Review of the Sustainability of Fishing Effort in the Queensland East Coast Trawl Fishery
Edited by Kerrigan, B., Gaddes, S., Norris, W.

Major Contributors:
Dr Michael O’Neill, Dr Tony Courtney, Mr Clive Turnbull, Dr Neil Gribble, Mr Wez Norris, Mr Shane Gaddes, Mr Brad Zeller, Mr Lew Williams, Ms Claire Bullock, Dr Brigid Kerrigan.
1 EXECUTIVE SUMMARY .................................................................................................................. 1

2 INTRODUCTION .................................................................................................................................. 4

2.1 REASON FOR THE GENERAL EFFORT REVIEW ........................................................................ 4

2.2 COMMONWEALTH/STATE AGREEMENTS REGARDING FISHING EFFORT ......................... 4

2.3 ECOLOGICAL SUSTAINABILITY ................................................................................................. 4

2.4 OBJECTIVES OF THE REVIEW .................................................................................................. 5

2.5 STRUCTURE OF THE GER ........................................................................................................ 5

2.6 DEVELOPMENT OF THE GER .................................................................................................. 6

2.7 CONSULTATION ............................................................................................................................ 6

3 BACKGROUND ON THE EAST COAST TRAWL FISHERY ...................................................... 6

3.1 CHANGES IN FLEET PROFILE – OTTER TRAWL ..................................................................... 6

3.1.1 Purpose .................................................................................................................................... 6

3.1.2 Changes in the number of vessels ........................................................................................ 6

3.1.3 Change in size of vessels .................................................................................................... 7

3.1.4 Technological development of the otter trawl fleet .............................................................. 8

3.1.5 Temporal Comparison of Relative Fishing Power between Different Sectors 21

3.1.6 Fishing Effort ......................................................................................................................... 29

3.1.7 Discussion ............................................................................................................................ 35

3.2 SPATIAL CHANGES IN FISHING EFFORT .................................................................................. 38

3.2.1 Purpose .................................................................................................................................... 38

3.2.2 Methods .................................................................................................................................. 38

3.2.3 Entire ECTF ............................................................................................................................ 41

3.2.4 Eastern King Prawns ........................................................................................................... 45

3.2.5 Tiger / Endeavour prawn ..................................................................................................... 49

3.2.6 Saucer Scallops .................................................................................................................... 52

3.2.7 Red spot king prawns .......................................................................................................... 55

3.2.8 Banana and Bay Prawns ...................................................................................................... 57

3.2.9 Effort for vessels no longer in the fishery ........................................................................... 60

3.2.10 Great Barrier Reef World Heritage Area ............................................................................ 61

3.2.11 Discussion ............................................................................................................................ 62

3.3 TEMPORAL CHANGES IN CATCH AND EFFORT IN MORETON BAY ...................................... 64

3.3.1 Purpose .................................................................................................................................... 64

3.3.2 Methods .................................................................................................................................. 64

3.3.3 Results ..................................................................................................................................... 65

3.3.4 Fishing effort and number of boats ....................................................................................... 65

3.3.5 M1/T1 Effort unit holding ....................................................................................................... 67

3.3.6 Annual catch by species ....................................................................................................... 67

3.3.7 Monthly catch and effort by species ..................................................................................... 68

3.3.8 Annual trends in catch per unit of effort (CPUE) .................................................................. 74

3.3.9 Discussion ............................................................................................................................. 77

3.4 SPATIAL AND TEMPORAL CHANGES IN FISHING EFFORT – RIVER AND INSHORE TRAWL FISHERY ................................................................. 79

4 SUSTAINABILITY OF PRINCIPAL SPECIES ............................................................................. 84

4.1 PURPOSE ........................................................................................................................................ 84

4.2 SOURCE ......................................................................................................................................... 84
4.3 SUMMARY ........................................................................................................ 84
4.4 METHODS ........................................................................................................ 85
4.5 EASTERN KING PRAWNS ............................................................................. 89
4.6 SAUCER SCALLOPS ........................................................................................ 101
4.7 TIGER / ENDEAVOUR PRAWNS ................................................................... 115
4.8 DISCUSSION .................................................................................................. 120
4.9 STOCK ASSESSMENT AND FUTURE DEVELOPMENT ..................................... 123
4.10 TARGET SPECIES WITHOUT STOCK ASSESSMENTS .................................. 126
   4.10.1 Penaeus monodon ................................................................................ 126
   4.10.2 Reef King Prawns ................................................................................. 134
   4.10.3 Bay Prawns ........................................................................................... 135
   4.10.4 Moreton Bay Bugs ................................................................................ 136
   4.10.5 Squid ..................................................................................................... 138

