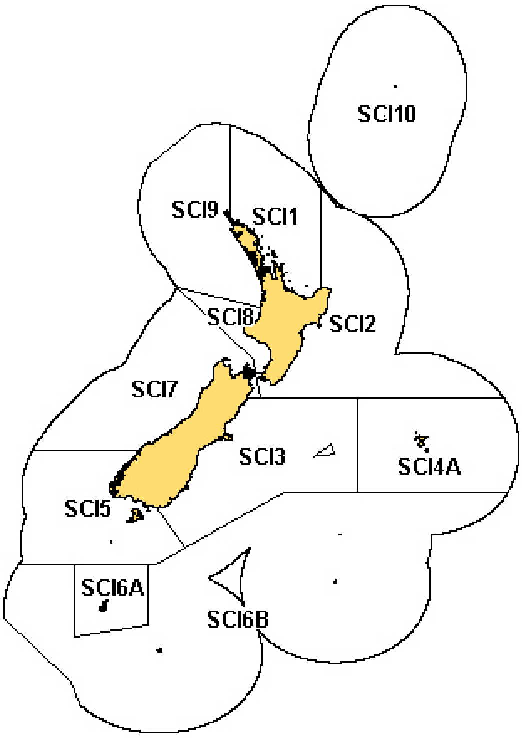
SCAMPI (SCI)

(*Metanephrops challengeri*)



1. FISHERY SUMMARY

(a) 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 1). On 1 October 2004, scampi was introduced to the QMS whereupon management areas on the Chatham Rise (SCI 3 and 4) and in the Sub-Antarctic (SCI 6A and 6B) were substantially modified. TACs and TACCs by stock are shown in Table 2.

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 4 (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.

Table 1: Estimated commercial landings (t) from the 1986–87 to 2005–06 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, 4, 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

	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

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

(b) Recreational fisheries

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

(c) Maori customary fisheries

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

(d) Illegal catch

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

(e) 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. Work on more recent trawl surveys in SCI 1 and 2 suggest that 50% of females were mature at 30 mm OCL in these areas. 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.

Table 3: Estimates of biological parameters.

Population	Estimate			Source
1. Weight = a(orbital carapace length)^b (weight in g, OCL in mm)				
All males: SCI 1	a = 0.000373	b = 3.145		Cryer & Stotter (1997)
Ovigerous females: SCI 1	a = 0.003821	b = 2.533		Cryer & Stotter (1997)
Other females: SCI 1	a = 0.000443	b = 3.092		Cryer & Stotter (1997)
All females: SCI 1	a = 0.000461	b = 3.083		Cryer & Stotter (1997)
2. von Bertalanffy growth parameters				
	K (yr^{-1})	**L_∞ (OCL, mm)**	**t_0 (yr)**	
Females: SCI 1 (tag)	0.11–0.14	48.0–49.0	0.0	Cryer & Stotter (1999)
Females: SCI 2 (aquarium)	0.31	48.8	0.0	Cryer & Oliver (2001)
Males: SCI 2 (aquarium)	0.32	51.2	0.0	Cryer & Oliver (2001)
3. Natural mortality (M)				
Females: SCI 1	M = 0.20–0.25			Cryer & Stotter (1999)

Scampi from SCI 2 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 SCI 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, 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, 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 6 are genetically distinct from those in other areas, and there is substantial heterogeneity in samples from SCI 1, 2, and 4. The abbreviated larval phase of this species may lead to low rates of gene mixing. Differences among some SCI 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 4 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.

Environmental effects of scampi trawl fisheries

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 bycatch is discarded on the grounds.

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 bycatch by scampi trawlers for the fishing years 1997–98 to 2003–04. Median 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).

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. STOCK ASSESSMENT

(a) Estimates of fishery parameters and abundance

Attempts have been made to index scampi abundance using CPUE and trawl survey indices and, most 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 SCI 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 1). 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 declined between 1995–96 and 2001–02, increased in 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 but, in contrast to SCI 1, has remained relatively stable since then, with evidence of a slight increase. In SCI 3, CPUE seems to be fluctuating about a slowly declining trend, after a steady increase between 1993–94 and 2000–01. 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. Note the scale on the y axis of this plot is greater than for the others. In SCI 6A, after an initial decline, CPUE has been relatively flat since 1993–94 with a slightly increasing trend over the last 5 years. 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.

