5. Assessments in the East Coast Trawl Fishery

The Commonwealth "**Guidelines for the Ecologically Sustainable Management of Fisheries**" require that for assessing the impact of the fishery on the stock levels of target and by-product species:

- *"there is a robust assessment of the dynamics and status of the species/fishery and periodic review of the process and the data collected. Assessment should include a process to identify any reduction in biological diversity and /or reproductive capacity. Review should take place at regular intervals but at least every three years."* **[Guideline 1.1.2]**;
- "*the distribution and spatial structure of the stock(s) has been established and factored into management responses*" **[Guideline 1.1.3]**;
- "*there are reliable estimates of all removals, including commercial (landings and discards), recreational and indigenous, from the fished stock. These estimates have been factored into stock assessments and target species catch levels*" **[Guideline 1.1.4]**; and
- "*there is a sound estimate of the potential productivity of the fished stock/s and the proportion that could be harvested"* **[Guideline 1.1.5]**.

This section of the Audit Report discusses fishery assessment in the ECTF (as distinct from monitoring and research). These processes deal with the same data sources. Monitoring and research generate data, whereas fishery assessment uses these data. There is some commonality between the comments made in Sections 4 and 5 with respect to data quality and process.

The ECTF is a multi-species fishery, with at least 14 target species, some 50 by-product species and over a thousand species of bycatch. The fishery spans over 2,500 km of coastline and fishing operations vary according to the targeted species. ECTF stock assessment is a challenging task, given the fishery's geographical spread, its species diversity, high inter-annual variability and the complexity of habitat types encountered.

Before providing a critical appraisal of the ECTF assessment process, it is noted that there are few fisheries (if any) in Australia, which meet the Commonwealth Guidelines for fishery assessment adequately at all levels. In general, even those fisheries with sophisticated stock assessment models and a high degree of real-time monitoring of resource trends fail to assess adequately the impact of the fishery on non-target species and the ecosystem.

5.1 Reported Resource Status and Fishery Trends

This section provides an outline of the status of the ECTF species and the resource trends as reported by the QDPI. The Audit Report makes no comments at this point about the veracity of the reported data and trends. However, an appraisal of the assessment methodology and its findings is provided in Sections 5.2. and 5.3. respectively. It should be noted that the status and trend reports only refer to the commercial catch (i.e. target and by-product species). There is no formal assessment of the status of bycatch species or the environmental impact of the fishery. Bycatch issues are considered in Section 7.

Until recently the primary assessment method used by the QDPI for determining the status of principal ECTF species is an analysis of the catch rate using nominal CPUE data (i.e. the total recorded catch is divided by the total recorded fishing days). These data have not been adjusted (i.e. standardised) for changes in fishing power or the temporal and spatial distributions of fishing effort. Assessment of the "health" of the key species is based on the slope of the CPUE graphs. For example, if there is a general incline in the slope of the graph, the catch rate is interpreted as increasing and this is seen as a

positive trend in the fishery. Similarly, if there is a general decline in the slope of the graph, the catch rate is interpreted as decreasing and this is seen as a negative trend in the fishery. The recent development by AFFS of fishing power curves has enabled the inclusion of standardised CPUE data in future stock assessments.

Generally, commercial ECTF species are short-lived and highly fecund. A characteristic of such species is that their recruitment and abundance tends to be highly variable from year to year. For example, in "good seasons" (i.e. when conditions are favourable) a large number of recruits may enter the fishery and these strong recruitment pulses generally result in a higher number of individuals available to be caught and hence higher catch rates compared to "normal seasons". If amalgamated historical data are presented graphically, such year-to-year variability should be reflected through error bars on the graph, indicating the statistical confidence limits of the data. The graphs provided by the QDPI depicting long-term CPUE trends in the ECTF do not show such confidence limits.

5.1.1 Target Species

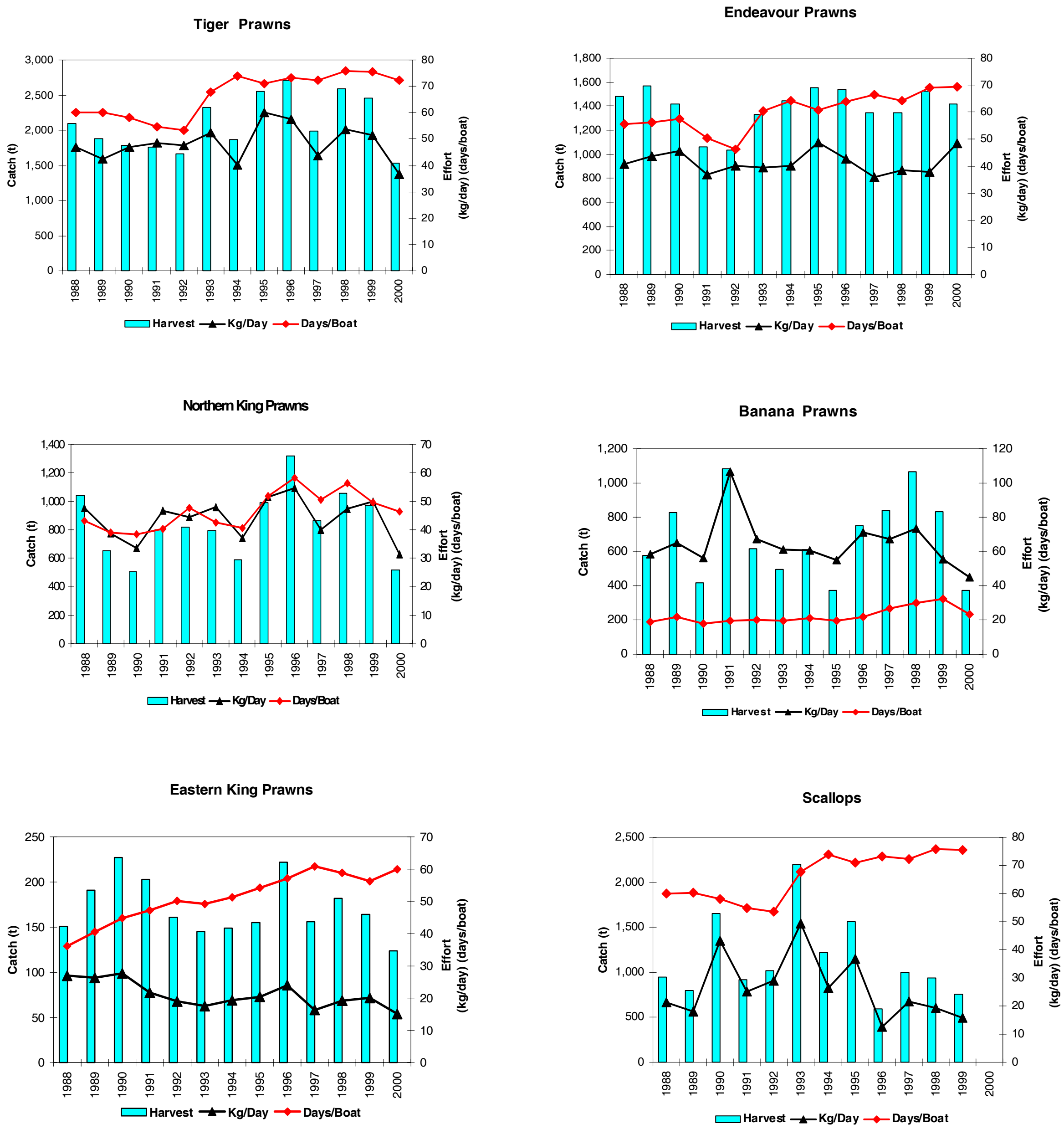
The most recent "Condition and Trends Report" makes the following comments about the target species taken in the ECTF.

Table 9: Harvest trends for the principal (i.e. target) species in the ECTF, as reported by the QDPI.

Common Name	Species	Harvest Trends
Tiger Prawns	*Penaeus esculentus* *Penaeus semisulcatus* *Penaeus monodon*	➢ long-term trend generally is stable, but wide annual variation with volatility increasing over the last 5 years ➢ possible decrease in CPUE due to increasing effective effort
Endeavour Prawns	*Metapenaeus endeavouri* *Metapenaeus ensis*	➢ considerable annual variation but no consistent increases or declines ➢ possible decrease in daily boat harvest due to increasing effective effort
Northern King Prawn	*Penaeus longistylus* *Penaeus latisculatus*	➢ long-term trend generally is stable, but with wide annual variation; ➢ possible decrease in fleet mean daily catch due to increasing effective effort
Banana Prawns	*Penaeus merguiensis*	➢ highly variable ➢ harvests related to rainfall and climatic events
Scallops	*Amusium japonicum balloti* *Amusium pleuronectes*	➢ stable harvest and harvest rate since 1997
Eastern King Prawn	*Penaeus plebejus*	➢ stable harvest rate reported state-wide since early 1990s, but with increased harvest
Bay Prawns	*Metapenaeus bennettae* Other species	➢ harvest has shown considerable variability over the past 12 years, with 2000 harvest being one of the lowest
Bugs	*Thenus* spp *Ibacus* spp *Scyllaroides* spp	➢ declined from a maximum in 1997 and 1998 ➢ mean daily catch per boat declined from a peak in 1992

Squid	*Photololigo spp* *Sepioteuthis lessoniana* Other species	➢ variable, with between 125 and 225t reported annually from trawl and inshore net fisheries ➢ declining trend since 1991 in the Moreton Bay trawl harvest and in the small net fishery harvest since 1998

Figure 7: Time series of catch and effort trends for the major ECTF target species - 1988 to 2000. (Data Source: ECTF Logbooks; Information Source: Condition and Trends Report (Williams, 2002).)



Note: 1. The above figures were prepared from the catch effort statistics reported in the "Condition and Trends Report" and are based on nominal CPUE data (standardised CPUE data were not available).

2. Bay Prawns have been excluded from the figure, as they are a species mix and generally taken outside the GBR Marine Park.

The report provides data on the catch, effort and nominal CPUE for the key commercial species. This information is presented in Figure 6, which shows several important trends. Firstly, there is

considerable inter-annual variability in the reported catch of target species. This is pronounced particularly with banana prawns and scallops. Secondly, for most sectors (tiger, endeavour, northern king and eastern king prawns) recorded catches peaked around 1996, which is the year nominated in the revised Trawl Plan as the benchmark for effort unit allocation. Thirdly, the graphs show a general decrease in nominal CPUE (reported as kg/day) and a general increase in fishing effort (reported as days/boat) by the fleet. The QFS has reported that nominal CPUE for scallops, endeavour prawns and tiger prawns were stable from 1995 to 2000. In contrast, nominal CPUE for banana prawns and northern king prawns decreased over the same period. Following the implementation of the Trawl Plan, fishing effort has decreased for some of the main target species (tiger, northern king and banana prawns).