5 SUSTAINABILITY OF PERMITTED SPECIES .................................................. 142
   5.1 PERMITTED SPECIES RISK ASSESSMENT ................................................ 142
       5.1.1 Executive Summary .............................................................................. 142
       5.1.2 Introduction ........................................................................................... 143
       5.1.3 Existing Management Arrangements .................................................... 144
       5.1.4 Assessment of Risk for Permitted Species ........................................... 145
       5.1.5 Method .................................................................................................. 145
       5.1.6 Results .................................................................................................. 149
       5.1.7 Discussion - Management Response to Risk ....................................... 158

6 BYCATCH ........................................................................................................... 180
   6.1 ADDRESSING BYCATCH IN THE QECTF .................................................. 180
       6.1.1 Purpose ................................................................................................ 180
       6.1.2 Achievements under the plan ............................................................... 180
       6.1.3 Research to assess the sustainability of bycatch ................................. 182
       6.1.4 Summary ............................................................................................... 183

7 ECONOMIC SUSTAINABILITY ...................................................................... 184
   7.1 ECONOMIC ANALYSIS OF CHANGES IN THE FISHERY ................................ 184
       7.1.1 Purpose ................................................................................................ 184
       7.1.2 Economic studies of otter trawl fleets ................................................... 184
       7.1.3 Which data to use? ............................................................................... 184
       7.1.4 Prawn price trends ............................................................................... 184
       7.1.5 Possible future trends in prawn prices .................................................. 186
       7.1.6 Performance of the T1/T2 fleet – 1996 to 2003 .................................... 187
       7.1.7 State wide performance - Distribution analysis ..................................... 188
       7.1.8 Performance of boats operating in 2003 – trends since 1996 .............. 194
       7.1.9 Regional Analysis – ALL T1/T2 vessels ............................................. 197

8 EFFORT MANAGEMENT ................................................................................ 199
   8.1 REVIEW OF EFFORT MANAGEMENT TOOLS UNDER THE FISHERIES (EAST COAST
       TRAWL) MANAGEMENT PLAN 1999 ............................................................ 199
       8.1.1 Purpose ................................................................................................ 199
       8.1.2 Measures of Effort ............................................................................... 199
       8.1.3 Relationship between Boat Length and Fishing Power ....................... 200
       8.1.4 Effort Unit Reduction Targets ............................................................... 201
1 Executive Summary

The General Effort Review represents a comprehensive assessment, using available data and information, of the ecological sustainability of current levels of effort in Queensland’s East Coast trawl fishery.

A comprehensive analysis of the sustainability of principal and permitted species indicates that overall the current levels of effort applied to these species in the Fishery Area are ecologically sustainable.

Significant reductions in effort in terms of days fished (approximately 40%) and effort units (approximately 32%) used in the fishery have been achieved since 1996 and the introduction of the Plan in November 1999. This reduction in fishing effort is mirrored by a significant reduction in the number of vessels in the fleet, from approximately 1400 licenced operators in early 1980’s to 800 vessels at the introduction of the Plan to 520 as of May 2004.

The decline in boat numbers is considered a positive for the fishery as over capitalisation and an excessive number of licences were identified prior to the Plan as being negative in relation to long-term sustainability and viability.

A small degree of under-utilization of effort units occurs in the fishery. However, the majority of licence holders have used 100% of their allocation in at least one year since 1999. The under-utilisation of individual effort allocations is at acceptable levels (approximately 16%). The total amount of effort considered appropriate for the fishery is capped via the individual allocations; any unused effort represents a benefit to the fishery.

Since the introduction of the Plan (2000 to 2003) average boat size has increased. It is not considered to be a negative trend for sustainability of the fishery. The increase is primarily a result of a reduction in the number of vessels between 10 and 40 hull units (HU); it is not due to an increase in the number of larger vessels.