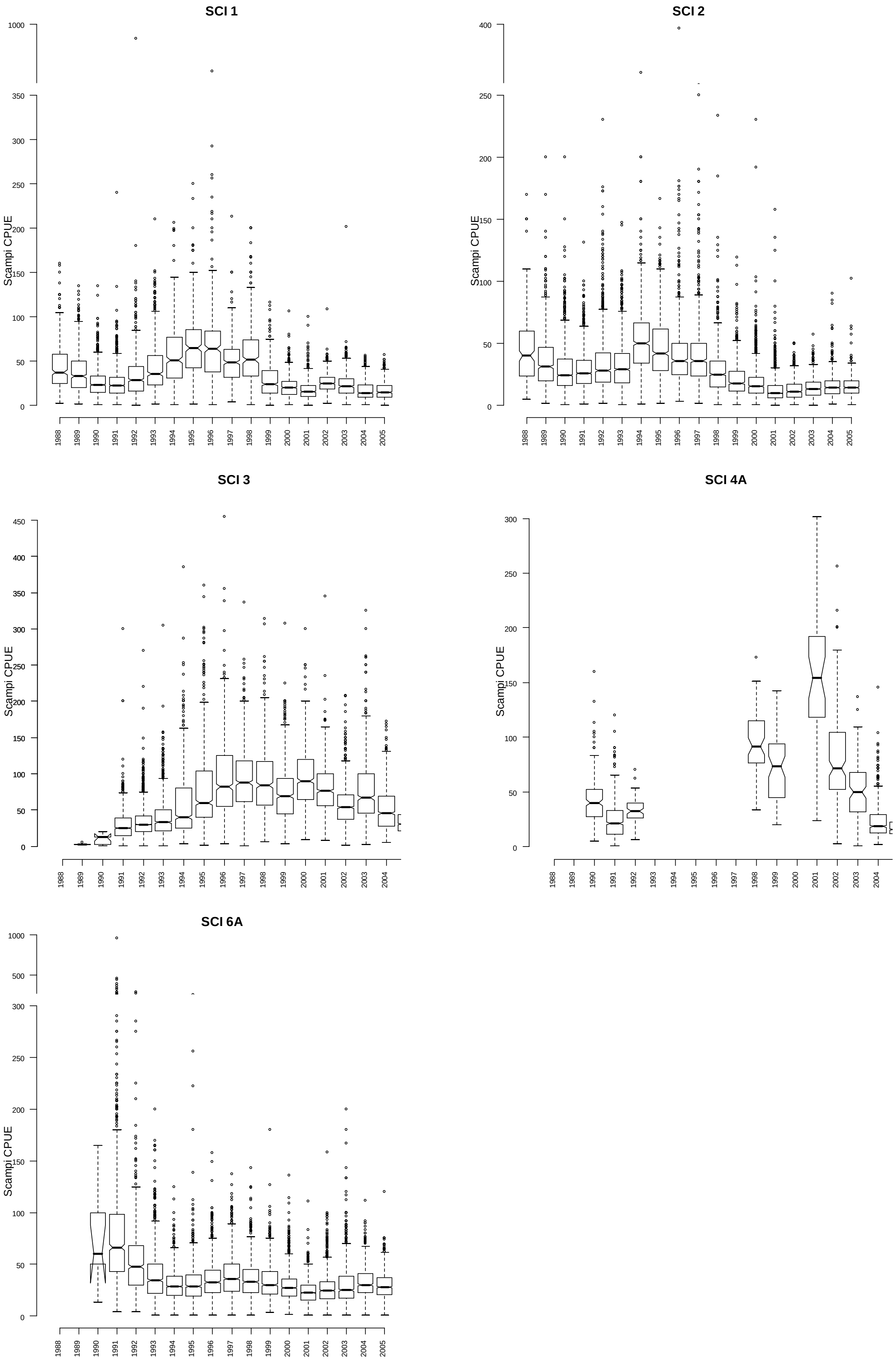


Figure 1: Box plots of unstandardised catch rate for scampi (tow catch (kg) divided by tow effort (hours)) with tows of zero scampi catch excluded, for main stocks. Note different scales between plots, and truncated y axis for SCI 1, 2 and 6A.

