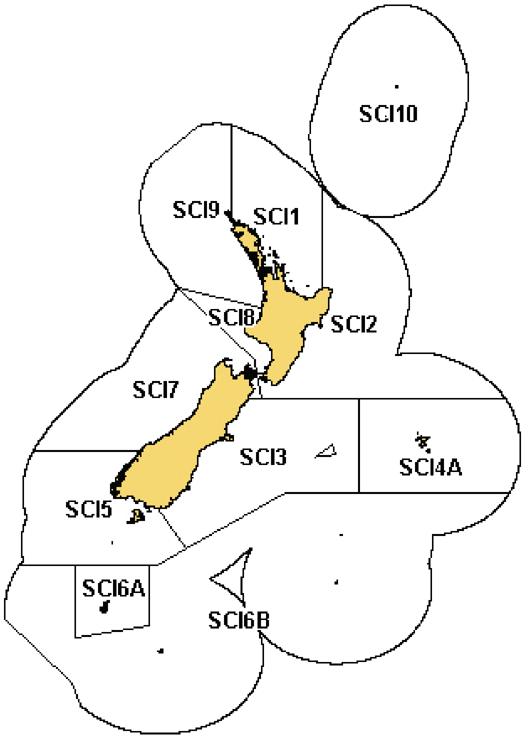
SCAMPI (SCI)

(*Metanephrops challengeri*)



1. FISHERY SUMMARY

1.1 Commercial fisheries

Target trawl fisheries for scampi developed first in the late 1980's. Access was restricted and, until the 1999–00 fishing year, there were restrictions on the vessels that could be used in each stock. Between October 1991 and September 2002, catches were restrained using a mixture of competitive and individually allocated catch limits but, between October 2001 and September 2004, all scampi fisheries were managed using competitive catch limits (Table 1, Figure 2). On 1 October 2004, scampi was introduced to the QMS whereupon management areas on the Chatham Rise (SCIs 3 and 4) and in the SubAntarctic (SCIs 6A and 6B) were substantially modified. TACs and TACCs by stock are shown in Table 2, while Figure 1 shows the historical landings and TACC for the main SCI stocks.

The fishery is conducted mainly by 20–40 m vessels using light bottom trawl gear. All vessels use multiple rigs of two or three nets of very low headline height. The main fisheries are in waters 300–500 m deep in SCI 1 (Bay of Plenty), SCI 2 (Hawke Bay, Wairarapa Coast), SCI 3 (Mernoo Bank) SCI 4A (western Chatham Rise and Chatham Islands) and SCI 6 (Sub-Antarctic) (Table 1). Some fishing has been reported on the Challenger Plateau outside the EEZ.

The TACC has been undercaught in SCI 2 in recent years. This is thought to be largely related to fleet economics. Minimal fishing for scampi has taken place in SCI 5, 6B, 7, 8 and 9.

Table 1: Estimated commercial landings (t) from the 1986–87 to 2007–08 fishing years (based on management areas in force since introduction to the QMS in October 2004) and catch limits (t) by SCI (from CLR and TCEPR, MFish landings and catch effort databases, early years may be incomplete). No limits before 1991–92 fishing year, (†) catch limits allocated individually until the end of 2000–01. *Note that management areas SCI 3, 4A, 6A and 6B changed in October 2004, and the catch limits applied to the old areas are not relevant to the landings, which have been reallocated to the revised areas on a pro-rata basis in relation to the TECPR data, which has previously been found to match landings well.

	SCI 1		SCI 2		SCI 3		SCI 4A		SCI 5	
	Landings	Limit (†) / TACC	Landings	Limit (†) / TACC	Landings	Limit / TACC	Landings	Limit (†) / TACC	Landings	Limit / TACC
1986–87	5	–	0	–	0	–	0	–	–	–
1987–88	15	–	5	–	0	–	0	–	0	–
1988–89	60	–	17	–	0	–	0	–	0	–
1989–90	104	–	138	–	0	–	0	–	0	–
1990–91	179	–	295	–	0	–	32	–	0	–
1991–92	132	120	221	246	153	–	78	–	0	60
1992–93	114	120	210	246	296	–	11	–	2	60
1993–94	115	120	244	246	324	–	0	–	1	60
1994–95	114	120	226	246	292	–	0	–	0	60
1995–96	117	120	230	246	306	–	0	–	0	60
1996–97	117	120	213	246	304	–	0	–	2	60
1997–98	107	120	224	246	296	–	0	–	0	60
1998–99	110	120	233	246	292	–	28	–	30	60
1999–00	124	120	193	246	322	–	23	–	9	40
2000–01	120	120	146	246	333	–	0	–	7	40
2001–02	124	120	247	246	304	–	30	–	< 1	40
2002–03	121	120	134	246	264	–	79	–	7	40
2003–04	120	120	64	246	277	–	41	–	5	40
2004–05	114	120	71	200	335	340	101	120	1	40
2005–06	109	120	77	200	319	340	79	120	< 1	40
2006–07	110	120	80	200	307	340	39	120	< 1	40
2007–08	102	120	61	200	209	340	8	120	< 1	40

	SCI 6A		SCI 6B		SCI 7		SCI 8		SCI 9	
	Landings	Limit (†) / TACC	Landings	Limit / TACC	Landings	Limit / TACC	Landings	Limit / TACC	Landings	Limit / TACC
1986–87	0	–	0	–	0	–	0	–	0	–
1987–88	0	–	0	–	0	–	0	–	0	–
1988–89	0	–	0	–	0	–	0	–	0	–
1989–90	0	–	0	–	0	–	0	–	0	–
1990–91	2	–	0	–	0	–	0	–	0	–
1991–92	325	–	0	–	0	75	0	60	0	60
1992–93	279	–	0	–	2	75	0	60	2	60
1993–94	303	–	0	–	0	75	0	60	1	60
1994–95	239	–	0	–	2	75	0	60	0	60
1995–96	270	–	0	–	1	75	0	60	0	60
1996–97	275	–	0	–	0	75	0	60	0	60
1997–98	279	–	0	–	0	75	0	60	0	60
1998–99	325	–	<1	–	1	75	0	60	<1	60
1999–00	328	–	0	–	1	75	0	5	0	35
2000–01	264	–	0	–	<1	75	0	5	0	35
2001–02	272	–	0	–	<1	75	0	5	0	35
2002–03	255	–	0	–	<1	75	0	5	0	35
2003–04	311	–	0	–	1	75	0	5	0	35
2004–05	295	306	0	50	1	75	0	5	0	35
2005–06	286	306	0	50	1	75	0	5	0	35
2006–07	302	306	0	50	<1	75	0	5	0	35
2007–08	287	306	0	50	1	75	0	5	0	35

Table 2: Total allowable catches (TAC, t) allowances for customary fishing, recreational fishing, and other sources of mortality (t) and Total Allowable Commercial Catches (TACC, t) declared for scampi on introduction to the QMS in October 2004. These figures are still in force.

