Queensland Government

At-sea observation of the Fin Fish (Stout Whiting) Trawl Fishery 2009–10

Fisheries Queensland

Department of **Agriculture, Fisheries and Forestry**

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Contents

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Summary

In November 2009 at the request of the three operators, the Fin Fish (Stout Whiting) Trawl Fishery was expanded to the south by Fisheries Queensland. Permits allowed the fishery to operate using demersal otter trawls and Danish seine nets for the remainder of the 2009 season (ending 31 December) and also the entire 2010 season (1 April to 31 December) in a southern trial extension area (STEA), as well as in the pre-existing northern regulated area (NRA) (*see* Figure 1).

The expansion of fishing grounds was trialled to see whether fishing a larger area would be beneficial to the T4 operators in terms of economic efficiency and improved catch rates. While this trial did not affect the annual total allowable catch (TAC) of stout whiting, concern was raised over the incidental interactions by T4 gear with species targeted in other fisheries (including recreational fisheries) operating in the STEA.

The stout whiting observer program was developed to collect accurate and detailed catch and effort information on T4 fishing operations, target species, by-product and bycatch (including protected species) in the northern and southern areas using the two gear types. This will be used to inform management decisions consistent with the 'driven by knowledge' guiding principle of the Queensland Fisheries Strategy 2009–14. By experiencing firsthand the issues faced by industry, fisheries observers are also well placed to advise Fisheries Queensland on management arrangements that are not practical or enforceable, or present genuine difficulties with compliance.

Participation in an at-sea observer program was presented as a key permit condition to gain access to these southern grounds. Subsequently, largely funded by industry itself, an experienced observer was employed full time to work exclusively in the stout whiting fishery from November 2009 to December 2010. Over this period, 110 days of at-sea observation were attained across all permit holders.

The main points arising from the stout whiting observer program were:

- Catch rates of stout whiting were observed to be similar in the two fishing areas for both gear types where direct monthly comparisons could be made—no comparative data were available for otter trawl gear from April through to October 2010.
- Danish seine gear was observed to be more efficient in capturing the target species.
- Relatively few interactions with species of recreational importance were observed using otter trawl, though generally higher rates occurred in the NRA. However, trawling was not observed in the STEA during the winter months when these species might be more available to capture.
- The Danish seine operator had very little interaction with recreationally important species during the months observed (June to November).
- Relatively few prawns were caught, especially when using Danish seine gear. Of the various prawn species observed in each of the two areas using the different gear types, king prawns captured in otter trawl nets operating in the STEA had the highest percentage of total catch (by weight).

- Compared to prawns, the observed interactions (by weight) with crabs were an order of magnitude higher but still relatively low. Blue swimmer crabs and three-spotted crabs were the two main species captured irrespective of gear type; both species represented higher percentages of the total observed catch (by weight) in the STEA compared to the NRA.
- The species composition of the bycatch varied between gear types and areas. A less diverse species assemblage was observed in the STEA, making it the 'cleaner' fishing area.
- Two permitted species, squids and yellowtail scad, were sometimes observed to be discarded dead because trip limits had been reached.
- Seasnakes and syngnathids (pipehorses only) were the only species of conservation interest (SOCI) observed. They were observed in low numbers and predominantly with otter trawl.
- Compared to otter trawl, the Danish seine gear caught much higher numbers of rays, especially eastern shovelnose rays and common stingarees. Examination of individual trip data showed this to be largely attributable to the occasional capture of large aggregations rather than to consistently higher interaction rates.
- Some 17 interactions with 'monster' sharks and rays were observed with the Danish seine gear, though 14 of these individuals were released alive. Only a single 'monster' interaction was observed on the otter trawlers, which, unlike the Danish seine, operate with a turtle exclusion device (TED).
- The new T4 discard logbook was not an effective tool for fishers to provide quality bycatch data.

The observer program has provided detailed catch information that fisheries managers can use in making decisions about continued future access to the southern extension area.

At a broader level, the observer program aims to collect accurate, detailed and reliable information that can lead to better assessments of the status of target species and understanding of the interaction between fishing and the marine ecosystem. This in turn will help to ensure sustainable and profitable fisheries in Queensland for generations to come.

Overview of Queensland's stout whiting fishery

Stout whiting (*Sillago robusta*) is an endemic demersal finfish that inhabits open waters of the continental shelf and upper continental slope of northern Australia (McKay 1992). There are two distinct populations in Australia. The west coast population occurs between Shark Bay and Fremantle off Western Australia and the east coast population ranges from Bustard Head, central Queensland, to northern New South Wales (NSW) (McKay 1992). The east coast population is believed to constitute a single genetic stock unit (Ovenden & Butcher 1999).

The Queensland Fin Fish (Stout Whiting) Trawl Fishery (FTF) is a relatively small, commercial-only fishery operating off southern Queensland (*see* Appendix 1 for historical information). The fishery is permitted to target both stout whiting and red spot whiting (*Sillago flindersi*), though *S. robusta* comprises the vast majority of the catch.[1] The FTF is the only fishery in Queensland waters permitted to retain these whiting species, though both are caught as bycatch in the East Coast Otter Trawl Fishery (ECOTF) by demersal trawlers targeting prawns and scallops. These whiting species are also caught by trawlers operating in northern NSW, where a few hundred tonnes are retained annually and an unquantified amount discarded (Rowling et al. 2010).

The primary market for Queensland's stout whiting is overseas and hence, this fishery needs approval for a Wildlife Trade Operation (WTO) (*see* Appendix 2 for current WTO conditions and recommendations). Most of the catch is exported as whole fish to Asian countries where they are processed for the Japanese Kisu Hiraki market—a butterfly fillet used as a finger food (O'Sullivan et al. 2005). Some of this processed product is then re-exported back into Australian markets (O'Neill et al. 2002).

Market demand can influence commercial effort in the FTF. Other overseas whiting fisheries have the potential to flood the market with cheaper product, causing a reduction in demand for Australian product. Further, the strength of the Australian dollar can cause fluctuation to the export value of the bulk product. In 2003 only 246 t of an 800 t quota were harvested, which was attributed to low market demand and price. In subsequent years the markets have stabilised; however, the fishery continues to be subject to market fluctuations.

In last year's report *Stock status of Queensland's fisheries resources 2009–10*, stout whiting was listed as 'sustainably fished', with this assessment based mainly on recent annual harvests being lower than the sustainable total allowable catch (TAC).

[1] Red spot whiting has only been observed from off the Gold Coast, which supports the documented northern distributional limit of this species (Kailola et al. 1993). Further, when captured, red spot whiting was found to represent less than 5 per cent of the total whiting catch, with no species separation being made for market. For ease of reporting, all whiting catches referenced throughout this document are thus treated as comprising a single species, *S. robusta*.

Current management arrangements

The T4 fishery is managed through various input and output controls that stem from a range of voluntary agreements, permits and/or legislation.

Limited entry

A T4 fishery symbol must be attached to a primary commercial fishing boat licence to participate in the stout whiting fishery. Only five T4 symbols have been issued and these are currently shared between three licence holders.

Permitted species

Under the Fisheries Regulation 1995 (and 2008), T4 fishers are only permitted to retain stout whiting and red spot whiting. Since 2002 the stout whiting fishers have been able to retain additional by-product species under permit. Permits to retain prawns have not been issued by Fisheries Queensland on the basis that these are the principal species for the ECOTF.

Quantities of by-product are regulated by standard box sizes and in-possession limits are in place to ensure that these species are not actively targeted. For 2010, the permitted by-product species with in-possession limits were:

- yellowtail scad (*Trachurus novaezelandiae*) 40 boxes (20-kg boxes)
- goatfish (family Mullidae) 40 boxes (20-kg boxes)
- squids (loliginids and *Nototodarus* spp.) 52 boxes (5-kg boxes)
- cuttlefish (*Metasepia* sp. and *Sepia* spp.) 52 boxes (5-kg boxes)
- threadfin breams (family Nemipteridae) 10 boxes (20-kg boxes)
- octopus 20 boxes (5-kg boxes).

Balmain bugs (*Ibacus* spp.) and Moreton Bay bugs (*Thenus* spp.) could also be retained if they were of legal size[2] though no in-possession limits applied.

Seasonal closure

Under the Fisheries Regulation 1995, the T4 fishery was closed between 1 January and 31 March each year. Although this seasonal closure still applies, under the Fisheries Regulation 2008 the actual dates became a permit condition, which affords Fisheries Queensland more flexibility to alter the timing of the closure as further biological information is attained.

In 1999 a southern ECOTF closure was introduced prohibiting trawling between 20 September and 1 November each year. While this closure is not legally applicable at present to T4 fishers, the T4 licence holders have agreed in the past not to fish during this period to minimise conflict with the ECOTF licence holders.

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[2] *Thenus* spp., *Ibacus alticrenatus* and *I. brucei* have a minimum carapace width of 75 mm whereas that for *I. chacei* is 105 mm.

Gear restrictions

The FTF generally has similar gear restrictions to those that apply in the ECOTF. Both fisheries have a maximum total net length of 88 m and comparable mesh size regulations (38–60 mm). However, the FTF can use longer sweeps (up to 128 m each) to herd the target species into the net. As had happened earlier with other trawl sectors, the use of turtle exclusion devices (TEDs) was introduced in 2005 as a licence condition for all T4 operators.

In late 2006 a permit was issued to one T4 licence holder to trial Danish seine gear in this fishery. This gear uses traditional trawl nets, but these are retrieved using very long ropes without otter boards. Under the permit conditions, each sweep rope was limited to 2500 m and participation in the observer program was as requested by Fisheries Queensland. At-sea observation showed that Danish seine was more selective for whiting and resulted in less bycatch in comparison to historical data collected for the conventional demersal otter trawl gear (FOP unpublished report 2007). The permit has subsequently been re-issued each year.

TED trials with Danish seine however were observed to be unsuccessful, causing multiple gear failures. In 2008 this operator became exempt from this requirement. The justification for this decision was that Danish seine has a short fishing time, and thus affords a higher survival rate of any turtles incidentally captured.

Fishing area

As defined in the Fisheries Regulation 1995 (and 2008) the stout whiting operators have a restricted fishing area that extends between the 20 and 50 fathom depth contours from Sandy Cape (northern tip of Fraser Island) to Caloundra. In November 2009 all T4 licence holders were granted a permit by Fisheries Queensland that temporarily extended their area of operation south from Caloundra to the NSW border, but still within the 20 and 50 fathom depth contours (*see* Figure 1). The permit was effective from the date of issue until 31 December 2010.

There is only one spatial closure within the current T4 fishery grounds. This was introduced in 2003 to protect a key aggregation site for grey nurse sharks (*Carcharias taurus*) (Fisheries Regulation 2008). Inshore trawl closures associated with state marine parks in Hervey Bay, Great Sandy Strait and in Moreton Bay are located adjacent to the T4 grounds.

Total allowable catch

The harvest is managed via an annually agreed TAC that is evenly divided among licence holders. Thus, this fishery effectively operates under an ITQ (individual transferable quota) system rather than as a competitive TAC. This choice of output control was chosen by Fisheries Queensland to ensure that T4 operators who fish in other jurisdictions for part of the year can remain viable in this fishery through having access to a guaranteed share of the catch.

Under the current management framework the annual TAC is specified as a licence condition rather than legislated in the Fisheries Regulation 2008. This enables the quota to be changed on a yearly basis as required. The TAC for this fishery is set according to a combination of a full stock assessment (based on a statistical catch-at-age model) conducted every 5 years and annual decision rules. In interim years, a

TAC table is used to provide annual adjustment of the quota in response to changes in standardised catch rates and fish catch-at-age frequencies. Using this matrix the new TAC may remain unchanged from the year before, or vary by 50 or 100 t. The maximum TAC that can be set under this model is 1500 t.

The agreed TAC was 1450 t for 2009 and 1500 t for 2010. The total whiting catch for these years were 1159 t and 1170 t, respectively. Most years there is some under-fishing or overfishing of quota by individuals, but the overall TAC has not been exceeded to date.

The last stock assessment was in 2006 and was based on 2005 data collected from samples provided by industry.[3] It showed the stout whiting fishery biomass to be greater than 40 per cent of virgin biomass (Thwaites & Anderson 2008). To date, no provision has been made in the model to standardise catch rates for the different gear types, which are not treated separately, or to take into account the STEA. These issues will be addressed in the scheduled 2011 stock assessment.

The stout whiting observer program

Since its implementation, the annual TAC for stout whiting is yet to be reached. The T4 fishers attest that the reason for this is that the spatial constraint of the fishery affects their catch rates as stock availability varies over the season, which makes attaining the TAC economically unviable. They argue that by having access to more grounds, the fleet will fish more schools of fish, which will in turn reduce overall fishing effort and lower benthic impact while increasing profitability.

At industry's request, in November 2009 all T4 licence holders were granted a permit by Fisheries Queensland that temporarily extended their area of operation to include a southern trial extension area (STEA). The permit was effective from the date of issue until 31 December 2010.

These permits raised concerns among commercial ECOTF operators who are active in the southern region and numerous recreational groups. These concerns essentially echoed those raised regarding a previous application to extend the T4 fishing grounds to the NSW border, which were:

- potential conflict with historic resource users (i.e. prawn trawlers and line fishers)
- a reduction in the precautionary nature of management in the T4 fishery, given the unknown effects of T4 operations on the broader ecosystem and other fisheries in this area
- an increase in the incidental fishing mortality of rocky reef (RR) species[4], in particular snapper (*Pagrus auratus*).

[3] From every trip conducted by vessels operating in the T4 fishery a 5-kg night and day sample is randomly collected by crew and retained for Fisheries Queensland. These samples are used by Fisheries Queensland's Long Term Monitoring Program to collect length-at-age information. Catch per unit effort data are available through each vessel's daily Fisheries Queensland logbook records.

[4] The Rocky Reef Fin Fish Fishery (RRFFF) is an important commercial, recreational and charter line fishery that operates in southern Queensland waters. It catches a suite of species including snapper, pearl perch, teraglin and cobia associated with rocky reefs and inter-reefal areas.

In 2009, to address these concerns and give the stout whiting fishers an opportunity to provide supporting evidence for their counterarguments, industry and government negotiated the implementation of a dedicated Fisheries Queensland observer program to assess the impact of T4 fishing operations in the STEA. The subsequent 2009–10 stout whiting observer program, which was largely funded by industry, enabled an experienced observer to be employed full time to monitor this fishery exclusively over this period.

As part of their permit conditions, T4 licence holders were required to advise Fisheries Queensland when they intended to fish in the STEA, and to accommodate an observer when requested to ensure sufficient observer coverage. A target was set of 100 at-sea observing days in this fishery, with observation occurring across both the NRA and STEA.

Throughout the observing period, all decisions regarding fishing operations were made by the permit holders/skippers themselves; however, after several months in which only the NRA was fished, Fisheries Queensland repeatedly emphasised the need to collect fisheries data from the STEA to inform subsequent management decisions. While this may have influenced subsequent fishing decisions, for the most part the observer was reporting on fishing practices that were considered 'normal' for this fishery, with the exception of two other conditions that were placed on this permit. One of these conditions required the permit holder to give shot-by-shot logbook returns documenting all interactions with RR finfish species (as detailed in the Queensland east coast line finfish fisheries logbook). This T4 discard logbook was to be completed within both the NRA and the STEA. The other condition was the introduction of a move-on provision whereby if more than 25 kg of 'reef' species[5] were caught in a single shot the vessel moved at least 1 nautical mile away before resuming trawling or Danish seining.