5.1.2 By-product Species

Until recently the status of by-product species has not been the subject of focussed research and monitoring efforts in the ECTF. In fact, by-product information was not collected until the introduction of the amended OT07 logbook in July 1999. The following reported harvest trends are excerpts from the "*F(ECT) Management Plan Review Paper – Permitted Fish (other than principal fish) and Steaming Day Review*", hereafter referred to as the "Trawl Plan Review", released by the QFS in August 2001. In reviewing the take of permitted species, the QFS collated the catch/effort information available at the time.

Table 10: Harvest trends for the permitted (i.e. by-product) species in the ECTF
(Data Source: ECTF Logbooks; Information Source: Trawl Plan Review)

Common Name	Species	Resource Comments
Blue Swimmer Crabs	*Portunus pelagicus*	➢ mortality rates and stock recruitment have not been estimated ➢ no concerns about ability to withstand current fishing pressures (800 t/yr overall, 150 t/yr trawl) ➢ very high fecundity and rapid growth rate ➢ recruitment is likely to be a function of environmental and hydrological conditions ➢ high catchability and low discard mortality
Pipefish and Seahorses	*Solegnathus hardwickii* *Solegnathus dunckeri* Other species**	➢ strong habitat preference ➢ low fecundity ➢ susceptible to overfishing and listed as "vulnerable" under IUCN ➢ recruitment, stock size and the impact of trawling is poorly understood ➢ high catchability and high discard mortality
Barking Crayfish	*Linuparus trigonus*	➢ no information on species' biology ➢ unknown catchability or discard mortality
Balmain Bugs	*Ibacus* spp (5)	➢ long-lived species (up to 10 yrs) ➢ two species commonly taken (*I. peroni* and *I.* spp) have very similar morphology but different life histories and behaviour ➢ have the potential to be sequentially depleted

Common Name	Species	Resource Comments
		➢ high catchability and unknown discard mortality
Cuttlefish	*Sepia* spp (15) *Metasepia pfefferi*	➢ no information on species' biology ➢ habitat preference for at least part of the life cycle ➢ high catchability and high discard mortality
Goatfish*	*Mullidae (55)*	➢ appear to be abundant ➢ display schooling behaviour ➢ pelagic spawners ➢ some species display habitat preference ➢ high catchability and medium discard mortality
Mantis Shrimp	*Squilloidea (8)*	➢ no information on species' biology ➢ appear to have low discard mortality
Octopus	*Octopus* spp (8 –10)	➢ little information on species' biology ➢ appear to be short-lived species ➢ display habitat preference and territorial behaviour ➢ high catchability but low discard mortality
Pinkies	*Nemipterus* spp (5)	➢ appear to be abundant ➢ may display schooling behaviour ➢ pelagic spawners ➢ high catchability and medium discard mortality
Red Spot Crab	*Portunus sanguinolentus*	➢ little information on species' biology ➢ high catchability and low discard mortality
Sharks*	*Charcharhinus* spp	➢ little information on species' biology ➢ concerns about the sustainability of some shark stocks, both nationally and internationally ➢ low catchability (post TED introduction) and low discard mortality
Whiptails*	*Pentapodus* spp	➢ high catchability and high discard mortality

*Note: Species groups denoted by * were removed from the permitted species list following the August 2001 review.*

Mantis shrimp are taken only in significant quantities in Moreton Bay (outside the GBR Marine Park).

5.2 General Comments about the Assessment Methodology

5.2.1 Reliability of Information Sources

As outlined in Section 4.3.2, there are several (at times major) limitations to data collection in the ECTF. This may impact considerably on the reliability of assessment results. Firstly, the data collected are mainly fishery dependent. Even when there are fishery-independent surveys, such as in the scallop and North Queensland prawn LTMPs, the areas surveyed are restricted generally to major commercial grounds. This is done because of constraints on funding but it introduces a fishery bias to

the data, which is difficult to quantify. Information gaps exist on species distribution and abundance outside the area of commercial activity.

Secondly, there is uncertainty over the quality of commercial logbook data, which are the dominant information source for ECTF assessment. These data are not validated and it is of concern that the veracity of the key estimator of stock abundance (i.e. CPUE) remains unknown.

A third important source of uncertainty concerns the species reported. As a result of prawns being graded by size and the natural co-occurrence of certain species, there is evidence of inadequate reporting. For example, the category of "bay prawns" is known to contain unsorted catches of small eastern king prawns, greasy back prawns, school prawns and red-spot king prawns. Such practices are a major source of uncertainty in the assessment process, although it is more of a problem in inshore and enclosed waters like Moreton Bay and Hervey Bay than in the GBR Marine Park.

Section 4.3 contains recommendations on how data reliability and information gaps can be addressed. Principally, it is recommended that, following a review of its statistical design, the fishery-wide monitoring program should be expanded spatially and in terms of the species covered. This would provide fishery-independent data at a high level of resolution. It is recommended that the logbook data provided by industry be validated through an at-sea observer program and other mechanisms. This would give greater confidence in the reliability of the logbook data and, again, give a higher level of data resolution. Technology that monitors vessel and gear movement (such as the VMS and gear sensors) would also verify the spatial and effort information provided by industry.

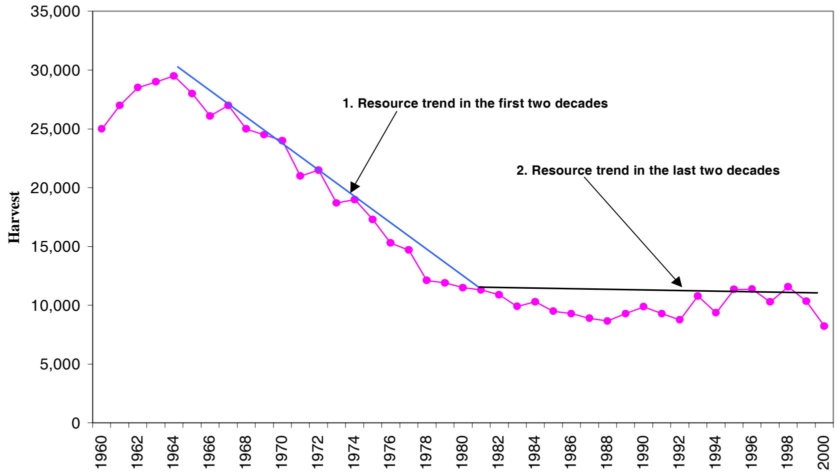
5.2.2 Time Series of Fishery Data

A major limitation of the ECTF assessment process is its chronological coverage. The fishery began in the 1950s in Moreton Bay and expanded sequentially in a northerly direction. Yet, despite five decades of commercial fishing, current fishery assessments have taken account of the last two decades of data only. The QFS's CFISH database covers the period from when logbooks first became mandatory (i.e. 1988) to the present. This means that the assessment provides only a snapshot of the data that relate to a period that represents less than half of the fishery's existence.

As outlined in Section 5.1.1, the QDPI interprets the catch and effort trends for major target species as being "relatively stable", despite considerable inter-annual variations. However, the proceedings of the "South-East Queensland Stock Assessment Review Workshop (August 1998)" note that "*the CFISH data tends to have little year to year contrast. Within the years there is a marked seasonal pattern. Historical data from voluntary logbook programs and other studies would extend the data to about 1970, but is* [sic] *unavailable for analysis because the database entry is incomplete and unchecked. Data resides with* (the then) *QFMA. There is an urgent need to have the data developed and made available."* (Dichmont *et al.*, 1999)

Whilst it is acknowledged that there may be quality issues with the pre-1988 data, the Audit Report supports the need to assess the fishery against the background of its entire history. To illustrate the point, Figure 7 depicts a hypothetical harvest trend, which assumes an annual harvest of between 25,000 to 30,000 tonnes of virgin biomass when the fishery began in the 1960s. The graph, based on hypothetical values, shows a different harvest trend in the first two decades compared to the last two decades of the fishery. The first period would be indicative of the "fish down" of a virgin biomass, whereas the second period would be indicative of a "plateauing out" of catch rates.

Figure 8: Hypothetical Harvest Trend 1960 – 2000.



A decline in catch is to be expected as a virgin biomass is fished down, even with species that are relatively short lived and highly fecund. A decline of stock abundance from virgin biomass does not present a problem, provided that appropriate decision rules are applied to provide the necessary feedback and control to ensure that the abundance of the stock is maintained at a level required for the sustainability of the stock.

By using the full dataset in the assessment, as much information as possible concerning the relationship between equilibrium yield and fishing effort or stock size may be extracted. It is noted that from a fishery analysis viewpoint, the data most useful for the calculation of MSY usually are contained in the first ("fish-down") phase of the fishery and little information on this estimate is available if the stock assessment is confined to the data pertaining only to the second period. For example, pre-1988 data were used in scallop and Eastern king prawn stock assessments to establish a stock-recruitment relationship (Gribble *et al.*, 1995).

Recommendation 13

- ***That, notwithstanding data quality and compatibility issues, an attempt be made to analyse historical (i.e. pre-1988) ECTF data and to assess the level of catch and effort since the fishery's inception.***

5.2.3 Changes in Fishing Power

The increasing fishing power of a fleet over time, due to gear and technological advances, is referred to as "effort creep". While some management measures[38] have the effect of reducing effort, advances in fishing technology frequently offset such measures.

When the ECTF first developed in Moreton Bay, operators were restricted to a maximum trip time of four days because their product was iced. Radar had not been adopted at the time and the only high-technology equipment aboard the vessel was an unsophisticated echo sounder. Nowadays, state-of-the-art equipment such as sonar, GPS and plotters allow the exact location of fishing grounds (i.e. they

[38] Such measures include restrictions such as night-time only fishing, limitations on vessel size and below deck capacity, the requirement for excluder devices such as TEDs and BRDs and various net restrictions.

reduce search time) and allow trawling in areas adjacent to unsuitable grounds (i.e. they allow for the expansion of the fishery into areas previously not fished).