				Allowances	
Stock	TAC	Customary	Recreational	Other*	TACC
SCI 1	126	0	0	6	120
SCI 2	210	0	0	10	200
SCI 3	357	0	0	17	340
SCI 4A	126	0	0	6	120
SCI 5	42	0	0	2	40
SCI 6A	321	0	0	15	306
SCI 6B	53	0	0	3	50
SCI 7	79	0	0	4	75
SCI 8	5	0	0	0	5
SCI 9	37	0	0	2	35
SCI 10	0	0	0	0	0

* Details of components of other allowances provided in section 1.5.

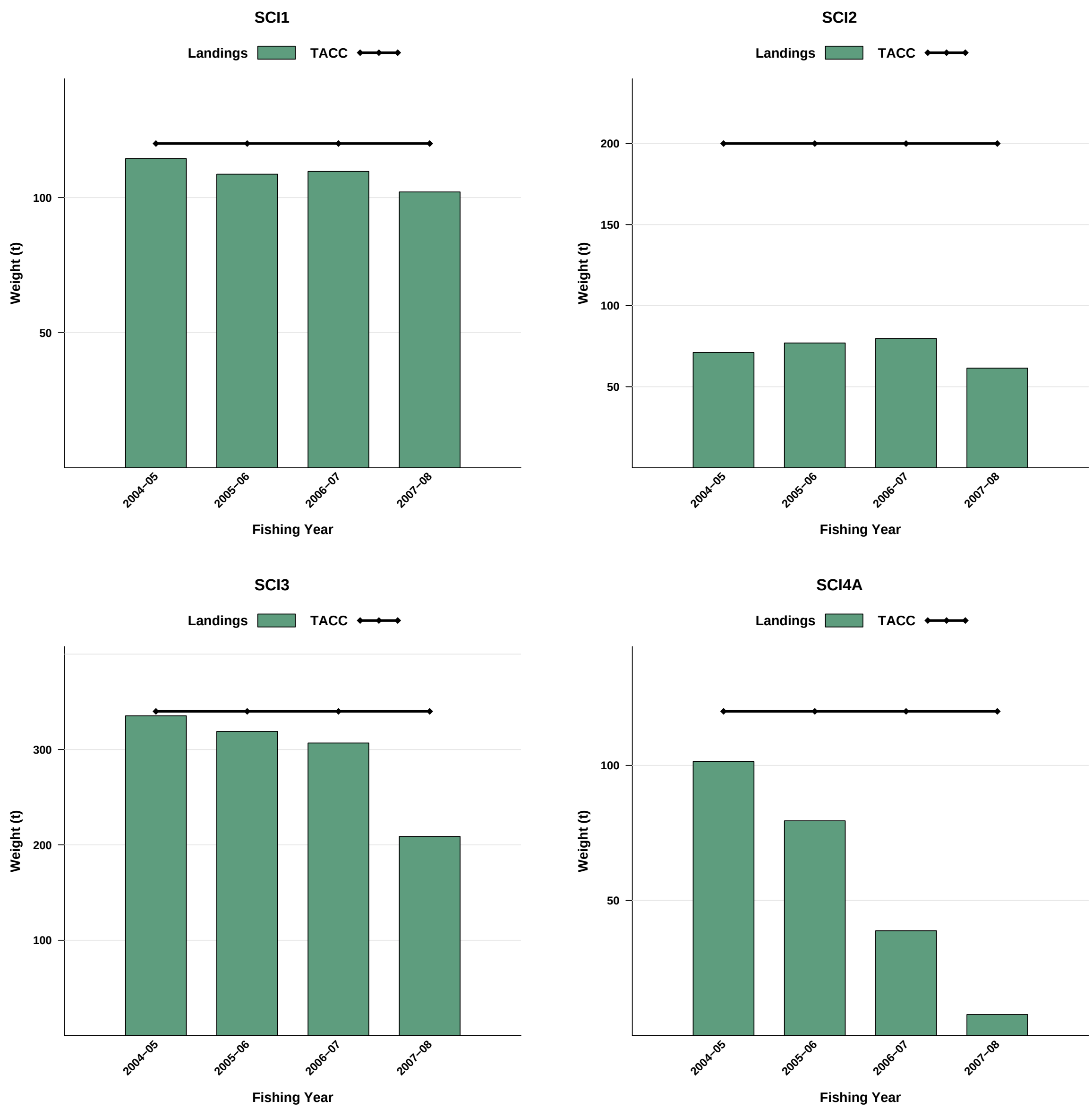


Figure 1: Historical landings and TACC for the five main SCI stocks. From top left: SCI1 (Auckland East), SCI2 (Central East), SCI3 (South East Coast), SCI 4A (Chatham Islands East). [Continued on next page]…

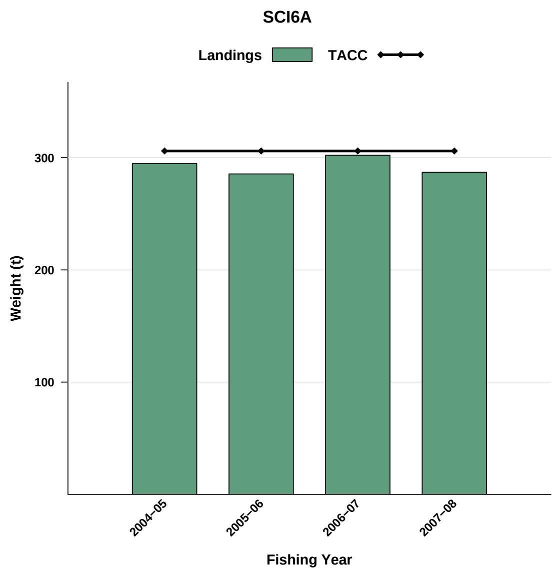


Figure 1 [Continued]: Historical landings and TACC for the five main SCI stocks. SCI6A (Auckland Islands). Note that these figures do not show data prior to entry into the QMS.

1.2 Recreational fisheries
There is no quantitative information on the level of recreational take, but it is probably non-existent.

1.3 Maori customary fisheries
There is no quantitative information on the level of Maori customary take, but it is also probably non-existent.

1.4 Illegal catch
There is no quantitative information on the level of illegal catch.

1.5 Other sources of mortality
Unaccounted sources of mortality in scampi could include incidental effects of trawl gear on the animals and their habitat, and the death of the generally small but occasionally significant (being greater during the moult period when animals are soft) amount of scampi discarded before introduction to the QMS. There is a modest bycatch of scampi in some middle depth trawl fisheries but this has not been quantified for the period prior to the introduction of scampi into the QMS.

2. BIOLOGY

Scampi are widely distributed around the New Zealand coast, principally in depths between 200 and 500 m on the continental slope. Like other species of *Metanephrops* and *Nephrops*, *M. challengeri* builds a burrow in the sediment and may spend a considerable proportion of time within this burrow. From trawl catch rates, it appears that there are daily and seasonal cycles of emergence from burrows onto the sediment surface.