[5] These reef species are as listed in the T4 discard logbook.

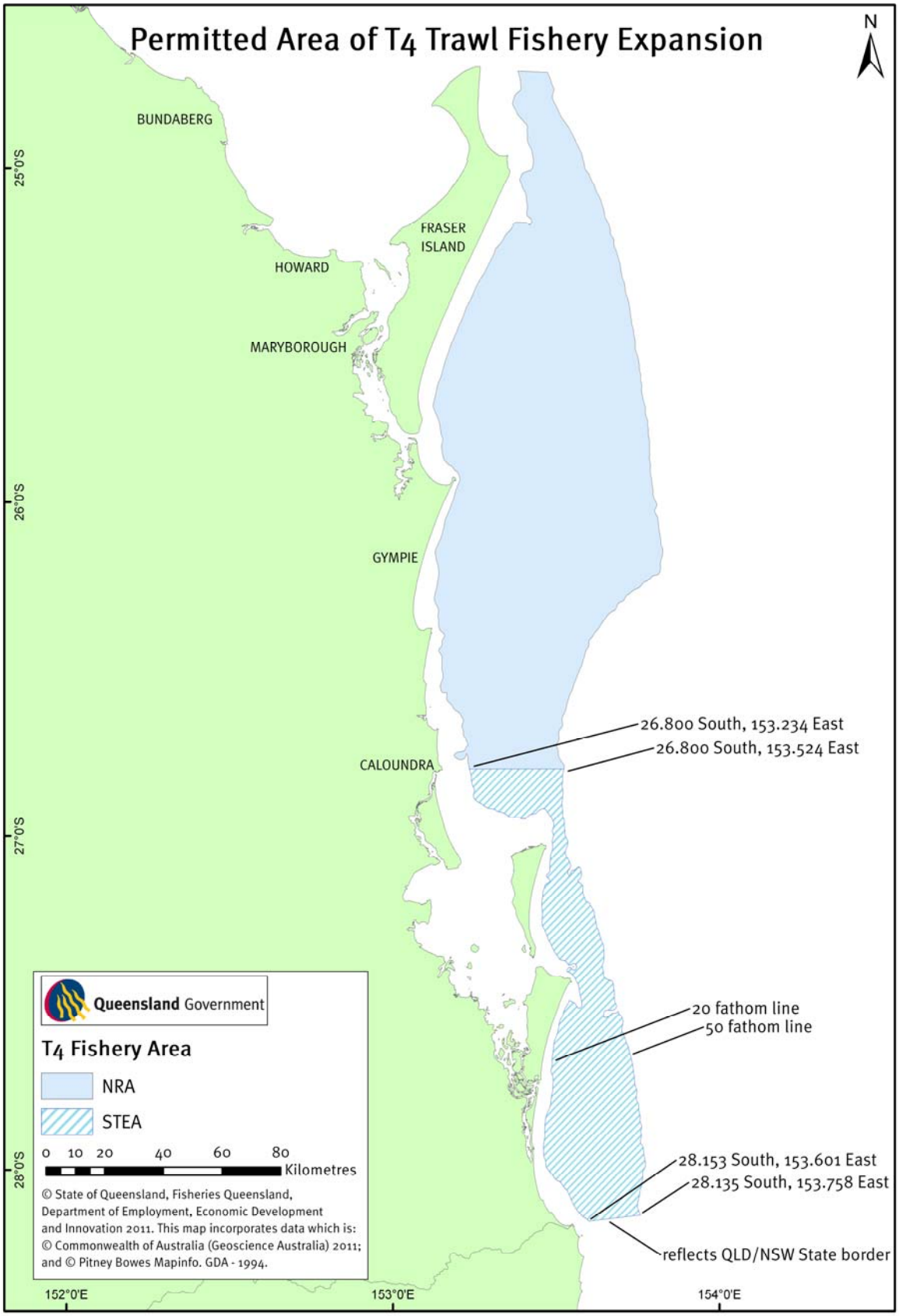

Figure 1 Map of southern Queensland waters showing the northern regulated area (NRA) and the southern trial extension area (STEA) of the T4 fishery

Program aims and objectives

The primary aim of the 2009–10 stout whiting fishery observer program was to collect unbiased, accurate and broad catch information to inform a decision on the future extent of the T4 fishery area, which includes both the northern regulated area and southern trial expansion area.

Being independent from commercial fisheries logbooks, the data collected by at-sea observers can promote public confidence in the decisions fisheries managers subsequently make with regard to conflicting resource use or sustainability concerns. The observer program can provide independent, accurate and detailed estimates of both the landed catch composition and bycatch composition, as well as document interactions with species of conversation interest.

To achieve its primary aim, the program's specific objectives were to:

1. Attain spatial and temporal observer effort that enables subsequent gear and fishing area comparisons and provides good representation of commercial activities.

2. Compare species catch composition between the two areas for each gear type.

3. Compare catch rates of the major species caught using the different gear types.

4. Compare interaction rates with species of recreational importance between the two areas for each gear type.

5. Obtain estimates of prawn catch for both gear types and fishing areas.

6. Compare interactions with species of conservation interest between areas and between gear types.

7. Compare the rate and fate of interactions with chondrichthyans (sharks and rays) between the two areas and the two gear types.

8. Assess the effectiveness of the T4 discard logbook.

9. Gain a better understanding of the at-sea fishing operations to help inform future management decisions regarding this fishery, in particular to identify the challenges the fishers may face in complying with current management arrangements.

Data collection

Prior to the implementation of this dedicated observer program, at least one FTF operator had been observed by the Fisheries Observer Program (FOP) each year, as part of Fisheries Queensland's broader ongoing assessment and monitoring strategy. Prior to November 2009, observers had joined three different T4 vessels for seven separate trips totalling 46 days.

On two separate occasions involving different otter trawlers, two observers joined the same trip in which round-the-clock fishing occurred, as is the usual practice for these vessels. In doing so, 15 days of at-sea observation were achieved in which 100 per cent of the commercial effort was monitored. Bycatch samples were collected from each shot for subsequent laboratory sorting to enable comparison of species composition between day, night and crepuscular (dawn/dusk) periods.

Using these background data in consultation with advice from a biometrician a sampling framework for the stout whiting observer program was developed.

Data analyses showed that there were significant differences in catch composition between the two gear types, thus necessitating future analyses to consider otter trawl and Danish seine data separately.

Statistical analyses of the larger data set comprising observed otter trawl trips (all obtained from the NRA) showed differences in species composition between grids to be non-significant. This meant that in structuring the current observer program, data could be pooled within each of the two fishing areas thus enhancing their number and strengthening their value.

Significant differences, however, were detected between trawl trips for seven species, which suggested a seasonal influence and/or fisher effect. Therefore adequate sampling across the entire fishing season was considered necessary to enhance the validity of the NRA/STEA comparisons.

Similarly, significant diel effects were obtained for four species, which included yellowtail scad (*Trachurus novaezelandiae*), two flathead species (*Platycephalus longispinis* and *Ambiserrula jugosa*) and a gurnard (*Lepidotrigla umbrosa*). The last three species are abundant in the discarded bycatch and their sustainability is not of current concern. However, the significant effect of fishing time on the catches of yellowtail scad, which is a permitted species, does necessitate the inclusion of this factor in stratifying data collection. Therefore, it was deemed preferable in the design of the current observer program to standardise the period of data collection (where possible) for future valid comparisons between areas.

Previous observation in the fishery demonstrated interactions with recreational finfish species were infrequent and predominantly occurred during the day (FOP unpublished report 2006). Given the objectives of the current monitoring program and the deployment of a single observer in this program (instead of two), there was justification in focusing the at-sea observation on operations conducted during daylight hours. In practice, as many shots as possible were observed, though when a rest period was needed this was taken during the night.

For each shot observed the following information was recorded in line with the FOP's at-sea sampling protocol for stout whiting:

1. Site data were recorded at the beginning and end of every shot including:

   - start time: time when the net reaches fishing depth (otter trawl) or when the ropes begin to be retrieved (Danish seine)
   - end time: time the net is winched from fishing depth
   - shot number
   - date
   - latitude and longitude
   - depth
   - average trawl speed.

   The information was often taken from the vessel logbook. Attention was paid to ensure the skipper was accurately recording these data.

2. Weights and numbers for all retained and discarded permitted species were recorded; if too numerous to count, the number of boxes at the end of each shot was counted instead, as executed for stout whiting. Average box weights were used to estimate the total weight retained.

3. Weights and numbers of species of fisheries interest (SOFI) and species of conservation interest (SOCI) were recorded from each shot observed. SOFI included all reef quota (RQ) species, all shark and rays, all rocky reef (RR) species, and a number of other commercially and recreationally important species (see Appendix 3). Specimens were collected directly from sorting belts and then tallied and weighed. When not limited by time, the lengths of all RQ species, all shark and rays, and all RR finfish were measured. In instances when species were too numerous or individually too large to weigh, estimates were made instead.

   It should be noted that a few species, including gurnards, proved to be consistently abundant but were not recorded at sea because they did not meet the criteria for inclusion in this species list. Instead these species were recorded through the bycatch sampling strategy that was implemented alongside at-sea observation (see point 5).

4. Total discard weights were based on estimates that the observer made during the sorting process. The amount of discarded bycatch was visually compared to retained product, and then this percentage applied to the measured weight of whole retained product. Validation of visual estimates was not made as the use of a load sensor cell was raised as a safety concern by fishers in the 2010 industry meeting. However, observer bias was removed by using the same observer for all 2010 at-sea observations.

5. As not all species could be identified and measured at sea, 'other bycatch' samples were collected for subsequent laboratory sorting. A cumulative species curve based on samples that had been collected from T4 boats during past FOP observations was used to determine the optimum number of bycatch samples

required. This curve, plotting cumulative number of species against number of samples, showed a levelling off at around 10 samples (10 kg) and 70–80 species. This suggested that a minimum number of 10 samples was required to be assured of observing most species present. Thus, allowing for known diel and seasonal effects, one 10-kg bycatch sample was collected each day from the 'noon' shot. If fishing operations were not occurring during this time, no bycatch samples were collected on that day.

Each bycatch sample was collected at timed intervals during the sorting of a shot to avoid the effects of stratification from the hopper. The samples were frozen and thawed in a laboratory before sorting. Bycatch was identified to the species level where possible, with weights and numbers recorded.

In theory all species listed for 'at-sea observation' should have been absent from the samples sorted in the laboratory. In practice, however, this was not the case as the smaller individuals were inevitably overlooked when collecting bycatch samples.

Summary of observer effort

Objective 1: Attain spatial and temporal observer effort that enables subsequent gear and fishing area comparisons and provides good representation of commercial activities.

Table 1 At-sea observer effort achieved in the NRA and STEA over the duration of the program, by month

		NRA				STA				Monthly totals	
Trip start	Vessel	Days no.		Shots no.	Target catch kg	Days no.		Shots no.	Target catch kg	Days no.	Shots no.
Nov 09	OT	1		1	68	5	(18)	33	13 976	6	34
Dec 09	OT	7		28	16 422	3	(9)	12	2 856	12	46
		2		6	1 105						
Jan–Mar T4 fishery closure											
Apr 10	OT	2	(1)	6	2 210					9	37
		7	(6)	31	23 001						
May 10	OT	1		1	476					10	31
		2	(2)	9	1 122						
		4	(3)	10	23 426						
		3	(3)	11	20 825						
Jun 10	OT	4	(4)	24	20 757					4	24
	DS	3	(2)	11	17 820					8	36
		3	(3)	22	20 390						
		2		3	4 428						
Jul 10	DS	4	(3)	22	14 220	4	(1)	22	20 898	12	63
						4	(2)	19	19 170		
Aug 10	OT	6	(5)	35	12 937					6	35
	DS					5	(2)	26	19 422	5	26
Sep 10	OT	7	(6)	46	16 167					7	46
Oct 10	DS	1	(1)	2	0	3	(2)	23	17 532	7	36
		3	(1)	11	19 728						
Nov 10	OT	3	(1)	8	612	2	(1)	9	1 581	10*	54
		6	(5)	37	6 630						
	DS	2		7	810					2	7
Dec 10	OT	5		19	7 837	5	(4)	31	11 169	12*	63
						3	(1)	13	3 009		
Observed totals	OT	60	(36)	272	153 595	18	(33)	98	32 591		
	DS	18	(10)	78	77 396	16	(7)	90	77 022		
Logbook totals	OT			1562				431			
	DS			363				156			
All observer effort		**78**	**(46)**	**350**		**34**	**(40)**	**188**		**110**	**538**

Notes: Number of days represents at-sea 'observing' days in each area for each gear type (OT = otter trawl, DS = Danish seine). On 2 days, both areas were fished by the same boat; here a day's observer effort is reported under both the NRA and STEA but only once under the monthly totals (marked by an asterisk).

Numbers in parentheses are the number of bycatch samples collected for subsequent laboratory processing.

Number of shots represents those observed while on the vessel (logbook effort may be higher).

Target catch (trip totals) is shown to demonstrate the variability in the catch rate of stout whiting.

2009 observation was conducted by 3 observers, 2010 observation by just 1.

The main points arising from Table 1 are:

- In total, 110 days at-sea observation were attained in this T4 program. Relative to the commercial effort (number of shots) recorded in the fishers' logbooks, the total observed effort in the NRA for the November 2009 to December 2010 period was 17 per cent for otter trawl and 22 per cent for Danish seine. The comparative values for the STEA were 23 per cent and 58 per cent respectively.

- At-sea observation was attained each month over the entire November 2009 to December 2010 period (excluding the January to March closure). However, this effort was not distributed evenly, ranging between 0 and 10 days each month for a given gear type. Although the aim was to observe both otter trawl and Danish seine operations regularly throughout the year in both fishing areas, the fisheries-dependent nature of this program did not facilitate this. In practice, the Danish seine operator was observed from June to November (except September) and the otter trawl was observed in all (permitted) calendar months except July and October. For both gear types no observation was attained in the STEA at the start of the fishing season (Apr–Jun) when catches in the NRA were good.
- The number of shots per trip was highly variable (1–46), which is largely a product of the hugely variable catch rates that are often associated with schooling species. Also, on multiple occasions trips were cut short due to gear breakdowns.
- Bycatch samples were collected at noon throughout the 2010 program. However, because several of the observed Danish seine trips were predominantly night-based operations, such sampling tended to be biased towards otter trawlers that usually operated round the clock. Notwithstanding, for a given gear type the total number of samples was comparable between the two areas.
- During 2009, multiple bycatch samples were collected during daylight hours by other observers. Despite being sourced from different periods of the day (no night samples were collected) these were included in the STEA dataset to enhance the information available from the 2010 otter trawl samples.

For the most part, the operators were compliant and cooperative in accommodating the observer. However, there was difficulty in joining one vessel when it operated with a full crew because in doing so the number of crew/passengers allowed under the vessel's Certificate of Survey was exceeded. To address this, a Restricted Use Flag[6] needed to be secured, which involved arranging for the boat to be inspected by an accredited boat surveyor (with minimal disruption to fishing activities) and hiring an extra life raft to meet survey requirements. This exercise was completed once in 2010 and a flag subsequently issued for 1 month, which enabled observation onboard this vessel early in the season when catch rates were high. Later in the year the observer was able to gain access without these hurdles because this vessel was operating with fewer crew members.