Stock assessment experts have hypothesised that the introduction of triple and quad gear in prawn fisheries between 1976 and 1978 led to a 20% increase in efficiency. Similarly, it is estimated that the use of try gear in the mid-1980s and the introduction of GPS in 1990 resulted in an increase in effective effort of 5% and 10% respectively (Dichmont *et al.*, 1999). This represents an overall increase of 35%, without taking into account later developments such as bulbous bows, propeller nozzles differential GPS, improved otter boards, faster winches, enhanced net designs and improved communication equipment.

A further aspect of effort creep is the increase in boat size and engine power. In the ECTF, there had been an influx of larger boats from the Gulf of Carpentaria until 1984. This led to the introduction by fishery managers of a boat size limit (20 m) and hull unitisation. The revised Trawl Plan recognises the different fishing capacities between smaller and larger vessels by applying a proportional conversion factor to hull units in the calculation of effort units. In other words, larger vessels have a higher conversion factor applied, which recognises their greater fishing power.

If CPUE is a parameter in stock assessment, it is essential that an accurate estimate of effort creep is obtained[39]. A downward trend in stock abundance may be masked if increases in fishing power are not recognised. Specifically, it may appear from the recorded logbook information that there has not been an increase in fishing effort, when in fact "effective effort" in the fishery may have increased several-fold. Thus, if the level of catch remains the same under this scenario, the fishery will have experienced a drop in CPUE, which will not be reflected in the logbook data.

Consequently, it is crucial that effort creep is quantified and accounted for in the stock assessment process. This is done through an adjustment of the nominal fishing effort. By applying an adjustment factor to the effort data to account for the increased efficiency of the fleet, the CPUE becomes "standardised" for effort creep.

In the case of the ECTF, CPUE is the major (and, in many instances, the only) input variable used in stock assessment. Recognising the importance of this, QDPI initiated the "Effort Creep Study" (FRDC Project No. 1999/120), which is nearing completion. The study examined technological changes in fishing gear through a voluntary industry survey. The results of this survey were then applied to commercial logbook data. The final report from this study is yet to be reviewed and published. Interim data derived from the study were made available for this report.

The study is based primarily on CFISH data and, therefore, relies predominantly on the period 1988-1999. The first two decades of the ECTF's existence are not captured in the analysis. Given the fishery's development, it would be reasonable to assume that some of the most marked changes in fishing power occurred during those first 20 years. The study would not have taken account of the earlier efficiency increases brought about by the introduction of try, triple and quad gear.

The FRDC study had a number of important objectives. Firstly, it was to describe the gear and technological improvements over time in Queensland's tiger prawn, saucer scallop and shallow-water and deep-water eastern king prawn fisheries[40]. Preliminary results indicate that increases in fishing power varied across the sectors, as did the factors influencing effort creep.

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[39] The NPF is now in its second phase of estimating increased efficiency over time, by quantifying the relative contribution of each of the factors influencing fishing power. However, it has been difficult to establish consensus on what the level of increase has been and how this has been offset by consecutive management intervention.

[40] The Torres Strait tiger prawn fishery was also included in this study but is not cited in this report.

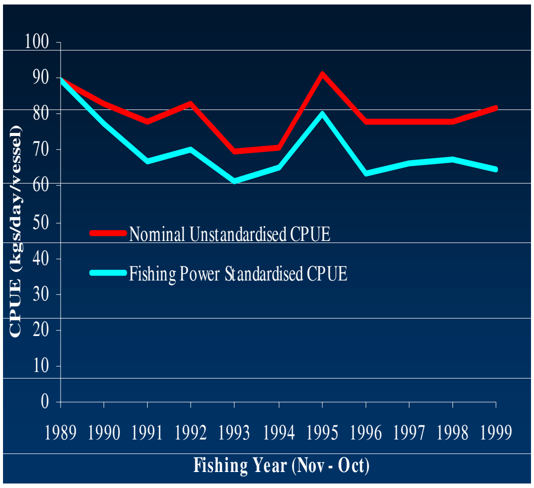
Table 11: Preliminary results on effort creep in the ECTF
(Information source: Voluntary Industry Survey).

	Estimated Fishing Power		
Sector	**% Increase/Year**	**Range**	**Important Factors**
Eastern King Prawn – Shallow	1.6	0.6 to 2.7	➢ vessel length ➢ engine power
Eastern King Prawn – Deep	0.3	-0.1 to 0.7	➢ net size ➢ otter board size ➢ fuel capacity
Tiger Prawn	0.6	-0.2 to 1.5	➢ GPS /DGPS
Scallop	0.2	-0.7 to 1.1	➢ engine power ➢ use of try gear

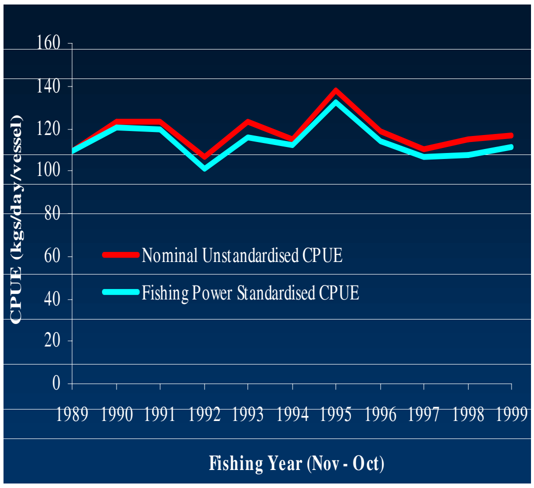
Note: *The above preliminary results were provided courtesy of Mick O'Neil (QDPI, AFFS) and relate to information to be published in the Final Report on FRDC Project No. 1999/120.*

Figure 9: Nominal versus standardised CPUE for four major ECTF sectors.

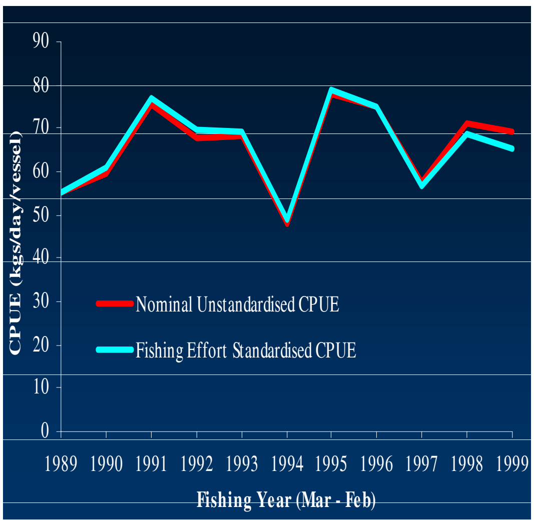
(i) Easter King Prawn – Shallow



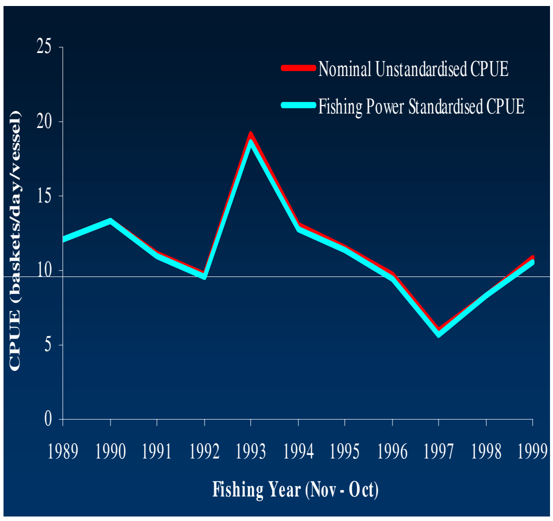
(ii) Eastern King Prawns - Deep



(iii) Tiger Prawns



(iv) Scallops



Note: The above figures were provided also courtesy of Mick O'Neil (QDPI, AFFS) and relate to information to be published in the Final Report on FRDC Project No. 1999/120.

The second objective of the study was to standardise CPUE in light of the fishing power analysis. Because effort creep was estimated to be low in the deep-water eastern king prawn, tiger prawn and scallop sectors, there did not appear to be a significant difference between the nominal and standardised CPUE graphs. However, in the case of the shallow-water eastern king prawn sector, there appears to be a significant difference between the two. These results of CPUE standardisation are presented in Figure 9.

The third objective of the study was to compare current management reference points with standardised and nominal CPUE and investigate possible alternatives. The results of this part of the study are not yet available.

The estimates of effort creep in the study are surprisingly low compared to the estimated effort creep in the NPF, which is calculated at an average 5% per annum and is the subject of continued (and highly contested) research. It could be argued that, historically, the ECTF has had more effort constraints imposed on it than the NPF and that this would have reduced effort creep significantly[41]. However, technological advances in satellite navigation and improvements in the performance of fishing gear/vessels would have been adopted equally in both fisheries and would have improved fishing efficiency and fishing power significantly. Intuitively, it seems unlikely that industry would invest in improved and costly fishing technology without benefiting from increased efficiency. In the case of the NPF, it was found that knowledge accumulation and improved operational practices by industry contributed considerably to increased fishing efficiency. The study by O'Neil *et al.* included such factors as skipper experience.

The FRDC study was undertaken just prior to the restructure of the ECTF. The dynamics of the fishery have been altered fundamentally since the introduction of revised management arrangements. It would be erroneous to attempt to extrapolate past effort creep estimates to the current situation. With the freeing up of the boat replacement policy and greater economic viability of the remaining fleet, it is expected that effort creep in the fishery would have increased substantially since January 2001.

This contention is supported by the ECOTF Status Report 2001, which states that, due to the fishery's structural adjustment, there has been a shift to larger vessels and greater average engine power. The report explains that the buy-back scheme bought out proportionally more smaller vessels than larger vessels. With the removal of the "2 for 1" boat replacement policy, it is anticipated that, over time, fewer but larger trawlers will be fishing in the GBR Marine Park. Furthermore, under the new effort system, operators will be fishing fewer days but (because of this limitation) they will do so more efficiently by spending more hours actually fishing during any allocated fishing day. Prior to the plan, there was an incentive to continue fishing in less productive times if there was a marginal cost benefit. The new limitation on the number of days that each boat is entitled to fish will cause operators to be more selective about the days on which they actually fish, so as to maximise the catch from their time allocation.

It is important that effort creep continues to be monitored in the ECTF, as it is likely to have increased since 1 January 2001. Substantial changes in the fleet's efficiency could effectively undermine the effort reductions achieved by the revised management plan. In trying to quantify changes in fishing power under the revised system, it is important to account for efficiency decreases brought about any product loss through excluder devices such as TEDs and BRDs.