The majority of EUs have been transferred from medium to large boats. The total change in EU holdings within the fleet is not considered to be a reflection of adverse conditions for small operators.

Tracking temporal changes in effort creep is pivotal to effective management of the fishery to ensure the fishing effort remains sustainable. Current estimates put average “effort creep” between 0.2 and 1.6% per year since 1989, depending on the sector of the fishery. These estimates of effort creep are used in the stock assessments of principal species and to standardise Catch per Unit Effort (CPUE) estimates.

Significant changes in where effort is applied in the fishery have occurred from 1996 to present. An overall shift in effort away from the tiger/endeavour prawn, saucer scallop and banana and bay prawn sectors has occurred. This effort has moved into the eastern king prawn sector with a 6% increase in the proportion of total fishing effort from the ECTF after the implementation of the plan. Minor spatial changes within each major sector have also occurred primarily in response to small-scale spatial variability in productivity.

Model predictions for the eastern king prawn fishery indicated that eastern king prawn biomass was at or below a stable exploitable biomass from 1991–1999, moving above
the stable exploitable biomass in 2000-2001. A further assessment, incorporating 2002 and 2003 data should be completed before effort-based management of the EKP is considered. This assessment and subsequent development of management options should be completed in cooperation with NSW Fisheries. Alternative, or complementary management arrangements such as spawning closures should also be investigated.

The stock assessment model for saucer scallops advocates between 6,300 and 11,700 nights directed towards scallops depending on the model and management target used. In 2002, approximately 7,400 nights were used in the scallop sector, which is substantially lower than the historical average (approximately 13,600 nights). Using the Beverton-Holt model above, a precautionary target of 3/4 EMSY would advocate a significant increase in allowable effort (approximately 1,400 nights).

Stock assessments of Tiger/endeavour prawn stocks in north Queensland were based on the results of the surplus production model. Both Tiger and Endeavour Prawn stocks were identified as fully exploited. However, these stocks should be re-assessed using a more dynamic model when the required biological data becomes available.

Stock assessments are not currently available for the remaining target species. It is considered that the biological data available for reef king prawns, bay prawns, black tiger prawns, Moreton Bay bugs and squid are insufficient to conduct a robust stock assessment for these species. Preliminary analysis of these species has not identified any sustainability concerns. However, the 70% cpue indicators identified in the Plan have been found inadequate for some species and need to be replaced with a more suitable assessment method.

Sustainability of the permitted fish was assessed using a ‘Productivity – Susceptibility Assessment Process (PSA) adapted from previous models developed by the CSIRO. Although the PSA identified several species at ‘True High Risk’ and ‘Probable High Risk’ from trawling, the management arrangements currently in place are anticipated to offset any sustainability concerns. The PSA also identified data deficiencies for many of the permitted species leading to them being classified in higher risk categories.

The GER highlights the need for further research focused on the biology and ecology of the permitted species, continued refinement of existing stock assessments and the development of stock or fishery assessments for the remainder of the principal species in the fishery. The continued building of data and information on the principal and permitted species and bycatch in the fishery and continued refinement of fishing gear technology in particular BRDs is critical to the on-going ecological sustainability of the fishery.

As the understanding of stock dynamics improves, the DPI&F’s ability to determine appropriate effort and or catch targets will be enhanced. Currently the management of effort in the fishery is at the scale of the entire East Coast with the exception of the cap in effort in the Great Barrier Reef World Heritage Area. The concept of single stock management, either via area based effort caps, species based effort caps or stock based endorsements, will form the basis of a two-year feasibility assessment of smaller scale management in the fishery. The DPI&F is committed over the next three years to the feasibility assessment. This assessment will be conducted through TrawlMAC and take into account the outcomes of stock assessments. DPI&F emphasises that this study will be a feasibility assessment and will be conducted over the next few years involving consultation with Industry and other key stakeholders.

The Plan has not introduced any form of effort management on the beam trawl fishery. Given the observed reduction in catch and effort, management intervention in this sector of the fishery does not appear to be a significant priority but requires continual review.
A qualitative analysis of bycatch indicated that the precautionary management measures in place are adequate to ensure that the impacts on the bycatch species in the fishery area are sustainable. A more comprehensive quantitative analysis may be available when the results of current research projects, in particular the Seabed Biodiversity Mapping Project due for completion in 2007, are published.