[6] A Restricted Use Flag is a form of temporary registration issued for a specified period that allows restricted operating rights for vessels that would not otherwise be permitted to operate in Queensland's waters.

Figures 2 and 3 show observer effort (shots observed) relative to all commercial effort for otter trawl and Danish seine respectively. Both maps show a high correlation between commercial and observer effort, thus enabling a high level of confidence to be placed on the representativeness of the observer data. For both gear types, common areas of preferred operation can be clearly identified.

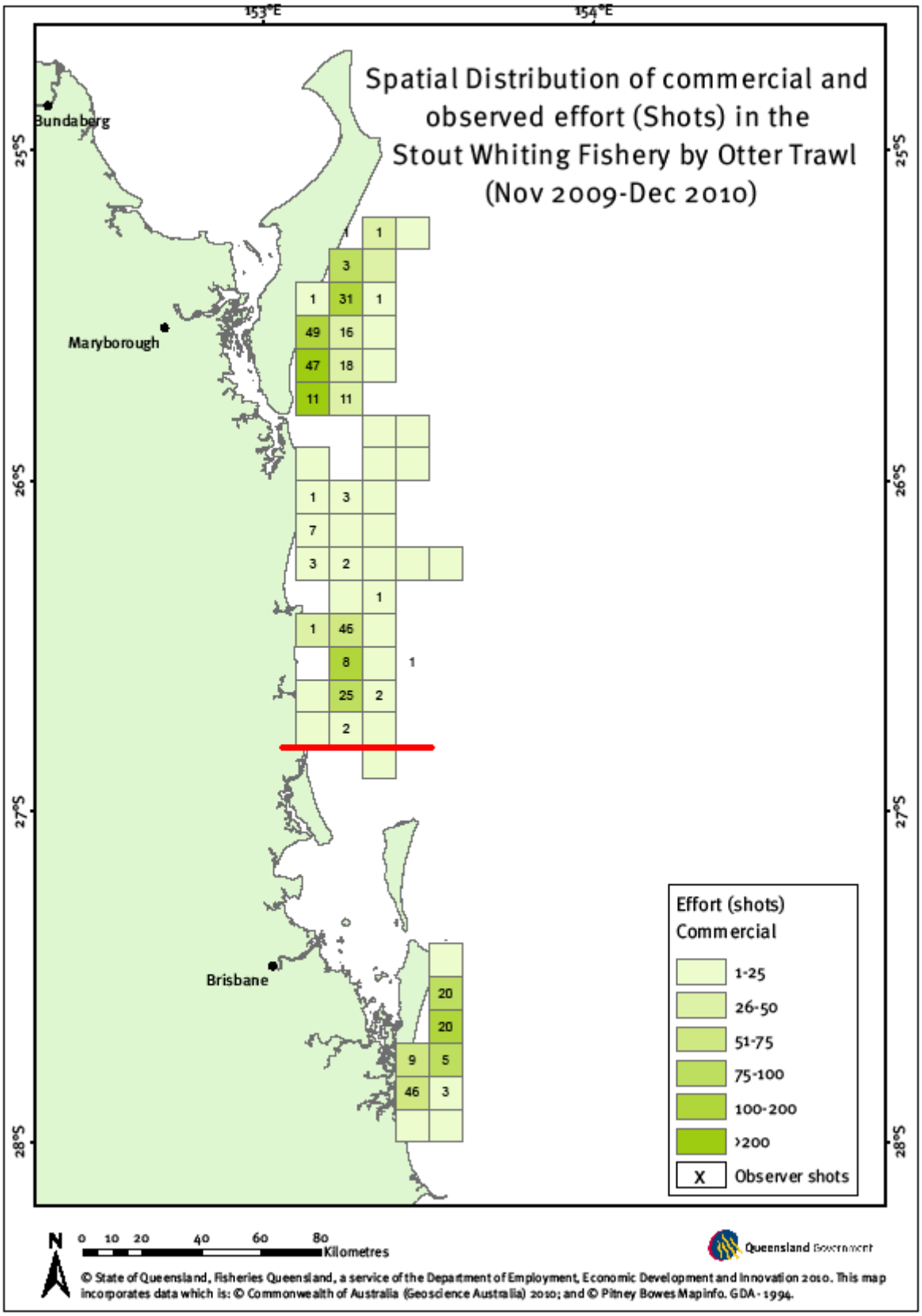

Figure 2 Map depicting the spatial distribution of all commercial and observer effort for otter trawl in the T4 fishery for the period November 2009 to December 2010

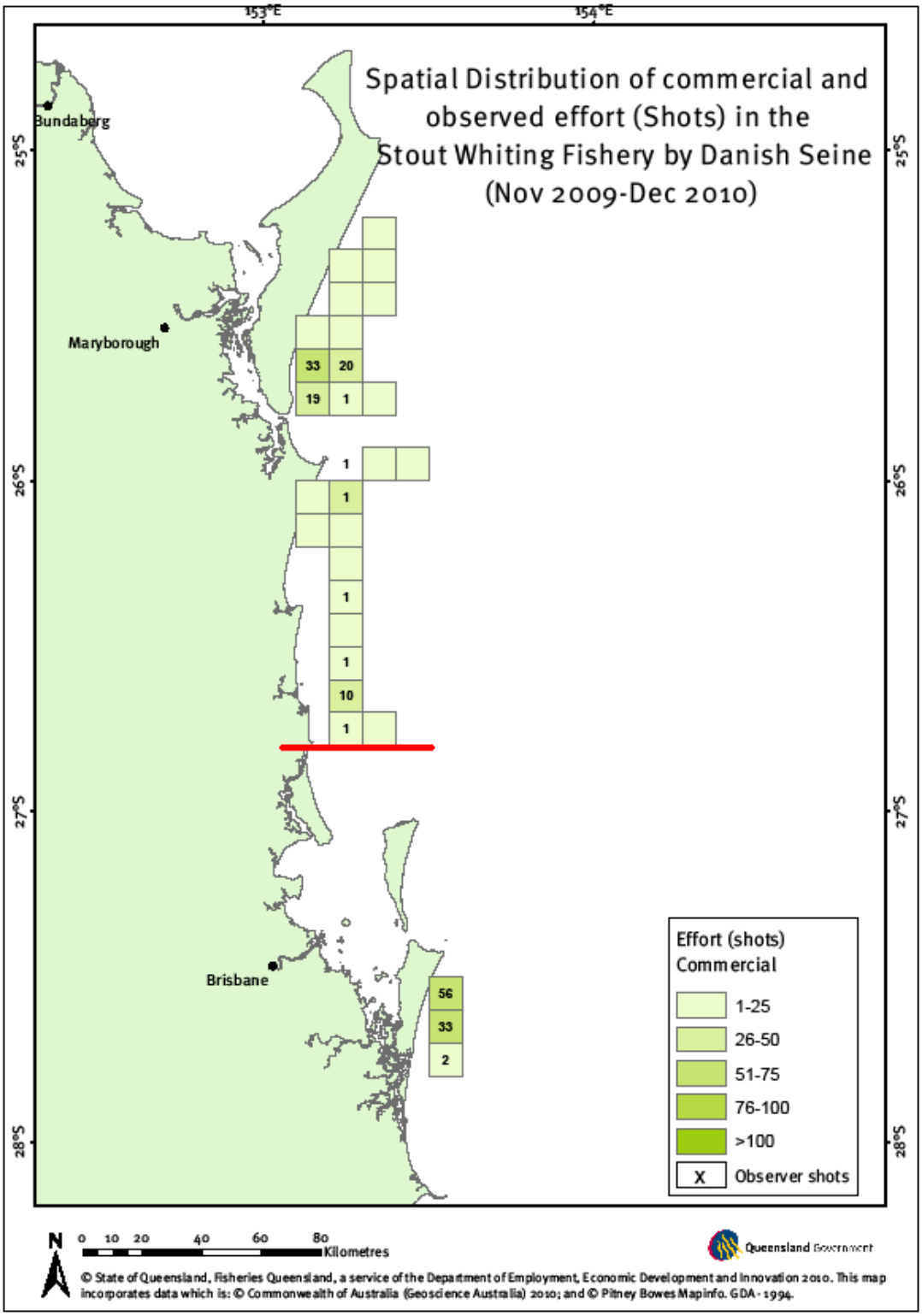

Figure 3 Map depicting the spatial distribution of all commercial and observer effort for Danish seine in the T4 fishery for the period November 2009 to December 2010

Species catch composition

Objective 2: Compare species catch composition between the two areas for each gear type.

At-sea observations: otter trawl

It can be seen from Table 2 that stout whiting comprised a higher percentage of the total biomass captured in the STEA (55.6 per cent) than in the NRA (49.2 per cent). Also, a higher number of species (target, permitted, SOFI and SOCI combined) were observed in the NRA (66) than in the STEA (40 species), making the STEA the 'cleaner' fishing area.

Given that three times as many at-sea observing days were attained in the north, the observed difference in species number was perhaps to be expected. However, nearly a quarter of the 'southern' species were only observed in this region, suggesting the species composition of the two areas is actually different and not wholly attributable to the sampling undertaken. Greater benthic habitat diversity where fishing occurred in the NRA may also be a factor in species composition differences. Further, the NRA and STEA are close to the latitudinal limit of the geographic distribution for a number of tropical and temperate species (e.g. fossil shark, saucer scallop, hussar in the NRA and coffin ray, eastern fiddler ray and John Dory in the STEA).

Seasonal variation in the spatial distribution of certain species is also likely to manifest as differences in the species composition between the two areas. Unless a rigorous fisheries-independent study is carried out whereby the two areas are observed at the same time (using identical gear), such temporal variation is difficult to exclude as an explanatory factor. In this study, all the otter trawl observation in the southern trial extension area occurred in November and December and therefore the observed differences in catch between the two sites would have been affected to some extent by underlying temporal differences.

The main differences apparent between the two areas were:

- A very large quantity of Theodore's threadfin bream was observed in the NRA, with virtually none in the STEA.
- Relative to total catch, yellowtail scad were much more abundant in the STEA than in the NRA.
- Asymmetric goatfish occurred predominantly in the north.
- Blue swimmer crabs represented a higher percentage of the total catch in the STEA (0.8 per cent) than in the NRA (0.4 per cent); three-spotted crabs showed a similar pattern, comprising 0.7 per cent of the total catch in the STEA and 0.4 per cent in the NRA.
- Greasy/school prawns were only observed in the south where they represented 0.2 per cent of the catch.[7]

[7] This entire catch came from a single trip, which was carried out in November 2009 during a particularly good season for school prawns off the Gold Coast.

Comparative catches per hour are presented on page 21 under Objective 3. Data for individual trips have been compiled and provided to fisheries managers to inform their decision-making, but for confidentiality reasons have been omitted from this report.

Table 2 Observed at-sea catch summary for otter trawl comparing species composition in the NRA and STEA for the period November 2009 to December 2010

Region fished	**NRA**			**STEA**		
Number of observed trips	**15**			**5**		
Total number of shots	**292**			**103**		
Number of observed shots	**272**			**98**		
Number of observed days	**60**			**18**		
Observed fishing hours	**508.5**			**233.25**		
SPECIES	**Weight kg**	**Catch %**	**Catch rate[1]**	**Weight kg**	**Catch %**	**Catch rate**
Total biomass captured	**311 935.0**			**58 601.0**		
Retained species						
Asymmetric goatfish	1 528.0	0.5	9.9			
Balmain bug	72.0	0.0	0.5	2.4	0.0	0.1
Cuttlefish	611.7	0.2	4.0	12.5	0.0	0.4
Goatfishes				49.7	0.1	1.5
Moreton Bay bug	48.2	0.0	0.3	0.8	0.0	0.0
Octopods	182.5	0.1	1.2	28.6	0.0	0.9
Slender squid	1 743.2	0.6	11.3	373.6	0.6	11.5
Stout whiting	**153 595.2**	**49.2**	**1 000.0**	**32 591.0**	**55.6**	**1 000.0**
Yellowtail scad	2 225.5	0.7	14.5	2 614.3	4.5	80.2
Total retained	**160 006.30**	**51.3**	**1 041.70**	**35 672.9**	**60.8**	**1 094.6**
Discarded species						
Australian bonito	6.9	0.0	0.0			
Australian butterfly ray	7.5	0.0	0.0			
Asymmetric goatfish	1 471.6	0.5	9.6	1.4	0.0	0.0
Ballot's saucer scallop	4.0	0.0	0.0	1.8	0.0	0.1
Balmain bug	6.6	0.0	0.0	1.9	0.0	0.1
Blackbanded amberjack	26.6	0.0	0.2			
Black tiger prawn	0.6	0.0	0.0			
Blue swimmer crab	1 109.9	0.4	7.2	480.9	0.8	14.8
Bluespotted maskray	97.7	0.0	0.6	8.5	0.0	0.3
Brown tiger prawn	78.2	0.0	0.5	24.8	0.0	0.8
Cobia	116.5	0.0	0.8	90.3	0.2	2.8
Coffin ray				29.1	0.0	0.9
Common stingaree	8.6	0.0	0.1	75.2	0.1	2.3
Cuttlefish	75.7	0.0	0.5	7.5	0.0	0.2
Eagle ray	2.0	0.0	0.0			
Eastern fiddler ray				0.3	0.0	0.0
Eastern shovelnose ray	171.8	0.1	1.1	102.8	0.2	3.2
Eastern spotted gummy shark	3.2	0.0	0.0	2.5	0.0	0.1
Fossil shark	30.5	0.0	0.2			
Frypan bream	4.5	0.0	0.0			
Giant mud crab				0.4	0.0	0.0
Goatfishes				2.5	0.0	0.1
Goldspotted rockcod	188.0	0.1	1.2	0.7	0.0	0.0
Grass emperor	2.0	0.0	0.0			
Grey carpetshark	39.1	0.0	0.3			
Guitarfishes	144.7	0.0	0.9			
Hussar	0.9	0.0	0.0			
John Dory				0.3	0.0	0.0
King prawns	219.0	0.1	1.4	142.0	0.2	4.4
Leaping bonito	0.3	0.0	0.0			
Mantis shrimps	1.1	0.0	0.0	2.6	0.0	0.1
Maori rockcod	0.7	0.0	0.0			

SPECIES	Weight kg	Catch %	Catch rate[1]	Weight kg	Catch %	Catch rate
Milk shark	20.6	0.0	0.1			
Moreton Bay bug	27.8	0.0	0.2	0.4	0.0	0.0
Moses' snapper	7.8	0.0	0.1			
Mulloway	11.0	0.0	0.1	0.1	0.0	0.0
Octopods				1.2	0.0	0.0
Ornate rocklobster	8.2	0.0	0.1			
Oval rockcod	8.4	0.0	0.1			
Painted maskray	4.0	0.0	0.0			
Pearl perch	111.0	0.0	0.7			
Prawn – greasy/school				90.6	0.2	2.8
Purple tuskfish	13.3	0.0	0.1	1.4	0.0	0.0
Red emperor	12.7	0.0	0.1			
Redspot king prawn				0.1	0.0	0.0
Saddletail snapper	24.9	0.0	0.2	0.2	0.0	0.0
Sand whiting	11.9	0.0	0.1	1.3	0.0	0.0
Scalloped hammerhead	48.3	0.0	0.3	6.0	0.0	0.2
School mackerel	24.0	0.0	0.2			
Snapper	93.3	0.0	0.6	0.6	0.0	0.0
Silvertip shark	2.5	0.0	0.0			
Slender squid	92.2	0.0	0.6			
Sliteye shark	51.1	0.0	0.3			
Spanner crab	7.7	0.0	0.0	6.5	0.0	0.2
Spinner shark	23.9	0.0	0.2			
Spotted wobbegong				5.3	0.0	0.2
Tailor	578.1	0.2	3.8	97.6	0.2	3.1
Tarwhine	38.7	0.0	0.3	0.2	0.0	0.0
Teraglin	0.9	0.0	0.0	9.4	0.0	0.3
Theodore's threadfin bream	25 015.0	8.0	162.9	0.1	0.0	0.0
Threadfins	0.4	0.0	0.0			
Three-spotted crab	1 118.0	0.4	7.3	428.7	0.7	13.2
Trumpeter whiting	0.4	0.0	0.0			
Venus tuskfish	12.9	0.0	0.1			
Weasel shark	56.3	0.0	0.4	0.1	0.0	0.0
Whaler shark (unidentified)	8.0	0.0	0.1			
Wobbegong sp.				0.1	0.0	0.0
Yellowtail scad	2 540.2	0.8	16.5	324.1	0.6	9.9
SOCI						
Elegant seasnake (2)	2.9	0.0	0.0			
Seasnake (unidentified) (9)	17.0	0.0	0.1			
Spiny pipehorse (1)	0.05	0.0	0.0			
Pipehorse (10)	0.27	0.0	0.0			
Unidentified discards	**119 644.93**	**38.4**		**20 978.8**	**35.8**	
Total discards	**153 456.85**	**49.2**	**999.1**	**22 928.3**	**39.1**	**703.5**
Monsters						
Skate (unidentified) (1)	100					

Notes: Species listed according to whether they were retained or discarded: some may occur under both headings.