A time series of trawl surveys designed to measure relative biomass of scampi in SCI 1 and 2 ran between January 1993 and January 1995. Estimated indices of abundance relative to 1993 are shown in Table 4. The index for SCI 1 covers the area between Great Barrier and White Islands, and that in SCI 2 the area between Mahia and Castle Point. The precision (CV) of indices of relative biomass from trawl surveys was in the range 10 to 16%.

Table 4: Trawl survey estimates of minimum biomass (t) for scampi in survey strata within SCI 1 and 2, and an index relative to January 1993.

	SCI 1 trawl survey		SCI 2 trawl survey	
	Min. biomass	**Rel. index**	**Min. biomass**	**Rel. index**
1993	223	1.00	167	1.00
1994	276	1.24	126	0.72
1995	338	1.52	154	0.88

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 Figures 2 and 3. In SCI 1 the additional trawling was conducted in support of a tagging programme (1995 & 1996), to assess trawl selectivity (1996) and in support of photographic surveys (since 1998). 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 2002). The trends observed are very similar to the trends in commercial CPUE (Figure 1).

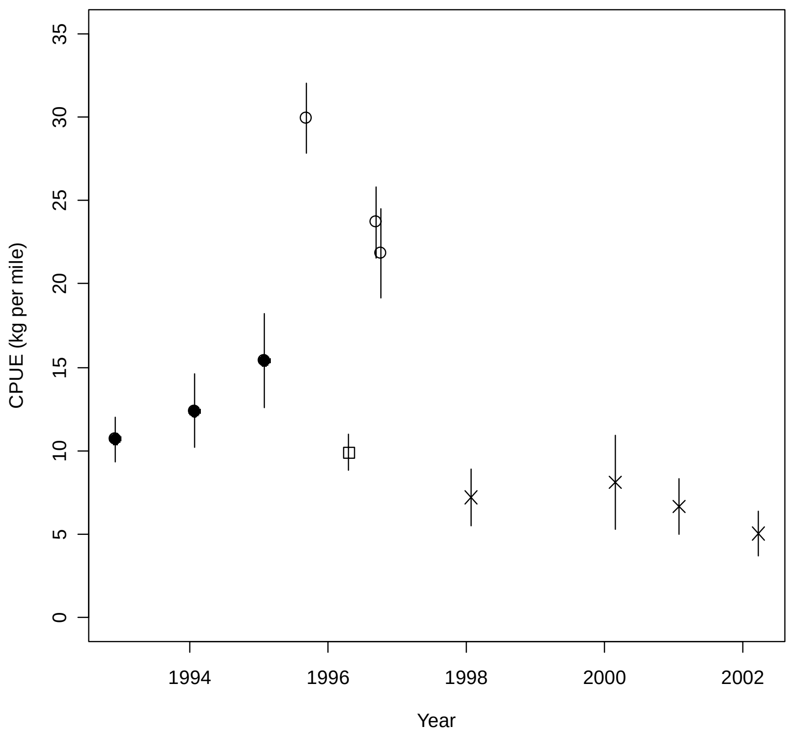


Figure 2: Mean catch rates (± one standard error) of research trawling in the core area of SCI 1. Symbols represent different aims of trawling work (● – trawl survey, ○ – tagging work, □ – trawl selectivity, ×- photo survey.