Overall, the economic section of the review indicates that profitability in 2002/03 was more positive than in years prior to the Plan. It is not possible to conclusively state the factors that have caused this result. More detailed modelling is required to determine the link between the reductions in effort and boats and increasing profitability in the remaining fleet.

The reduction in effort in the fishery has been significant and a major contributor to the current sustainability of the principal and permitted species and bycatch taken or impacted on by the fishery.

In 2000 the State and Commonwealth Governments implemented a structural adjustment scheme (buy-back) that removed 99 licenses from the fishery. This adjustment scheme involved a contribution of $10 million from each jurisdiction and an equivalent reduction in effort (5% of Effort Units) as the industry contribution. The adjustment scheme and the effort reductions resulting from boat replacements, licence transfers and effort unit transfers has resulted in the meeting of agreed and legislative effort reductions by the end of 2003. The agreed and legislative targets were a 15% reduction up front and an annual reduction that accounted for effort creep. Although the effort management system in the Plan has achieved its’ intended purpose to date, it requires review in order for the system to be effective in the future and not impede effort trading within the industry.
2 Introduction

The *Fisheries (East Coast Trawl) Management Plan 1999* (the Plan) was first gazetted in November 1999 to consolidate aspects of trawl fishery management and provide a basis for further development of the fishery towards ecological sustainability and economic viability.

Since that time, the Plan has undergone significant review and change. There are several sections within the Plan that require formal reviews of the fishery. The first of these was the review of permitted fish (other than principal fish) that was completed by the QFS (now Department of Primary Industries & Fisheries (DPI&F)) in 2001. This General Effort Review (GER) is the second major review under the Plan.

2.1 Reason for the General Effort Review

The Effort Management System (EMS) that was introduced under the Plan in 2001 represents the single most significant management regime in the trawl fishery and probably the largest operational change in a fishery in Queensland’s history. The EMS is discussed in detail below. Although the EMS was introduced following extensive consultation, negotiation and modelling, it represented a new direction for fisheries management in Queensland and was therefore surrounded with some uncertainty.

The GER represents a formal review of the current levels of effort resulting from the EMS. The purpose of the GER is therefore to allow the DPI&F to determine whether fishing effort in the fishery is ecologically sustainable.

2.2 Commonwealth/State Agreements regarding Fishing Effort

Immediately prior to the introduction of the EMS, the State and Commonwealth Governments implemented a structural adjustment scheme (buy-back) that removed 99 licenses from the fishery. This adjustment scheme involved a contribution of $10 million from each jurisdiction and an equivalent reduction in effort (5% of Effort Units) as the industry contribution.

Given the significant monetary investment, the appropriate management of fishing effort to achieve ecological sustainability was a focal point of negotiations at that time. The GER and any subsequent legislative amendments arising from the Review are intended to ensure that the initial reduction and subsequent management of effort are sustainable over the long-term.

2.3 Ecological Sustainability

“Ecologically Sustainable Development” (ESD) is defined in the Fisheries Act 1994 as:

"Using, conserving and enhancing the community’s fisheries resources and fish habitats so that—
The ecological processes on which life depends are maintained; and
The total quality of life, both now and in the future, can be improved."

There are many tools in fisheries management that play an active role in assessing the impact that fisheries have on the sustainability of target and non-target species specifically and ecosystems in general. These include specific tools such as stock assessments and risk assessments as well as general principles for resource management such as the Precautionary Principle and intergenerational equity.

The Precautionary Principle is particularly important in fisheries as the assessment of sustainability impacts is often conducted in an information poor environment. The Precautionary Principal is defined in the Fisheries Act 1994 as:
“The principle that, if there is a threat of serious or irreversible environmental damage, lack of scientific certainty should not be used as a reason to postpone measures to prevent environment degradation, or possible environmental degradation, because of the threat.”

The GER has collated available information to allow for an assessment of fishing effort against sustainability criteria, cognizant of the definitions above.

2.4 Objectives of the Review
Terms of Reference for the GER were developed by the DPI&F prior to the commencement of the Review. These terms of reference were subsequently reviewed and amended by the stakeholder steering committee. Where practical the sustainability of species was assessed using (but not limited to) review events outlined in Schedule 2 of the Plan and in accordance with the principles of ecological sustainable development.

