 20%, loggerhead turtles and 13% Pacific ridley turtles (*Lepidochelys olivacea*) (Robins and Mayer 1998).

Table 8. Preliminary estimates of total annual bycatch in the red spot king prawn sector.

Source	Discard data	Method	Mean (tonnes)
Hill <i>et al.</i> (1999) QFISH logbook data	10:1 discard in offshore areas, assume 800 t prawn catch	Ratio	8,000 t
Hill <i>et al.</i> (1999), Robins and Mayer (1998)	55 kg/hr x 10 hrs x 13,000 nights effort	CPUE	7,150 t

The tiger and endeavour prawn sector

Tiger prawns (*Penaeus esculentus*, *P. semisulcatus*, *P. monodon*) and endeavour prawns (*Metapenaeus endeavouri*, *M. ensis*) are the main target species of trawlers working the coastal, inshore waters of the Queensland coast north of about Mackay (21°30'S). This is a major sector of the Queensland Trawl Fishery, representing 32% of total effort and valued at A\$45 million per year (Williams 1997). It occurs primarily within the Great Barrier Reef World Heritage Area.

Bycatch issues

Bycatch issues pertain to: i) the impact of trawling on benthic habitats, benthic communities and the ecosystem, ii) the impact on threatened and protected species such as sea turtles, sea snakes, saw fish and pipefish, iii) the washup of dead fish on public beaches and iv) the World Heritage status of much of the trawled area.

Extent and characterisation of catch

Research on the tiger and endeavour prawn sector has been focussed primarily on the target species, but a number of studies have characterised the bycatch in certain areas in north Queensland; (Dredge 1988; Dredge 1989; Jones and Derbyshire 1988; Watson and Goeden 1989; Watson *et al.* 1990). The inshore and coastal sites examined in these studies (Townsville to Lucinda) include tiger prawn trawl grounds in the central Great Barrier Reef. Coastal sites sampled with an 11 fathom net (30 minute tows) had an average sample

bycatch of 13 to 19 kg (Dredge 1988). Bycatch weights at inshore sites were more variable, ranging from 25 kg to 54 kg per sample. The study also identified some seasonal variation, with the biomass of bycatch peaking in May and falling to a minimum in November. Watson *et al.* (1990) reported that variation in bycatch weight was not related to the proximity to the coast, nor was it related to depth or any of the other physical parameters recorded. Coastal sites that were considered typical tiger prawn trawl ground yielded large numbers of javelinfish (*Pomadourys trifasciata*), grinner (*Saurida tumbil*), goatfish (*Upeneus sundaicus*), dragonet (*Callionymus belcheri*), redspot monocle bream (*Scolopsis taenipterus*), naked headed catfish (*Euristhmus nudiceps*), mud scallop (*Amusium pleuronectes*) and toadfish (*Torquigener whitlei*). They were also characterised with higher numbers of twin banded rock cod (*Epinephelus sexfasciatus*), large scaled grunter (*Terapon theraps*) and a crab (*Charybdis truncata*) than sites representative of the red spot king prawn sector (Watson *et al.* 1990).

The recent study located in the northern Great Barrier Reef (Hill *et al.* 1999) also collected information on the trawlable fauna of the cross-shelf closure (about 12°S) and adjacent areas. Research trawls reported a mean fish catch rate in inshore (= lagoon) areas of 17.2 kg/hr and an invertebrate catch rate of 13.1 kg/hr. Fish were the dominant taxonomic group in the discards (Table 9, Chapter 6, Poiner *et al.* 1999).

Table 9. Discards by taxonomic group from 79 inshore trawls in the Green Zone, reproduced from Poiner *et al.* (1999).

