Bycatch weight, composition and preliminary estimates of the impact of bycatch reduction devices in Queensland's trawl fishery


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This report provides quantitative information on the effects of turtle excluder devices (TEDs) and bycatch reduction devices (BRDs) on the catch rates of bycatch, prawns, scallops and byproduct species, such as Moreton Bay bugs and Balmain bugs, in Queensland's major trawl fishing sectors. It also provides biological information on, and management advice for several species referred to in the Fishery Management Plan as the permitted species. Several recommendations are included for reducing bycatch in the trawl fishery and for sustaining stocks of the permitted species.

The Department of Primary Industries and Fisheries (DPI&F) seeks to maximise the economic potential of Queensland’s primary industries on a sustainable basis.

This publication has been compiled by A. J. Courtney of Sustainable Fisheries.

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1 Objectives

1) Describe the bycatch species composition and catch rates under standard trawl net conditions [non-Turtle Exclusion Devices (TEDs) and non-Bycatch Reduction Devices (BRDs)] in Queensland’s major trawl sectors (eastern king prawn, scallop and tiger/endeavour prawn sectors).

2) Describe the bycatch species composition and catch rates when nets have TEDs and BRDs installed in Queensland’s major trawl sectors (eastern king prawn, scallop and tiger/endeavour prawn sectors).

3) Test and quantify the impact of different combinations of TEDs and BRDs on bycatch and target species against standard nets under controlled experimental conditions using chartered commercial trawlers in the eastern king prawn, scallop and tiger/endeavour prawn sectors.

4) Review the known biology and distribution of all recently approved “permitted fish” species associated with the trawl fishery.

5) Quantify key population parameter estimates, including growth rates, size at maturity, distribution and landings, for all recently approved “permitted fish” species.

6) Apply power analysis to determine how many samples are needed to detect various levels of change in bycatch species catch rates.

7) Provide advice on the guidelines and definitions of BRDs and TEDs so that the Boating and Fisheries Patrol can confidently enforce the regulations.
2 Non-technical Summary

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<td>• All stakeholders, including the Queensland Fishery Managers, conservation agencies, industry, recreational fishing groups, the public, the Great Barrier Reef Marine Park Authority (GBRMPA) and DEH, are in a much more informed position to comment on how well the fishery management initiatives are reducing bycatch, and perhaps what more needs to be done.</td>
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<tr>
<td>• Greatly improved understanding of the catch rates and composition of bycatch in each of the major trawl fishery sectors.</td>
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<tr>
<td>• More fishers are using highly effective square mesh codends in the scallop and eastern king prawn fisheries as a result of the project.</td>
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<tr>
<td>• The project demonstrated that bycatch rates in the scallop fishery can be reduced by 77% if square mesh codend BRDs are made mandatory in this sector with TEDs. This large reduction can be achieved with no loss of marketable scallops and with 63% fewer undersize scallops being caught.</td>
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<td>• Improved understanding of the impacts of trawling on species of high conservation or recreational value.</td>
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<td>• The project showed fishers and managers how to reduce the incidental catch rate of stout whiting caught in prawn trawl nets by 57%.</td>
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<td>• Greatly improved understanding of the elasmobranch bycatch in the trawl fishery, and the effects of TEDs and BRDs upon them.</td>
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<td>• Stakeholders are in a more informed position to determine whether the bycatch composition in each of the major sectors is likely change as a result of TEDs and BRDs.</td>
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<td>• The accuracy of standardised catch rates and stock assessments for prawns, scallops and bugs has improved because the project quantified the effects of TEDs and BRDs on them.</td>
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<td>• Queensland fishery managers are in a stronger position to discuss the value of bycatch monitoring programs, to decide upon their implementation and to provide input to their design.</td>
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<td>• Through the project staff involvement with the Technical Working Group, the design and specifications of BRDs has been improved.</td>
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<td>• Through project staff interaction with the Boating and Fisheries Patrol, patrol officers are more informed about TED and BRD design specifications and functions. The Patrol are in a stronger position to police and enforce the devices.</td>
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<tr>
<td>• The yield and value of three spot crabs <em>Portunus sanguinolentus</em> has improved and the likelihood of overfishing this stock is reduced as a result of the project.</td>
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<tr>
<td>• Managers have an improved understanding of the distribution and composition of Balmain bug (<em>Ibacus</em> spp.) and mantis shrimp landings in Queensland.</td>
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<td>• Reduced likelihood of overfishing Balmain bugs, as a result of the minimum legal size advice as a direct result of the project.</td>
</tr>
<tr>
<td>• Information obtained on the distribution of the pipehorse (<em>Solegnathus cf. hardwickii</em>), which is listed as vulnerable on the IUCN Red List, can be used to conserve populations of this species.</td>
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The project provided quantitative biological and technical information on two issues relating to the Queensland trawl fishery:  
1) the assessment of TEDs and BRDs on the catch rates of bycatch, target species and bycatch community structure in the main trawl sectors, and  
2) the biology, population dynamics and management of several species that are caught incidentally in the fishery that can now be retained and marketed.
These species are listed in the Trawl Fishery Management Plan [Fisheries (East Coast Trawl) Management Plan 1999] as the permitted species and include barking crayfish (Linuparus trigonus), Balmain bugs (Ibacus spp.), three spot crabs (Portunus sanguinolentus), mantis shrimps, (Stomatopoda), cuttlefish (Sepia spp.), octopus (Octopus spp.), pipehorses (Solegnathus spp.) and Pinkies (Nemipterus spp.).