Scampi moult several times per year in early life and probably about once a year after sexual maturity (at least in females). Early work suggested that female *M. challengeri* achieve sexual maturity at about 40 mm orbital carapace length (OCL) in the Bay of Plenty and on the Chatham Rise, about 36 mm OCL off the Wairarapa coast, and about 56 mm OCL around the Auckland Islands. Examination of ovary maturity on more recent trawl surveys suggest that 50% of females were mature at 30 mm OCL in SCI 1 and 2, and at about 38 mm in SCI 6A. The peak of moulting and spawning activity seems to occur in spring or early summer. Larval development of *M. challengeri* is probably very short, and may be less than 3 days in the wild. The abbreviated larval phase may, in part, explain the low fecundity of *M. challengeri* compared with *N. norvegicus* (that of the former being about 10–20% that of the latter).

Relatively little is known of the growth rate of any of the *Metanephrops* species in the wild. Tagging of *M. challengeri* to determine growth rates was undertaken in the Bay of Plenty in 1995, and the bulk of recaptures were made late in 1996. About 1% of tagged animals were recaptured, similar to the average return rate of similar tagging studies for scampi and prawns overseas. Many more females than males were recaptured, and small males were almost entirely absent from the recapture sample. Scampi captured and tagged at night were much more likely to be recaptured than those exposed to sunlight. Estimates from this work of growth rate and mortality for females are given in Table 3. The data for males were insufficient for analysis, although the average annual increment with size appeared to be greater than in females.

A tagging project is currently underway in SCI 6A, with three release events (March 2007, 2008 and 2009). By February 2009, 5.8% of the 2007 releases had been recaptured, and 3% of the 2008 releases. Most recaptures occur within a year of release.

Table 3: Estimates of biological parameters.

Population		Estimate	Source
1. Weight = a(orbital carapace length)^b (weight in g, OCL in mm)			
	a	b	
All males: SCI 1	0.000373	3.145	Cryer & Stotter (1997)
Ovigerous females: SCI 1	0.003821	2.533	Cryer & Stotter (1997)
Other females: SCI 1	0.000443	3.092	Cryer & Stotter (1997)
All females: SCI 1	0.000461	3.083	Cryer & Stotter (1997)
2. von Bertalanffy growth parameters			
	K (yr^{-1})	L_∞ (OCL, mm)	
Females: SCI 1 (tag)	0.11–0.14	48.0–49.0	Cryer & Stotter (1999)
Females: SCI 2 (aquarium)	0.31	48.8	Cryer & Oliver (2001)
Males: SCI 2 (aquarium)	0.32	51.2	Cryer & Oliver (2001)
3. Natural mortality (*M*)			
Females: SCI 1		0.20–0.25	Cryer & Stotter (1999)

Scampi from SCI2 were successfully reared in aquariums for over 12 months in 1999–2000. Results from these growth trials suggested a von Bertalanffy K of about 0.3 for both sexes, compared with <0.15 for the tagging trial. Extrapolating the length-based results to age-based curves suggests that scampi are about 3–4 years old at 30 mm carapace length and may live for 15 years. There are many uncertainties with captive reared animals, however, and these estimates should not be regarded as definitive. In particular, the rearing temperature was 12º C compared with about 10º C in the wild (in SCIs 1 and 2), and the effects of captivity are largely unknown.

The maximum age of New Zealand scampi is not known, although analysis of tag return data and aquarium trials suggest that this species may be quite long lived. *Metanephrops* spp in Australian waters may grow rather slowly and take up to 6 years to recruit to the commercial fishery (Rainer, 1992), consistent with estimates of growth in *M. challengeri* (Table 3). *N. norvegicus* populations in some northern European populations achieve a maximum age of 15–20 years (Bell et al., 2006), consistent with the estimates of natural mortality, M, for *M. challengeri*.

3. STOCKS AND AREAS

Stock structure of scampi in New Zealand waters is not well known. Preliminary electrophoretic analyses suggest that scampi in SCI 6A are genetically distinct from those in other areas, and there is substantial heterogeneity in samples from SCIs 1, 2, and 4A. The abbreviated larval phase of this species may lead to low rates of gene mixing. Differences among some SCIs in average size, size at maturity, the timing of diel and seasonal cycles of catchability, catch to bycatch ratios, and CPUE trends also suggest that treatment as separate management units is appropriate.

A review of stock boundaries between SCI 3 and SCI 4A and between SCI 6A and SCI 6B was conducted in 2000, prior to introduction of scampi into the Quota Management System. Following the recommendation of this review, the boundaries were changed on 1st October 2004, to reflect the distribution of scampi stocks and fisheries more appropriately.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

4.1 Sea-bed disturbance

Examination of the invertebrate bycatch of research trawls in SCI 1 (Bay of Plenty) in relation to the distribution of previous trawling effort for scampi and finfish (Cryer et al. 1999) led Cryer et al. (2002, 2005) to conclude that bottom trawling for scampi has impacts on benthic community structure that are similar to those frequently observed in coastal fisheries. Both species richness (observed number of species) and the Shannon-Weaver diversity index were negatively correlated with an index of historical scampi fishing effort. Many species of benthic invertebrates were substantially less common in heavily trawled areas, although some species, including scampi, were more common in heavily trawled areas.

4.2 Incidental catch (fish and invertebrates)

Scampi trawlers take a substantial bycatch of QMS and non-QMS fish species (Cryer et al. 1999, Hartill et al. 2004), the amount and composition of which varies both within and between QMAs (Cryer 2000). Most of the non-QMS by-catch is discarded on the grounds (Ballara and Anderson, 2008).

4.3 Incidental catch (seabirds and mammals)

Baird (2001, 2004a,b,c, 2005a) summarised observed seabird captures in scampi target tows for the fishing years 1998–99 to 2002–03. Observed captures ranged from 6 to 17 per year. Total seabird captures were not estimated for any scampi fishery because less than 10% of fishing effort was observed and the ratio estimators are unreliable when observer coverage is low or unrepresentative (Bradford, 2002). MacKenzie & Fletcher (2006) produced model based estimates of the nationwide seabird by-catch by scampi trawlers for the fishing years 1997–98 to 2003–04. Estimates of total annual captures ranged from 13 to 93 seabirds, but the confidence intervals around these estimates are large and caution should be exercised when interpreting the estimates. Capture estimates include only those seabirds landed (alive, injured or dead) on fishing vessels. Seabird "warp strike", where seabirds are struck by trawl warps as they forage on offal or discarded fish near the vessel, has not been quantified in scampi fisheries but is a generic problem in fisheries where offal is discarded whilst trawling. Birds killed or injured as a result of such interactions may not be recovered aboard the vessel, in which case they will not be included in capture estimates.