Weights represent totals across all observed shots.

Percentages are expressed relative to the total catch (biomass) captured in that area.

The catch rate of a species represents its relative weight (kg) per tonne of stout whiting captured; values are thus comparable among species for a given area and between areas for a given species.

'Monsters' represent large discarded animals that became caught up in the TED; they were excluded from the total biomass to avoid skewing the data.

The number of interactions with both SOCI and monsters is given in parentheses.

At-sea observations: Danish seine

Table 3 shows that Danish seine operations also captured a higher number of (at-sea recorded) species in the NRA (43), than in the STEA (34), even though more fishing hours were observed in the south. However, the target species comprised a much higher percentage of the total biomass in the STEA shots (76 per cent) than in the NRA shots (48.3 per cent).

The main differences observed between the two areas with respect to permitted species were:

- Over 10 per cent of the biomass in the NRA was attributable to Theodore's threadfin bream, yet there were no observed interactions with this species in the STEA.
- A much larger quantity of yellowtail scad was caught in the STEA.
- Asymmetric goatfish were only observed in the north.
- A much higher catch rate (relative to stout whiting tonnage) of cuttlefish was observed in the current regulated area.

On the Danish seine vessel, permitted species were often discarded by fisher choice: trip limits for catches of permitted species were not reached, although the limits for squid and cuttlefish were sometimes approached.

With regards to non-permitted species, the main differences observed between the areas were:

- The relative abundance of blue swimmer crabs (expressed as a percentage of total biomass) in the STEA was four times that in the NRA.
- Relative to total biomass captured, the percentage of eastern shovelnose rays was six times as great for the STEA as for the NRA.

At-sea observations: gear comparison

When comparing the species composition between gear types, the main differences were:

- The diversity of 'at-sea observed' species captured using otter trawl gear (74) was greater than with Danish seine gear (53). Some 29 species were only observed using otter trawl gear, and these included two ray species and eight shark species.
- Excluding 'monster' interactions, there were just three 'at-sea observed' species that were only caught using Danish seine gear (stingaree, stingray and yellowfin tuna).
- 'Monster' interactions were much greater for Danish seine gear (34) than otter trawl gear (1).

Table 3 Observed at-sea catch summary for Danish seine comparing species composition in the NRA and STEA for the period November 2009 to December 2010

Region fished	**NRA**	**STEA**
Number of observed trips	**7**	**4**
Total number of shots	**87**	**92**
Number of observed shots	**78**	**90**
Number of observed days	**18**	**16**
Observed fishing hours	**78.0**	**90.0**

SPECIES	Weight kg	Catch %	Catch rate	Weight kg	Catch %	Catch rate
Total biomass captured	**160 350.0**			**101 300.0**		
Retained species						
Cuttlefish	**402.0**	0.3	5.2	**22.0**	0.0	0.3
Octopods	55.8	0.0	0.7	78.1	0.1	1.0
Slender squid	103.6	0.1	1.3	104.9	0.1	1.4
Stout whiting	**77 396.0**	**48.3**	**1 000.0**	**77 022.0**	**76.0**	**1 000.0**
Theodore's threadfin bream	295.0	0.2	3.8			
Total retained	**78 252.4**	**48.8**	**1 011.1**	**77 227.0**	**76.2**	**1 002.7**
Discarded species						
Australian butterfly ray				4.2	0.0	0.1
Asymmetric goatfish	782.5	0.5	10.1			
Ballot's saucer scallop	30.2	0.0	0.4			
Balmain bug	4.0	0.0	0.1	1.3	0.0	0.0
Blackbanded amberjack	0.9	0.0	0.0	0.2	0.0	0.0
Blue swimmer crab	237.2	0.1	3.1	392.6	0.4	5.1
Bluespotted maskray	8.4	0.0	0.1	56.4	0.1	0.7
Brown tiger prawn	7.4	0.0	0.1	41.1	0.0	0.5
Cobia	6.8	0.0	0.1	9.0	0.0	0.1
Coffin ray				75.2	0.1	1.0
Common stingaree				45.0	0.0	0.6
Cuttlefish	2.3	0.0	0.0	0.5	0.0	0.0
Eastern fiddler ray				0.5	0.0	0.0
Eastern shovelnose ray	104.8	0.1	1.4	579.3	0.6	7.5
Giant mud crab				2.3	0.0	0.0
Grey carpetshark	2.0	0.0	0.0			
Guitarfishes	92.2	0.1	1.2			
Hussar	0.7	0.0	0.0			
King prawns	6.0	0.0	0.1	14.4	0.0	0.2
Mantis shrimps	0.2	0.0	0.0	1.3	0.0	0.0
Moreton Bay bug	3.2	0.0	0.0	1.5	0.0	0.0
Octopods				0.5	0.0	0.0
Pearl perch	0.8	0.0	0.0			
Purple tuskfish	0.8	0.0	0.0			
Red emperor	0.1	0.0	0.0			
Sand whiting	0.6	0.0	0.0	9.2	0.0	0.1
Scalloped hammerhead	2.9	0.0	0.0			
School mackerel	0.6	0.0	0.0			
School prawn	0.4	0.0	0.0			
Slender squid				0.5	0.0	0.0
Snapper	0.6	0.0	0.0	0.1	0.0	0.0
Spanner crab	2.7	0.0	0.0	1.1	0.0	0.0
Stingaree (Urolophidae spp.)	3.6	0.0	0.0			
Stingray (Dasyatidae spp.)	6.6	0.0	0.1			
Tailor	73.1	0.0	0.9	158.5	0.2	2.0

SPECIES	Weight kg	Catch %	Catch rate	Weight kg	Catch %	Catch rate
Tarwhine	3.1	0.0	0.0	0.7	0.0	0.0
Teraglin				2.9	0.0	0.0
Theodore's threadfin bream	17 165.0	10.7	221.8			
Three-spotted crab	248.1	0.2	3.2	211.2	0.2	2.7
Weasel shark	17.8	0.0	0.2	2.6	0.0	0.0
Yellowfin tuna	7.4	0.0	0.1			
Yellowtail scad	135.0	0.1	1.7	5 032.0	5.0	65.3
SOCI						
Seasnake (unidentified) (1)(1)	2.0	0.0	0.0	1.0	0.0	0.0
Pipehorse (2)	0.1	0.0	0.0			
Unidentified discards	**63 137.5**	**39.4**		**17 427.9**	**17.2**	
Total discards	**82 097.6**	**51.2**	**1 060.7**	**24 073.0**	**23.8**	**312.5**
Monsters						
Cobia (5) (4)	62			45		
Eastern shovelnose ray (2)	175					
Guitarfishes (1) (3)	100			125		
Mulloway (1)				13		
Pigeye shark (1)				200		
Shark ray (1)	150					
Silvertip sharks (3)				55		
Skate (Rajidae spp.) (1) (4)	100			550		
Sponges (5)	37					
Whaler shark (Carcharhinidae spp.) (1)				20		
Zebra shark (1)	50					

Notes: Species are listed according to whether they were retained or discarded: some may occur under both headings.

Weights represent totals across all observed shots.

Percentages are expressed relative to the total biomass captured in that area.

The catch rate of a species represents its relative weight (kg) per tonne of stout whiting captured; values are thus comparable among species for a given area and between areas for a given species.

'Monsters' represent discarded animals that were considered to be unusually large and rarely caught; they were excluded from the total biomass to avoid skewing the data.

The number of interactions with both SOCI and monsters are given in parentheses: where there are two numbers, these refer to the numbers observed in the NRA and STEA respectively.

Laboratory samples of ‘unidentified discards’: both gear types

Additional data were also collected for ‘other’ bycatch species, which could not practically be examined at sea. In total, 69 samples were collected from the ‘unidentified discards’ component of the otter trawl catch and 17 from the Danish seine catch (*see* ‘Observed totals’ in Table 1). Each sample filled a standard 10-kg box. While the bycatch samples show an obvious bias towards otter trawl, it was considered important to sample at a time when interactions with species of recreational importance were most likely to be observed. Past observation in this fishery had demonstrated much higher interactions with these species during the day and thus it was felt that night-time sampling may have given rise to underestimates of these important statistics.

Based on the number of samples collected, the percentages of the unidentified discards that were processed in the laboratory were 0.30 per cent for otter trawl in the NRA and 1.57 per cent in the STEA. The corresponding values for Danish seine were 0.16 per cent and 0.4 per cent respectively.

In total approximately 860 kg of ‘other’ bycatch from the T4 fishery were sorted and identified in the laboratory to give information on the species assemblages. As reflected in the comparable ‘at-sea’ data, the number of discarded species for Danish seine was found to be greater in the NRA than in the STEA. More than twice as many species were identified in the otter trawl samples compared to those for Danish seine, though given the disparity in sample number this is not too unexpected. For both fishing areas and both gear types, the top 10 species combined ranged from 81 to 96 per cent of all animals recorded, as summarised in Table 4. Three species occurred in all four lists: eye gurnard, largescale saury and spotted dragonet.

It should be noted that nearly 20 per cent of the species identified in the laboratory (28 out of 145) represented ‘at-sea observed’ species, though most of these were represented by just a few individuals. They were generally small animals and thus easily overlooked when sampling ‘other bycatch’ in the field. Appendix 4 lists all the species identified in these laboratory processed samples, and identifies the subset of species that was recorded predominantly at-sea.

Table 4 Summary of the 10 most frequently occurring species (by number) collected in the laboratory stout whiting bycatch samples, differentiated according to gear type and fishing area

Rank	OTTER TRAWL			
	NRA	**%**	**STEA**	**%**
1	Eye gurnard (*Lepidotrigla argus*)	22.6	Eye gurnard (*Lepidotrigla argus*)	28.7
2	Theodore's threadfin bream (*Nemipterus theodorei*)	16.4	Spotted dragonet (*Repomucenus calcaratus*)	17.0
3	Largescale saury (*Saurida undosquamis*)	16.2	Highfin toadfish (*Torquigener altipinnis*)	9.5
4	Spotted bigeye (*Priacanthus macracanthus*)	8.6	Sharpfin barracuda (*Sphyraena acutipinnis*)	8.4
5	Yellowtail scad (*Trachurus novaezelandiae*)	6.7	Longspine flathead (*Platycephalus longispinis*)	7.6
6	Highfin toadfish (*Torquigener altipinnis*)	6.6	Maray (*Etrumeus teres*)	3.0
7	Asymmetric goatfish (*Upeneus asymmetricus*)	4.5	Australian anchovy (*Engraulis australis*)	2.2
8	Spotted dragonet (*Repomucenus calcaratus*)	2.7	Largescale saury (*Saurida undosquamis*)	1.0
9	Slender squid (*Uroteuthis chinensis* complex)	2.1	School prawn (*Metapenaeus macleayi*)	1.8
10	Orangefin ponyfish (*Leiognathus bindus*)	1.2	Common silverbiddy (*Gerres subfasciatus*)	1.8
	Total % represented by top 10 species	**87.6**	**Total % represented by top 10 species**	**81.0**
	DANISH SEINE			
1	Eye gurnard (*Lepidotrigla argus*)	34.5	Eye gurnard (*Lepidotrigla argus*)	28.6
2	Theodore's threadfin bream (*Nemipterus theodorei*)	18.9	Spotted dragonet (*Repomucenus calcaratus*)	27.0
3	Longspine flathead (*Platycephalus longispinis*)	11.5	Longspine flathead (*Platycephalus longispinis*)	17.0
4	Largescale saury (*Saurida undosquamis*)	10.2	Slender squid (*Uroteuthis chinensis* complex)	7.6
5	Spotted dragonet (*Repomucenus calcaratus*)	4.4	Yellowtail scad (*Trachurus novaezelandiae*)	7.1
6	Zoanthid anemone (*Sphenopus marsupialis*)	3.7	Highfin toadfish (*Torquigener altipinnis*)	3.7
7	Asymmetric goatfish (*Upeneus asymmetricus*)	3.5	Australian sardine (*Sardinops neopilchardus*)	1.8
8	Spotted bigeye (*Priacanthus macracanthus*)	3.4	Spotted bigeye (*Priacanthus macracanthus*)	1.6
9	Spot-tail wide-eye flounder (*Engyprosopon grandisquama*)	1.9	Largescale saury (*Saurida undosquamis*)	1.4
10	Seastar (*Stellaster equestris*)	1.3	Whitley's gurnard perch (*Maxillicosta whitleyi*)	0.4
	Total % represented by top 10 species	**93.3**	**Total % represented by top 10 species**	**96.2**

When looking at biomass as opposed to number, a slightly different species composition is presented for the four sectors (*see* Table 5) though the same three species mentioned above are common to each. The top 10 species combined for each sector accounted for 73 to 92 per cent of the samples by weight.