[41] Before the introduction of the revised Trawl Plan, constraints, which may have impeded effort creep, included high penalties on boat replacement (2 for 1) and a maximum permitted number of hull unit of 40.

Recommendation 14

- ***That there be a review of the estimated changes in fishing power in the ECTF from the fishery's inception in the 1960s till today, using both historical (pre-1988) and recent (1988 – today) data.***

5.2.4 Spatial Distribution and Variability of the Fishery

Due to the large geographical area covered by the ECTF, there are spatial variations in species distribution and abundance. Firstly, there is a latitudinal trend in species distribution across the fishery, ranging from the tropical penaeid fishery made up primarily of tiger and endeavour prawns in the far north to the more temperate eastern king prawn fishery in the south. Secondly, there can be considerable variation in abundance on a smaller spatial scale within the known area of a species' distribution. This is particularly pronounced in species that are known to aggregate, like banana prawns and tiger prawns. As outlined in the Trawl Plan Review, habitat preferences have been noted for cuttlefish, octopus, pipefish and seahorses. Thirdly, there can be spatial variation in species abundance depending on their life-cycle stage. For example, juveniles of many prawn species are found in shallow inshore nursery areas and then migrate into deeper waters as adults. The eastern king prawn in particular is known for its offshore movement as recruiting adults, but also undertakes a longitudinal migration during its life cycle.

Logbook data indicate that trawling is not distributed uniformly across the fishery but is highly aggregated spatially. Over time, as successive closures were introduced, there has been a reduction in the area available to the fishery. Anecdotal reports from industry suggest that there has been a contraction of fishing effort into well-established grounds, especially since the removal of effort through the ECTF Structural Adjustment Scheme.

Table 12: Trawled area in the fishery and the GBR Marine Park.
(Information Source: ECOTF Status Report – 2001)

	Total Fishery		GBRMP	
	Area (km^2)	**%**	**Area (km^2)**	**%**
Total area of fishery	546267	100	345848	100
Total area of permanent closures[1]	176133	32	173904	50
Total area available to be fished	370134	68	171944	50
Area fished	143110	26	106519	31
Area not fished	227023	42	65425	19
Area of major seasonal closures	312654	57	255798	74
Area with some restriction on trawling[2]	324469	59	262073	76

Note:1 – Under Queensland fisheries legislation and GBRMP zoning
2 – Restriction may be in the form of permanent or temporal closures

The "ECOTF Status Report 2001" notes that only 26% of the total area of the fishery is trawled or 31% of the GBR Marine Park (Table 12). If permanent closures are not included in the calculation, this equates to about 39% of the total available area being fished in the overall fishery or 62% in the case of the GBR Marine Park. However, the trawl area information is based on 6' x 6' grids and within each grid fishing activity is even more aggregated. The "Condition and Trends Report" states that trawling occurs in *"concentrated areas of the fishery and boats frequently operate within one square kilometre during the course of a night"* (Williams, 2002).

This spatial pattern in fleet behaviour is reflected in the frequency of trawl usage. Most of the fishery area (about 90%) is fished at low (i.e. less than 21 boat days per year) to moderate (i.e. less than 99

boat days per year) levels of effort, with 10% (or 8% in the case of the GBR Marine Park) fished heavily at more than 100 boat days per year (Table 13).

Table 13 Level of activity in the area of the ECTF and the GBR Marine Park.
(Information Source: ECTF Status Report – 2001)

	Total Fishery		GBRMP	
	Area	**%**	**Area**	**%**
Area fished less than 21 boat days per year	89451	63	67942	64
Area fished between 21 and 99 boat days per year	39343	27	29734	28
Area fished between 100 and 199 boat days per year	9710	7	6841	6
Area fished more than 200 boat days per year	4607	3	2003	2
Total	143110	100	106519	100

From a stock assessment perspective, it is crucial that the causes underlying the spatial patterns of a fishery are understood fully. For example, about half of all the bugs taken in the ECTF come from two distinct areas (off Townsville and Gladstone). It is important to know if bugs are "naturally" more abundant in these areas, if the fishers target bugs more heavily off Townsville and Gladstone than elsewhere in the fishery or if the numbers of bugs have been reduced in the other areas due to heavy fishing in the past. The way in which the fishery area data are stratified and analysed during stock assessment depends on which scenario reflects reality. A failure to recognise the underlying causes may lead to a misinterpretation of the status of the fishery.

A case in point is the tiger prawn sector of the NPF. Fishing has contracted in its area of operation since the 1980s. It was found that "*between 20% and 40% of the catch was coming from (6nm x 6nm) grids that are no longer being fished today*" (Die *et al.*, 1995). As noted in a stock assessment review by an external consultant "*such contractions have caused assessments of fish stocks in other parts of the world to make a downward revision of their abundance indices to account for the contraction. The downward revision depends on the extent to which animal density in the non-fished areas is below the average animal density in the fished areas.*" (Deriso, 2001). The reviewer concluded that a fishery-independent survey was required for non-fished areas to improve the assessment advice in the NPF. Subsequently, this recommendation was implemented.

In the absence of long-term fishery-independent surveys across the entire ECTF, it is uncertain if the spatial patterns observed are a natural habitat-associated phenomenon of the species caught, a reflection of fleet behaviour or the sequential impact of fishing. It is of concern that there could be a spatial contraction of fishing due to reduced species abundance, but that this may go unnoticed. In particular, assessments of CPUE trends at a fishery-wide level may not detect spatial depletion, because catch rates may remain unaltered in a contracting fishery.

A more detailed spatial analysis of the CPUE data is required and this information should be used in the stratification of fisheries data to account for the spatial variability of the fishery. The investigation of trawl track signatures will assist in the future spatial analysis of the fisheries data and provide a finer resolution of the fishing pattern. However, long-term fishery-independent surveys across the ECTF are required to obtain information on species abundance in areas where the commercial fleet does not operate. Such information is required for biomass estimates and to determine the impact of area closures on species abundance and recruitment. AFFS has sought to initiate a research program focused on evaluating current management systems for the main target species; however, to date this has not received funding from FRDC.

It would be useful to conduct a fine-scale spatial analysis of the fishing patterns in the ECTF over time. This would show the extent to which the reduction in the area fished is a reflection of the decrease in the number of operators over time, the introduction of closures or regional stock depletion and decreasing catch rates. In undertaking such an analysis, the historical (i.e. pre-1988) data should

be included. This would show how fishing effort has shifted geographically over time since the fishery began.

Recommendation 15

- ***That, as part of the fishery assessment process, there be a fine-scale spatial analysis of the fishery in terms of species abundance and fishing effort over time, and that appropriate stratifications be applied to the CPUE data to account for the fishery's spatial variability.***

Most of the species taken in this fishery are also taken in other State and Territory jurisdictions. While there may be distinct stocks off the Queensland coast with little mixing between populations for some species, others have an extremely large geographical distribution and a high degree of genetic mixing. The eastern king prawn fishery is a good example, which spans three jurisdictions (Queensland, New South Wales and Victoria) and the sub-adults and adults undertake longitudinal migrations of over 1,000km. Where species are shared between jurisdictions, it is essential that available assessment data are analysed over the species' entire geographical range. It is acknowledged that under such circumstances data access can present a problem and that it requires collaboration with other fisheries management agencies to achieve a comprehensive stock assessment.

5.2.5 Temporal Distribution and Variability of the Fishery

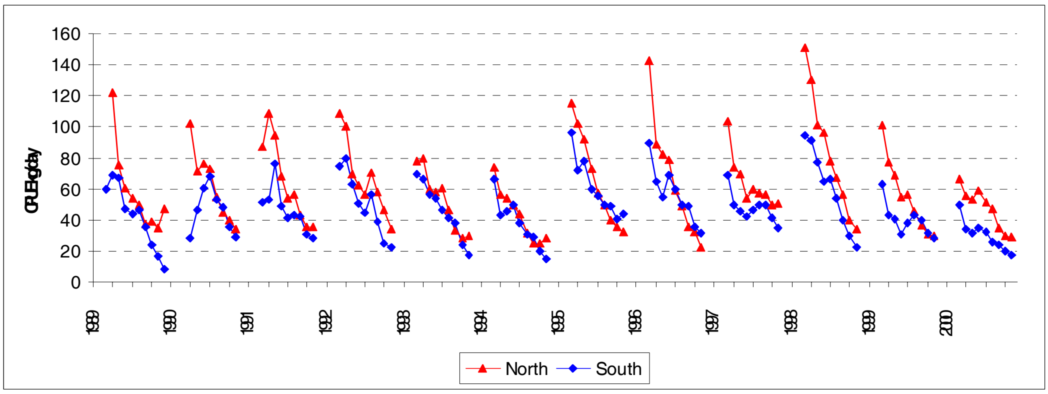
Temporal variation in species abundance is common in many tropical penaeid prawn fisheries. Firstly, there can be high inter-annual variability, particularly when recruitment is affected by environmental conditions such as rainfall and discharge from rivers. In the case of the ECTF, the most variable fishery is the banana prawn fishery, where annual catches have ranged from a couple of hundred tonnes to over a thousand tonnes. It is noted that all the stock assessment trends reported in the various QDPI publications cited in Section 5.3 are prefaced with comments about the large variability in catches and catch rates between years.

Secondly, many prawn species have distinct spawning periods and the recruitment of adults to the fishery occurs after the juvenile phase has been completed. In many prawn fisheries, there is a strong recruitment pulse, which may disappear over time as the adults are fished down or become less available to the commercial fishery for behavioural reasons. The changing CPUE in the Torres Strait Prawn Fishery on a seasonal basis between 1989 and 2000 illustrates this point (Figure 10). The trend in the Torres Strait Prawn Fishery of declining CPUE within each season and within each region appears to be relatively consistent from year to year. Such clear trends would not be observed in fisheries where spawning is continuous throughout the year. For example, endeavour prawns spawn all year, with a peak during summer.

A third example of temporal variability is the lunar periodicity of many prawn fisheries. With the exception of the red spot king prawn, all other ECTF prawn species appear to become unavailable to the commercial fishery at the time of the full moon. What is ultimately a behavioural phenomenon may appear as a periodic decrease in abundance from a stock assessment and industry perspective.

To compare CPUE in a meaningful manner across years and on a seasonal basis, stock assessments need to take account of these temporal variations. As with spatial variations, data need to be standardised for this type of variability. For example, in prawn fisheries that have a single clear recruitment pulse, it would be meaningless to compare catch rates at the beginning of the season in one year with the catch rates at the end of a season in another year.