Scampi trawlers occasionally catch marine mammals, including fur seals (e.g., two observed landed dead in 2002–03, Baird 2005c) and sea lions (e.g., four observed captures, two of which were released alive, in 2000–01, Baird & Doonan 2005, but none in 2001–02 or 2002–03, Baird 2005b,c). Total annual estimates are unavailable.

4.4 Community and trophic structure

The effects of fishing for scampi on the community and trophic structure are unknown.

4.5 Spawning disruption

The effects of fishing for scampi on spawning are unknown.

4.6 Habitats of special significance

Habitats of special significance have not been defined for this fishery.

4.7 Biodiversity

The effect of fishing for scampi on the maintenance and healthy functioning of the natural marine habitat and ecosystems is unknown.

5. STOCK ASSESSMENT

5.1 Estimates of fishery parameters and abundance

Attempts have been made to index scampi abundance using CPUE and trawl survey indices and, more recently, photographic surveys of scampi burrows. It is not known whether CPUE or abundance estimates from trawl surveys or photography are reliable indices of scampi abundance.

Standardised CPUE indices were first calculated for SCI 1 and used as abundance indices for the assessments in 1992, 1993 and 1995. Similar standardised indices for SCIs 2, 3, 4 and 6A were estimated in 1997, 1998 and 1999. These indices for all areas were highly correlated with the unstandardised index (total catch divided by total effort). In 1998 the Shellfish Fishery Assessment Working Group decided that the standardised CPUE analyses were not providing reliable indices of abundance for scampi.

Annual unstandardised CPUE indices (total catch divided by total effort (hours of trawling)) have been calculated for each area using the data from all vessels that fished (Figure 2). Concerns over potential variability in catchability between years mean that these are not considered reliable indices of abundance by the Shellfish Fishery Assessment Working Group, but are provided for comparison with the photographic survey index. The indices for areas SCI 3, 4A 6A and 6B have been recalculated over the time series in light of the alterations of some stock boundaries, following the review described above. In SCI 1, CPUE increased in the early 1990s, and then declined between 1995–96 and 2001–02, increased to 2002-03, but has decreased to the 2001-02 level in the most recent years. In SCI 2, CPUE declined steadily between 1994–95 and 2001–02 and has remained relatively stable since then. In SCI 3, CPUE rose steadily through the early 1990s, fluctuated around a slowly declining trend in the late 1990s and early 2000s, but has shown a steeper decline in the most recent years. The 2007-08 CPUE level is comparable to the other northern stocks. In SCI 4A, CPUE observations were intermittent between 1991–92 and 2003-03 and showed a dramatic increase, but have shown a very rapid decline since then. In SCI 6A, after an initial decline in the early 1990s, CPUE has been relatively stable with the values over the last 5 years slightly higher than those observed in 2001-02 and 2002-03. With the revision of the stock boundaries, data are only available for one year for SCI 6B, and are therefore not presented. For both SCI 5 and SCI 7, observations have been intermittent, and consistently low.

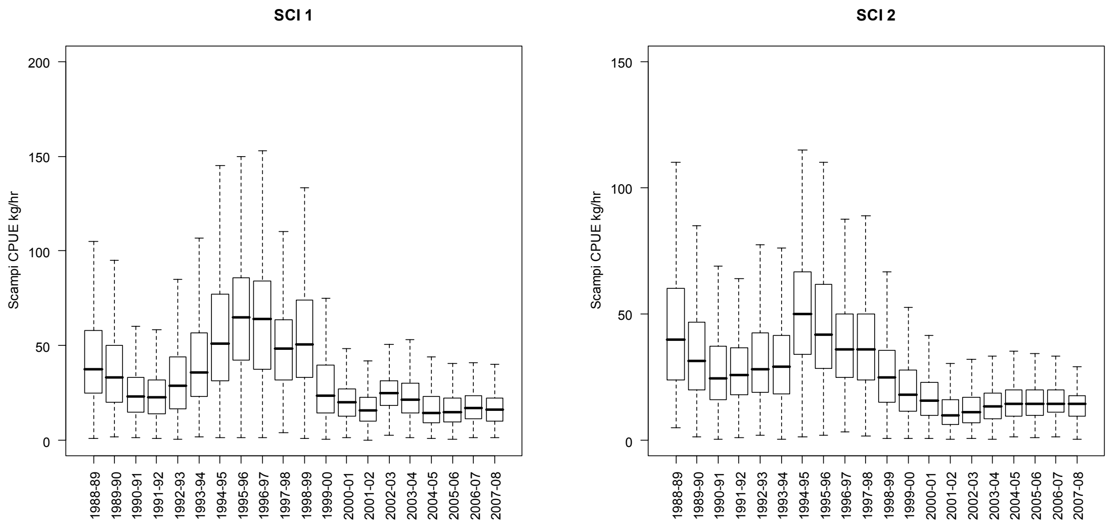


Figure 2: Box plots (with outliers removed) of individual observations of unstandardised catch rate for scampi (tow catch (kg) divided by tow effort (hours)) with tows of zero scampi catch excluded, by fishing year for main stocks. Note different scales between plots. Horizontal bars within boxes represent distribution median. Upper and lower limits of boxes represent upper and lower quartiles. Whisker extends to largest (or smallest) observation which is less than or equal (greater than or equal) to the upper quartile plus 1.5 times the interquartile range (lower quartile less 1.5 times the interquartile range). Outliers (removed from this plot) are values outside the whiskers. **[Continued on next page]…**