Table 5 Summary of the top 10 species (by weight) recorded from the laboratory stout whiting bycatch samples, differentiated according to gear type and fishing area

Rank	OTTER TRAWL			
	NRA	**%**	**STEA**	**%**
1	Largescale saury (*Saurida undosquamis*)	28.13	Eye gurnard (*Lepidotrigla argus*)	19.39
2	Theodore's threadfin bream (*Nemipterus theodorei*)	14.42	Spotted dragonet (*Repomucenus calcaratus*)	11.25
3	Eye gurnard (*Lepidotrigla argus*)	14.40	Sharpfin barracuda (*Sphyraena acutipinnis*)	8.30
4	Spotted bigeye (*Priacanthus macracanthus*)	10.08	Highfin toadfish (*Torquigener altipinnis*)	7.56
5	Yellowtail scad (*Trachurus novaezelandiae*)	8.17	Longspine flathead (*Platycephalus longispinis*)	5.97
6	Asymmetric goatfish (*Upeneus asymmetricus*)	3.89	Largescale saury (*Saurida undosquamis*)	5.64
7	Spotted dragonet (*Repomucenus calcaratus*)	1.93	Bluespotted flathead (*Platycephalus caeruleopunctatus*)	5.18
8	Three-spotted crab (*Portunus sanguinolentus*)	1.66	Painted grinner (*Trachinocephalus myops*)	3.89
9	Northern sand flathead (*Platycephalus arenarius*)	1.38	Common silverbiddy (*Gerres subfasciatus*)	2.99
10	Highfin toadfish (*Torquigener altipinnis*)	1.31	Eastern smooth boxfish (*Anoplocapros inermis*)	2.91
	Total % represented by top 10 species	**85.37**	**Total % represented by top 10 species**	**73.08**
	DANISH SEINE			
1	Eye gurnard (*Lepidotrigla argus*)	22.06	Eye Gurnard (*Lepidotrigla argus*)	22.41
2	Largescale saury (*Saurida undosquamis*)	21.93	Longspine flathead (*Platycephalus longispinis*)	18.81
3	Theodore's threadfin bream (*Nemipterus theodorei*)	20.24	Spotted dragonet (*Repomucenus calcaratus*)	15.57
4	Longspine flathead (*Platycephalus longispinis*)	9.41	Yellowtail scad (*Trachurus novaezelandiae*)	15.50
5	Spotted bigeye (*Priacanthus macracanthus*)	5.90	Slender squid (*Uroteuthis chinensis* complex)	5.38
6	Spotted dragonet (*Repomucenus calcaratus*)	3.80	Spotted bigeye (*Priacanthus macracanthus*)	4.27
7	Zoanthid anemone (*Sphenopus marsupialis*)	3.20	Highfin toadfish (*Torquigener* altipinnis)	4.03
8	Asymmetric goatfish (*Upeneus asymmetricus*)	2.99	Australian sardine (*Sardinops neopilchardus*)	2.37
9	Seastar (*Stellaster equestris*)	1.81	Largescale saury (*Saurida undosquamis*)	1.94
10	Yellowtail scad (*Trachurus novaezelandiae*)	1.10	Eastern smooth boxfish (*Anoplocapros inermis*)	1.87
	Total % represented by top 10 species	**92.44**	**Total % represented by top 10 species**	**92.15**

Additional information can be obtained by using a diversity index such as the Shannon-Weaver Index (H'), which combines the concept of species richness and relative species abundances into a single measure of diversity. Table 6 presents some summary statistics for these bycatch data.

Table 6 Comparison of species richness and diversity statistics for the NRA and STEA, as observed in laboratory otter trawl and Danish seine bycatch samples

	Otter trawl		Danish Seine	
Statistic	**NRA**	**STEA**	**NRA**	**STEA**
Number of species	99	98	45	35
Shannon-Weaver Index (H')[a]	1.13	1.16	0.95	0.86
H_{MAX}[b]	2.00	1.99	1.65	1.54
J (index of evenness)[c]	0.56	0.58	0.57	0.56

a H' is calculated using the equation $H' = -\sum p \log p$, where p is the proportion of each species in the sample.

b H_{MAX} is the maximum value that the Shannon-Weaver index can reach for a given number of species (k) and occurs when all species are equally represented; where there is an equal distribution H' increases with species number.

c J is a standardised index, calculated by dividing H' by H_{MAX}. It ranges in value from 0 (a single species) to 1 when all species are evenly distributed (equal number).

Examination of this table shows that the Shannon-Weaver indices were larger for the otter trawl samples than for the Danish seine ones, which largely reflects the higher species richness of this bycatch. However, the J values were very similar for all sectors, which suggests that the same level of species 'evenness' is present both between areas and between gear types. This information may be useful in tracking trends or shifts in species assemblages in future years.

Catch per unit effort data

Objective 3: Compare catch rates of the major species caught using the different gear types.

From Table 7 it can be seen that the observed catch per unit effort (CPUE) (kg/hr) for stout whiting and most permitted species was much higher in the NRA than in the STEA, which was not unexpected given that fishing in the southern area was largely exploratory in nature. The notable exception was the catch rate of yellowtail scad, which was appreciably higher in the STEA when using Danish seine.

Table 7 Catch per unit effort (CPUE) data for target, permitted and major non-permitted species caught by otter trawl and by Danish seine in the two fishing areas

Fishing gear	Otter trawl				Danish seine			
Fishing area	NRA		STEA		NRA		STEA	
Mean duration of observed shots (hrs)	1.87		2.38		1.00		1.00	
	kg / shot	kg / hr	kg / shot	kg / hr	kg / shot	kg / hr	kg / shot	kg / hr
Target/permitted species								
Asymmetric goatfish	11.03	**5.90**	0.01	0.01	9.34	**9.34**	0.00	0.00
Balmain bug	0.29	**0.15**	0.04	0.02	0.05	**0.05**	0.01	0.01
Cuttlefish	2.53	**1.35**	0.20	0.09	5.18	**5.18**	0.25	0.25
Goatfishes	0.00	0.00	0.53	0.22	0.00	0.00	0.00	0.00
Moreton Bay bug	0.28	**0.15**	0.01	0.01	0.04	**0.04**	0.02	0.02
Octopods	0.67	**0.36**	0.30	0.13	0.72	**0.72**	0.87	**0.87**
Slender squid	6.75	**3.61**	3.81	1.60	1.33	**1.33**	1.17	1.17
Stout whiting	564.69	**302.06**	332.56	139.73	992.26	**992.26**	855.80	855.80
Theodore's threadfin bream	91.97	**49.19**	0.00	0.00	223.85	**223.85**	0.00	0.00
Yellowtail scad	17.52	**9.37**	29.98	12.60	1.73	**1.73**	55.91	**55.91**
Non-permitted species								
Blue swimmer crab	4.08	**2.18**	4.91	2.06	3.50	3.50	4.36	**4.36**
Tailor	2.13	**1.14**	1.00	0.42	0.94	0.94	1.76	**1.76**
Three-spotted crab	4.11	**2.20**	4.37	1.84	3.18	**3.18**	2.35	2.35

Notes: For the target and permitted species, all catches are considered in the CPUE calculations irrespective of whether they were retained or not.

Non-permitted species are presented if total catch in any area with either gear type exceeds 500 kg.

Shot duration for otter trawl commences when the net reaches the sea floor and finishes when the winch is deployed.

Shot duration for Danish seine commences when the buoy is retrieved and finishes when the footrope is attached and the winch started.

Bolded CPUEs (kg/hr) highlight the area with the highest catch for that species for each gear type.

The limitations of the sampling program also need to be acknowledged. In particular the observer noted that the operators tended to prefer to fish in the northern waters when the stout whiting catches were high, only venturing south when the catch rates in the NRA dropped off. Therefore, more valid comparisons are between the stout whiting catch rates in the NRA and those in the STEA during the same months.

As illustrated in Figures 4 and 5, the stout whiting catch rates for the STEA sit within the normal NRA range when comparing shots from the same month/season. The observer program was unable to collect temporally stratified information from the two fishing areas that would enable direct statistical comparison of catch rates throughout the year.

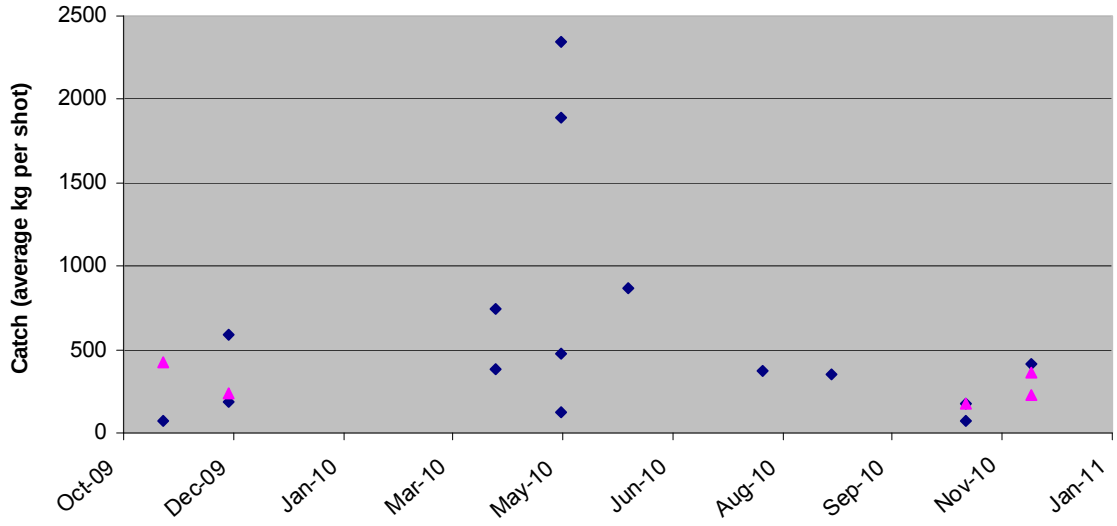

Figure 4 Mean whiting catch per shot for otter trawl trips observed in the NRA (■) and in the STEA (▲)

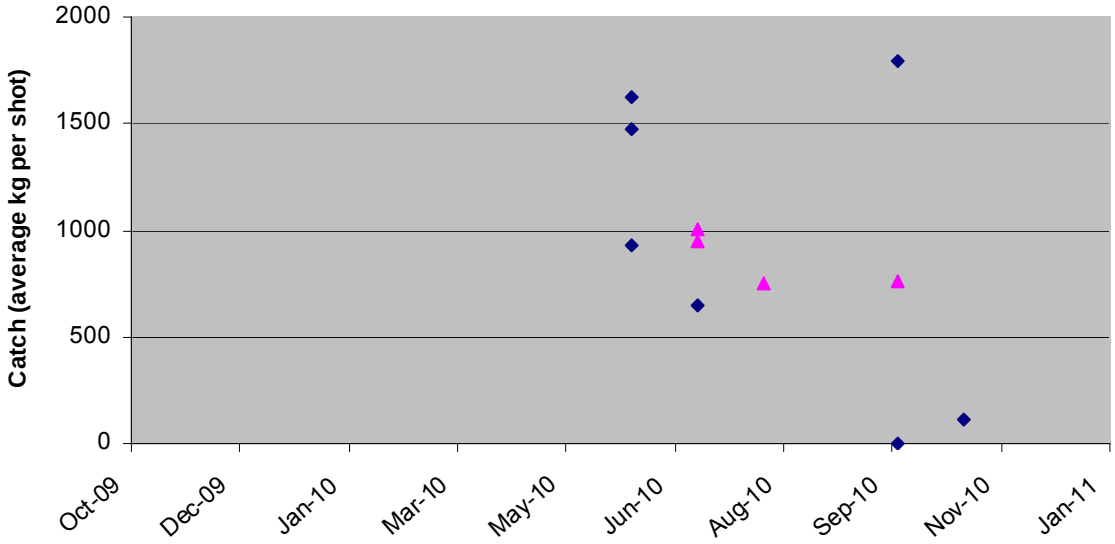

Figure 5 Mean whiting catch per shot for Danish seine trips observed in the NRA (■) and in the STEA (▲)

Interactions with species of recreational importance

Objective 4: Compare interaction rates with species of recreational importance between the two areas for each gear type.

A key objective identified for this program was to quantify the level of interaction by T4 fishers with species of recreational importance, in particular snapper.

Interactions with the key rocky reef (RR) species were observed to be low (*see* Tables 2 and 3). For the observed catches in the NRA the trawl operators captured 93.3 kg of snapper, 111.0 kg of pearl perch and 0.9 kg of teraglin while yielding over 153 t of whiting; the values for the Danish seine operator were 0.6 kg of snapper, 0.8 kg of pearl perch and no teraglin, with 77 t of whiting. In the STEA the otter trawl operators interacted with 0.6 kg of snapper, no pearl perch and 9.4 kg of teraglin, with a yield of 32 t of whiting, whereas the Danish seine operator caught virtually no snapper (0.1 kg) or pearl perch and 2.9 kg of teraglin for 77 t of whiting.

However, given that there is known seasonality in line fishing/catch rates of RR species, with the best fishing occurring in the cooler months, it is valuable to explore when exactly the observed T4 interactions with these species occurred.

As shown in Table 8, snapper, pearl perch and cobia interactions with otter trawl were scattered throughout the year but the majority occurred during mid to late autumn (cobia), late autumn to early winter (snapper) or early winter (pearl perch). Hence, given the distribution of observer effort, it cannot be determined whether the apparent differences in snapper interaction rates between the NRA and the STEA are real or merely a reflection of the months in which these areas were observed.

Irrespective of the month, the observer data do, however, show that most interactions with RR species were observed when aboard otter trawlers. The Danish seine gear works by herding the fish towards the net upon the slow retrieval of the seine ropes.[8] It is likely that snapper, pearl perch and teraglin do not respond highly to this herding method and thus easily avoid capture. Also, the ability of the otter trawl operators to fish closer to 'hard bottom' would increase their chances of encountering reef fish, while the Danish seine operator's preference to carry out night-time fishing would reduce their likelihood of interaction even further.[9]

In contrast to otter trawl, Danish seine operations were observed during the winter in both areas. The paucity of interactions observed during this period thus provides further evidence that these species are much less likely to be captured using this gear type. Although Danish seine had more interactions with cobia than with snapper or pearl perch, a third of these were surveyed as 'monster'; had these fish been encountered in gear with a TED they may not have been captured.

[8] Danish seine gear is retrieved at a considerably slower pace than the speed typical of otter trawl (<1 knot compared to 3-4 knots respectively).

[9] Previous round-the-clock observation of T4 otter trawl operations carried out by the FOP in 2006 demonstrated that most interactions with RR species occurred during the day.

Table 8 Comparison of the number of key recreational species observed each month, according to gear type and fishing area

Observed no. of:	Gear	Area	2009			2010								
			Nov	Dec	Jan–Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shots	OT	NRA	1	51		37	31	26		35	46		46	19
	OT	STEA	38	12									9	44
	DS	NRA						40	24			14	9	
	DS	STEA						1	42	26		23		
Snapper	OT	NRA		49		13	127	131		5	15		5	53
	OT	STEA	1	4										
	DS	NRA						2					1	
	DS	STEA							1					
Pearl perch	OT	NRA		13		3	3	162		1			31	2
	OT	STEA												
	DS	NRA						2				1		
	DS	STEA												
Teraglin	OT	NRA				1								
	OT	STEA	31	12										6
	DS	NRA												
	DS	STEA							2	3		7		
Cobia	OT	NRA		4		38	14	1		17	12		2	
	OT	STEA	3	1									1	
	DS	NRA						10	2					
	DS	STEA							4	12		3		
Tailor	OT	NRA		290		888	676	342		71	258		259	195
	OT	STEA	51	427									15	44
	DS	NRA						217	215					
	DS	STEA												

Notes: The shaded rows present the total number of shots observed in each sector.
OT = otter trawl, DS = Danish seine.

Although only a few hundred interactions with snapper were observed in total during this program, the importance of this iconic south-eastern Queensland species to both the commercial line and recreational sectors warrants further examination of the nature of these interactions.

From Table 9, it can be seen that 95 per cent or more of the observed shots for the Danish seine vessel operating in both areas and by the otter trawlers in the STEA had no interactions with snapper. The highest rate of interaction (16 per cent of observed shots) occurred in the regulated area using otter trawl. All interactions except one were with fish below the minimum legal size of 35 cm total length (equivalent to about 30 cm fork length). No snapper were present in any of the bycatch samples that were processed in the laboratory.