Figure 10: Seasonal declines in tiger prawn CPUE in the Torres Strait Prawn Fishery (1989 to 2001). (Data Source: QDPI survey data)



Note: The above graph was supplied courtesy of Clive Turnbull (QDPI) and represents the results from fishery surveys in the Torres Straits.

Similarly, annual catch rates (i.e. total annual catch divided by total annual effort) may not detect seasonal peaks and troughs in abundance or availability because the CPUE is averaged over the entire year. Assessments need to take account of these variations.

The importance of the comparison periods is examined further in Section 7.3.1, where the performance of the fishery against the stated performance indicators is discussed. The strong temporal variability of the ECTF needs to be factored into the design of any LTMPs and the logbook and monitoring data need to be stratified accordingly.

Recommendation 16

- ***That, as part of the fishery assessment process, there be a temporal analysis of the fishery in terms of known species abundance and fishing effort over time and that appropriate stratifications be applied to the CPUE data to account for the fishery's temporal variability.***

5.2.6 Multi-Species Catch Composition and Targeting

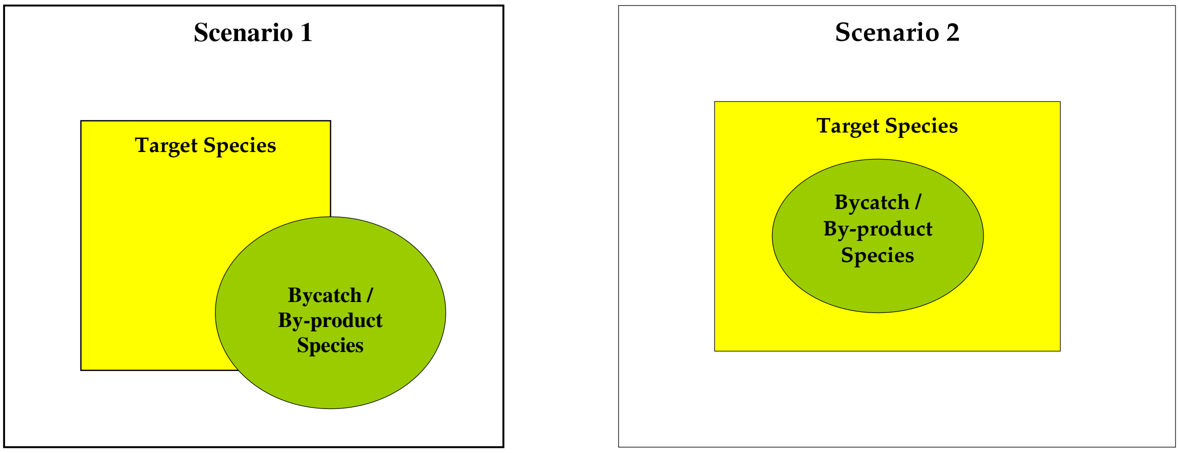
"Targeting behaviour" in a multi-species fishery, such as the ECTF, adds another level of complexity to the stock assessment process and can undermine the usefulness of CPUE as an indicator of stock abundance. If species are taken incidentally to target species, inferences concerning the abundance of this by-product or bycatch cannot necessarily be drawn from the recorded CPUE data. A hypothetical example (Figure 11) demonstrates this point.

Under Scenario 1, the area of distribution of bycatch partly overlaps the area of distribution of the target species. In other words, there are areas of the fishery where the bycatch species is found, but which are not fished commercially because they fall outside the area of the target species abundance. The degree of overlap is the critical issue. Under this scenario it could be misleading to extrapolate from the bycatch CPUE in the fished area to other parts of the fishery. In contrast, such an extrapolation would be appropriate under Scenario 2, where the area of distribution of bycatch occurs entirely within that of the target species.

Consequently, it is important to understand the population biology of bycatch species and, in particular, their distribution and abundance. Such knowledge is crucial in determining whether a decline in catch rates (should this occur) is an indicator of decreased bycatch abundance (i.e. scenario

2) or a localised phenomenon with the species being protected in the non-fished parts of the fishery (i.e. scenario 1).

Figure11: Hypothetical scenarios of bycatch and target species distributions.



Recommendation 17

- ***That, based on all available data (i.e. logbook, LTMP and research data), there be an assessment of the spatial distribution of commercial by-product species in the ECTF;***

Recommendation 18

- ***That there be a peer review of the use and limitations of CPUE as an indicator of abundance for all principal and permitted ECTF species.***

5.2.7 Development of Assessment Models

Having outlined the limitations of CPUE as an indicator of stock abundance, it is noted that alternative assessment methods currently are being investigated by the AFFS. Specifically, assessment models, which predict stock abundance, are being developed for tiger prawns, endeavour prawns, eastern king prawns and scallops. These models will cover about 80% of the stock taken in the ECTF. The results from this work are not yet available.

Table 14: Stock assessment models being developed by the QDPI
(Information Source: the ECOTF Ecological Assessment Report (Zeller, 2002)).

Fishery	Assessment Type	Status
Bugs	➢ Yield-per-Recruit model	➢ Completed internal report being peer-reviewed
Eastern King Prawns	➢ Age structured model	➢ Completed report to FRDC due mid 2003
Scallops	➢ Age structured model	➢ Completed report to FRDC due mid 2003
Northern Tiger and Endeavour Prawns	➢ Surplus production model	➢ Completed internal report being peer-reviewed
Blue Swimmer Crab	➢ Biomass model	➢ Completed report to FRDC

The development of such models is a considerable improvement in the ECTF stock assessment process. However, for these models to predict population size adequately, two conditions must be met. Firstly, assessment models are used to estimate population parameters such as natural mortality, catchability, virgin biomass and spawner/recruitment relationships. If the data are non-informative with respect to estimating the relevant population parameters, information needs to be sought from other studies and the results applied to the stock assessment model. Under such circumstances, the accuracy of the assessment results will depend on the appropriateness of the parameters used. Secondly (and in line with the previous consideration), the uncertainty associated with the parameter estimate and the impact of such uncertainty on the results needs to be explored using the model. In other words, a sensitivity or baysian analysis should be carried out to test the results of the model under a range of parameter estimates. Again, any historical (i.e. pre-1988) ECTF data would provide an important contrast in the dataset.

The data used in the models are from 1988 only, when logbooks were introduced for target species, despite the fact that catch information has been collected since the fishery's inception in the 1950s. In order to estimate virgin biomass and to analyse fishery trends over the life of the fishery, pre-1988 data should be used in stock assessments.

The underlying assumption in the models being developed is that CPUE is a good estimator of biomass. As outlined in Section 5.3.4, there are concerns about the adequacy of CPUE as a population parameter. Also, it is uncertain to what degree the CPUE data used in these models have been standardised for changes in fishing power, geographical area and season (as discussed in Section 5.3.3.).

Based on percentage composition of catch, logbook data used in the tiger/endeavour prawn assessment model are filtered for targeting. In a mixed-species fishery, there is an inherent risk in adopting such an approach. The filter may screen out data as non-target catch, when in fact there has been a decline in percentage catch composition due to declines in stock abundance. Thus, overfishing of one species in a multi-species fishery may not be detected.

Recommendation 19

- ***That the development of assessment models for the principal ECTF species be progressed as a matter of priority and that they be used in the recommended annual fishery assessment process as the input data become available***

5.3 Specific Comments about the Assessment Findings

There are no periodic assessment reports that summarise the status of stocks in the ECTF in light of the most recent monitoring and research findings. The proceedings of the last stock assessment workshop held by the QDPI, while highly valuable at the time, are now dated and only address the status of saucer scallops and eastern king prawns in the ECTF. As outlined in Section 5.2, there is uncertainty associated with the CPUE trends reported for the ECTF species, which limit their usefulness as an assessment tool. Only now are assessment models beginning to be developed for some of the major target species.

The most current assessment on the status of stocks by QDPI is reported in the "ECOTF Status Report - 2001" (Zeller, 2002) and the "Condition and Trends Report" (Williams, 2002). Useful information on species distribution, stock structure and life history is also contained in the BRS Atlas on "*Australian Fisheries Resources*" (Kailola *et al.*, 1993), hereafter referred to as the "BRS Atlas". The following sections contain excerpts from these and other relevant sources on stock assessments of the principal ECTF species and a critique of these findings. A summary table of the information in this section is provided in Appendix 6. It is noted that "Bay Prawns" are not considered in this report, as

these include the juveniles of species considered separately (i.e. tiger prawns, endeavour prawns, king prawns and banana prawns). Furthermore, greasyback prawns and school prawns occur mostly outside the GBR Marine Park.

5.3.1 Tiger Prawns

Tiger prawns are the major commercial species caught in the GBR Marine Park and, together with endeavour prawns, form the most valuable sector of the ECTF. Estimates of the MSY for the northern region (Cape Tribulation to Cape York) suggest an annual catch of between 1,227 and 1,400 tonnes. The average annual catch for that region in the 1988-2001 period was 1,167 tonnes (Gribble and Turnbull, 2003).

The tiger prawn is one of the few ECTF species for which additional assessment work (apart from the routine nominal CPUE analysis) is being done, reflecting its commercial importance. The "ECOTF Ecological Assessment Report " notes that "*from 1988 to 2000 there are no consistent trends in the catch*" and that "*annual variability was high*". It is acknowledged that the "*adoption of advanced navigation aids, such as GPS and differential GPS, may have increased fishing efficiency"* and therefore *"resulting in decreases in CPUE"* (Zeller, 2002).

The same report makes the following statement about the status of tiger prawns: "Yearly catch rate data for tiger prawns in the northern part of the fishery (Cape York to Cape Tribulation; 16^{o}S) have been fitted to a Schaefer non-equilibrium surplus production model, with effort creep scenarios factored into the model. This model indicated that although the stock is exploited fully, catch rates (and stocks) have not declined over the last ten years. A number of caveats need to be applied to this assessment however: the data time-series is relatively short and does not contain the developmental stage of the fishery; the logbook categories used are suites of species and consequently may mask stock changes in individual species; and these prawns aggregate, which may make CPUE a poor indicator of underlying abundance".

The uncertainty surrounding the status of tiger prawns is of concern. Recruitment overfishing has been demonstrated for these species in other parts of Australia (Western Australia and the Gulf of Carpentaria). As outlined in Section 5.2, it is likely that the three assumptions underlying the surplus production model are being violated. A sensitivity analysis is required to determine how robust the results are if the assumptions are not being met.