	Number (%)	Weight (%)
All fish	74	72
All sponges	na	13
Hard corals	0	0
All crustaceans	13	7
Crabs (brachyurans) only	11	5
All molluscs	12	5
Bivalves only	11	3
Cephalopods only	1	1
All echinoderms	1	1
Total number or weight analysed	36,289	1,315 kg

Short-term sampling of bycatch in the tiger prawn sector occurred during commercial trialing of turtle excluder devices (TEDs) and BRDs in north Queensland (Robins *et al.* 1997). From commercial trawling undertaken between Townsville and Hinchinbrook Island, average bycatch:prawn catch ratios of 5.7:1 (range 3.1:1 to 42.8, $n = 8$) for the Palm Island area and 16.3:1 (range 8.6:1 to 31.5:1, $n = 8$) for the Hinchinbrook Island area, were obtained. Samples taken from commercial vessels recorded 113 and 90 species of fish, crustaceans and molluscs (sponges, echinoderms were not examined) for the two areas fished respectively. BRD trialing during commercial trawling in the Townsville area recorded an average bycatch:prawn catch ratio of 4.8:1 (range 3.4:1 to 9.9:1, QDPI unpublished data) in standard trawl nets. Prawn catch represented 17% of the total catch, but ranged from 9.1% to 22.6% ($n = 14$). Sea snakes (*Lapemis hardwickii* and *Hydrophis elegans*) were caught occasionally in the standard trawls. Commercial BRD trials adjacent to Cape Flattery (14°57'S) recorded an average bycatch:catch ratio of 4.3:1 (range 3.1 to 4.9, QDPI unpublished data). Prawn catch represented 18.8% of the total catch, but ranged from 16.8% to 24.6% ($n = 15$).

Estimates of total bycatch

Two estimates of total bycatch in the tiger/endeavour prawn sector were calculated. Using the ratio method, a bycatch:prawn catch ratio of 6:1 in inshore areas (Hill *et al.* 1999) and an average annual catch of 3,200 t (Williams 1997), total annual bycatch is estimated to be in the order of 19,200 t. Using the bycatch CPUE method, which is based on the product of an average nightly bycatch rate of 380 kg per vessel (Hill *et al.* 1999) and an average annual fishing effort of 27,000 boat-nights (Robins and Mayer 1998), total annual bycatch is in the order of 10,260 t.

These estimates are preliminary and need to be qualified by a brief discussion of the assumptions and limitations of the two approaches. For example, the estimate of 19,200 t per year obtained from the ratio method is likely to be biased upwards because the catch estimate of 3,200 t is likely to be high for this fishing sector due to the inclusion of incidental catches of tiger and endeavour prawns from other sectors (i.e. the scallop, red spot king prawn sectors, the eastern king prawn sector and the banana prawn sector). In contrast, the estimate obtained using the

bycatch CPUE method of 10,260 t is heavily influenced by the use of a single bycatch rate estimate of 380 kg per boat-night (from Hill *et al.* 1999), although bycatch rates for this sector are likely to vary spatially and temporally.

Sea turtle bycatch in the tiger and endeavour prawn sector was estimated to be 1,636 turtles per year (Robins and Mayer 1998). Species composition is predominantly flatback (40%), green turtles (34%) and Pacific ridley turtles (13%).

Summary

The bycatch issues

Several bycatch issues are common across sectors of the Queensland Trawl Fishery. Inter-sector conflict is most prevalent when the sectors of the fishery occur adjacent to population centres with a recreational fishing contingent (e.g. beam trawl, banana prawn sector, Moreton Bay) or when there is conflict between overlapping sectors of the commercial fishing industry over resource allocation (e.g. blue swimmer crabs). Concerns over impacts on benthic communities and habitat structure are common to almost all sectors, the exceptions being the eastern king prawn and stout whiting sectors, which occur mainly in oceanic waters. The impact on benthic communities and habitat structure is a growing issue for sectors occurring within the Great Barrier Reef World Heritage Area (e.g. the tiger/endeavour prawn, red spot king prawn, banana prawn and the scallop sectors). The wash up of dead fish on beaches is an issue mostly for inshore sectors (i.e. Moreton Bay, beam trawl, banana prawn) and the inshore portions of the tiger and endeavour prawn sector of north Queensland. The capture of unwanted species and the subsequent 'waste' of these animals is an issue common throughout the fishery, although the magnitude of the problem varies considerably

between sectors. The incidental capture of protected species such as sea turtles and sea snakes is also an issue in all sectors of the fishery. Again, the magnitude of the problem varies between sectors and is mostly a direct correlation between the abundance of a particular protected species and the intensity of trawling effort.