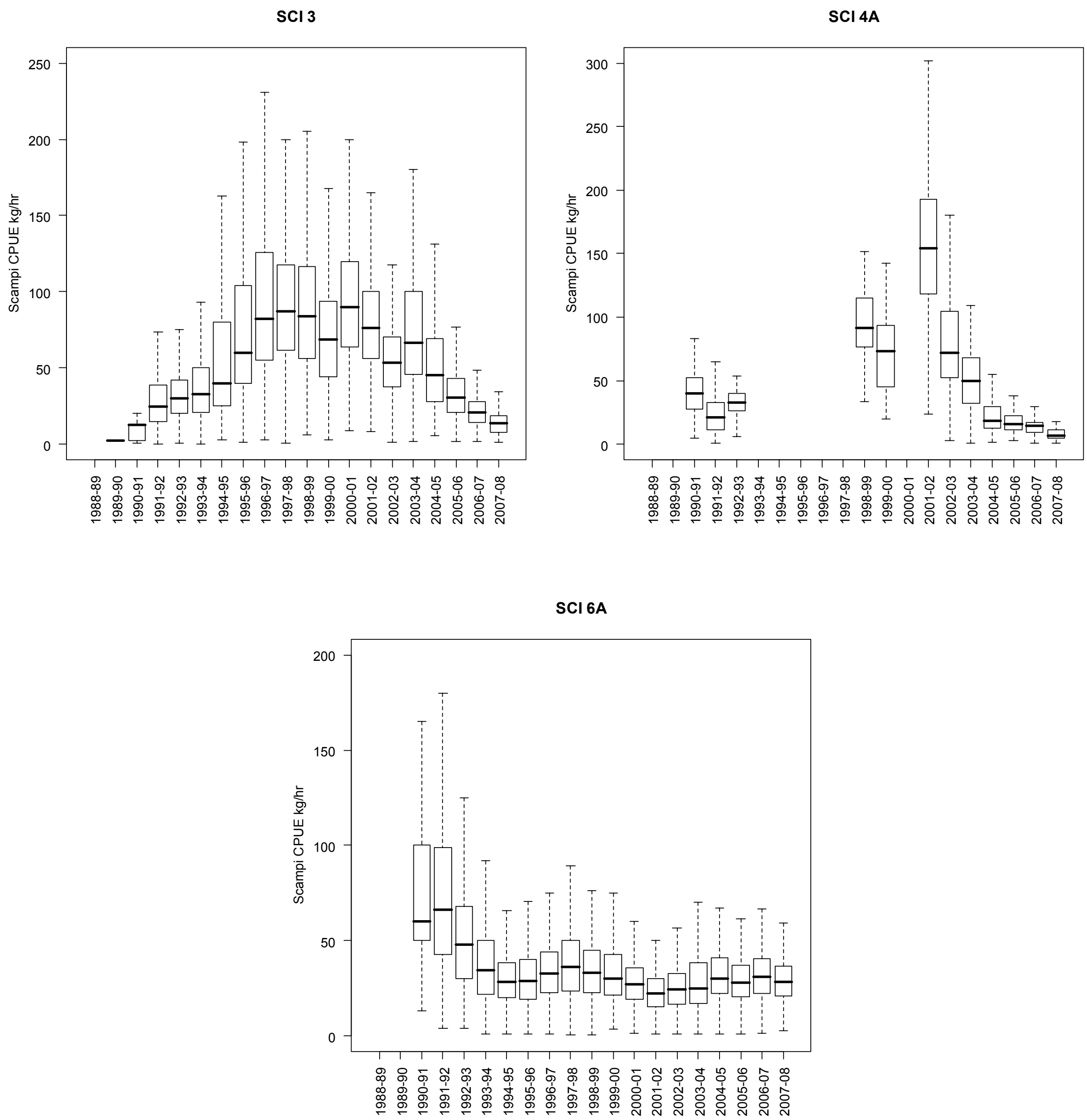


Figure 2 [Continued]: Box plots (with outliers removed) of individual observations of unstandardised catch rate for scampi (tow catch (kg) divided by tow effort (hours)) with tows of zero scampi catch excluded, by fishing year for main stocks. Note different scales between plots. Horizontal bars within boxes represent distribution median. Upper and lower limits of boxes represent upper and lower quartiles. Whisker extends to largest (or smallest) observation which is less than or equal (greater than or equal) to the upper quartile plus 1.5 times the interquartile range (lower quartile less 1.5 times the interquartile range). Outliers (removed from this plot) are values outside the whiskers.

A time series of trawl surveys designed to measure relative biomass of scampi in SCIs 1 and 2 ran between January 1993 and January 1995. Estimates of minimum biomass are shown in Table 4, worked up over the standard photographic survey strata surveyed in more recent years.

Research trawling for other purposes has been conducted in both SCI 1 and SCI 2 in several other years, and catch rates from appropriate hauls within these studies have been plotted alongside the dedicated trawl survey data in Figure 3 and Figure 4. In SCI 1 the additional trawling was conducted in support of a tagging programme (1995 & 1996), which was conducted by a commercial vessel in the peak area of the fishery, while work to assess trawl selectivity (1996) and in support of photographic surveys (since 1998) may have been more representative of the overall area. In SCI 2 the additional trawling was conducted in support a growth investigation through length frequency data (1999 & 2000) and in support of photographic surveys (since 2003). All the work was carried out by the same research vessel, but while the work in support of photographic surveys was carried out over the whole area, the work related to the growth investigation was concentrated in a small area at the south of the SCI 2 area. Only the additional trawl survey work in support of photographic surveys has been included in Table 4, since the other studies did not have comparable spatial coverage. The trends observed are similar to the trends in commercial CPUE (Figure 2).

Table 4: Trawl survey estimates of minimum biomass (t) for scampi in survey strata within SCIs 1, 2, 3 and 6A. CVs of estimates in parenthesis.

	SCI 1	SCI 2	SCI 3	SCI 6A	Comments
1993	175.8 (0.12)	174.6 (0.12)			Dedicated trawl survey
1994	192.1 (0.17)	141.7 (0.14)			Dedicated trawl survey
1995	243.3 (0.17)	154.4 (0.17)			Dedicated trawl survey
1996					
1997					
1998	123.3 (0.21)				Trawling in support of photo survey
1999					
2000	129.9 (*)				Trawling in support of photo survey
2001	115 (0.27)		230.5 (*)		Trawling in support of photo survey SCI 3 pre season survey
2002	75.7 (0.22)				Trawling in support of photo survey
2003		17.8 (*)			Trawling in support of photo survey
2004		29.7 (0.21)			Trawling in support of photo survey
2005		33.1 (0.34)			Trawling in support of photo survey
2006		26.8 (0.26)			Trawling in support of photo survey
2007				224.8 (*)	Trawling in support of photo survey
2008	132.4 (*)			272.6 (*)	Trawling in support of photo survey

* - where no cv is provided, one stratum had only one valid station. Strata included: SCI 1 – 302,303, 402, 403; SCI 2 – 701, 702, 703, 801, 802, 803; SCI 3 – 902, 903, 904; SCI 6A (main area) – 350m, 400m, 450m, 500m.

Table 5: Photographic survey estimates of abundance (millions) based on major openings and visible scampi in survey strata within SCIs 1, 2, 3 and 6A. Abundance estimate based on visible scampi considered minimum absolute abundance, while estimate based on major openings assumed 100% occupancy. CVs of estimates in parenthesis.

	SCI 1		SCI 2		SCI 3		SCI 6A		Comments
	Major openings	Visible scampi	Major openings	Visible scampi	Major openings	Visible scampi	Major openings	Visible scampi	
1998	155.1 (0.15)	27.9 (0.22)							
1999									
2000	96.7 (0.13)	18.2 (0.18)							
2001	135.9 (0.12)	12.3 (0.26)			267.3 (0.09) 443.8 (0.17)	72.9 (0.16) 77.5 (0.14)			SCI 3, two surveys in 2001, Aug/Sept and Oct
2002	128.2 (0.08)	16.7 (0.21)							
2003	101.9 (0.12)	14.4 (0.21)	161.6 (0.12)	10.0 (0.39)					
2004			210.8 (0.17)	20.6 (0.28)					
2005			152.5 (0.11)	14.6 (0.20)					
2006			134.2 (0.10)	13.3 (0.23)					
2007							153.7 (0.08)	44.5 (0.10)	SCI 6A estimate for main area*
2008	100.8 (0.08)	12.5 (0.13)					37.1 (0.10)	23.9 (0.09)	

* - SCI 6A estimate provided for main area as future surveys may not survey secondary area

Table 6: Photographic survey estimates of biomass (t) based on major openings and visible scampi in survey strata within SCIs 1, 2, 3 and 6A. Biomass estimate based on visible scampi considered minimum absolute biomass, while estimate based on major openings assumed 100% occupancy. CVs of estimates in parenthesis.