**Evaluating the performance of TEDs and BRDs**

The project obtained 1619 measurements and sub-samples of bycatch during a) dedicated research charters that were designed to test TEDs and BRDs, and b) opportunistic sampling on board commercial vessels during their normal fishing activities. A total of 49.1 tonnes of bycatch was weighed at sea, of which 9.8 tonnes was sub-sampled and processed to species level in the laboratory. Over 1300 taxa were recorded in the bycatch, including records of new species occurrences in Queensland, and new information on the extent of species’ distributions.

Information is provided on the a) bycatch species composition in each major sector of the fishery and their catch rates, b) effects of TEDs and BRDs on the catch rates of prawns, scallops, byproduct species (i.e., Moreton Bay bugs and Balmain bugs), total bycatch and individual bycatch species, including the elasmobranchs (sharks and rays), and c) bycatch community assemblages and how they vary with latitude, depth and BRD type.

**Research charters**

The most promising finding from the project was obtained from one of the research charters which demonstrated that bycatch rates in the saucer scallop fishery could be reduced by a mean of 77% by using nets with both TEDs and square mesh codend BRDs, compared to standard nets. Importantly, this reduction was achieved with no reduction in the catch rate of legal size scallops, and with 63% fewer undersize scallops being caught. For these reasons we recommend that square mesh codend BRDs be made compulsory in the scallop fishery. (TEDs are already compulsory in all trawl sectors, but fishers can use less effective BRDs). If all scallop fishers used these devices, it would equate to a reduction in bycatch of over 10,000 tonnes annually compared to pre-2000 levels (i.e., before TEDs and BRDs were introduced). Use of the square mesh codend BRDs is likely to lower the incidental fishing mortality on undersize scallops, and possibly increase the available exploitable biomass.

The project also demonstrated high potential for square mesh codend BRDs with TEDs in the deepwater eastern king prawn fishery, where the mean bycatch rate was reduced by 29%, with no loss of targeted prawn catch. For this reason, we also recommend the mandatory use of square mesh codend BRDs in this sector.

Another 10-night charter undertaken in the shallow water eastern king prawn fishery demonstrated a significant reduction in mean bycatch rate of 24% by using a radial escape section BRD and TED, compared to a standard net. This combination of devices was particularly effective at reducing catch rates of benthic-pelagic species with fusiform body shape, such as stout whiting Sillago robusta (57% reduction) and yellowtail scad Trachurus novaezelandiae (32% reduction). Unfortunately, the mean catch rate of marketable size eastern king prawns was also reduced by a mean 20%
during the charter, mainly via the TED. The charter showed high potential application for the radial escape section BRD in the shallow water eastern king prawn fishery. We believe the prawn loss could be largely mitigated by adjusting the angle of the TED.

The radial escape section BRD and TED were also evaluated in the north Queensland tiger/endeavour prawn fishery during an eight-night charter. While a significant 20% reduction in mean bycatch rate was demonstrated, it was concluded that the radial escape section BRD was less effective in this sector because a) the bycatch fish species were generally smaller than those of the eastern king prawn fishery and therefore less capable of swimming to, and escaping out of, the device, and b) trawl speed is higher and codends are longer in the tiger/endeavour prawn fishery, thus making it more difficult for small fish species to swim forward and out of the device. The results show that one BRD type is not suitable for all sectors of the fishery, that each sector has its own unique bycatch properties and that effective BRD usage needs to be tailored to each sector.