The terms of reference determine that the objective of the General Effort Review is to provide a fully comprehensive assessment of the ecological sustainability of principal and permitted species and bycatch impacted by the fishery and review the economic performance of the fishery since the introduction of the Plan. The review does not extend to the assessment of the sustainability of overall ecosystem functioning in the fishery areas due to the lack of available data.

2.5 Structure of the GER
The GER has been a comprehensive review of many aspects of the fishery. This report summarises the:
- Change in fleet profile since introduction of the Plan;
- Spatial change in fishing effort since introduction of the Plan in 1999; including changes in beam trawl fishing effort and changes in Moreton Bay fishing effort;
- Sustainability of principal species;
- Sustainability of permitted species;
- Sustainability of bycatch; and
- Economic performance of the fleet.

There are three levels of information reported in the GER. The first is the research material and published data that forms the basis of most of the information used in the Review. Citations and publications are listed in the ‘Reference section’ at the end of this report, for the purposes of transparency. It is anticipated that stakeholders will not need to refer to the majority of references, unless it is to gain a detailed understanding of the technical and scientific aspects of the GER.

This report is the second component of the GER. The Report represents a comprehensive analysis and summary of the available information. It is acknowledged that the GER Report is extremely comprehensive and at times complex, and may be challenging for some stakeholders to fully understand. This is a result of the technical nature of the issues that have been discussed. Every effort has been made to ensure that information presented in the report is correct and provided in sufficient detail.

Finally, a Discussion Paper that summarizes the issues covered by the GER has been developed. It is envisaged that the Discussion Paper will be of most value to the majority of individual stakeholders, while the GER Report may be of value to key stakeholder groups who are interested in the detailed analyses and methods used in the Review.

The discussion paper also contains several policy statements or recommendations at the conclusion of each section. These have been included to ensure transparency so that stakeholders can be clear as to the DPI&F’s interpretation of the available information. These statements do not represent Government Policy and may be
subject to change as more information, such as feedback from stakeholders becomes available through the consultation process.

2.6 Development of the GER
The Department of Primary Industries & Fisheries formerly the Queensland Fisheries Service (QFS) and the Agency for Food and Fibre Sciences (AFFS) have developed the GER Report and Discussion Paper. A stakeholder-based Steering Committee and the Trawl Management Advisory Committee (TrawlMAC) have overseen this process to ensure transparency and provided constructive comment that has enhanced the quality of the Review.

2.7 Consultation
The Plan states that if the Review concludes that fishing effort in the fishery is not ecologically sustainable, the Plan must be amended before 2006. The role of the GER Report and Discussion Paper is to provide information to managers and stakeholders on which to base consideration of management options. It is important to note that these documents are only the first stage in stakeholder consultation regarding any possible amendment to the Trawl Plan.

The DPI&F and TrawlMAC will consider feedback to the GER before recommending management changes. Stakeholders will be further consulted regarding proposals for legislative amendment through the Regulatory Impact Statement/Public Benefit Test process. In this way, it is envisaged that the management of the fishery can be progressed to achieve ecological sustainability in a manner that maintains economic viability of the catching and processing sector and ensure social well being.

3 Background on the East Coast Trawl Fishery

3.1 Changes in Fleet Profile – Otter Trawl
3.1.1 Purpose
The ECTF is a complicated fishery with vessel characteristics and fishing gear varying depending on the principal species being targeted. Any effective management arrangements need to take into account not only the temporal changes in the number of boats, their catch and effort but also any significant changes in fishing equipment.

3.1.2 Changes in the number of vessels
Significant changes in the number of otter trawl vessels licenced to operate in the fishery have occurred since the late 1960’s (Figure 2.1).
Between the late 1960’s and the early 1980’s, licence numbers increased by over 250% to peak at just over 1,400 vessels (Figure 2.1). Management arrangements introduced since that time saw a reduction of approximately 30% in vessel numbers over a 10-year period.