There are two species of tiger prawns; the brown tiger prawn (*Penaeus esculentus*) and the grooved tiger prawn (*Penaeus semisulcatus*), which are taken in commercial quantities in the ECTF[42]. There has been no separation of these two species in the ECTF logbooks to date. Tiger prawns form part of the multi-species mix of tropical penaeid prawn fisheries, which includes other species such as endeavour prawns and northern king prawns. As discussed in Section 5.2.6, a decline in one of the species may be masked by the higher abundance of one or more of the other species and remain undetected in a CPUE analysis (Deriso, 2001). The "Condition and Trends Report" notes that endeavour prawns "*appear to be opportunistic in their habitat requirements, and have increased in trawl areas that were previously dominated by tiger prawns"* (Williams, 2002). Spatial stratification of logbook data and an analysis of historical data from fishery-independent surveys in the far north are required to determine if there has been a contraction of the tiger prawn fishery similar to that experienced in the NPF.

5.3.2 Endeavour Prawns

The endeavour prawn stock assessment situation is similar to that for tiger prawns. Estimates of the MSY for the northern region suggest an annual catch if 1,053t. The average annual catch of endeavour prawns for the region is 1,039t (Gribble and Turnbull, 2003).

[42] The giant tiger or leader prawn is taken only in small quantities.

The high inter-annual variability does not indicate any clear CPUE trends (Williams, 2002). The "ECOTF Assessment Report" suggests that *"the adoption of improved navigational aids such as GPS by the fleet may have increased the fishing efficiency. The resulting increasing effective effort may give a slightly decreasing mean daily boat harvest*" (Zeller, 2002).

Because of their commercial value, additional stock assessment is being done on endeavour prawns. A Schaefer non-equilibrium surplus production model has been fitted to the yearly catch rate data for endeavour prawns in the northern part of the fishery and possible effort creep scenarios have been factored in. It is presumed that the same caveats that apply to the tiger prawn assessment model also apply to that for endeavour prawns. The "ECOTF Assessment Report " states that "*the results indicate that the stock is fully exploited, however there have not been any apparent detrimental trends in the logbook catch and effort data indicative of sustainability concerns at current levels of harvest"* (Zeller, 2002). The robustness of this assessment in light of the assumptions in the model being violated is questioned.

As with tiger prawns, there has been no separation of the two species of endeavour prawns – the true endeavour prawn (*Metapenaeus endeavouri*) and the false endeavour prawn (*Metapenaeus ensis*), in the ECTF logbooks to date. They are part of the multi-species tropical penaeid fishery complex, which may mask a decline in any one of the species. The "Condition and Trends Report" comments on the product status of these species by noting that "*endeavour prawns are now retained in their own right, rather than kept only if the harvest of tigers is poor, as was the case in the past when only local markets were available. Markets and price can affect the proportion of retained (reported) harvest of endeavour prawns – a factor that must be taken into account when using commercial logbook information to assess the status of stocks"* (Williams, 2002). The Audit Report questions if the reported "opportunistic behaviour" of endeavour prawns taken over the tiger prawn grounds (Section 5.3.1) could be a reflection of endeavour prawns being retained now when previously they were discarded in favour of tiger prawns.

Endeavour prawns show a complex movement between the shallower inshore juvenile habitat and the deeper offshore adult habitat. This offshore movement is not consistent across the fishery and depends on latitude (Kailola *et al.,* 1993), thereby highlighting the need for spatial stratification of the fishery assessment data. Endeavour prawns spawn throughout the year (with peak activity in summer) and there is no clear recruitment pulse within the fishery.

5.3.3 Northern King Prawns

There is no other assessment of the status of northern king prawns apart from the nominal CPUE analysis. As with the other penaeid fisheries in northern Queensland, high inter-annual variability of catch has been reported. The "Condition and Trends Report" states that "*there are no long-term signals in the harvest and effort data that suggest the population of red spot kings is overexploited, but more detailed assessment and monitoring is needed to strengthen this observation"* (Williams, 2002). This report does not refer to the status of the blue-legged king prawn. The ECOTF Ecological Assessment Report, while noting a decrease in the fleet CPUE (possibly due to "*increasing effective effort*"), supports the contention that there are no clear long-term trends in the CPUE data (Zeller, 2002).

Two species constitute the northern king prawn catch, with red spot king prawns (*Penaeus longistylus*) being more abundant than blue-legged king prawns (*Penaeus latisculcatus*). Unlike the situation for tiger prawns, the logbook requires the two species of northern king prawns to be identified. The degree to which these species are targeted depends on latitude. In the far north of the GBR Marine Park they form part of the tropical penaeid prawn complex, whereas in the southern part they are the subject of directed effort.

Less seems to be known about blue-legged king prawns than about red spot king prawns. Yet, based on their longevity (up to 4 years), this species has been reported as "overfished" in areas of high fishing activity like the Gulf of St. Vincent in South Australia (Kailola *et al.*, 1993).

5.3.4 Banana Prawns

No stock assessment of any kind is conducted on the banana prawn fishery. It is regarded as a minor seasonal fishery on a relatively short-lived species (about one year). In any event, stock assessment is made difficult by the species' strong schooling behaviour and the pronounced (albeit poorly understood) relationship between recruitment and rainfall (Vance, 1985). It is noted that in the NPF, where banana prawns (*Penaeus merguiensis*) are a major sector of the fishery, stock assessment also has not been undertaken for these reasons.

5.3.5 Eastern King Prawns

Eastern king prawns (*Penaeus plebejus*) are harvested predominantly outside the GBR Marine Park, as they generally occur south of 22^{o}S. Consequently, a detailed consideration of the assessment of the status of this species is beyond the scope of the Audit Report. However, a couple of points are worth noting, as they reflect concerns about the current assessment methodology in the ECTF.

The "ECOTF Ecological Assessment Report" noted that "*assessment of fishery-independent survey data collected in 1971-73 and 1989-90 indicates that there has been some decline in the recruitment of juvenile prawns to the ocean fishery, with a significant decrease in juvenile king prawn numbers on inshore nursery grounds*" (Zeller, 2002). However, the "Condition and Trends Report" stated that "*the mean daily harvest (of Eastern king prawns) has remained relatively stable with a slight upwards trend*" (Williams, 2002). It is recognised that these comments relate to different periods and that juvenile recruitment may have "recovered" in the last decade. Clearly this demonstrates the need to use long-term data sets (as discussed in Section 5.2.2.) and justifies further fishery-independent surveys. Also, it may indicate that CPUE is not a good indicator of stock abundance for Eastern king prawns because of their complex life cycle (involving offshore and latitudinal migration).

The 1998 stock assessment workshop conducted by the QDPI noted that Eastern king prawns are vulnerable to recruitment and growth overfishing. Simulation models demonstrated that the yearly recruitment index was declining over time. Given the species' susceptibility to overfishing and the downward trends, the adoption of a precautionary approach in interpreting assessment results and setting limit reference points is warranted.

5.3.6 Scallops

Two species of scallops are harvested in the GBR Marine Park – saucer scallops (*Amusium japonicum balloti*) and mud scallops (*Amusium pleuronectes).* The saucer scallop (the larger of the two) has been the subject of considerable research and stock assessment because of its economic importance as a major target species in the southern part of the ECTF. The smaller mud scallop is a by-product of the northern, multi-species trawl fishery. It has been less well studied but is *"assumed to have the same general lifecycle as saucer scallops"* (Williams, 2002).

The "Condition and Trends Report" comments that the "*the total scallop harvest from Queensland is relatively more stable compared to other scallop fisheries around the world. Harvest and mean daily boat harvest, after falling by an order of magnitude between the late 1970s and early 1980s, have remained at generally stable levels during the past 13 years"* (Williams, 2002). However, the report acknowledges that there have been huge fluctuations in the harvest between 1988 and 2000, ranging from 600t to 2200t. Having estimated the mean harvest to be around 1100t per year, the report states

that "effort applied to the fishery peaked in 1995 and 1997" and that "the trend in harvest appears downward with the last five years' harvest being below the mean".

The use of CPUE trends as an indicator for scallop fisheries is questioned, given the aggregating behaviour of scallops once they settle into beds as adults. The "ECOTF Ecological Assessment Report" noted that more advanced assessment work had begun for saucer scallops. In particular, it stated that the "*biomass dynamics model* [sic] *which relates annual catch and effort to estimate optimum effort levels, sustainable yield and potential biomass levels*" (Zeller, 2002). However, assessment results from this work are not yet available.

Despite high inter-annual fluctuations in abundance (based on variable recruitment), scallop fisheries can be overfished through recruitment overfishing. The "BRS Atlas" notes that "*saucer scallop densities in many Queensland beds have been reduced from about 1 animal per* m^2 *to 1 per* $150m^2$. *This reduction has probably been caused by intense fishing, which also removes large numbers of young, pre-spawning scallops and their occurrence in discrete beds also make stocks vulnerable to depletion under heavy fishing pressure.*" (Kailola *et al.*, 1993). The "Condition and Trends Report" appears cognisant of this concern in stating that "*the saucer scallop resource appears to be heavily exploited. There is sufficient fishing effort being directed towards saucer scallops to cover all available fishing grounds annually*" and that "*some grounds are heavily fished, and trawled repeatedly within a year.*". The report speculates that "*it is quite possible that low-density areas of scallops between fished beds constitute an appreciable proportion of the breeding population.*" The report concludes that "*should a major increase in effort be directed towards the scallop stock, the risk of overfishing should not be ignored*." (Williams, 2002).

5.3.7 Moreton Bay Bugs

Of the several species of bugs harvested in the ECTF, only the two species of Moreton Bay bugs are discussed in this section. Balmain Bugs are taken as a by-product of the eastern king prawn fishery and occur mostly outside the GBR Marine Park.

Of the Moreton Bay bugs, the reef bug (*Thenus orientalis*) is the larger of the two. It is found mainly at depths of 25-60 m and is taken predominantly as a by-product of the red spot king prawn fishery. The mud bug (*Thennus indicus*) is found in shallower waters (less than 25 m) and is taken predominantly as a by-product in the tiger/endeavour prawn and (to a lesser degree) banana prawn fisheries. Both species have been commercially important by-products of their respective fisheries. The introduction of TEDs and BRDs is reported to have reduced their take as by-product (Zeller, 2002).