Finally, mention should be made of an important East Coast Inshore Fin Fish Fishery (ECIFFF) species, tailor, which was also observed more frequently with otter trawl gear from mid-autumn to early winter though in much higher numbers than for the other recreational species (*see* Table 7 for catch rates). While all fish encountered were well below the minimum legal size for tailor (35 cm), given the number of interactions observed (3516 interactions in otter trawl and 432 in Danish seine), fishing mortality incurred by T4 operations may warrant consideration in future stock assessments for this species.

Table 9 Summary information on snapper interactions observed during the period November 2009 to December 2010

	Otter trawl		Danish Seine		
	NRA	STEA	NRA	STEA	TOTAL
Total number of commercial shots	1562	431	363	156	2 512
Observed number of shots (percentage of total)	272 (17%)	98 (23%)	78 (22%)	90 (58%)	538
Number of shots observed with snapper	43	5	2	1	51
Percentage shots observed without snapper	84%	95%	97.4%	99%	
Wt (kg) snapper observed	93.30	0.55	0.55	0.10	94.50
Total number of snapper	398	5	3	1	407
Percentage snapper during daylight hours (6 am – 6 pm)	78.6%	80%	33.3%	100%	
Length range (fork length)	9–26 cm (mode 21) for both gear types & areas, with one 73 cm interaction in OT (NRA)				

Notes: All interactions presented below were observed at sea—no snapper were present in the laboratory processed samples.
The total number of commercial shots refers to fisheries logbook records covering the study period.

Interactions with important ECOTF species

Objective 5: Obtain estimates of prawn catch for both gear types and fishing areas.

Given their commercial importance in the ECOTF, prawns were among those species observed at-sea. However, they were also represented in the laboratory sorted samples, presumably because small individuals were easily overlooked among the larger teleosts and crustaceans. Therefore, to gauge the level of interaction with prawns by T4 fishers it is important to consider both sources of bycatch information.

It can be seen from Table 10 that even when considering both at-sea observations and laboratory processed samples, the impact of T4 operations on the prawn population was very low, with a mean catch rate for all species combined of just 1 kg/hour. However, the extrapolated estimates do assume that:

- the samples taken were a good representation of the total catch that remained 'unidentified' at sea
- observer effort was a good representation of typical commercial fishing effort, both spatially and temporally.

While the first assumption may not hold true for several reasons[10], more representative sampling would not necessarily have resulted in higher total prawn capture rates than those observed. Given that the observer effort was spatially thorough and a good reflection of the commercial effort, the extrapolated estimates are not considered to be unreasonable.

Table 10 Interactions with prawns by gear type and fishing area

		Prawn biomass (kg) from:				Total	Prawn
Area	Gear	At-sea observation	Laboratory sample	Extrapolated estimate for all unidentified discards	Total	hours observed	catch rate kg / hr
NRA	OT	297.8	0.267	89.0	386.8	508.50	0.76
	DS	13.8	0.023	14.4	28.2	78.00	0.36
STEA	OT	257.5	3.675	234.1	491.6	233.25	2.11
	DS	55.5	0.066	16.5	72.0	90.00	0.80
All T4		**624.6**	**4.031**	**354.0**	**978.6**	**909.75**	**Mean = 1.00**

Note: Prawns comprise several species, including black tiger prawn, brown tiger prawn, king prawn, greasy prawn, school prawn and redspot king prawn.

The individual weights of the species represented by the at-sea observation values are given in Table 2 for otter trawl and Table 3 for Danish seine.

The individual weights of the species represented by the laboratory sample values are given in Appendix 4 (*Melicertus plebejus*, *Metapenaeopsis palmensis*, *Metapenaeus macleayi* and *Penaeus esculentus*).

The extrapolated estimates are calculated by dividing the laboratory sample weights by the percentages of unidentified discards processed in the laboratory and then multiplying by 100.

The total prawn biomass represents the sum of the at-sea value and the extrapolated estimate for the unidentified discards component of the catch.

[10] These include the program's decision to favour observation of day shots over night shots, the collection of noon bycatch samples only for laboratory processing, the highly variable catch rates of prawns at the individual shot level, the exploratory nature of fishing operations observed in the STEA, and the atypical rainfall patterns experienced in the region during 2010.

Interactions with species of conservation interest

Objective 6: To compare interactions with species of conservation interest between areas and between gear types.

Table 11 Interactions with species of conservation interest, differentiated according to gear type and fishing area.

	NRA				STEA			
	Otter trawl		Danish Seine		Otter trawl		Danish Seine	
Species	**RA**	**RD**	**RA**	**RD**	**RA**	**RD**	**RA**	**RD**
Elegant seasnake		2						
Seasnake unidentified	8	1	1				1	
Pipehorse (*S. dunkeri/hardwickii*)		10		2				
Spiny pipehorse (*S. spinosissimus*)		1						

Note RA = released alive, RD = released dead.

There were few interactions observed with species of conservation interest throughout the 2009–10 stout whiting observer program. In total, from the 110 days spent observing aboard the vessels and over 500 shots surveyed there were 13 interactions with seasnakes and 12 interactions with pipehorses (no other syngnathids). There were no observed interactions with marine mammals or turtles.

Further identification of seasnakes was not carried out on live specimens because of the risk involved in handling them and their low occurrence. Two dead specimens were retained and later identified as elegant seasnakes (*Hydrophis elegans*). The majority of seasnake interactions were recorded in the NRA using otter trawl gear. Mortality rates were reasonably low for both gear types, especially Danish seine (0 per cent).

Twelve of the 13 pipehorse interactions were with either *Solegnathus hardwicki* or *Solegnathus dunckeri*, though these species were not differentiated given their similar taxonomy. A single spiny pipehorse (*Solegnathus spinosissimus*) was observed throughout the surveys. All pipehorse interactions occurred in the NRA and were predominantly with the use of otter trawl.

The pipehorses were clearly much more vulnerable in the nets than the seasnakes, with all the observations made on dead animals.

It should be noted that *S. hardwicki* and *S. dunckeri* are harvested in the ECOTF, with a possession limit of 50 pipehorses in total (O'Sullivan et al. 2005).

Interactions with sharks and rays

Objective 7: Compare the rate and fate of interactions with chondrichthyans (sharks and rays) between the two areas and the two gear types.

Table 12 shows that the T4 fishery interacts with a relatively broad range of chondrichthyans, all of which were discarded as non-permitted species. For otter trawl, more interactions occurred in the NRA whereas for Danish seine over four times as many were observed in the STEA, though this difference was largely attributable to just 12 shots in which over 1100 rays were captured in total.

Table 12 Chondrichthyan (shark and ray) interactions observed in the stout whiting fishery, separated according to gear type and fishing area

	Otter trawl						Danish Seine						Total interactions (species)
	NRA			STEA			NRA			STEA			
Species	**D**	**RA**	**RD**	**D**	**RA**	**RD**	**D**	**RA**	**RD**	**D**	**RA**	**RD**	
Australian butterfly ray		2	1								1	1	5
Bluespotted maskray		26	104		1	16		8		12	96	12	275
Coffin ray					12	4					23	1	40
Common stingaree		10	12		1	53		1		100	35	29	241
Eagle ray (unidentified)		1											1
Eastern fiddler ray					2						2		4
Eastern shovelnose ray	14	24	287	25	27	358	43	185_2	162	1696	239	15	3 075
Eastern spotted gummy shark		1	3			2							6
Fossil shark		1	20										21
Grey carpetshark	8	6	7		1			1					23
Guitarfishes	6	18	90				6	85_1	8		3_3		216
Milk shark			12										12
Painted maskray			3										3
Pigeye shark											1_1		1
Scalloped hammerhead		4	48			3			1				56
Shark ray								1_1					1
Silvertip shark			1								1_1	2_2	4
Skate (unidentified)		1_1									4_4		5
Sliteye shark			35										35
Spinner shark			7										7
Spotted wobbegong					4								4
Stingrays			1						1				2
Weasel shark	2	2	85		1			4	8			1	103
Whaler shark (unidentified)	2											1_1	3
Wobbegong (unidentified)					1								1
Zebra shark								1_1					1
Fate totals	32	96	716	25	50	436	49	286	180	1808	405	62	4 145
All interactions (gear/area)	844			511			515			2 275			

Notes: D = discarded, RA = released alive, RD = released dead.

A 'discarded' fate code was used when it was not possible (often owing to large numbers) to discern whether the animal was dead or alive upon release.

Some animals, in particular 'monsters', were not able to be fully identified before being released; in these cases photographs were taken to assist with later identification.

Subscript numbers represent the 'monster' catch.

The otter trawl operators were observed to interact with 23 different species and the Danish seine operator with 17, while 14 species were common to both gear types. None of these interactions involved protected species. For both gear types most interactions occurred with eastern shovelnose rays. In total, 3075 interactions were observed for this species, with the majority occurring with Danish seine in the STEA. On average, there were about 10 interactions per shot using Danish seine gear, though the rates were highly variable ranging from 0 to 166. However, whereas eastern shovelnose rays caught using otter trawl had a high mortality rate[11] (>90 per cent), those caught using Danish seine fared much better (<30 per cent if discarded values are disregarded).

For otter trawl, the bluespotted maskray had the next highest number of interactions observed, closely followed by guitarfishes and weasel sharks. These occurred mainly in the NRA and had high associated mortalities (82, 83 and 97 per cent respectively). In contrast, when using Danish seine gear, the common stingaree was the second most common chondrichthyan captured followed by the bluespotted maskray. Most of these interactions occurred in the STEA. The survival rates of sharks and rays caught using this gear were generally higher than those for otter trawl, irrespective of fishing area, which can probably be explained by the shorter shots.

However, the Danish seine apparatus did not compare as favourably with respect to 'monster' interactions, which mainly comprised chondrichthyans. Although the majority of these were returned alive and may have a high post-catch survival rate, the higher incidence of capture by Danish seine is undoubtedly due to this gear not operating with a TED.

The size distribution of all observed chondrichthyans in the FTF is summarised in Table 13.

[11] This rate is calculated using the RA and RD values only.

Table 13 A comparison of the largest and smallest chondrichthyans captured in the T4 fishery using the two permitted gear types

	Otter trawl			Danish Seine		
SHARKS	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Total length (cm)	130	900	486	280	990	483
Species	Eastern fiddler ray	Scalloped hammerhead		Eastern shovelnose ray	Weasel shark	
Shark 'monsters'						
Total length (cm)				1050	2400	1617
Species				Silvertip shark	Guitarfish	
RAYS	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Disc width (cm)	90	810	262	140	610	230
Species	Bluespotted maskray	Bluespotted maskray		Common stingaree	Australian butterfly ray	
Ray 'monsters'						
Disc width (cm)	N/A (100 kg)					
Species	Skate					

Notes: Given similar morphology, eastern shovelnose rays, guitarfish and eastern fiddler ray were measured as 'sharks'.

To avoid skewing the data 'monster' interactions are presented separately.

No width measurement was taken for the 'monster' skate captured by otter trawl, though its weight was estimated.

Appraisal of the T4 discard logbook

Objective 8: Assess the effectiveness of the T4 discard logbook.

In 2009, coinciding with the trial expansion of the southern area, fisheries managers trialled a T4 discard logbook to complement the standard T4 daily catch and effort logbook.

In most situations observed during 2010 the crew had limited species identification skills and were not capable of providing the information to the skippers who were responsible for the discard logbooks. Also, the skippers did not always have strong fish identification skills beyond the target and permitted species and were unable to be on deck when catch was sorted as they were operating a vessel and redeploying gear from the wheelhouse.

Irrespective of the vessel, the observer was often asked to provide the discard information for fishers to enter into this new logbook. A preliminary analysis has shown that on trips when the observer was not present there was a reduction in total discards reported. Further, on trips when the observer was not asked to help there was a notable reduction in recordings (*see* Table 14).

Table 14 Comparison of typical observer and fisher records of discards from a single T4 trip

	Observer data		Discard logbook data	
Species	**Number**	**Weight (kg)**	**Number**	**Weight (kg)**
Cobia	33	110.2	0	0
Goldspotted rockcod	1	5.6	0	0
Grass sweetlip	1	2.7	0	0
Pearl perch	2	0.1	0	0
Red emperor	1	0.5	0	0
Sharks	18	8.9	0	0
Snapper	53	9.2	0	0
Teraglin	1	0.4	0	0
Venus tuskfish	1	0.1	0	0

Note: These data were collected in the summer and comprise the observations made on multiple shots.

'Sharks' includes eastern shovelnose rays (16 at 5.5 kg), sliteye shark (1 at 1.7 kg) and spotted wobbegong (1 at 1.7 kg).

Based on the observed skills of the crews, the accuracy of the information recorded in the discard logbooks on all T4 vessels in 2010 is highly questionable; the discard logbook at the level of detail requested is not seen as successful. If fisheries managers have an ongoing need for the information provided by the discard logbook, alternatives must be explored. If detailed bycatch data are required, then using a trained fishery observer for an appropriate number of trips/days to document discards accurately remains the best approach.

Issues raised by the stout whiting operators

Objective 9: Gain a better understanding of the at-sea fishing operations to help inform future management decisions regarding this fishery, in particular to identify the challenges the fishers may face in complying with current management arrangements.

A key objective of the Fisheries Observer Program is to become familiar with the hands-on operation of commercial fisheries. This 'real life' experience enables fisheries observers to provide feedback to management regarding challenges fishers may have under current management arrangements. This extension role is aimed at building positive relationships between Fisheries Queensland and commercial operators. Throughout the 2009–10 observer program there were several issues raised with the onboard observer. These issues are identified below and have been forwarded to management for consideration.

- The Danish seine operator would like to see the Danish seine gear type become an approved gear type under fisheries regulations.
- The current restriction to operate in waters deeper than 20 fathoms was raised by all operators. From communications with prawn trawl operators, all stout whiting fishers believe there is a large stout whiting resource inside the 20 fathom contour and that they could fish in shallower depths without fishing juvenile whiting.
- There was some discussion from operators regarding negotiating the 3-month summer closure. However, there was no agreement among the fleet as to when they would prefer a closure.
- All operators, particularly the trawl operators, raised concerns that the current limitations on by-product were too restrictive and made retention of these species 'barely worth it'.
- Crew and skippers had difficulty accurately completing the T4 discard logbook and believed it was an unreasonable request. 'Why do we carry observers?' was a question often asked.
- All fishers expressed concern regarding the marine bioregional planning currently being developed by the Australian Government that aims to establish new Commonwealth marine reserves. One area that has been identified for further assessment in the East Marine Region encompasses their main fishing grounds east of Fraser Island.

Key outcomes from the stout whiting observer program

Performance differences in gear type

Relating to whether Danish seine should become an approved gear type under fisheries regulations

The deployment of the net in the Danish seine operation is targeted to schools of fish seen on sonar. In a shot of similar overall duration the net itself sweeps a smaller area than the demersal otter trawl net and fishes a greater proportion of the water column; the combination of sweep ropes and net more selectively harvests the target species, stout whiting. Also, because it is retrieved at a much slower speed than the otter trawl net, Danish seine enables those non-target species that exhibit less of a herding response (including recreational finfish species) to more readily escape capture.

In addition, given its efficiency in capturing whiting, the Danish seine operator was observed to fish at least 8 hours less each day than the otter trawl operators, thus affording the crew an opportunity for daily extended rest periods (pers. obs., Rowsell).