The extent and characterisation of bycatch and the knowledge base

Several studies have contributed to a growing checklist of demersal fauna vulnerable to trawling in all sectors of the Queensland Trawl Fishery, with the exception of the eastern king prawn and scallop sectors. While some studies also provide estimates of bycatch:prawn catch ratios, these were obtained mostly during research activities, and as such, may not be truly representative of commercial fishing activities. Our understanding of the temporal and spatial variation in the ratios within sectors is generally poor. Caution is required when extrapolating results across entire sectors, especially for the tiger/endeavour prawn and the red spot king prawn sectors, as these encompass vast areas (over 10° of latitude) and a wide range of benthic communities.

Although there are no reliable estimates of total bycatch of the Queensland Trawl Fishery, the available information can be used to derive crude estimates for most sectors of the fishery (Table 1). An exception to this is the estimate of turtle bycatch which was the subject of a specific research project.

There is virtually no quantitative information from which to draw conclusions about the long term impact of bycatch in the Queensland Trawl Fishery. As an industry, prawn trawling commenced in the early 1950s and expanded northwards from the Moreton Bay and Bundaberg region. Unlike the Northern Prawn

Fishery, there is scant information on the species composition or abundance of bycatch during the early days of the fishery.

Policies and management of the bycatch issue

The Queensland Fisheries Management Authority (QFMA) is the agency primarily responsible for the management of the fishery. The QFMA, through the Fisheries Management Advisory Committee (TrawlMAC), has developed a management plan for the Queensland Trawl Fishery (Anonymous 1998). The plan considers bycatch a significant issue and acknowledges the need to reduce the impact of trawling on non-target species and communities, and recognises that trawling affects some fisheries' habitats. To this end, the plan seeks to minimise all impacts of trawling on non-target species and ensure that any impacts on threatened or endangered species are negligible and acceptable to key conservation agencies.

Reducing the impact of trawling on bycatch species is primarily being achieved through the introduction of turtle excluder devices (TEDs) and bycatch reduction devices (BRDs). TEDs have been defined as a device or modifications to the trawl net that allow turtles to escape immediately from the net. BRDs have a more generic description of excluding bycatch from the trawl net. Examples of BRDs include square-mesh panels, radial escape devices, bigeyes and fisheyes. (Technically a TED is a type of BRD). The QFMA has adopted a 'phase-in' approach to TEDs and BRDs to allow fishers to prepare for changes associated with bycatch reduction. It includes the compulsory use of TEDs in high risk areas from 1st May 1999, including Moreton Bay, the inshore waters south of Cape Moreton and

coastal waters up to about six nautical miles from the shore in the following areas:

- the coastline from Round Hill Head to Gateways Bay (southern Hervey Bay);
- Repulse Bay;
- Cleveland Bay, and waters off Magnetic Island;
- Cape Grafton to Cape Flattery; and
- waters between Cape Melville and Portland Roads.

An ongoing risk assessment process will review additional areas in which TEDs may be needed.

BRDs were made compulsory in day time prawn trawling operations as of 1st May 1999. The management plan for the fishery aims to have all trawlers working within five nautical miles of the coast using BRDs by 1st January 2000, and then BRDs used by all trawlers fishing in the Great Barrier Reef Marine Park by 1st January 2001¹.

The Great Barrier Reef Marine Park Authority (GBRMPA) also has an interest in the Queensland Trawl Fishery, especially in regard to ensuring that fishing activities within the Great Barrier Reef World Heritage Area conform to the principles of ecological sustainable development and do not detract from the World Heritage status of the area. The QFMA and the GBRMPA recognise the public expectation that reduction in trawl bycatch is desirable for maintaining biodiversity and minimising 'waste'.

In conclusion, bycatch associated with the Queensland Trawl Fishery generates a wide range of economic, social and ecological issues. While initiatives are currently underway to document and reduce bycatch, our understanding of the ecological impacts pertaining to trawl bycatch remain poor.

¹ Ongoing negotiations between State and Commonwealth Governments.

This aside, the most immediate problem facing industry and management is a lack of statistically robust targets upon which to focus bycatch reduction initiatives. The long-term result of this scenario is that while bycatch initiatives will continue to be introduced, we will not be able to precisely quantify their impact on the populations of bycatch species.

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