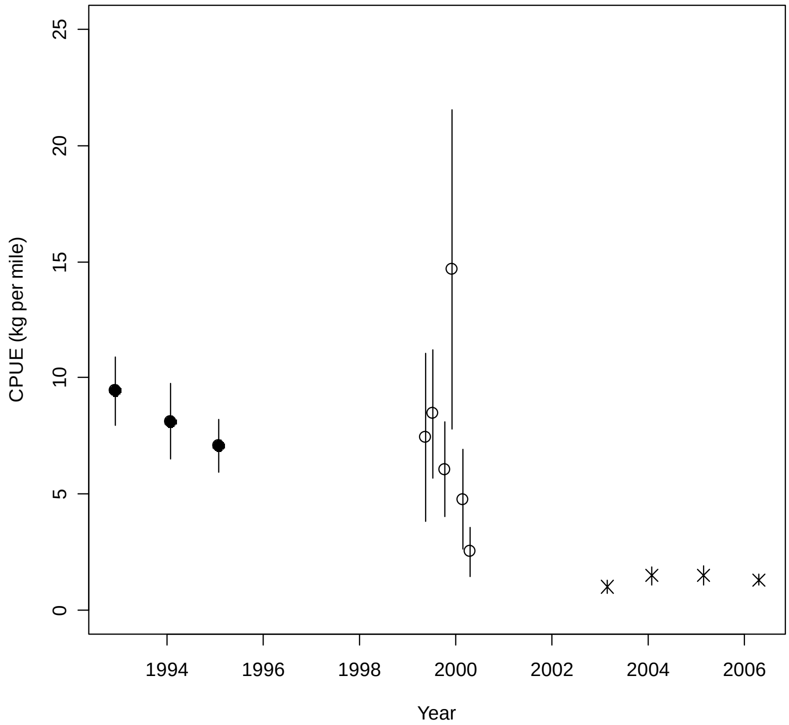


Figure 3: Mean catch rates (± one standard error) of research trawling in the core area of SCI 2. Symbols represent different aims of trawling work (● – trawl survey, ○ – growth investigation, ×- photo survey.

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, five 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), and four surveys have been undertaken in SCI 2 (Mahia Peninsula to Castle Point 200 to 500 m depth). 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). 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.

The two indices estimated from the core area of SCI 1 (in 1998, 2000, 2001, 2002, and 2003) show different trends (Figure 4). The estimated abundance of visible scampi decreased from 28 million in 1998 to about 13 million in 2003 (this trend is similar to that of unstandardised CPUE in SCI 1). Conversely, the estimated abundance of major burrow openings decreased from 155 million in 1998 to about 97 million in 2000, then increased to around 130 million in 2001 and 2002, then decreased again to just over 100 million in 2003. There seems little trend in this index, especially if it is converted to biomass (taking into account the size of observed burrows and the fact that larger burrows tend to be inhabited by larger scampi).

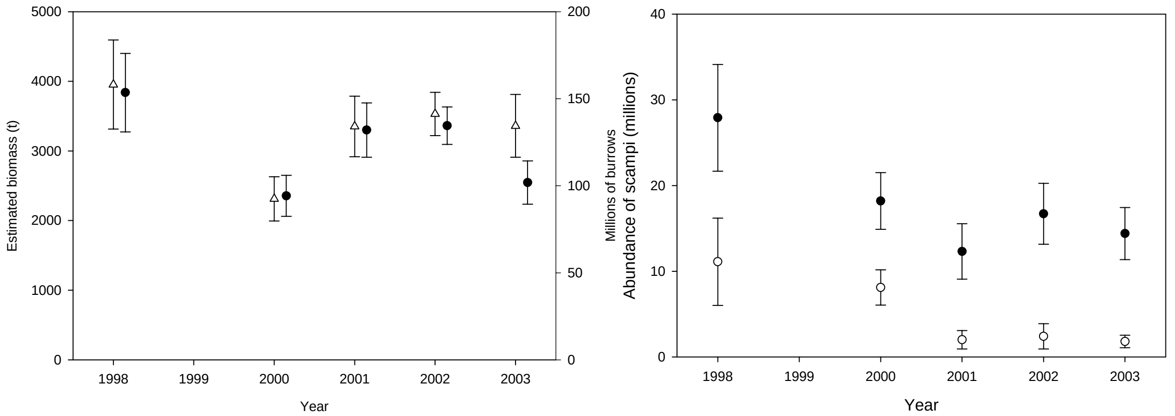


Figure 4: Estimated abundance (± one standard error) of major burrow openings (left, solid symbols), biomass (left, open symbols, assuming 100% occupancy and a relationship between burrow and occupant size), all visible scampi (right, solid symbols), and scampi entirely free of burrows (right, open symbols) in the core area of the SCI 1 fishery, 1998 to 2003.

For SCI 2, the two indices from the photographic survey are more consistent (**Error! Reference source not found.**), although the time series is shorter (four years). Both series suggest that abundance increased between 2003 and 2004, but then decreased to approximately 2003 levels by 2005, and remaining at this level in 2006. Assuming 100% occupancy of major burrow openings, the estimated abundance was 135 million in 2006.