**Opportunistic measures on board commercial vessels**

Analysis of the opportunistic sampling obtained on board commercial vessels during their normal fishing activities indicated that, across the major prawn trawl sectors (i.e., north Queensland tiger/endeavour prawn, and shallow- and deepwater eastern king prawns sectors) there was no statistically significant reduction in total mean bycatch rate (i.e., all bycatch including large sharks, large rays and large sponges known collectively as “monsters”) due to TEDs and BRDs, compared to standard nets. When analyses were undertaken excluding large fauna, the mean bycatch rate (i.e., excluding monsters) was significantly reduced by 25%, when both TEDs and BRDs were installed. The reduction in bycatch rate due to the TEDs and BRDs that were used by commercial fishers was low compared to those obtained during the research charters. Reductions in bycatch rates were greater in the tiger/endeavour prawn fishery, while no significant reductions were detected for devices being used in the shallow- and deepwater eastern king prawn sectors. No significant effects on marketable prawn catch rates were detected for the devices being used by industry. In the saucer scallop fishery, the TEDs and BRDs that were being used by fishers resulted in a reduction in total mean bycatch rate (i.e., includes monsters) of 68%. This reduction was due mainly to TEDs excluding large sponges which dominate the bycatch weight in this sector. A significant reduction in scallop catch rate of 11% was detected and mainly attributed to BRDs.

Bycatch reduction could be improved in the Queensland trawl fishery by a) promoting regular meetings of the Technical Working Group which was formed to evaluate BRDs and improve upon their technical specifications, b) further research and testing of BRDs, c) workshops with fishers that demonstrate and promote the more effective devices, d) educational programs for the Boating and Fisheries Patrol to enhance enforcement of the devices, and e) incentives for fishers to reduce their bycatch.

**Biology and management of the permitted species**

The project provided information on the biology, distribution and management of the permitted species. New information is provided on the species composition of Balmain bug landings in Queensland; the garlic bug *Ibacus chacei* constitutes the majority of Balmain bug landings, followed by the honey bug *Ibacus brucei* and the velvet bug *Ibacus alticrenatus*. The project provided a clearer understanding of the
distribution and fishery for these species, as well as an improved understanding of the
growth rates of I. chacei and the size, age and location at which it reproduces.
Minimum legal sizes for Balmain bugs were developed and recommended to the
fishery managers. The first detailed description of the reproductive biology,
distribution and fishery for the little-known barking crayfish Linuparus trigonus is
provided. We also recommended a minimum legal size of 80 mm CL for barking
crayfish. The reproductive biology and growth of three spot crabs Portunus
sanguinolentus were described and a minimum legal size of 100 mm CW was
recommended and adopted, based on yield-per-recruit analysis. The project provided
new information on the distribution and reproductive biology of mantis shrimps in
Moreton Bay, where the majority of mantis shrimp reported catch is taken. New
information on the catch rates, distribution, sizes and faunal community associations
for the pipehorse, Solegnathus cf hardwickii, which is considered vulnerable and
listed on the International Union for the Conservation of Nature Red List, is also
provided. Information obtained on pinkies (Nemipterus theodorei and N. aurifilum) is
preliminary and includes the first published accounts of the reproductive biology,
distribution and growth for N. theodorei, which is the main species being retained and
marketed. Collectively, the permitted species are valued at $1–2 million annually in
Queensland and while the study has made a significant contribution to understanding
their biology and improving management, further effort and funding are required to
reduce the risk of overfishing these resources.

KEYWORDS: Trawl bycatch, prawns, eastern king prawn, Penaeus plebejus,
tiger prawns, Penaeus esculentus, saucer scallops, Amusium japonicum balloti, TEDs,
BRDs, square mesh codends, radial escape sections, pipehorses, Solegnathus
hardwickii, Balmain bugs, Ibacus chacei, Ibacus brucei, Ibacus alticrenatus, Moreton
Bay bugs, Thenus orientalis, stout whiting, Sillago robusta, three spot crabs, Portunus
sanguinolentus, barking crayfish, Linuparus trigonus, Mantis shrimps, Oratosquilla
interrupta, Oratosquilla stephensi, Erugosquilla woodmasoni, Harpiosquilla
harpax, Nemipterus theodorei, Nemipterus aurifilum, elasmobranchs, rhinobatids,
Aptychotrema rostrata, urolophids, Trygonoptera testacea, Urolophus sp., Rajids,
Dipturus polyommata, Scyliorhinids, Asymbolus rubiginosus, Galeus boardmani,
generalised linear models, GLM.