	SCI 1		SCI 2		SCI 3		SCI 6A		Mean weight*
	Major openings	Visible scampi	Major openings	Visible scampi	Major openings	Visible scampi	Major openings	Visible scampi	
1998	3996 (0.15)	719 (0.22)							SCI 1 – 25.76g
1999									
2000	2373 (0.13)	447 (0.18)							SCI 1 – 24.54g
2001	3451 (0.12)	312 (0.26)			9490 (0.09) 15 756 (0.17)	2588 (0.16) 2752 (0.14)			SCI 1 – 25.40g SCI 3 – 35.5g
2002	3366 (0.08)	438 (0.21)							SCI 1 – 26.26g
2003	3364 (0.12)	475 (0.21)	4572 (0.12)	283 (0.39)					SCI 1 – 33.01g SCI 2 – 28.29g
2004			4298 (0.17)	420 (0.28)					SCI 2 – 20.28g
2005			4701 (0.11)	450 (0.20)					SCI 2 – 30.83g
2006			3727 (0.10)	369 (0.23)					SCI 2 – 27.77g
2007							4775 (0.08)	1382 (0.09)	SCI 6A – 31.70g
2008	2723 (0.08)	338 (0.13)					1154 (0.10)	743 (0.09)	SCI 1 – 27.0g SCI 6A – 31.70g

* - Mean weight for SCI 1 and SCI 2 for each survey to 2006 estimated from size distribution of burrows, and relationship between burrow and scampi size. Mean weight for SCI 1 in 2008 taken as average of previous SCI 1 surveys. Mean weight for SCI 3 assumed. Mean weight for SCI 6A estimated from length cohort analysis of removals to estimate population size >20 mm CL. The same mean weight has been applied to both the major openings and visible scampi within each survey/year combination.

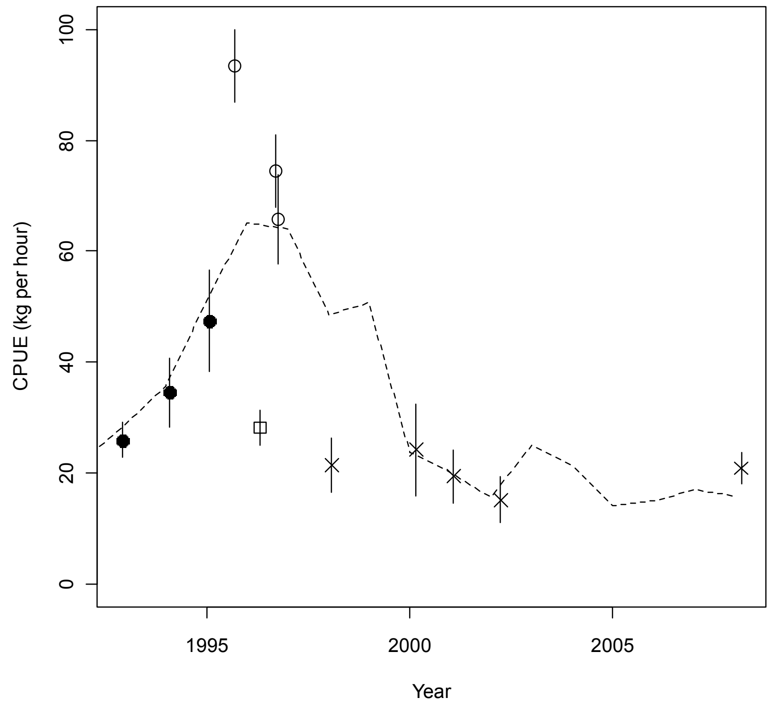


Figure 3: Mean catch rates (± one standard error) of research trawling in the core area of SCI 1. Symbols represent different aims of trawling work (● – trawl survey, ○ – tagging work, □ – trawl selectivity, ×- photo survey. Dotted line represents median of annual unstandardised CPUE for SCI 1 from Figure 2.

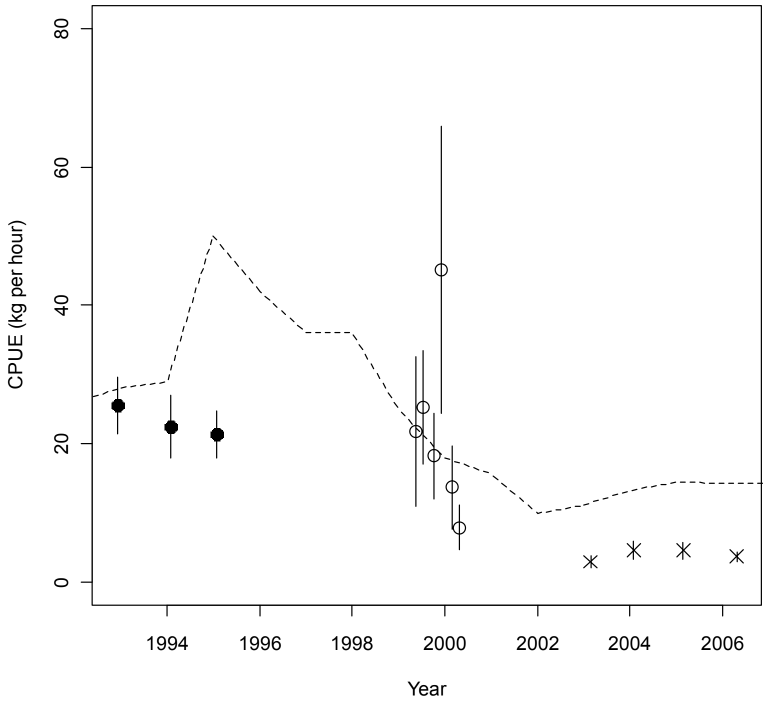


Figure 4: Mean catch rates (± one standard error) of research trawling in the core area of SCI 2. Symbols represent different aims of trawling work (● – trawl survey, ○ – growth investigation, ×- photo survey. Dotted line represents median of annual unstandardised CPUE for SCI 2 from Figure 2.