The ECOTF Ecological Assessment Report notes a decline in the catches of the two bug species since 2000, but links this primarily to a decrease in fishing effort and the introduction of bycatch mitigation devices (Zeller, 2002). The recent "Condition and Trend Report 1988-2000" notes that the "*mean daily catch per boat shows a decline from 1992 to 2000, when State wide data is* [sic] *used. Regional analysis of bug catch rates also shows a decline, especially in 1999 – 2000 in some major producing regions.*"

This report also acknowledges that "*bugs typically display a low fecundity and low density, meaning they face some risk of over-exploitation*" (Zeller, 2002). The "BRS Atlas" notes that these species "*are heavily exploited where prawns are targeted and evidence of overfishing comes from reduced catch rates and average size of caught individuals.*" However, it adds "*there are extensive areas that are not suitable for prawn fishing (due to rough grounds and/or low prawn densities) which do not support bay lobster* (i.e. name used for Moreton Bay bugs) *stocks*." (Kailola *et al.*, 1993). This suggests that these areas may act as potential refuge/ replenishment areas.

As outlined in Section 5.2, the bug fishery has many characteristics, which make CPUE a poor indicator of stock abundance[43]. It is acknowledged that the decline in catch rates may be a reflection of changing fleet behaviour and greater escapement of bugs through TEDs and BRDs. However, this needs to be confirmed through research and stock assessment.

5.3.8 Squid

Several species of squid of the families Omnastrephidae (arrow squids of deeper oceanic waters) and Loliginidae (the pencil squids of the continental shelf and upper slope) are taken in the ECTF. The inshore pencil squids and calamarys are the predominant species, usually as by-product. Most squid are taken outside the GBR Marine Park.[44]

Little is known about the biology and life history of the various squid species. However, it appears that they have certain population characteristics that make them vulnerable to demersal trawling. Firstly, they deposit their eggs in clusters on the seabed, which increases the likelihood of them being damaged by trawling. Secondly, they aggregate for feeding and breeding and, consequently, can be targeted readily. The "BRS Atlas" states that "*Jigging is the only method that specifically targets calamary and squid. In fisheries using other methods calamary are taken as part of mixed species catch, although they may be targeted at certain times of the year (eg when spawning aggregations occur*)" (Kailola *et. al*., 1993).

Using CPUE data as an indication of stock abundance and to assess the population trends of the ECTF squid species would be inappropriate, given their aggregating behaviour and their usual status as by-product species. The "Condition and Trend Report" acknowledges that there may be "*possible under-reporting in commercial logbooks*". The retention of squid is driven strongly by market forces. Little is also known about stock structure and population sizes of these squid.

5.3.9 Summary of the Stock Status of the Principal Species taken in the ECTF

Table 15 summarises the key issues discussed in section 5.3.1-5.3.8. This table has also been presented in the Executive Summary as Table 1.

Table 15: Key findings of the Audit Report on the assessment status of the principal ECTF species.

Species Grouping	Commercial Value	Reported CPUE Trend	CPUE as Performance Indicator	Alternative Assessment Methods	Population Status	Estimated Sustainable Catch	Life Cycle & Biology Knowledge
Tiger Prawns *	High	Slightly decreasing	Adequate	Surplus Production Model	Fully exploited	1,227-1,400 t/yr for FNQ	Good - Adequate
Endeavour Prawns	High	Slightly decreasing	Adequate	Surplus Production Model	Fully exploited	1,053 t/yr.	Good - Adequate
Northern King Prawns *	Medium	Decreasing	Adequate - Poor	Nil	Possibly over-exploited	Unknown	Adequate
Banana Prawns	Low	Decreasing	Poor	Nil	Unknown but likely to be sustainable	Unknown	Adequate - Poor

[43] High spatial variability, by-product (rather than target species) and lack of species separation.
[44] 80% of the reported squid catches in the ECTF are taken south of Caloundra and trawl operators appear to target these species in Moreton Bay and the Great Sandy Strait between April and October (Kailola *et.al*, 1993).

Species Grouping	Commercial Value	Reported CPUE Trend	CPUE as Performance Indicator	Alternative Assessment Methods	Population Status	Estimated Sustainable Catch	Life Cycle & Biology Knowledge
Eastern King Prawns *	High (outside Marine Park)	Decreasing	Adequate - Poor	Age structured model	Possibly over-exploited	Unknown	Good - Adequate
Scallops *	High	Decreasing	Poor	Age structured model	Heavily exploited	Unknown	Good - Adequate
Bugs *	Low	Decreasing	Poor	Nil	Possibly fully exploited	Unknown	Adequate - Poor
Squid	Low	Decreasing	Poor	Nil	Unknown	Unknown	Poor

Note: 1. ** Denotes there are demonstrated cases of overfishing for these species within Australia.*
2. *FNQ refers to Far North Queensland.*

The limitations of CPUE as an indicator of stock abundance and resource trends, particularly where highly aggregated and by-product species are concerned, were highlighted in section 5.3. In light of the high inter-annual variability in the catches of most ECTF species and the high degree of spatial and temporal variations in this fishery, caution needs to be exercised when using CPUE data. The development of alternative assessment methods is recommended as a matter of priority.

Fisheries managers and stock assessment scientists are generally aware of the limitations of CPUE for stock assessment. A lack of resources and data frequently slow down the development of alternative assessment methods. However, there is concern that the reporting of "stable" nominal CPUE trends in public reports may create a false sense of confidence about the status of the resource.

This section highlights the need for fishery-independent surveys and at-sea observer programs. With such additional monitoring and research, information could be collected on the size composition of the catch. Provided there is adequate stratification of the data, this would assist with the development of alternative assessment models. Furthermore, changes in the size composition of the catch can be an indicator of changes in population structure. Provided there is wide coverage, fishery-independent surveys can provide valuable information on resource abundance in areas not fished by the commercial fleet. This could provide a quantitative indication of the importance of unfished areas to recruitment.

This section also has highlighted the wide geographical distribution of many ECTF species, ranging across Northern Australia from Western Australia into New South Wales. For most species, there is limited understanding of underlying stock structure and the degree of genetic mixing. Such issues can be resolved only through collaborative research and assessment work between the responsible management agencies.

It is noted that the degree of stock knowledge and assessment is determined by the economic importance of the fishery. Thus, for the less important target species, which are essentially taken as by-product (northern king prawns, squid and bugs), there is limited information available on which to base stock assessment. No stock assessments for any of the permitted species under the Trawl Plan have been conducted to date. Acknowledging the current information and resource constraints, it is recommended that assessment gaps be addressed in a systematic manner within a defined timeframe. The processes recommended in Section 4.2.3 and 5.3.4 (if adopted) should assist in this regard.

5.4 Formalisation of the Assessment Process

It is recognised that in such a biologically diverse fishery as the ECTF not all information gathering and assessment demands can be met at once and within a short timeframe. An information base needs to be built gradually over time. However, fisheries assessment and its supporting monitoring and research work need to be strategically targeted and designed to yield optimum results within a limited budget.

The stock assessment process for fisheries managed by Queensland is described in Dunning (1998). There is no formal or structured assessment process in place to assess the status of stocks in the ECTF on a regular basis. Assessment is frequently driven by the specific interests of researchers and subject to available monitoring and research funding. The SAG generally is provided with a broad, verbal summary of the outcomes of LTMPs and other relevant research and is invited to comment on the drafts of stock trend reports. However, given the infrequency with which the SAG meets and the duration of its meetings (usually half days), there is limited scope for any in-depth review of the results of monitoring, research and stock assessment.

ECTF-specific publications are limited and many of the more recent research and survey results have not been disseminated or formally published (see Section 4.2.3). The "Condition and Trends Report" report had a production time of almost five years between successive editions. Whilst it is a useful summary of catch/effort trends in Queensland's commercial fisheries, it should not be seen as a substitute for sound fishery or stock assessment work.

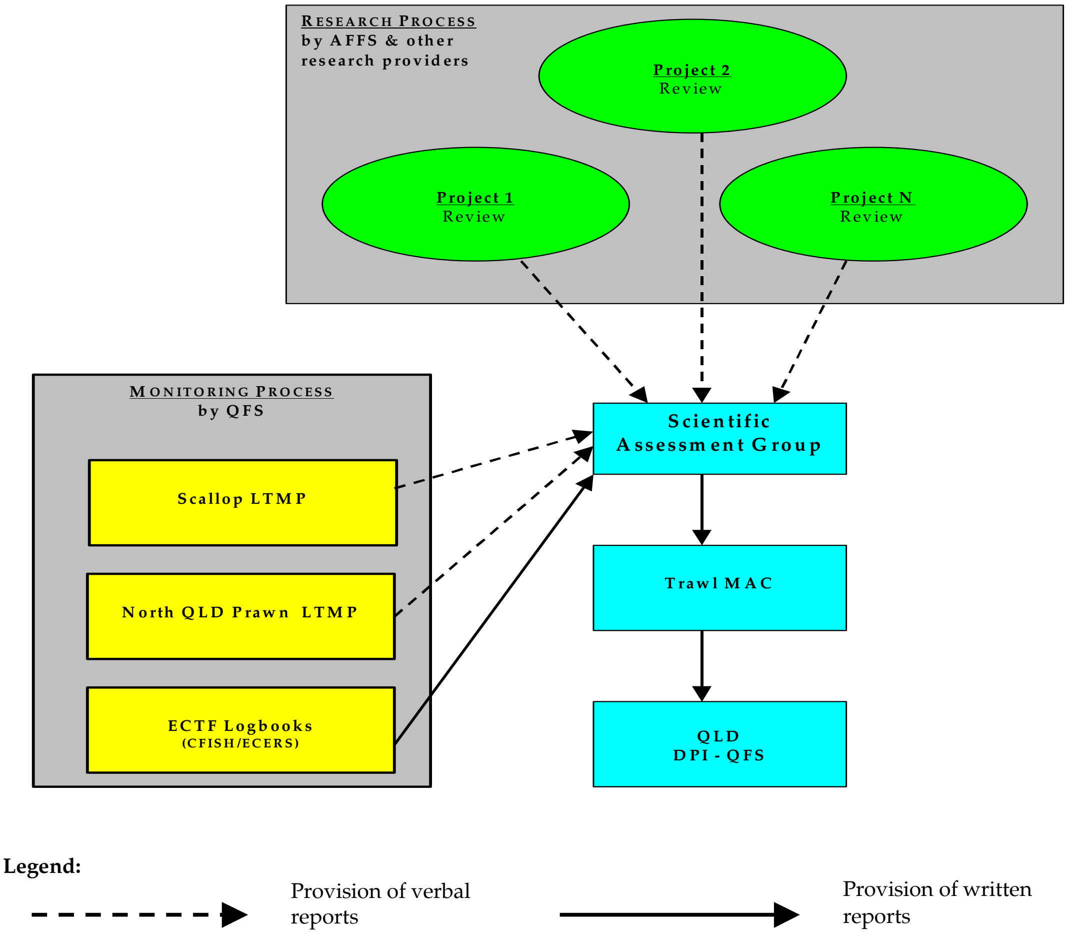
The QFS agreed in 2002 to produce annual status reports on the ECTF, which will outline basic catch and effort trends in the fishery from year to year. The first report "ECOTF Status Report - 2001*"* was finalised in September 2002. This document presents an important overview of the fishery on a more timely basis, but lacks sufficiently detailed resolution of data and analysis to be of significant fishery assessment benefit.