3 Background

Prawn trawling generates a higher proportion of discards than any other type of
fishing (Alverson et al., 1994). The Queensland East Coast Trawl Fishery (QECTF) is
the largest trawl fleet in Australia, and in 2004 consisted of about 500 licensed otter
trawlers that were allocated approximately 80,000 boat-nights (predominantly a night-
time fishery) of effort annually. In the late 1990s it was estimated that annual
production of bycatch by the fishery was likely to exceed 25,000 t (Robins and
Courtney, 1998).

The Queensland Government has recognised the need to reduce trawl bycatch and to
this end, has undertaken research to address the problem, with FRDC support.
Research initiatives include FRDC 93/231.07 (Development of the AusTED), FRDC
96/254 (Commercialisation and Extension of Bycatch Reduction Devices) and FRDC
96/257 (Ecological sustainability of bycatch and biodiversity in prawn trawl
fisheries).
The Queensland *Fisheries (East Coast Trawl) Fishery Management Plan 1999* sought to reduce bycatch through the mandatory use of turtle exclusion devices (TEDs) and bycatch reduction devices (BRDs) throughout the entire fishery. (Note: when the project proposal was finalised Moreton Bay trawl fishers were still exempt from using BRDs). Initially, some fishers argued that there were problems with the design, function and safety of TEDs and BRDs in the scallop and deepwater (> 50 fm) sectors and as a consequence, implementation of the devices in these sectors was delayed, but by 2002 both TEDs and BRDs were mandatory in all otter trawl nets throughout the state.

The research undertaken in this project has quantified the effects of TEDs and BRDs in the major prawn trawl sectors. It has also demonstrated the potential bycatch reduction that could be achieved if fishers were to use highly effective BRDs, such as square mesh codends, in certain sectors.

The trawl Management Plan put forward a Review Event to assess and evaluate the process of bycatch reduction. The Review Event was a 40% reduction in bycatch by 1 January 2005. However, it is important to note that demonstrating such a reduction is extremely difficult and dependent upon the ability to measure bycatch production before, and again after, the management changes were introduced. It is both difficult and impractical for fishers to weigh and record their bycatch during normal commercial fishing and as a result, there is no known way to directly measure the total tonnage of bycatch produced in the fishery. Much of the research presented here focused on quantifying the effects of TEDs and BRDs on catch rates, rather than total production.

The trawl fishery Management Plan also increased the number of species that commercial trawler operators were legally allowed to retain and market. In the past the “principal fish” species that operators were permitted to retain was restricted to prawns, scallops, bugs, squid and blue swimmer crabs. However, an additional list of “permitted fish” species has increased the number of species that fishers can retain. This list includes Balmain bugs (*Ibacus* spp.), barking crayfish (*Linuparus trigonus*), cuttlefish (*Sepia* spp.), goatfish (*Upeneus* spp.), mantis shrimp (*Squilla* spp., *Oratosquilla* spp.), octopus (*Octopus* spp.), pinkies (*Nemipterus* spp.) pipefish (*Solegnathus* spp., *Haliichthys* spp., *Halicampus* spp.), three spot crabs (*Portunus sanguinolentus*), sharks (*Carcharhinus* spp.) and whiptails (*Pentapodus paradiseus*). As these species are now permitted catch and the Queensland Government is obliged to manage the stocks, the project also focused on quantifying the population dynamics of many of these species and providing advice on optimising and sustaining their value.

4 Need

There was a strong need to examine how bycatch rates in the Queensland East Coast Trawl Fishery were affected by the mandatory introduction of TEDs and BRDs. This need was driven by a) changes in the *Wildlife Protection Act 1984* and Environment Australia’s Criteria for Assessing Sustainability of Commercial Fisheries, b) national and global political pressure, and c) a general increase in the awareness of prawn trawl bycatch by the Australian public.
Although extremely difficult to quantify, there was also a need to consider the 40% bycatch reduction Review Event outlined in the fishery’s Management Plan. Directly measuring the total amount of bycatch produced by prawn trawl fisheries is not possible, and the statistical robustness of estimates is generally considered to be weak (Andrew and Pepperell, 1992). There is therefore a need to improve methods for measuring bycatch if reductions are to be demonstrated.

References