Photographic surveying (usually by video) has been used extensively to estimate the abundance of the European scampi *Nephrops norvegicus*. In New Zealand, development of photographic techniques, including surveys, has been underway since 1998. To-date, six surveys have been undertaken in SCI 1 (between Cuvier Island and White Island at a depth of 300 to 500 m), two surveys have been undertaken in SCI 3 (northeastern Mernoo Bank only, 200 to 600 m depth), four surveys have been undertaken in SCI 2 (Mahia Peninsula to Castle Point 200 to 500 m depth), and two survey in SCI 6A (to the east of the Auckland Islands, 350–550 m depth). The association between scampi and burrows in SCI 6A appears to be different to other areas examined, and it is uncertain whether the relationship between scampi and burrow abundance is constant between areas, or whether the marked decline in burrow abundance observed between 2007 and 2008 in SCI 6A (Table 5 and Table 6) reflects scampi abundance (particularly when trawl survey catch rates increased (Table 4)).

At this stage in the development of photographic survey techniques, two indices are showing promise: the density of visible scampi (as a minimum estimate of absolute abundance), and the density of major burrow openings (counts of which are now consistent among experienced readers, and repeatable, following development of a between reader standardisation process). Both of these can be used to estimate indices of biomass, using estimates of mean individual weight or the size distribution of animals in the surveyed population. The Bayesian length based model currently under development for scampi uses the estimated abundance of major burrow openings (or a biomass estimated from this) as an abundance index, and future development plans include using the estimated abundance of visible scampi as a minimum estimate of abundance.

Estimates of major burrow opening and visible scampi abundance are provided in Table 5. The two indices estimated from the core area of SCI 1 and SCI 2 are shown in Figure 5 and Figure 6.

Length frequency distributions from trawl surveys and from scientific observers do not show a consistent increase in the proportion of small individuals in any SCI following the development of significant fisheries for scampi. Analyses of information from trawl survey and scientific observers in SCIs 1 and 6A up to about 1996 suggested that the proportion of small animals in the catch declined markedly in both areas, despite the fact that CPUE declined markedly in SCI 6A and increased markedly in SCI 1. Where large differences in the length frequency distribution of scampi measured by observers have been detected (as in SCIs 1 and 6A), detailed analysis has shown that the spatial coverage of observer samples has varied with time, and this may have influenced the nature of the length frequency samples. The length composition of scampi is known to vary with depth and geographical location, and fishers may deliberately target certain size categories.

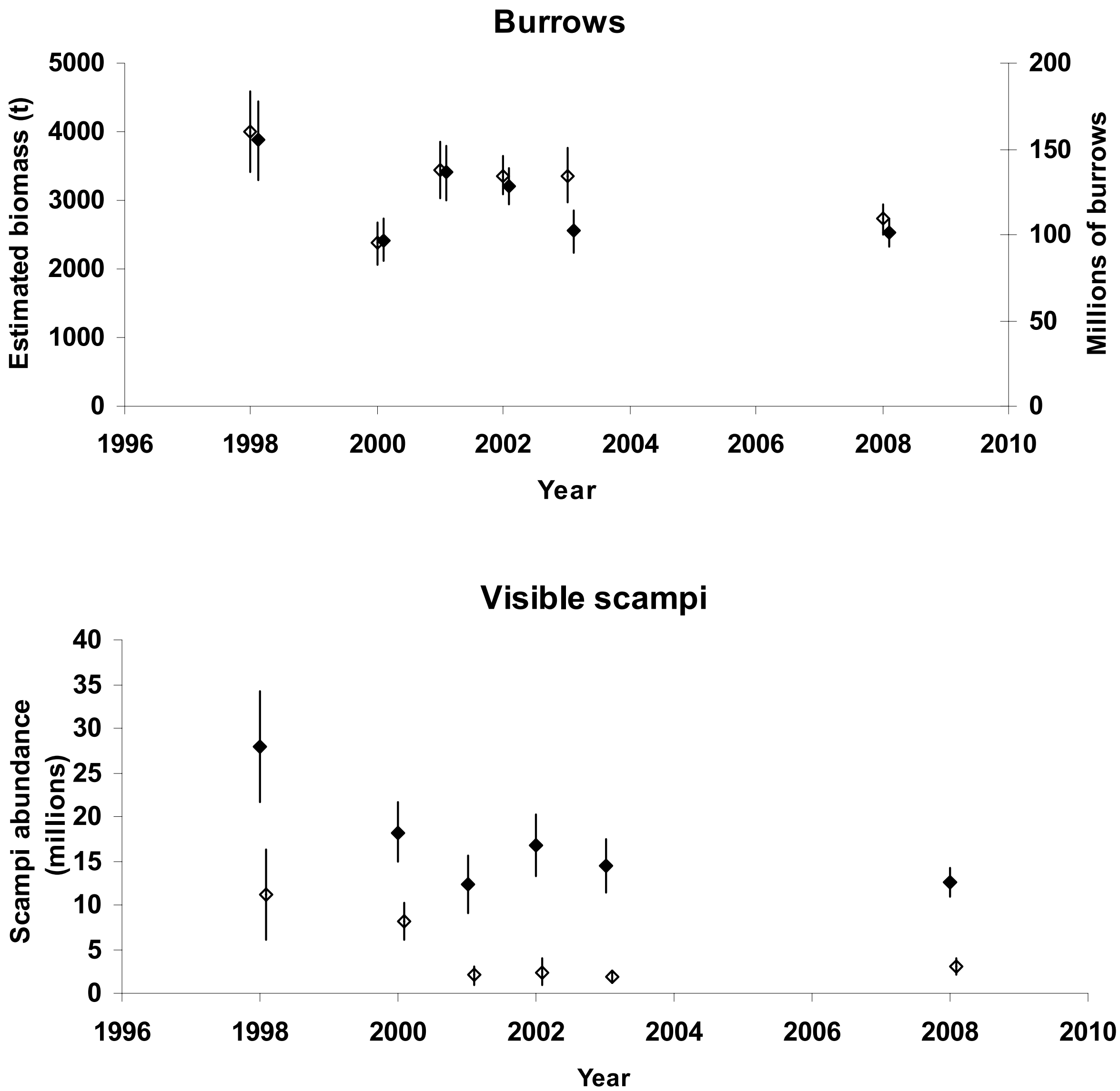


Figure 5: Estimated abundance (± c.v.s) of major burrow openings (upper plot, solid symbols), biomass (upper plot, open symbols, assuming 100% occupancy and a relationship between burrow and occupant size), all visible scampi (lower plot, solid symbols), and scampi entirely free of burrows (lower plot, open symbols) in the core area of the SCI 1 fishery, 1998 to 2008.

Some commercial fishers reported that they experienced historically low catch rates in SCIs 1 and 2 between 2001 and 2004. They further suggest that this reflects a decrease in abundance of scampi in these areas. Other fishers consider that catch rates do not necessarily reflect changes in abundance because they are influenced by management and fishing practices.