There needs to be an expertise-based group to review the monitoring and research results and to conduct assessments of the status of the fishery and stocks. Increasingly, such teams include population modellers, scientists, managers, industry experts, environmentalists and economists. Such a multi-disciplinary approach reflects a more holistic evaluation of the impacts of fishing on the ecosystem. An expertise-based group assists in examining the interpretation of the data and the appropriateness of the modelling assumptions.

Figure 12 represents the current research and stock assessment process and Figure 13 illustrates how this process could be improved in order to introduce greater scientific rigour and enhanced transparency. The proposed model is consistent with the assessment framework for many Australian fisheries at both the Commonwealth and State level.

In the current ECTF monitoring, research and fishery assessment approach, research reviews frequently are internal (i.e. between the research provider and the funding agency) and publication of research in peer-reviewed scientific journals is frequently delayed. Monitoring results from the scallop and North Queensland Prawn LTMPs generally are provided as verbal reports to the SAG, Trawl MAC and management. Logbook data are reported in Condition and Trend reports, frequently after some lengthy delays. The feedback to QFIRAC on the fishery's monitoring and research needs generally only occurs at a broad level.

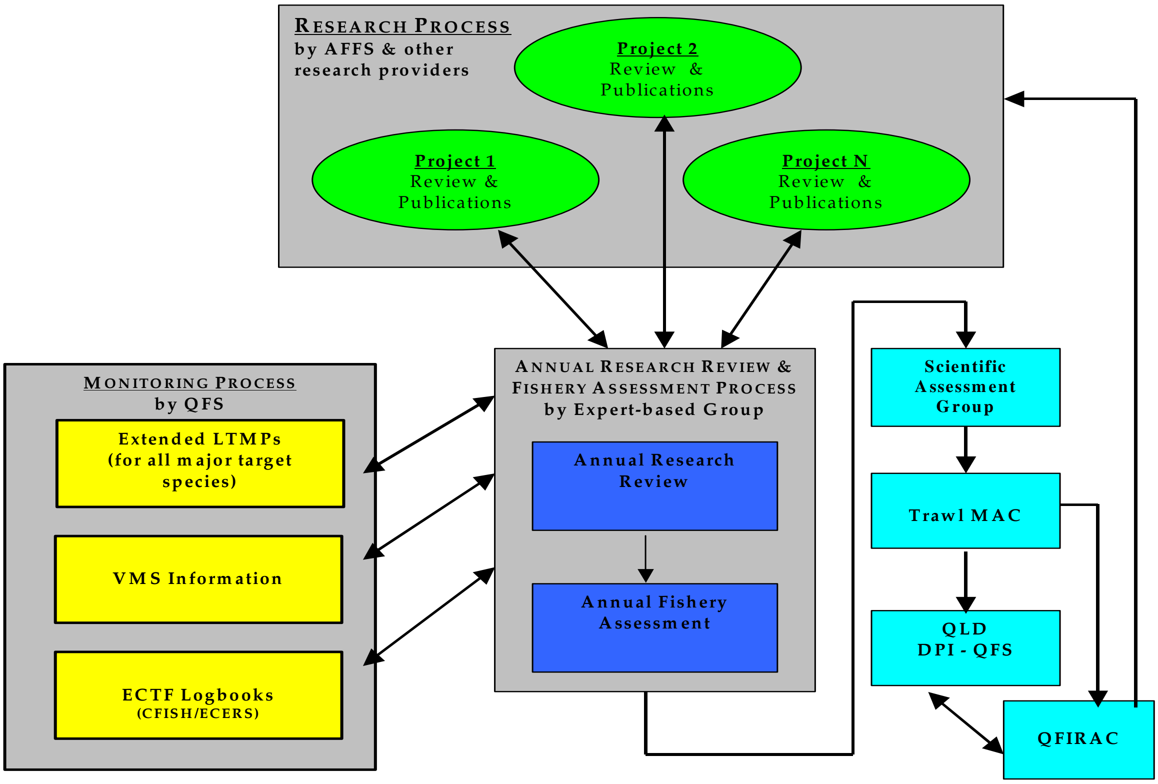
Figure 12: Current process for monitoring, research and fishery assessment in the ECTF.



To overcome these problems, the creation of an annual research review and fishery assessment process conducted by an expert-based group is recommended. The SAG and Trawl MAC would not be expected to carry out the review and assessments. The model proposes that the monitoring process be expanded to include the analysis of VMS information and LTMP data for the major target species. It is proposed that written reports be provided for the annual assessment process and that there be two-way communication between the data gathering and data assessment processes. Where possible, researchers should aim to publish their findings in the scientific literature or otherwise have their research independently peer reviewed in a timely manner. It is recommended that the QFIRAC be more closely linked to research prioritisation at the Trawl MAC and research provider level.

The benefits of adopting such an approach have been seen in past stock assessment workshops held by the QDPI for several major commercial species. The most recent one, in August 1998, examined (amongst other species) the status of eastern king prawns and saucer scallop stocks. The workshop was successful in bringing together biologists, stock assessment specialists, fishers and managers from Queensland and interstate. All available information on each of the species was collated and analysed. Shortfalls in the data were identified and accounted for in the simulation models. The workshop considered the evidence for overfishing and recommended priorities with respect to monitoring and research. It is recommended that such a structured process, involving a wide range of experts, be implemented on a regular basis in the ECTF to cover all major target/by-product species. It would be useful to link this process with the research review process (see Section 4.2.3).

Figure 13: Proposed process for improved monitoring, research and fishery assessment in the ECTF



Recommendation 20

- ***That a formalised fishery assessment process be developed for the ECTF, through Trawl MAC, which involves an expertise-based team reviewing research results and conducting the fishery and stock assessment process.***

The assessment process for the ECTF is focussed almost entirely on the major commercial target species. Minor commercial target species and by-product species receive little or no research attention and are not included in any regular stock assessments. Furthermore, bycatch in the ECTF is monitored and assessed only on an opportunistic basis, if external research grants become available. Regular review of the impact of the fishery on bycatch in terms of species composition and abundance does not occur. Although believed to be small, there are no detailed estimates of the recreational and Indigenous take of ECTF species.

Recommendation 21

- ***That the proposed assessment process be extended to include consideration of by-product and bycatch species taken in the ECTF.***

In relation to shared ECTF stocks, it is noted that, while joint research and assessments have been conducted on occasion, generally these have been project specific. Currently, there are no routine procedures in place for collaborative assessments.

Recommendation 22

- ***That, where there are stocks of species with distributions which extend outside Queensland, the ECTF assessment process take account of the research and stock assessment work done by other jurisdictions and that there be collaboration in the stock assessment.***

5.5 The Audit Report's Assessment against the Commonwealth Guidelines

With respect to Guideline 1.1.2

There are some serious deficiencies in the ECTF assessment process. Apart from the uncertainty over how stock assessments (and associated research) are funded each year, there are no clear strategic priorities and processes that address stock assessment shortfalls over time. The process lacks rigour in terms of regular peer review, and the publication/dissemination of stock assessment results is poor. The uncertainty over the reliability of the information used for stock assessment further undermines the robustness of the fishery assessment process.

Stock assessment efforts to date have been focussed on major commercial species (tiger prawns, endeavour prawns, eastern king prawns and scallops). There are several target species (defined as principal species under the Management Plan) that have received little or no research/stock assessment attention (bugs, banana prawns and squid). Also, there is no regular assessment of by-product species. The Trawl Plan Review had suggested that some species (such as the barking crayfish) were quite heavily fished by some operators.

The major performance indicator (and the only one published regularly) for stock abundance is the nominal CPUE. The potential problems associated with the sole use of commercial catch rates in stock assessments are outlined in this Audit Report. Given that the ECTF began in the 1950s, it is surprising that the development of biomass assessment models has not progressed further. Similarly, there is a paucity of historic (pre-1988) data available for the assessment process, which may distort current assessments of the status of the various stocks exploited in the fishery.

Assessment in the ECTF needs to move beyond basic CPUE analyses and aim to develop research data and models, which allow for a more accurate assessment of stock abundance. Estimates of the reproductive capacity of the major commercial species are needed. It is unlikely that the current stock assessment approach would detect any downturn in resource abundance as a result of overfishing. Similarly, the usefulness of the current performance indicators specified in the Management Plan is questionable.

With respect to Guideline 1.1.3

Given the large geographical area covered by the fishery and its multi-species nature, assessment of the distribution and spatial structure of ECTF stocks is difficult. There needs to be more research and fishery-independent surveys to obtain sufficient data for such assessments. The risks entailed in not taking proper account of the geographical distribution and spatial structure of stocks are highlighted in the Audit Report. As a useful first step, there would be great benefit in collaborative research and stock assessment for species that have distributions that extend beyond the ECTF (such as eastern king prawns and bugs). A precautionary approach should be adopted in setting harvest limits for by-product species, particularly for species such as syngnathids, Balmain bugs, barking crayfish and cuttlefish, which are likely to be susceptible to localised stock depletion.

With respect to Guideline 1.1.4

Catch data collected for the ECTF are derived only from the commercial sector. There are no estimates of the recreational and Indigenous take, although these are believed to be relatively small. Of greater concern is the reliability of the estimates of the commercial catch, since the information is derived solely from unverified logbook data.

With respect to Guideline 1.1.5

Biomass abundance models for the key commercial species are still in the preliminary stages of development. As with all such models, it will take a while (and several refinements) before there can be an accurate prediction of the potential productivity of the fished stocks.