In summary, compared to the traditional otter trawl gear, the Danish seine gear (exempt from TED) was observed to have the following benefits:

- higher catch rates of the target species (i.e. more selective fishing)
- lower interactions with species of recreational importance (e.g. snapper)
- lower interactions with commercially important crustaceans (prawns, crabs and bugs) retained by T1 fishers
- lower interactions with species of conservation importance (e.g. pipehorses and seasnakes)
- interaction with fewer species overall.

However, the observer work also showed the Danish seine gear to have:

- higher interactions with rays, especially eastern shovelnose rays
- higher interactions with large ‘monster’ sharks, rays and finfish.

An effective TED in the Danish seine net may reduce its shark and ray catch, making it more environmentally friendly in this respect. Although unsuccessful TED trials for Danish seine were conducted a few years ago, there have been recent developments in technology that may warrant revisiting the current TED exemption.

Differences in catch (target, by-product and bycatch) from the two fishing areas

Relating to whether the STEA should become an approved T4 fishing area under fisheries regulations

While observers were able to sample the catches of otter trawlers and the Danish seine vessel in both areas across winter and summer months in the NRA, observations on trawlers in the STEA could only be made during the summer months. Although this represents an information gap, the geographic extent of the areas fished commercially in late 2009 and 2010 was well covered by this observer program.

It should be noted that because this was the first season of fishing in the STEA all observations made there were essentially of an exploratory fishery.

Target species

Compared to that from the NRA, the catch of stout whiting from the STEA:

- represented a higher proportion of the total biomass captured
- had an overall lower catch rate
- had similar rates when comparing the same months.

Interactions with other commercially important species

The extended T4 grounds (NRA and STEA) lie wholly within the legislated T1 fishing grounds used by otter trawlers targeting prawns. That said, the interactions with prawns by the fish trawl nets and Danish seine net were observed to be very low, averaging just 1 kg/hr. Although potential conflict between resource users was raised as a concern, mapping of the spatial T4 commercial effort (*see* Figures 2 and 3) shows the T4 operators to have mainly fished along the 20 fathom contour line whereas much of the T1 effort for this region is in deeper waters according to commercial logbook data.

Although access to the stout whiting resource in shallower waters was raised as an issue by T4 fishers, this observer work provides no data to inform a decision on this matter. However, in the past Fisheries Queensland has used this level of protection as the basis of a precautionary management regime for the stout whiting stock. Juvenile stout whiting are known to inhabit these waters and therefore this current fishing restriction gives the stock some protection through reduced juvenile mortality (Thwaites & Andersen 2008).

Some of the main differences observed at sea between the two areas with respect to permitted species (retained or discarded) were:

- much larger quantities of yellowtail scad being caught regularly in the STEA
- no observed interactions with Theodore's threadfin bream in the south whereas this species represented over 10 per cent of the catch in the NRA
- asymmetric goatfish observed in the catches of both gears only in the north
- a much higher catch rate (relative to stout whiting tonnage) of cuttlefish observed in the regulated area

- bycatch representing a much lower proportion of the total catch overall in the STEA than in the NRA.

Overall more fish, crustacean and mollusc species were reported from Danish seine fishing operations in the NRA than in the STEA (45 compared to 34) but there was little difference in the number of species caught using otter trawls (98 compared to 99). These data indicate that the benthic communities of the trawlable ground in these two areas are both similarly diverse but different in species composition and relative abundance, perhaps reflecting structural habitat differences on the seabed.

Interactions with recreationally important fish species

This observer program has shown a low incidence of interaction by T4 operations with rocky reef species (snapper, pearl perch, teraglin and cobia). With the exception of teraglin, far fewer interactions were observed in the STEA than in the NRA for otter trawl, though this may have reflected observer effort and temporal differences in observation. The T4 trawlers did not fish the STEA in winter. Thus it remains unknown whether snapper and pearl perch catch rates in otter trawls in these grounds would show the major seasonal increase reflected in historical charter line fishery catch rates for these species (teraglin catch rates were somewhat higher in autumn and spring) (Sumpton et al. 2005).

At-sea observation of Danish seine gear operating in both areas over an extended period (June to November) demonstrated even lower interactions with these rocky reef species compared to otter trawl.

While tailor was the only species of recreational importance for which an appreciable number of interactions were observed (hundreds in some months), the impact of T4 operations on the tailor fishery (both recreational and commercial) is still considered to be low. These interactions were predominantly observed using otter trawl gear in the NRA. No interactions with tailor were observed in the STEA using Danish seine gear, even though more fishing effort occurred here.

Of these five species, only teraglin, pearl perch and tailor were present in the laboratory processed bycatch samples, where they had low representation (4, 20 and 3 individuals in total, respectively). The pearl perch all originated from a single otter trawl shot in the NRA and the teraglin from one in the STEA.

Interactions with species of conservation interest

Based on unbiased at-sea observation, the T4 fishery can be considered a fishery with a very low risk of interaction with threatened or endangered species. From the 103 trawl shots and 92 Danish seine shots surveyed in the STEA, there was only 1 observed interaction with a seasnake and none with syngnathids, marine mammals, protected sharks, seabirds or turtles. By contrast, 11 seasnakes and 13 pipehorses (but again no marine mammals, protected sharks, seabirds or turtles) were recorded in the 272 trawl shots and 78 Danish seine shots observed in the NRA, noting that trawling in this area occurred during winter, spring and summer.

In summary, half of the interactions that occurred were with pipehorse species that can be retained in the ECOTF (in-possession limit of 50 per trip) and the other half with seasnakes, with 70 per cent being released alive.

Observed stout whiting spawning aggregations

Observed stout whiting spawning aggregations

Relating to the timing of the fishery closure

Although a closure period that affords maximum protection to the spawning stock is desirable, assessing when peak spawning occurs in stout whiting is not straightforward as there is evidence of ripe females occurring throughout the year. Brown and Butcher (1995) investigated gonado-somatic indexes (GSI) from specimens collected from the NRA between 1991 and 1993, and found only loose trends: the GSI distribution was irregular, tending to be higher in summer months and declining in winter. Based on this information, the 1 January to 31 March annual fishery closure was subsequently implemented.

All fisheries-dependent collections of stout whiting that the LTMP has made post-1995 have not included the January to March fishery closure period and the GSI sampling undertaken has not been on randomly selected fish. Thus, while the long-term data presented in subsequent reports (O'Sullivan et al. 2005; O'Sullivan & Jebreen 2007) may have contradicted Brown and Butcher's findings, the assertions made in these reports with regard to a spawning peak in October are also questionable as the standard errors associated with these data are understood to be high (pers.com., Jason McGilvray).

To complicate the issue further, in the current observer program a definite spawning aggregation of stout whiting was recorded in May 2010 in the NRA, though ripe fish were observed throughout the season (pers. obs., N. Rowsell). This supports the assertions made by industry that spawning is protracted with possibly multiple spawning peaks occurring throughout the year. Research that definitely establishes the stout whiting spawning period would be welcomed.

Observed discarding of marketable species

Relating to permitted species and in-possession limits

The T4 fishers raised the issue of increasing by-product trip limits. The only permitted species that were observed to have their limits reached on occasion were squids and yellowtail scad, both of which incur heavy mortality upon capture. Given that these fishers are not able to target squids, but instead capture them on an ad hoc basis, further discussion with stakeholders regarding an increase in the trip in-possession limits for these species may be warranted. When fishing is poor and the vessels are unable to fill a container of stout whiting, the higher retention of squids could help raise crew income and assist the operators to retain crew.

As for the other permitted species, including yellowtail scad that can be targeted, the observer data do not support increased limits because these species were regularly observed to be discarded through fisher choice.

With regard to extending the permitted species list, the observer program has provided some catch rates that should help inform future management decisions on this issue in consultation with other stakeholders.

Reporting issues

Relating to the continued requirement of a T4 discard logbook

The T4 discard logbook was introduced to the stout whiting fishery as a permit condition in November 2009. The subsequent high level of observer coverage in this fishery revealed these discard data to be unreliable and inaccurate for several reasons, most of which are unlikely to change in the future.

Appendix 1 History of the fishery

During the 1980s and early 1990s all of Queensland's commercial fisheries had open access to stout and red spot whiting, which were largely landed as bycatch by trawlers targeting prawns or scallops. In 1981 one demersal otter trawl operator began targeting red spot whiting on the south coast of Queensland and then progressively moved to target stout whiting as exploration provided evidence that a commercial fishery existed for this species.

By 1984 other operators had realised the market potential of this fishery in the area and up to 1000 kg per day of stout whiting was being landed as by-product in the ECOTF. Other operators also attempted to target stout whiting; however, market value and competition both domestically and from overseas made the fishery volatile. The original operator was the only one to persevere through the early years (Thwaites & Andersen 2008).

This single operator went on to develop the stout whiting fishery by upgrading to more specialised equipment and fishing practices. These developments included using a large snap freezer, specialised hopper and conveyor equipment for at-sea sorting of catch. The fishery evolved into a more advanced operation, with an increased catch capability and drastically improved product quality (Thwaites & Andersen 2008).

Between 1989 and 1990 more than 10 boats were targeting stout whiting and the annual catch had risen to nearly 1800 tonnes. However, in 1991 the market collapsed resulting in significant volumes of unsold catch and a reduction in fishing effort. Consequently, later that same year, the fishery was restructured as a limited entry, developmental fish-trawling fishery (FTF) operating off southern Queensland only (Thwaites & Andersen 2008).

The introduction under Queensland law of the *Fisheries Act 1994* and the Fisheries Regulation 1995 saw further refinement to this regulatory structure, prescribing the apparatus that could be used, the area and time of operation and the two species that could be retained (stout and red spot whiting). The stout whiting fishery was allocated its own fishery symbol (T4). Five commercial fishing operations received a T4 fishery symbol, and entered into a memorandum of understanding (MOU) whereby a commitment was made by industry to work with the Queensland Government for stock assessment and monitoring purposes. The MOU was used as a basis for cooperative management, particularly in the setting of a total allowable catch (TAC) (Thwaites & Andersen 2008).

In 2006, under a general fisheries permit, one licence holder started fishing stout whiting using Danish seine gear instead of the conventional otter trawl gear. The proportion of the annual landings taken by this gear type has since varied, though in 2010 this single operator accounted for over 30 per cent of the total catch (*see* Figure A-1).

Currently the Danish seine operator is unique in using IQF (individual quick freeze), which gives a much higher quality product.

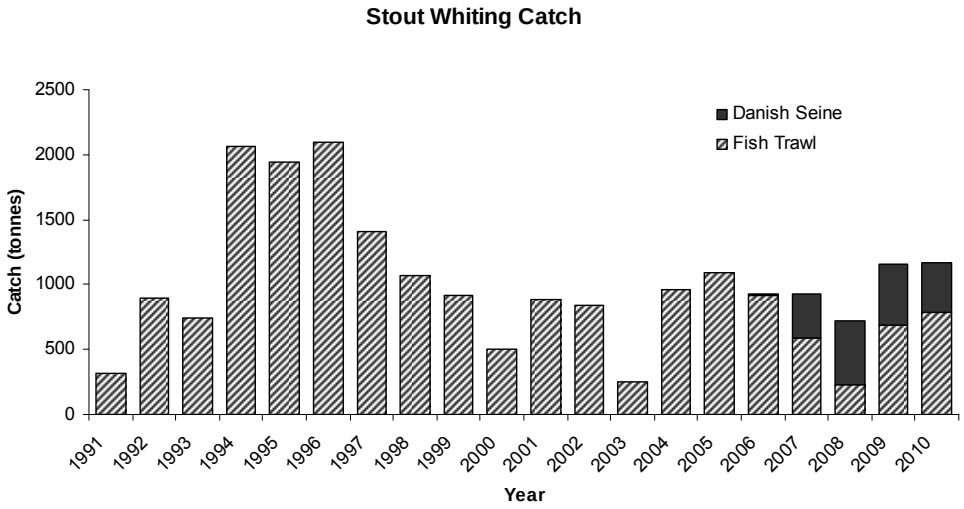

Figure A-1 Annual landings of stout whiting caught in Queensland using otter trawl (shown as 'Fish trawl') and Danish seine gear

Appendix 2 WTO approval

The stout whiting fishery has undergone two rounds of assessment under the *Environment Protection and Biodiversity Conservation Act 1999* in accordance with the Australian Government's *Guidelines for the ecologically sustainable management of fisheries*. On both occasions (2004 and 2007) a Wildlife Trade Operation (WTO) approval was granted for a period of 3 years. This accreditation acknowledges that the fishery is being managed in an ecologically sustainable manner and allows the export of the catch. Under Australian law all fisheries require WTO approval in order to export product and/or operate within designated Commonwealth waters.

The current WTO originally expired in November 2010, but was then extended by the Australian Department of Sustainability Environment Water Population and Communities (SWEPaC) to June 2011; subsequently the fishery was granted WTO approval until August 2014. As part of the approval process, the Australian Government assessed the progress of Fisheries Queensland in addressing the three 2007 WTO recommendations made 'to further strengthen the effectiveness of the management arrangements for the QFTF [Queensland Fin Fish Trawl Fishery] and minimise environmental risks in the medium term'.[12] The three recommendations stated in the 2007 WTO were:

1. The Department of Primary Industries and Fisheries (DPI&F)[13] to consider making the annual TAC enforceable. DPI&F to review the description of the TAC in the *Queensland Fin Fish Trawl Fishery—Statement of management arrangement*.

2. DPI&F to review the current closures in the QFTF to ensure that protection is provided during the peak spawning period of stout whiting.

3. DPI&F to pursue a reduction in the amount of bycatch taken in the QFTF. Industry will be encouraged to immediately adopt any effective and appropriate methods of bycatch reduction.

This dedicated observer program may help Fisheries Queensland to demonstrate progress against one or more of these recommendations through the collection of detailed and accurate fisheries data for which there are current information gaps.

The observer program also provides information for this fishery's performance measurement system (PMS). Performance indicators that are directly relevant to the observer program are:

- annual total catch of permitted species from compulsory daily logbooks validated through the observer program and weighbridge dockets
- estimated catch rates of 'top 10' bycatch species encountered during the observer program

[12] Letter from the Australian Department the Environment and Water Resources to the Queensland Minister for Primary Industries and Fisheries <www.environment.gov.au/coasts/fisheries/qld/stout-whiting/pubs/letter-minister-november-2007.pdf>.

[13] DPI&F refers to the previous name for Fisheries Queensland.

- estimated catch rates of recreationally and commercially important species
- estimated total bycatch weight per shot recorded through the observer program
- total number of species recorded in the observer program.

While this report does not address these performance measures directly, it presents pertinent data that can be used for this purpose in annual status reports and fishery reassessment submissions to SEWPaC.