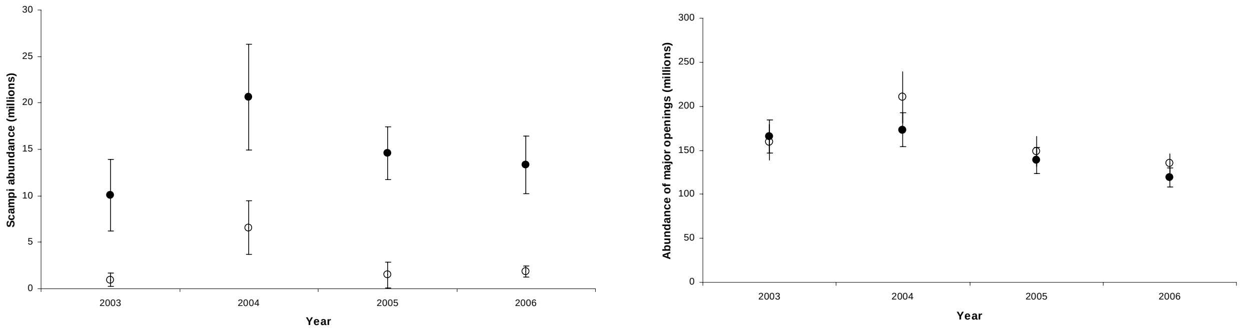


Figure 5: Estimated abundance (± one standard error) of major burrow openings (left), all visible scampi (right, solid symbols), and scampi entirely free of burrows (right, open symbols) in the core area of the SCI 2 fishery, 2003 to 2005.

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 SCI 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 SCI 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.

Some commercial fishers reported that they experienced historically low catch rates in SCI 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.

(b) Biomass estimates

There are no reliable estimates of virgin biomass, B_0, or the biomass that will support the MSY, B_{MSY}, for any scampi stock, although a Bayesian length-based model developed for SCI 1 may provide some estimates in future. There are no biomass estimates for any SCI other than estimates made using the area swept method from trawl surveys in SCI 1 and 2 (Table 4) and using photography in parts of SCI 1, 2, and 3. 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.

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. Photographic estimates based on major (front) burrow openings suggest a mean (1998–2003) biomass of about 4500 t in that part of SCI 1 between Great Mercury Island and White Island, 300–500 m (where the SCI 1 fishery predominantly occurs), assuming one animal per major burrow opening and a mean individual weight of 35 g. Based on the estimated abundance of visible scampi in photographic surveys, and using mean individual weights estimated from photographic length frequency distributions, the estimated minimum absolute biomass between 1998 and 2003 was 500–900 t. Applying the mean weight data from SCI 1, and assuming one animal per major burrow opening the preliminary biomass estimate for SCI 2 in 2005 is 5257 t (2003 to 2005 average of 6010 t). Based on the abundance of visible scampi and applying the same mean size as above, the estimated minimum absolute biomass between 2003 and 2005 was 350 t to 730 t (average 533 t).

(c) Estimation of Maximum Constant Yield (MCY)

Because of the lack of agreed biomass estimates and the constraint of catches, MCY was not determined. To be able to determine MCY from catch data (Method 4), it is important that the assumption of no change in fishing mortality be adhered to, and this is not the case.

(d) Estimation of Current Annual Yield (CAY)

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

(e) Other yield estimates and stock assessment results

There are no other yield estimates, but a Bayesian, length-based model is under development for the core area of the SCI 1 scampi fishery, Mercury Islands to White Island, 300–500 m depth. There are still many issues to address in this model, and preliminary model fits and sensitivities suggested that a wide range of biomass estimates were similarly plausible. The working group did not accept the model as a stock assessment in 2005, but noted the progress being made and discussed options for future development.

(f) Other factors

Unique among the “developed” scampi fishery areas, the catch limit in SCI 2 has been substantially undercaught since 2002–03. Only 71 - 77 t (35-38 %of the TACC) were reported caught in the most recent years of competitive fishing.

5. 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 is sustainable in the long term or will allow the stock to move towards a size which will support the maximum sustainable yield.

TACCs and reported landings, by Fishstock, for the 2005/06 fishing year are summarised in Table 5.

Table 5: TACCs (t) and reported landings (t) for the last fishing year 2005-06.

SCI	2005–06 TACC	Landings 2005–06 (QMR/MHR)
1	120	109
2	200	77
3	340	319
4	120	79
5	40	<1
6A	306	286
6B	50	0
7	75	1
8	5	0
9	35	0
Total	1291	872

6. FOR FURTHER INFORMATION

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