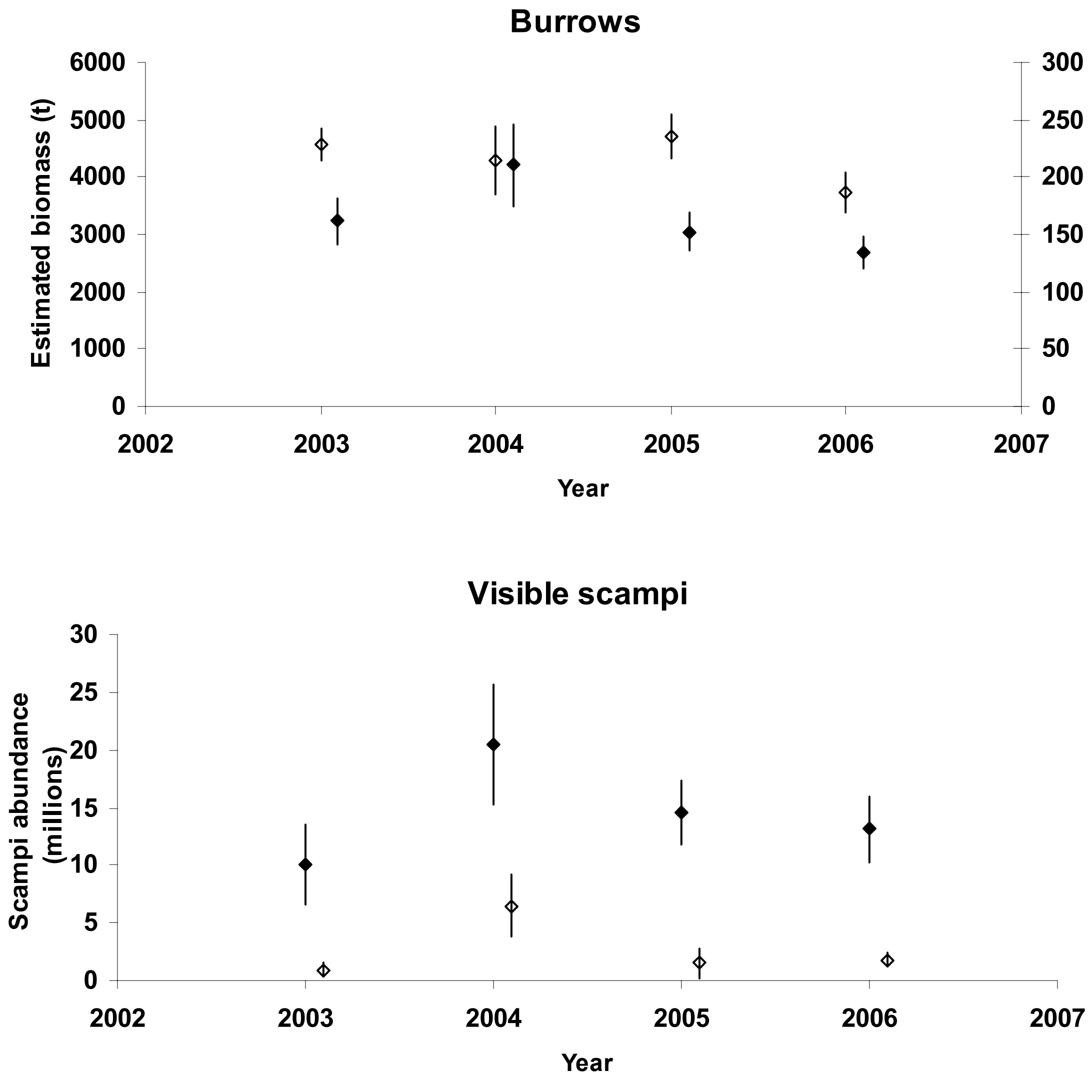


Figure 6: Estimated abundance (± c.v.s) of major burrow openings (upper plot, solid symbols), biomass (upper plot, open symbols, assuming 100% occupancy and a relationship between burrow and occupant size), all visible scampi (lower plot, solid symbols), and scampi entirely free of burrows (lower plot, open symbols) in the core area of the SCI 2 fishery, 2003 to 2006.

5.2 Biomass estimates

There are no agreed stock assessments for any scampi areas, although a Bayesian length-based approach is being developed which may provide useful estimates in future. There are no biomass estimates for any SCI other than estimates made using the area swept method from trawl surveys (Table 4) and using photography in parts of SCIs 1, 2, 3 and 6A (Table 6). Trawl survey estimates can be considered to be minimum estimates of biomass as it is unlikely that there will be any herding effect of sweeps and bridles and vertical availability to trawls can reasonably be expected to be <1 as many scampi will be found in burrows during the day. A preliminary estimate of standing biomass for the area off the Alderman Islands in SCI 1 has been generated from tag return data, although it should be noted that this programme was not designed to estimate biomass and violates many of the assumptions of the Petersen method. The estimated average biomass of scampi per nautical mile of suitable continental slope by this method was 50–130 t, depending on the assumed rate of initial mortality for tagged animals (assumed range 33–75%). This is more consistent with the photographic estimate of biomass than it is with trawl survey estimates. A preliminary estimate of scampi abundance for an area off the Auckland Islands has also been generated from tag return data, although it should again be noted that this programme was not designed to estimate biomass and violates many of the assumptions of the Petersen method. The estimated density of scampi for the Petersen method was similar to that estimated for visible scampi over the whole survey area from the photographic survey, although no account was taken of mortality or tag loss.

Burrow counts from photographic surveys are intended as an index of abundance, as an input into an assessment model. There is potential for the use of survey counts of visible scampi as a minimum abundance estimate (which could be used to estimate minimum biomass), subject to considerations over the mean size of individuals, burrow emergence and survey coverage. Estimates of biomass on the basis of abundance estimates of major openings and visible scampi are provided in Table 6. These estimates are calculated from estimates of abundance and an annually calculated mean weight (estimated from burrow size distributions and a relationship between burrow and scampi size, where possible). There is some uncertainty over the most appropriate mean weight to apply to the abundance estimates.

5.3 Estimation of Maximum Constant Yield (MCY)

Because of the lack of agreed biomass estimates and the constraint of catches, MCY was not determined.

5.4 Estimation of Current Annual Yield (CAY)

Because of the lack of agreed biomass estimates, CAY was not determined.

5.5 Other yield estimates and stock assessment results

There are no other yield estimates.

6. STATUS OF THE STOCKS

There are no stock assessments or yield estimates for any scampi stock. It is not known if recent catches and current catch limits for any scampi stock are sustainable in the long term or will allow the stock to move towards a size which will support the maximum sustainable yield.

Table 7: TACCs (t) and reported landings (t) for the last fishing year 2007-08.

SCI	2007-08 TACC	2007-08 Landings
1	120	102
2	200	61
3	340	209
4A	120	8
5	40	<1
6A	306	287
6B	50	0
7	75	1
8	5	0
9	35	0
Total	1291	668

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