Appendix 3 Glossary of species names documented during 'at-sea' observation

Sampling codes indicate the reason for documenting the species:

CHON	Chondrichthyan (shark/ray)
COMM	Commercially important species
REC	Recreationally important species
PERM	Permitted T4 by-product species
RQ (OS)	Reef quota (other species)
SOFI	Species of fisheries interest
RR	Rocky reef species
SOCI	Species of conservation interest

CODE	Common name	Scientific name	CAAB CODE
REC	Australian bonito	*Sarda australis*	37441020
CHON	Australian butterfly ray	*Gymnura australis*	37037001
PERM	Asymmetric goatfish	*Upeneus asymmetricus*	37355010
COMM	Ballot's saucer scallop	*Amusium balloti*	23270001
PERM	Balmain bug	*Ibacus* spp.	28821901
REC	Blackbanded amberjack	*Seriolina nigrofasciata*	37337014
COMM	Black tiger prawn	*Penaeus monodon*	28711051
COMM	Blue swimmer crab	*Portunus pelagicus*	28911005
CHON	Bluespotted maskray	*Dasyatis kuhlii*	37035004
COMM	Brown tiger prawn	*Penaeus esculentus*	28711044
RR	Cobia	*Rachycentron canadum*	37335001
CHON	Coffin ray	*Hypnos monopterygium*	37028001
CHON	Common Stingaree	*Trygonoptera testacea*	37038006
PERM	Cuttlefish	*Sepia* spp.	23607901
CHON	Eagle ray	Myliobatidae	37039000
CHON	Eastern fiddler ray	*Trygonorrhina fasciata*	37027006
CHON	Eastern shovelnose ray	*Aptychotrema rostrata*	37027009
CHON	Eastern spotted gummy shark	*Mustelus walkeri*	37017011
SOCI	Elegant seasnake	*Hydrophis elegans*	39125021
CHON	Fossil shark	*Hemipristis elongate*	37018011
RQ (OS)	Frypan bream	*Argyrops spinifer*	37353006
COMM	Giant mud crab	*Scylla serrata*	28911008
PERM	Goatfishes	Mullidae	37355000
REG	Grass emperor	*Lethrinus laticaudis*	37351006
RQ (OS)	Goldspotted rockcod	*Epinephelus coioides*	37311007
CHON	Grey carpetshark	*Chiloscyllium punctatum*	37013008
CHON	Guitarfishes	Rhinobatidae	37027000
RQ (OS)	Hussar	*Lutjanus adetii*	37346033
SOFI	John Dory	*Zeus faber*	37264004
COMM	King prawns	*Melicertus* spp.	28711901
SOFI	Leaping bonito	*Cybiosarda elegans*	37441008
SOFI	Mantis shrimps	Squillidae species	28051000
RQ (OS)	Maori rockcod	*Epinephelus undulatostriatus*	37311086
CHON	Milk shark	*Rhizoprionodon acutus*	37018006
PERM	Moreton Bay bug	*Thenus* spp.	28821903
RQ (OS)	Moses snapper	*Lutjanus russellii*	37346065
REC	Mulloway	*Argyrosomus hololepidotus*	37354001
PERM	Octopods	*Octopus* spp.	23650000
REG	Ornate rocklobster	*Panulirus ornatus*	28820006

CODE	Common name	Scientific name	CAAB CODE
SOFI	Oval rockcod	*Triso dermopterus*	37311165
COMM	Prawn - greasy/ school	*Metapenaeus macleayi & M. bennettae*	28711903
CHON	Painted maskray	*Dasyatis leylandi*	37035013
RR	Pearl perch	*Glaucosoma scapulare*	37320003
CHON	Pigeye shark	*Carcharhinus amboinensis*	37018026
SOCI	Pipehorse	Syngnathidae	37282000
RQ (OS)	Purple tuskfish	*Choerodon cephalotes*	37384004
RQ (OS)	Red emperor	*Lutjanus sebae*	37346004
COMM	Redspot king prawn	*Melicertus longistylus*	28711048
RQ (OS)	Saddletail snapper	*Lutjanus malabaricus*	37346007
REC	Sand whiting	*Sillago ciliata*	37330010
ELASMO	Scalloped hammerhead	*Sphyrna lewini*	37019001
COMM	School mackerel	*Scomberomorus queenslandicus*	37441014
COMM	School prawn	*Metapenaeus macleayi*	28711029
SOCI	Seasnake	Hydrophiidae	39125000
CHON	Shark ray	*Rhina ancylostoma*	37026002
CHON	Silvertip shark	*Carcharhinus albimarginatus*	37018027
CHON	Skate unidentified	Rajidae species	37031000
PERM	Slender squid	*Uroteuthis chinensis complex*	23617901
CHON	Sliteye shark	*Loxodon macrorhinus*	37018005
RR	Snapper	*Pagrus auratus*	37353001
REG	Spanner crab	*Ranina ranina*	28865001
CHON	Spinner shark	*Carcharhinus brevipinna*	37018023
SOCI	Spiny pipehorse	*Solegnathus spinosissimus*	37282029
SOFI	Sponges	Spongiidae	10114000
CHON	Spotted wobbegong	*Orectolobus maculatus*	37013003
CHON	Stingaree unidentified	Urolophidae	37038000
CHON	Stingray unidentified	Dasyatidae	37035000
COMM	Tailor	*Pomatomus saltatrix*	37334002
REC	Tarwhine	*Rhabdosargus sarba*	37353013
RR	Teraglin	*Atractoscion aequidens*	37354020
PERM	Theodore's threadfin bream	*Nemipterus theodorei*	37347036
SOFI	Threadfin	Polynemidae	37383000
REG	Three-spotted crab	*Portunus sanguinolentus*	28911006
REG	Trumpeter whiting	*Sillago maculata*	37330015
RQ (OS)	Venus tuskfish	*Choerodon venustus*	37384042
CHON	Weasel shark	*Hemigaleus australiensis*	37018020
CHON	Wobbegong	*Orectolobus spp.*	37013900
COMM	Yellowfin tuna	*Thunnus albacares*	37441002
PERM	Yellowtail scad	*Trachurus novaezelandiae*	37337003
CHON	Whaler and weasel sharks	Carcharhinidae & Hemigaleidae	37018000
CHON	Zebra shark	*Stegostoma fasciatum*	37013006

Notes: Trevally (Carangidae species) and Flathead (*Platycephalus* spp.) were present in the fishery but were omitted from sampling.

CAAB = Codes for Australian Aquatic Biota (maintained by CSIRO Marine and Atmospheric Research).

Appendix 4 Summary of species collected in laboratory-sorted bycatch samples

	Otter trawl NRA		Otter trawl STEA		Danish Seine NRA		Danish Seine STEA	
Species	**Number**	**Wt (g)**	**Number**	**Wt (g)**	**Number**	**Wt (g)**	**Number**	**Wt (g)**
Alepes apercna	17	1 879						
**Amusium balloti*	12	132	2	237	6	189		
Anoplocapros inermis	1	335	21	7 002			2	933
Antennarius striatus			4	54			1	13
Apogon fasciatus	2	10	10	84	2	10		
Apogon nigripinnis			7	89				
Apogon semilineatus	3	24						
Apogon truncatus	1	26						
**Aptychotrema rostrata*			5	658				
Arnoglossus waitei			1	10				
**Atractoscion aequidens*			4	349				
Atule mate	1	114						
Calappa philargius	1	55						
Calliurichthys ogilbyi	7	147			3	53		
Calliurichthys sp. A	4	134						
Carangoides chrysophrys	1	39						
Carangoides gymnostethus	3	253						
Centriscus scutatus	1	20						
Centropogon australis			12	200				
Chaetodon guentheri					1	25		
Charybdis feriata	5	872	3	316	1	323	1	8
Charybdis orientalis			1	15				
Cheilodactylus vestitus	1	65	2	63				
Chelidonichthys kumu	7	847	82	5 329	1	93		
**Choerodon cephalotes*			1	48				
Conger & short-tail conger eels			3	66				
Crossorhombus azureus			4	36				
Cynoglossus bilineatus	6	322						
Dactyloptena orientalis			2	25				
Dactyloptena papilio	10	331	2	22	9	265	2	20
Decapterus macrosoma			48	905				
Diagramma labiosum	1	36	1	26				
Dicotylichthys punctulatus			1	351				
Echeneis naucrates	1	90						
Engraulis australis			197	1 918				
Engyprosopon grandisquama	41	619	23	225	41	532	7	61
Engyprosopon maldivensis	2	84						
Engyprosopon sp. A	2	60	1	15				
Erosa erosa	1	20						
Etrumeus teres	14	433	271	2 987	8	436		
Fistularia petimba			3	43				
Foetorepus calauropomus			10	393				
Gerres filamentosus	4	235	14	531				
Gerres subfasciatus	20	909	164	7 199				
**Glaucosoma scapulare*	20	321			1	54		
Gonorynchus greyi			3	209				
Grammatobothus pennatus	2	64	1	31				

	Otter trawl NRA		Otter trawl STEA		Danish Seine NRA		Danish Seine STEA	
Species	**Number**	**Wt (g)**	**Number**	**Wt (g)**	**Number**	**Wt (g)**	**Number**	**Wt (g)**
Herklotsichthys lippa	6	230						
Holothuroid sp. A			140	1 205				
**Ibacus chacei*			1	53				
Ichthyscopus nigripinnis	1	73	1	120				
Inegocia japonica	15	725	7	350	3	91	6	115
Iniistius jacksonensis			2	112				
Lagocephalus cheesemanii	1	68	4	236				
Lagocephalus sceleratus			3	70	2	124		
Leiognathus bindus	83	708			15	146		
Leiognathus elongatus					2	13		
Leiognathus moretoniensis	5	90	27	69				
Lepidotrigla argus	1 520	45 634	2 570	46 730	740	17 867	591	11 176
Lepidotrigla calodactyla	32	2 069	1	41	9	381		
Lepidotrigla papilio	2	70						
Lepidotrigla umbrosa	1	22						
Lethrinus genivittatus	1	101			1	84		
Mantis shrimps			3	58				
Maxillicosta whitleyi			13	79			8	47
**Melicertus plebejus*	9	240	14	334	1	23		
Mene maculata	1	34						
Metapenaeopsis palmensis			1	10			1	5
**Metapenaeus macleayi*			165	3 316				
**Nemipterus theodorei*	1 105	45 702	3	84	405	16 391		
**Octopus australis*	4	305	2	140			2	107
Orbonymus rameus	2	43						
Papilloculiceps nematophthalmus			5	826	1	27		
Parachaetodon ocellatus	1	69						
Paramonacanthus filicauda	18	753	63	728	15	513		
Paramonacanthus otisensis	43	829	36	501	1	128		
Parapercis nebulosa	46	2 966	33	2 738	6	275	2	107
Paraplagusia bilineata	27	1 539	9	288	1	31		
Parastromateus niger	8	1 090						
Pardachirus hedleyi	1	33						
Pegasus volitans			2	15				
Pelates quadrilineatus	2	90	2	43				
Pelates sexlineatus	14	771	65	1 418	2	76	1	35
**Penaeus esculentus*	1	27	1	25			2	66
Pentapodus paradiseus	1	163						
Pentaprion longimanus			1	22				
Platycephalus arenarius	29	4 371	2	300	6	651		
Platycephalus caeruleopunctatus			94	12 484			1	229
Platycephalus endrachtensis	*2*	*808*						
Platycephalus longispinis	75	2 364	679	14 399	247	7 619	350	9 382
Plotosus lineatus	1	6	28	813				
Polydactylus multiradiatus	1	43						
**Pomatomus saltatrix*	2	338			1	82	4	400
Portunus Monomia rubromarginatus	7	151	45	1 363	2	54	4	103
**Portunus pelagicus*	1	60	22	3 960	1	162	2	378
**Portunus sanguinolentus*	54	5 273	43	5 454	5	666	1	70
Priacanthus macracanthus	577	31 951	47	1 156	72	4 777	32	2 132

	Otter trawl NRA		Otter trawl STEA		Danish Seine NRA		Danish Seine STEA	
Species	**Number**	**Wt (g)**	**Number**	**Wt (g)**	**Number**	**Wt (g)**	**Number**	**Wt (g)**
Pristotis obtusirostris	13	427						
Pseudocaranx dentex	3	793						
Pseudorhombus argus	1	25	21	1 164			2	99
Pseudorhombus arsius	1	115	16	2 721				
Pseudorhombus diplospilus					1	20		
Pseudorhombus dupliciocellatus	23	3 211	5	425			3	101
Pseudorhombus jenynsii	2	157	59	3 463			7	437
Pseudorhombus spinosus	1	121						
Rastrelliger kanagurta	5	622						
Reicheltia halsteadi			73	1 258				
Remora remora			1	1 038				
Repomucenus calcaratus	183	6 130	1 520	27 114	94	3 080	558	7 767
Repomucenus limiceps	10	358	3	37				
**Rhabdosargus sarba*	1	90						
**Sarda australis*	5	414	3	210				
Sardinops neopilchardus	11	120	57	2 805			37	1 182
Saurida undosquamis	1 094	89 154	175	14 628	220	17 760	28	970
Scomber australasicus	12	1 704					1	147
**Sepia elliptica*			1	6				
**Sepia plangon*	56	2 769	17	433				
**Sepia whitleyana*	25	2 892	1	43	1	75		
Sepioloidea lineolata			2	22				
Siganus nebulosus	1	70						
Siganus spinus	2	222						
Sillago flindersi			4	164			2	82
**Sillago maculata*			1	40				
Soleichthys microcephalus	1	73	2	60				
Sphenopus marsupialis	14	526	25	1 859	80	2 592	7	386
Sphyraena acutipinnis	1	156	753	19 992				
Stellaster equestris	7	296			28	1 463		
Synclidopus macleayana			1	40				
Tetrosomus reipublicae	3	181	4	344	1	52		
**Thenus orientalis*	1	43						
Torquigener altipinnis	441	4 150	848	18 232	4	65	77	2 010
Torquigener perlevis	7	659			2	221		
Trachinocephalus myops	24	1 190	150	9 380	5	122	7	245
Trachurus declivis			22	1 091				
**Trachurus novaezelandiae*	451	25 879	77	3 129	20	894	147	7 731
Trachypenaeus curvirostris			1	6				
Trichiurus lepturus	1	115						
Tripodichthys angustifrons	7	907						
**Trygonoptera testacea*			1	31				
Upeneichthys lineatus							7	391
**Upeneus asymmetricus*	300	12 323	23	944	76	2,418	6	261
**Uroteuthis chinensis complex*	138	2 771	60	963	5	64	157	2 684
**Uroteuthis noctiluca*			3	58				
**Uroteuthis Photololigo etheridgei*			1	313				
**Zeus faber*			1	22				
Grand total	**6 735**	**316 948**	**8 967**	**241 011**	**2 148**	**80 987**	**2 066**	**49 880**

*Intended for at-sea observation and thus overlooked in the sample collection process.

Abbreviations

CAAB	Codes for Australian Aquatic Biota (maintained by CSIRO Marine and Atmospheric Research)
CPUE	Catch per unit effort
ECIFFF	East Coast Inshore Fin Fish Fishery
ECOTF	East Coast Otter Trawl Fishery
EPBCA	*Environment Protection and Biodiversity Conservation Act 1999*
FOP	Fisheries Observer Program
FTF	Fin Fish (Stout Whiting) Trawl Fishery
ITQ	Individual transferable quota
L1	Licence held by line fishers operating off southern Queensland
LTMP	Long Term Monitoring Program, Fisheries Queensland
NRA	Northern regulated area
NSW	New South Wales
MOU	Memorandum of understanding
PMS	Performance measurement system
QFTF	Queensland Fin Fish Trawl Fishery
RQ	Reef quota species
RR	Rocky reef species (e.g. snapper, pearl perch and teraglin)
RRFFF	Rocky Reef Fin Fish Fishery
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SOCI	Species of conservation interest
SOFI	Species of fisheries interest
STEA	Southern trial extension area
T1	Licence held by fishers operating in the ECOTF
T4	Licence held by fishers operating in the FTF
TAC	Total allowable catch
TED	Turtle exclusion device
WTO	Wildlife Trade Operation

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