Even with the reduction leading up to the early 1990’s the number of licences and associated fishing effort in the otter trawl fleet were considered inappropriate in terms of long-term ecological sustainability and economic viability. The decreasing trend in vessel numbers due to management initiatives introduced prior to the Plan continued until 2000 when the first major amendments to the Plan were introduced.

A further reduction in vessel numbers of approximately 45% occurred between 1990 and 2003 (Figure 2.1). Licence numbers at the end of 2003 (527) were the lowest in over 30 years. Overall, the Plan has resulted in a reduction of about 33% in the number of licences. Interestingly, the structural adjustment scheme and the subsequent reduction in licences through effort trading have each been responsible for approximately half of this reduction, with the remainder resulting from licence holders surrendering their trawl endorsement after selling off their effort unit holdings.

3.1.3 Change in size of vessels

Figure 2.2 shows the variability in the distribution of Hull Units (HU) across the ECTF fleet. The post Plan HU distributions are marked by a modal shift towards vessels of larger holdings. Actual numbers of vessels in each of the HU classes have either decreased or remained unchanged. This restructure is in accordance with DPI&F policy expectations.

The modal shift in HU distribution was primarily caused by a reduction in the number of vessels in the HU classes between 10 and 40 HU. There have been a disproportionate number of vessels in these size classes removed from the fishery via the Buyback and through the process of licence holders surrendering the T1 fishery symbol after selling off their effort unit holdings (Figure 2.2).

The number of vessels in the 20-30 HU class decreased by approximately 60% between 2000 and 2002. Over the same period vessel numbers in 10-20 HU class
decreased by approximately 30%. Notably there has not been a commensurate increase in the number of larger vessels (>60 HU) since 2000. The observed changes in the HU profile of the fleet have purely been a result of the attrition of smaller vessels rather than the addition of larger boats.

3.1.4 Technological development of the otter trawl fleet

Methods
Data from this section were derived from two sources; the Fisheries Research and Development Corporation (FRDC) project number 1999/120: Reference point management and the role of catch-per-unit effort in prawn and scallop fisheries; and from the “Gear description forms” contained in the DPI&F OT08 Trawl fishery logbook, which was released in late 2002.

The data series on the types of devices and technologies adopted by fishers, and when they were adopted, was obtained from a purposely-designed survey of 344 past and present fishing vessel owner/operators selected randomly from the entire trawl fleet of 900 vessels that had fished during 1997 and 1998. The questionnaire considered a number of different vessel characteristics thought to affect fishing power. The 344 interviews represented a response rate of 85% of the 406 operators who were initially contacted. Overall, the sample included vessels that collectively accounted for about 40% of each sector’s total catch between 1989 and 1999.

It is important to note the further back in time that the project sought information from licence holders through the interviews, the less reliable the information was likely to become. The reason for this was because the early observations (those prior to 1970) were based on the recollections of a very small number of operators who were still available for interview, and also due to a less precise recollection over time. Observations from more recent years (i.e. 1980-2000) were likely to be more accurate because they were based on larger sample sizes (i.e. more interviewees) and presumably, more accurate recollections.

These data were supplemented for 2003 by returns from the “Gear description forms”. At this stage the gear data from this source are only indicative of the fleet in 2003, but will become a useful tool for tracking changes in the fishery as fishers are required to submit a new form when significant changes are made or when they start a new logbook.

Rates of change for certain technologies have been calculated by fitting a linear regression of the parameter with fishing year as the independent variable. The rate of change was then taken as the fitted regression coefficient. Technologies included in this section were based on those found to have a significant effect on catch rates by O’Neill et al (In Press). As mentioned previously, data prior to 1970 is thought to be less reliable and has been excluded from the analyses. The rate of change has been calculated for the three main sectors (eastern king prawn, scallop fishery and the northern tiger/endeavour) of the East coast trawl fishery (ECTF) over the last 30 years. It also compares and contrasts the three main sectors.

Results
Propeller Nozzles
The adoption of propeller nozzles has continued at a steady rate throughout the fishery after first being introduced in the late 1970’s. The rate of adoption was comparable between sectors being adopted at a rate of 2% of the fishery per year (P < 0.001, R² = 0.98). The 2003 values in the time series seen in Figure 2.3, which are the only data points after the implementation of the Plan, indicate that the post plan rate of uptake of propeller nozzles in the ECTF have continued as per the pre plan trends.